Congestion Management Process Addendum

MAY 2017

prepared for:

Pima Association of Governments

prepared by:

LEE ENGINEERING

in association with:

EPS GROUP

Engineering Mapping Solutions

Congestion Management Process Addendum

Prepared for:

Pima Association of Governments

1 E. Broadway Blvd., Suite 401
Tucson, AZ 85701
March 15, 2017

Prepared by:

Lee Engineering, LLC
3610 N. 44th Street, Suite 100
Phoenix, AZ 85018

In association with:

EPS Group, Inc.
8710 N. Thornydale Rd., #140
Tucson, AZ 85742

And

Engineering Mapping Solutions
2330 W Mission Ln 12
Phoenix, AZ 85021

TABLE OF CONTENTS

Page

1. INTRODUCTION 1
PROJECT PURPOSE AND BACKGROUND 1
2. FEDERAL LAW, GUIDANCE, AND RULE MAKING 5
PERFORMANCE BASED PLANNING, PERFORMANCE MEASURES AND PERFORMANCE TARGETS 5
Map-21 and the FAST Act Laws 5
Federal Highway Administration (FHWA) Emphasis and Guidance 8
2016 Transportation Planning Final Rule 12
Federal NPRM, April 22, 2016 Proposed Performance Measures and Performance Targets 13
3. THE PAG CMP 19
EVOLUTION OF THE PAG CMP PERFORMANCE MEASURES AND PERFORMANCE TARGET DEVELOPMENT 19
Incorporation of FHWA Emphasis and Requirements into the PAG CMP 21
The CMP and the Planning Process 22
VISUALIZATION TECHNIQUES 23
4. ROADWAY CONGESTION 25
OVERVIEW 25
RECURRING CONGESTION 29
NON-RECURRING CONGESTION 30
Oak Ridge National Laboratory Study 30
Washington State Transportation Commission Study 33
Maricopa Association of Governments Study 35
PAG CMP STEPS FOR ADDRESSING CONGESTION 39
5. CONGESTION MANAGEMENT STRATEGIES 41
CURRENT PAG CONGESTION MANAGEMENT PROJECTS AND PROGRAMS 41
The Current PAG Congestion Management Process (CMP) 41
PAG's Travel Reduction Program (TRP) 46
Sun Rideshare and Vanpool Programs 47
Park & Ride Lots 47
Regional Traffic Signal System 47
Sun Tran 48
Sun Van 49
Sun Link Streetcar 49
Sun Shuttle 50
Bus Pullouts 50
Transit Boarding Efficiencies 50
2045 RMAP Transit Projects 50
Pedestrian and Bicycle Facilities 50
Roadway Capacity Improvements 51
Summary of the 2045 RMAP Congestion Related Project Planned Expenditures 52
TOOLBOX OF POTENTIAL CM STRATEGIES 53
Texas Transportation Institute (TTI) Study 53
MAG Non-Recurring Congestion Study Relevant Countermeasures 60

6. FEDERAL REQUIREMENTS FOR NONATTAINMENT TMAs 61
CONGESTION MANAGEMENT PROCESS IN TRANSPORTATION MANAGEMENT AREAS 61
2016 NPRM – NATIONAL PERFORMANCE MANAGEMENT MEASURES 62
PAG STEPS IF AREA BECOMES NONATTAINMENT 63
7. MONITORING SYSTEM PERFORMANCE 65

APPENDIX
A. PAG 2045 RMAP Vision, Goals, Performance Measures and Strategies, and PAG Congestion Management Process
B. Appendix to CMP to Enhance TIP Implementation Process
C. 2011 TTI Study Congestion Mitigation Strategy Summary
D. 2011 MAG Non-Recurring Congestion Study Countermeasures
E. 2016 PAG CMP Addendum Performance Measures

LIST OF EXHIBITS

		Page
Exhibit 1	Illustrating the Components of Congestion	9
Exhibit 2	NCHRP Report 618 Quick Reference Guide to Selected Mobility and Reliability Measures	10
Exhibit 3	NCHRP Report 618 Summary of Key Characteristics of Mobility and Reliability Measures	11
Exhibit 4	Summary of 2016 NPRM Proposed Performance Metrics and Measures	16
Exhibit 5	Summary of 2016 NPRM Proposed Performance Measure Criteria	17
Exhibit 6	Example Performance Measure Targets for Congestion Management	19
Exhibit 7	Major Findings of the 2015 Urban Mobility Scorecard (471 U.S. Urban Areas)	26
Exhibit 8	*Urban Mobility Study* Congestion Statistics and Costs for Tucson, Arizona	27
Exhibit 9	2014 Congestion Indices for Select Medium Sized Urban Areas Including Tucson, AZ	27
Exhibit 10	Summary of *2015 Urban Mobility Scorecard* Congestion Measures	28
Exhibit 11	Sources of Total Congestion	30
Exhibit 12	Summary of TLC2 Study Results	31
Exhibit 13	TLC2 Study Comparison of Delay Estimates	32
Exhibit 14	Composite Picture of Delay from TLC2 Study	33
Exhibit 15	Freeway and Arterial Congestion from the 2011 MAG Study	37
Exhibit 16	Distribution of Weekday and Weekend Causes of Non-Recurring Congestion by Roadway Type from the MAG Study	38
Exhibit 17	Annual Congestion Estimates for the Entire MAG Region from the MAG Study	38
Exhibit 18	Example PAG Transportation Network Data Portal (TDNP) Interactive Web-Map	42
Exhibit 19	Example of PAG Performance Report Available Through the PAG TNDP	43
Exhibit 20	Example of PAG Supplemental Questions and Criteria Sheets	44
Exhibit 21	Example Performance Matrix from the PAG CMP Procedure	45
Exhibit 22	2045 RMAP Planned Expenditures on Congestion Management (CM) Projects	52
Exhibit 23	Congestion Mitigation Strategies Addressed in the TTI Study	54
Exhibit 24	Top 20 Most Implemented or Planned Congestion Mitigation Strategies Among Respondents in TTI Study Survey	56
Exhibit 25	Most Successful and Least Successful Mitigation Strategies as Identified by Respondents in the TTI Study Survey	57
Exhibit 26	Easiest and Most Difficult Congestion Mitigation Strategies to Implement as Identified by Respondents in TTI Study Survey	58
Exhibit 27	Non-Recurring Congestion Countermeasures from the MAG Study	60
Exhibit 28	Sample Comparison of Transportation System Performance to Performance Target	65

1. INTRODUCTION

PROJECT PURPOSE AND BACKGROUND

The Pima Association of Governments (PAG) Congestion Management Process (CMP) is a continuous and ongoing process for measuring, evaluating, and reporting the performance of the regional transportation system. In doing so, the CMP provides an insight and understanding of congestion, its causes, extent, intensity, and duration. This process supports performance based planning and decision making and is very useful to PAG's overall planning efforts. The establishment, maintenance, and application of a CMP in Transportation Management Areas (TMA: metropolitan areas over 200,000 in population) has been required by Federal law since 1991 when it was originally referred to as a Congestion Management System. Since their inception, the Federal requirements for the CMP have evolved as a result of national experience with the process, changes in program emphasis, improvements in data collection techniques, and changes in technology. PAG's original Congestion Management System was completed in 1993 and since that time PAG has been maintaining, improving, and updating its CMP on a frequent basis in response to changing Federal requirements and regional needs.

While refinement of the CMP by PAG is an ongoing process, the last major update to the PAG CMP was in 2010 and Federal requirements and emphasis have since evolved. PAG's desire has always been to make sure that their CMP is in full compliance with Federal regulations and that the CMP is administered in practice consistent with the guidance and direction put forth by the FHWA. Therefore, the overall purpose of this project is to make sure that the PAG CMP is in compliance with current Federal regulations. In addition, the objectives of the project are to enhance the automation of CMP process, institutionalize the analysis of the process, recommend additional CMP strategies, document the process and develop an online data dashboard that will provide a means to view the regional performance measures. It is also PAG's intent to make the CMP more useful, meaningful, and applicable in a performance based planning environment.

The 2010 PAG CMP[1] is consistent in many ways with the 2011 Congestion Management Process Guidebook[2] and the 2016 Federal Transportation Planning Final Rule[3]. The 2010 PAG CMP appears to satisfy the prior Federal requirements and guidance for CMP development. The requirement for a CMP for TMAs is retained in the 2016 Transportation Planning Final Rule and is largely unchanged. However, the 2016 Transportation Planning Final Rule contains new language and requirements for a CMP that are not directly addressed in the 2010 PAG CMP. The 2016 Transportation Planning Final Rule includes specific language and requirements that were not included in prior rules. The 2016 Transportation Planning Final Rule indicates that the basic elements that must be included in a CMP remain unchanged. These are:

1. Methods to monitor and evaluate the performance of the multimodal transportation system, identify the underlying causes of recurring and nonrecurring congestion, identify and evaluate

[1] *Congestion Management Process,* Pima Association of Governments, Final Report, June 2010, prepared by Morrison Maierle, Inc.
[2] *Congestion Management Process: A Guidebook*, USDOT, FHWA, April 2011, prepared by ICF International, Inc. et. al.
[3] *Federal Register, Vol. 81, No. 103, May 27, 2016, Statewide and Nonmetropolitan Transportation Planning: Metropolitan Transportation Planning, Final Rule*, Federal Highway Administration, Federal Transit Administration.

alternative strategies, provide information supporting the implementation of actions, and evaluate the effectiveness of implemented actions;

2. 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.
3. 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.
4. 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.
5. Identification of an implementation schedule, implementation responsibilities, and possible funding sources for each strategy (or combination of strategies) proposed for implementation; and
6. Implementation of a process for periodic assessment of the effectiveness of implemented strategies, in terms of the area's established performance measures.[4]

The 2010 PAG CMP addresses each of the above basic CMP elements through its general framework, policies, performance measures and monitoring, congestion management strategies, and implementation strategy. However, significant new elements presented in the 2016 Planning Final Rule remain to be addressed. The significant new elements in the 2016 Planning Final Rule that relate directly to the CMP are the following:

- The emphasis on performance based planning, the use of performance measures, and **the inclusion of performance targets** for the assessment of CMP performance relative to the established performance measures. The 2016 Transportation Planning Final Rule indicates that States shall set performance targets within 1-year of the effective date of the Department of Transportation Final Rule on performance measures, and each MPO shall set performance targets not later than 180-days after the State or public transportation provider establishes performance targets. In the 2016 Planning Final Rule, section 450.324 was amended to establish that, once performance targets are selected by MPOs, MPOs must reflect those targets in their Metropolitan Transportation Plans (MTPs). Accordingly, amended section 450.324 establishes that, in their transportation plans, MPOs would need to describe these performance targets, evaluate the condition and performance of the transportation system, and report on progress toward the achievement of their performance targets in their MTPs. "In a series of rulemakings, FHWA and FTA will establish national performance measures in key areas including congestion, safety, infrastructure condition, system reliability, emissions, and freight movement."[5] The current status of Federal rules on performance measures is the following[6]:

[4] *Federal Register, Vol. 81, No. 103, May 27, 2016, Statewide and Nonmetropolitan Transportation Planning: Metropolitan Transportation Planning, Final Rule*, Federal Highway Administration, Federal Transit Administration, pgs. 34152 and 34153, Sec. 450.322.

[5] *Federal Register, Vol. 81, No. 103, May 27, 2016, Statewide and Nonmetropolitan Transportation Planning: Metropolitan Transportation Planning, Final Rule*, Federal Highway Administration, Federal Transit Administration, pg. 34051.

[6] *Statewide &Nonmetropolitan & Metropolitan Transportation Planning Final Rule: External FHWA/FTA Webinar for Stakeholders,* June 14, 2016.

- Safety Performance Measures: Final Rule Published March 15, 2016.
- Highway Safety Improvement Program: Final Rule Published March 15, 2016.
- Pavement and Bridge Performance Measures: Final Rule anticipated November 2016.
- Performance of the NHS, Freight, and CMAQ Measures: Notice of Proposed Rule Making (NPRM) published April 22, 2016, Final Rule to be determined.
- Asset Management Plans and Periodic Evaluations of Facilities Repeatedly Requiring Repair and Reconstruction Due to Emergency Events: Final Rule Published October 24, 2016.
- National Performance Management Measures; Assessing Performance of the National Highway System, Freight Movement on the Interstate System, and Congestion Mitigation and Air Quality Improvement Program: Final Rule Published January 18, 2017. **(Note that this Final Rule addresses the April 22, 2016 NPRM referenced above, but was published too late for this report to be revised to reflect the Final Rule.)**

The 2010 PAG CMP did not include specific reference to measurable performance targets as this was not included the guidance and rule making considerations at that time.

- The **inclusion of the use of visualization techniques** to describe metropolitan transportation plans and Transportation Improvement Programs (TIPs). "*Visualization techniques* means methods used by States and MPOs in the development of transportation plans and programs with the public, elected and appointed officials, and other stakeholders in a clear and easily accessible format such as GIS or web-based surveys, inventories, maps, pictures, and/or displays."[7]
- The **inclusion of providers of public transportation** in the development of the CMP. MPO(s), the State(s), and the providers of public transportation must jointly agree upon and document in writing the coordinated processes for the collection of performance data, the selection of performance targets for the metropolitan area, the reporting of metropolitan area targets, and the reporting of actual system performance related to those targets. The documentation must also describe the roles and responsibilities for the collection of data for the NHS. Including this description is critical because of the new requirements for a State asset management plan for the NHS and establishment of performance measures and targets.[8] The selection of performance targets that address performance measures … shall be coordinated, to the maximum extent practicable, with public transportation providers to ensure consistency with the performance targets that public transportation providers establish under 49 U.S.C. 5326(c) and 49 U.S.C. 5329(d).[9]

The 2016 Transportation Planning Final Rule indicates that… "With respect to planning, although MAP–21 leaves the basic framework of the planning process largely untouched, the statute introduces critical changes to the planning process itself by requiring States, MPOs, and providers of public transportation to link investment priorities (the transportation improvement program of projects) to the achievement of performance targets that they would establish to address performance measures in the key areas

[7] *Federal Register, Vol. 81, No. 103, May 27, 2016, Statewide and Nonmetropolitan Transportation Planning: Metropolitan Transportation Planning, Final Rule*, Federal Highway Administration, Federal Transit Administration, pg. 34138.
[8] *Ibid*, pg. 34052.
[9] *Ibid*, pg. 34147, Sec. 450.306(d)(2)(iii)

such as safety, infrastructure condition, congestion, system reliability, emissions, and freight movement."[10]

Section 450.322(a) of the 2016 Transportation Planning Final Rule also provides examples of employer-based travel demand reduction strategies to be included in a CMP, which include, intercity bus, employer-based commuting programs such as a carpool program, vanpool program, transit benefit program, parking cash-out program (designed to reduce vehicle commute trips and emissions by offering employees the option of "cashing out" their subsidized parking space and taking transit, biking, walking or carpooling to work), shuttle program, or telework program, job access projects, and operational management strategies.

The 2016 Transportation Planning Final Rule also contains requirements for an optional Congestion Management Plan developed by an MPO. If an MPO chooses to develop a Congestion Management Plan, such plan shall:

- Develop regional goals to reduce vehicle miles traveled during peak commuting hours and improve transportation connections between areas with high job concentration and areas with high concentrations of low income households;
- Identify existing public transportation services, employer based commuter programs, and other existing transportation services that support access to jobs in the region; and
- Identify proposed projects and programs to reduce congestion and increase job access opportunities.[11]

At this time PAG has elected to focus its resources on updating its Congestion Management Process and has elected not to develop a Congestion Management Plan.

PAG has developed this project specifically in recognition of the new CMP elements contained in the 2016 Transportation Planning Final Rule and to incorporate new ideas, procedures, and concepts for addressing Federal requirements for a congestion management process, performance measures, and performance targets. In addition, this project is to assist PAG in the following areas:

- Identifying causes of non-recurring congestion and identify methods for quantifying non-recurring congestion,
- Assist in identifying a process to quantify the expected improvement of future projects.
- Identify missing potential strategies for addressing congestion through the CMP.
- Assist in identifying data collection and analysis procedures in support of the regional performance measures and performance targets.
- Assist in developing and documenting a clear understanding of the impacts non-attainment will have on the CMP requirements.

[10] *Federal Register, Vol. 81, No. 103, May 27, 2016, Statewide and Nonmetropolitan Transportation Planning: Metropolitan Transportation Planning, Final Rule*, Federal Highway Administration, Federal Transit Administration, pg. 34050.
[11] *Ibid,* pg. 34153, Sec. 450.322.

2. FEDERAL LAW, GUIDANCE, AND RULE MAKING

PERFORMANCE BASED PLANNING, PERFORMANCE MEASURES, AND PERFORMANCE TARGETS

This section of the report provides background information on the current Federal laws and requirements affecting States and MPOs with regard to the development and implementation of a congestion management process. The emphasis of this section is on the development and use of performance measures and performance targets to further the goals of performance based planning activities. Guidance from FHWA sponsored programs on the use and application of performance measures is summarized below. Also included are summaries of FHWA 2016 Transportation Planning Final Rule and the FHWA 2016 Notice of Proposed Rule Making (NPRM) on Performance Measures and Performance Targets. The FHWA guidance and rule making are intended to assist States and MPOs in the implementation of the Federal laws for congestion management process. Where there is an important nexus between the elements of the Federal law discussed below and the FHWA Final Rule or the NPRM pertaining to a congestion management process, the connection is presented with the Federal law.

MAP-21 and the FAST Act Laws

MAP-21, the Moving Ahead for Progress in the 21st Century Act (July 6, 2012) introduced changes to the planning process to increase transparency and accountability. There is a new mandate for States and MPOs to make a performance-based approach to planning and programming, linking investment decision-making to achievement of performance targets. As a fundamental element of the new performance management framework, States, MPOs, and providers of public transportation will need to establish targets in key national performance areas to document expectations for future performance. MAP-21 requires that MPOs reflect those in their metropolitan transportation plan. Both States and MPOs are expected to describe the anticipated effect toward achieving the targets in their respective Transportation Improvement Programs (TIPs). In addition to these proposed changes to the planning provisions, MAP–21 contains new performance-related provisions requiring States, MPOs, and public transportation providers to develop other performance-based plans and processes.

Current Federal legislation in the form of the Fixing America's Surface Transportation Act (FAST Act) (December 4, 2015) continues all programs and adopts everything from MAP-21 with modifications. With regard to congestion management, the FHWA provides the following summary of the FAST Act:

> "The FAST Act adds examples of travel demand reduction strategies for congestion management in a transportation management area (TMA). While retaining the requirement for a congestion management process for MPOs that serve a TMA, the law also allows an MPO that serves a TMA to develop a congestion management plan (distinct from the congestion management process) that will be considered in the MPO's transportation improvement program. Any such plan must include regional goals for reducing peak hour vehicle miles traveled and improving transportation connections, must identify existing services and programs that support access to jobs in the region, and must identify proposed projects and programs to reduce congestion and increase job access opportunities. The FAST Act specifies certain consultation requirements MPOs must use in developing the plan. [23 U.S.C. 134(k)(3)" [12]

[12] U.S Department of Transportation, Federal Highway Administration, FAST Act Fact Sheet, Metropolitan Planning, April 1, 2016.

The performance-related provisions within MAP-21 are organized into six basic elements:

- **National Goals** – to focus the Federal-aid highway program on specific areas of performance.
- **Measures** – to assess performance and condition to carry out performance-based Federal-aid highway programs.
- **Targets** – for each of the measures to document expectations of future performance.
- **Plans** – developed by recipients of Federal-aid highway funding to identify strategies and investments that will address performance needs.
- **Reports** – developed by recipients of Federal funding to document progress toward the achievement of targets, including the effectiveness of Federal-aid highway investments.
- **Accountability** – Requirements for recipients of Federal funding to use to achieve or make significant progress for established targets.

The following provides a summary of MAP -21 and other Federal provisions as they relate to the six elements listed above:

1. **National Goals** – seven areas of national goals have been established:
   - Safety – to achieve a significant reduction in traffic fatalities and serious injuries on all public roads.
   - Infrastructure conditions – to maintain the highway infrastructure assets in a state of good repair.
   - Congestion reduction – to achieve a significant reduction in congestion on the National Highway System (NHS).
   - System reliability – to improve surface transportation system efficiency.
   - Freight movement and economic vitality – to improve the national freight network, strengthen the ability of rural communities to access national and international trade markets, and support regional economic development.
   - Environmental sustainability – to enhance transportation system performance while protecting and enhancing the natural environment.
   - Reduce project delivery delays – to reduce project costs, promote jobs and the economy, and expedite the movement of people and goods by accelerating project completion.
2. **Measures –** MAP-21 requires the establishment of performance measures, in consultation with State DOTs, MPOs, and other stakeholders to evaluate Interstate and non-Interstate NHS infrastructure condition, assess safety on public roads, carry out the CMAQ program, assess traffic congestion and on-road mobile source emissions, and assess freight movement on the Interstate System.
3. **Targets –** State DOTs are required to establish performance targets reflecting performance measures established for the Federal-aid highway program and MPOs are required to establish performance targets for these measures where applicable. Additionally, State DOTs and MPOs are required to coordinate when selecting targets for the areas specified under 23 U.S.C. 150(c) in order to promote consistency.
4. **Plans –** MAP-21 requires States and MPOs to develop plans that provide strategic direction for addressing performance needs. MPOs serving large TMAs (population greater than 1 million) in areas of nonattainment or maintenance are required to develop a CMAQ Performance Plan. MPOs are required to include a System Performance Report in the Metropolitan Transportation Plan, and State DOTs and MPOs are required to include a discussion in their Transportation

Improvement Program (TIP) as to how the program would achieve the performance targets they have established for the area.

5. **Reports –** MAP-21 requires State DOTs to submit biennial reports to FHWA on the condition and performance of the NHS, the effectiveness of the State's investment strategy for the NHS, progress in achieving targets, and ways in which the State DOT is addressing congestion at freight bottlenecks. The April 22, 2016 Federal Notice of Proposed Rule Making (NPRM)[13] expands on the MPO's reporting requirements with the following statements:

   > "The MPOs shall establish targets…and report targets and progress toward the achievement of their targets in a manner that is consistent with the following:
   > - The MPOs shall report their established targets to their respective State DOT in a manner that is documented and mutually agreed upon by both parties.
   > - The MPOs shall report baseline condition/performance and progress toward the achievement of their targets in the system performance report in the metropolitan transportation plan in accordance with Part 450 of this chapter.
   > - MPOs serving a TMA with a population over one million representing nonattainment and maintenance areas for ozone, CO, or PM NAAQS shall develop a CMAQ performance plan as required by 23 U.S.C. 149(1)."[14]

   The April 22, 2016 FHWA NPRM Sec. 490.107 contains additional details on reporting requirements.

6. **Accountability –** Provisions within MAP-21 and the FAST Act for the National Highway Performance Program (NHPP), the Highway Safety Improvement Program (HSIP), and the National Highway Freight Program (NHFP) require the State DOT to undertake actions if significant progress is not made toward the achievement of the State DOT targets under these programs. If the State DOT has not achieved or made significant progress toward the achievement of applicable targets in a single FHWA biennial determination, then the State DOT must document in its next biennial report the actions it will take to achieve the targets. It is proposed in section 490.109(e) of the April 22, 2016 NPRM that FHWA would consider a State DOT has made significant progress toward the achievement of the NHPP or NFPP target under the following two conditions
   1. The actual condition/performance level is equal to or better than the established target.
   2. Or the actual condition/performance is better than the State identified baseline or condition/performance.

   (Additional details of the proposed Federal process for State accountability are contained in section 490.109 of the April 22, 2016 NPRM.)

[13] *National Performance Management Measures; Assessing Performance of the National Highway System, Freight Movement on the Interstate System, and Congestion Mitigation and Air Quality Improvement Program,* Federal Highway Administration, 23 CFR Part 490, Notice of Proposed Rule Making, April 22, 2016. https://www.fhwa.dot.gov/tpm/rule/pm3_nprm.pdf

[14] Ibid, pgs. 376 – 377.

Federal Highway Administration (FHWA) Emphasis and Guidance

NCHRP Report 618[15] is a guidebook for transportation agencies that presents methods to measure, predict, and report travel time, delay, and reliability measures for surface transportation system analysis and monitoring. The report's emphasis on travel time, delay, and reliability is based on the following position:

> "Agencies are seeking to develop and employ system performance measures that express congestion and mobility in terms that decision makers and system users can appreciate and understand. Interest specifically in measures of travel time, delay, and reliability is increasing, as system users seek to gain more control over their trip making decisions and outcomes. Interest also is increasing in measurements that individuals can use to reduce the uncertainty and loss of productivity that occur when system reliability is low."

NCHRP Report 618 recommends summarizing congestion effects using four general components:

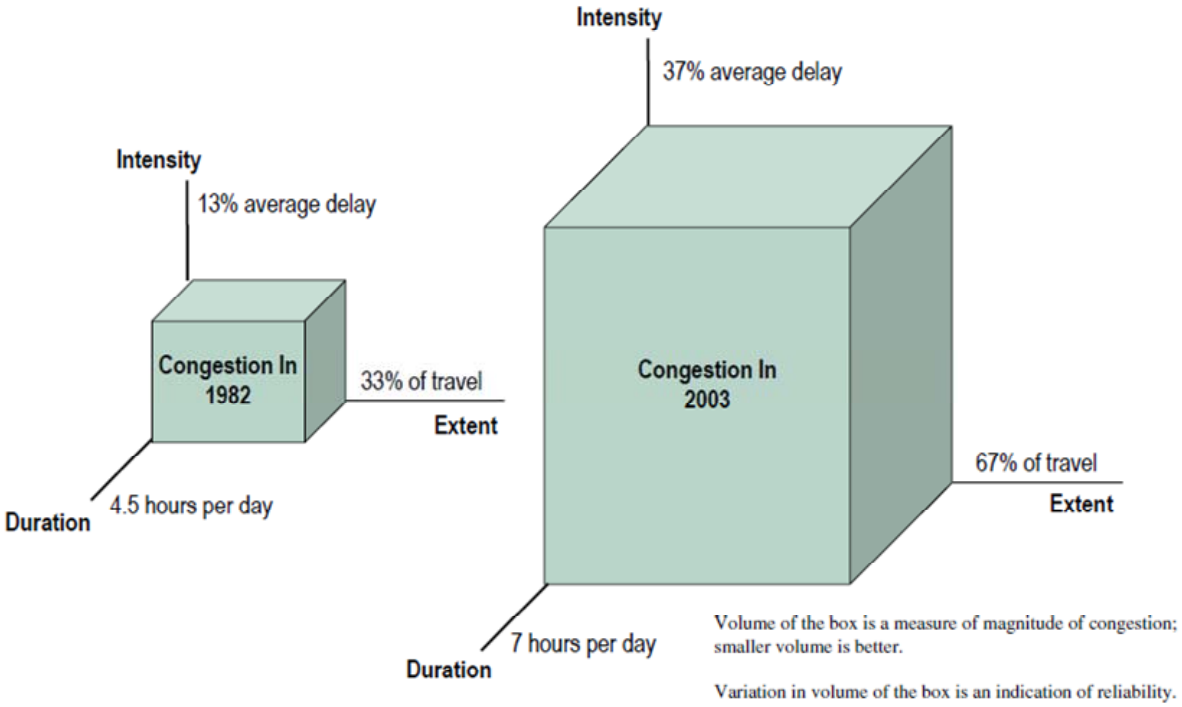
1. **Duration.** This is the length of time during which congestion affects the travel system. The measurement concept that illustrates duration is the amount of time during the day that the travel speed indicates congested travel on a system element or the entire system.
2. **Extent.** This is described by estimating the number of people or vehicles affected by congestion and by the geographic distribution of congestion. The person congestion extent may be measured by person-miles of travel or person-trips that occur during congested periods. The percent, route-miles, or lane-miles of the transportation system affected by congestion may be used to measure the geographic extent of mobility and reliability problems.
3. **Intensity.** The severity of congestion that affects travel is a measure from an individual traveler's perspective. In concept, it is measured as the difference between the desired condition and the conditions being analyzed.
4. **Variation.** This key component describes the change in the other three elements. Recurring delay (the regular, daily delay that occurs due to high traffic volumes) is relatively stable. Delay that occurs due to incidents is more difficult to predict.

Exhibit 1 shows how these components can be used to graphically illustrate changes in the magnitude of congestion over time.

[15] NCHRP Report 618, *Cost-Effective Performance Measures for Travel Time Delay, Variation, and Reliability,* National Cooperative Highway Research Program, Transportation Research Board, Washington, D.C., 2008.

Exhibit 1
Illustrating the Components of Congestion

Weekday Peak-Period Congestion Has Grown in Several Ways in Our Largest Cities



Based on data used in the 2005 Urban Mobility Report, Texas Transportation Institute.
Source: *Traffic Congestion and Reliability: Trends and Advanced Strategies for Congestion Mitigation,* prepared for Federal Highway Administration, prepared by Cambridge Systematics, Inc., September 1, 2005.

NCHRP Report 618 also provides a quick reference guide to selected mobility and reliability measures as shown in Exhibit 2.

Exhibit 2
NCHRP Report 618 Quick Reference Guide to Selected Mobility and Reliability Measures

Individual Measures[1]	
Delay per Traveler	$\text{Delay per Traveler}_{\text{(annual hours)}} = \left(\text{Actual Travel Time}_{\text{(minutes)}} - \text{FFS or PSL Travel Time}_{\text{(minutes)}}\right) \times \frac{250 \text{ weekdays}}{\text{year}} \times \frac{\text{hour}}{60 \text{ minutes}}$
Travel Time	$\text{Travel Time}_{\text{(person-minutes)}} = \text{Actual Travel Rate}_{\text{(minutes per mile)}} \times \text{Length}_{\text{(miles)}} \times \text{Vehicle Volume}_{\text{(vehicles)}} \times \text{Vehicle Occupancy}_{\text{(persons/vehicles)}}$
Travel Time Index[2]	$\text{Travel Time Index} = \frac{\text{Actual Travel Rate (minutes per mile)}}{\text{FFS or PSL Travel Rate (minutes per mile)}}$
Buffer Index[2]	$\text{Buffer Index}(\%) = \left[\frac{\text{95th Percentile Travel Time (minutes)} - \text{Average Travel Time (minutes)}}{\text{Average Travel Time (minutes)}}\right] \times 100\%$
Planning Time Index[2]	$\text{Planning Time Index}_{\text{(no units)}} = \frac{95^{\text{th}} \text{ Percentile Travel Time (minutes)}}{\text{FFS or PSL Travel Time (minutes)}}$
Area Measures[1]	
Total Delay	$\text{Total Segment Delay}_{\text{(person-minutes)}} = \left[\text{Actual Travel Time}_{\text{(minutes)}} - \text{FFS or PSL Travel Time}_{\text{(minutes)}}\right] \times \text{Vehicle Volume}_{\text{(vehicles)}} \times \text{Vehicle Occupancy}_{\text{(persons/vehicle)}}$
Congested Travel	$\text{Congested Travel}_{\text{(vehicle-miles)}} = \sum\left(\text{Congested Segment Length}_{\text{(miles)}} \times \text{Vehicle Volume}_{\text{(vehicles)}}\right)$
Percent of Congested Travel	$\text{Percent of Congested Travel} = \left[\frac{\sum_{i=1}^{m}\left(\left[\text{Actual Travel Time}_{i\text{ (minutes)}} - \text{FFS or PSL Travel Time}_{i\text{ (minutes)}}\right] \times \left[\text{Vehicle Volume}_{i\text{ (vehicles)}} \times \text{Vehicle Occupancy}_{i\text{ (persons/vehicle)}}\right]\right)_{\text{Each congested segment}}}{\sum_{i=1}^{n}\left(\text{Actual Travel Rate}_{i\text{ (minutes per mile)}} \times \text{Length}_{i\text{ (miles)}} \times \text{Vehicle Volume}_{i\text{ (vehicles)}} \times \text{Vehicle Occupancy}_{i\text{ (persons/vehicle)}}\right)_{\text{All segments}}}\right] \times 100$
Area Measures[1]	
Congested Roadway	$\text{Congested Roadway}_{\text{(miles)}} = \sum \text{Congested Segment Lengths (miles)}$
Accessibility	$\text{Accessibility}_{\text{(opportunities)}} = \sum \text{Objective Fulfillment Opportunities (e.g., jobs), Where Travel Time} \leq \text{Target Travel Time}$

[1] "Individual" measures are those measures that relate best to the individual traveler, whereas the "area" measures are more applicable beyond the individual (e.g., corridor, area, or region). Some individual measures are useful at the area level when weighted by Passenger Miles Traveled (PMT) or Vehicle Miles Traveled (VMT).

[2] Can be computed as a weighted average of all sections using VMT or PMT.

Note: FFS = Free-flow speed, and PSL = Posted speed limit.

Exhibit 3, taken from NCHRP Report 618 provides a summary of key characteristics of mobility and reliability measures.

Exhibit 3
NCHRP Report 618 Summary of Key Characteristics of Mobility and Reliability Measures

Performance Measure	Congestion Component Addressed	Geographic Area Addressed
Delay per Traveler	Intensity	Region, Subarea, Section, Corridor
Travel-Time Index	Intensity	Region, Subarea, Section, Corridor
Buffer Index	Intensity, Variability	Region, Subarea, Section, Corridor
Planning Time Index, Percent Variation	Intensity, Variability	Region, Subarea, Section, Corridor
Percent On-Time Arrival	Variability	Facility, Corridor, System
Total Delay	Intensity	Region, Subarea, Section, Corridor
Congested Travel	Extent, Intensity	Region, Subarea
Percent of Congested Travel	Duration, Extent, Intensity	Region, Subarea
Congested Roadway	Extent, Intensity	Region, Subarea
Misery Index	Intensity, Variability	Region, Subarea, Corridor
Accessibility	Extent, Intensity	Region, Subarea

The 2014 FHWA Urban Congestion Trends (UCT) Report[16] indicates the following:

> "Understanding how the transportation system is operating through monitoring and measuring performance is a vital aspect of performance management, a new approach that is being implemented in part through the MAP-21 Performance Management requirements…. One approach to calculating these metrics with the newly available National Performance Management Research Data Set (NPMRDS), which includes actual, observed travel times on the National Highway System (NHS) and is available for use by state departments of transportation (DOTs) and metropolitan planning organizations (MPOs) for their performance management activities."

The FHWA has previously emphasized the use of hours of congestion, travel time index (TTI), and planning time index (PTI) as primary congestion measures for the evaluation of monitoring of congestion nationwide. These measures are defined as follows with computational procedures for the TTI and PTI shown in Exhibit 2:

1. Hours of congestion – the average number of hours during specified time periods (6:00 AM to 10:00 PM for the FHWA UCT Reports) when roadways operate less than 90 percent of free-flow speeds.
2. Travel time index (TTI) – a dimensionless quantity that compares travel conditions in the peak period to travel during free-flow or posted speed limit conditions. For example, a TTI of 1.2

[16] *2014 Urban Congestion Trends: Improved Data for Operations Decision Making,* Federal Highway Administration, FHWA-HOP-15-006.

indicates that a trip that takes 20 minutes in the off-peak period will take 24 minutes in the peak period, or 20 percent longer (20 x 1.20). The TTI can be used to express congestion on individual roadway segments or for an entire urban area by combining the TTI values for individual segments into a weighted average based on vehicle miles of travel on each segment. For the FHWA UCT Reports this measure is computed for the AM peak period (6:00 AM to 9:00 AM) and the PM peak period (4:00 PM to 7:00 PM). Averages are weighted across time periods, traffic message channel paths (TCM road segment lengths), and by vehicle miles of travel (VMT) on each TCM path. Since NPMRDS does not include traffic counts, VMT weights are estimated using traffic count estimates from FHWA's Highway Performance Monitoring System (HPMS), but they can also be computed from volume data from other sources such as the PAG Traffic Count database.

The free-flow travel time for each TMC path is the 15th percentile travel time during traditional off-peak times (weekdays between 9:00 AM to 4:00 PM and 7:00 PM to 10:00 PM; weekends between 6:00 AM to 10:00 PM), not to exceed the travel time at the posted speed limit (or 60 mph where the posted speed is unknown).

3. Planning Time Index (PTI) – the time penalty for a trip to be on time for 95 percent of trips. The planning time index represents the total travel time that should be planned when an adequate buffer time is included. It compares near-worst case travel time to free-flow travel time. A PTI of 1.60 indicates a 20-minute free-flow trip takes more than 32 minutes (20 x 1.60) only one day per month. For the FHWA UCT Reports this measure is computed for the AM and PM peak hours as a weighted average, each of which as defined for the TTI above.

One significant limitation of the above approach to computing the TTI and PTI measures, or any measures based on travel time, is that the NPMRDS travel time data are only available for the National Highway System (NHS), which in the Tucson metro area includes only the interstate freeways and some portions of the arterial roadway system. Over 75 percent of vehicle miles of travel in the PAG region occurs on the arterial roadway system that makes up most of the CMP roadway network.[17] Therefore, while using the NPMRDS data might meet Federal requirements, making this meaningful at a local level would require other sources for travel time data to compute these performance measures for the entire region, or additional acceptable performance measures would need to be defined and implemented. Supplemental sources of travel time data include either the purchase of the data from a 3rd-party source (such as INRIX, which is currently used by the Maricopa Association of Governments), or by installing permanent travel time data collection sensors on key commuter routes within the region. These methods are often cost prohibitive for medium and smaller MPOs.

2016 Transportation Planning Final Rule[18]

The 2016 Transportation Planning Final Rule provides extensive emphasis on the importance of and requirements for the use of performance targets in the transportation planning and congestion management processes. The following represents a brief summary on performance targets from that document.

1. In the final rule, section 450.324 was amended to establish that, once performance targets are selected by MPOs, MPOs must reflect those targets in their MTPs. Accordingly, amended

[17] Source: Texas Transportation Institute, *2015 Urban Mobility Scorecard* Congestion Data for Your City, https://mobility.tamu.edu/ums/, 2014 data for Tucson, AZ.

[18] *Federal Register, Vol. 81, No. 103, May 27, 2016, Statewide and Nonmetropolitan Transportation Planning: Metropolitan Transportation Planning, Final Rule*, Federal Highway Administration, Federal Transit Administration.

section 450.324 establishes that, in their transportation plans, MPOs would need to describe these performance targets, evaluate the condition and performance of the transportation system, and report on progress toward the achievement of their performance targets.

2. MPOs must describe, to the maximum extent practicable, the anticipated effect of the investment priorities (or their program of transportation improvement projects) toward achieving the performance targets.
3. The Final Rule requires that the State and MPO performance targets for the metropolitan area should be coordinated and consistent to the maximum extent practicable (sections 450.206 and 450.306).
4. Under the final rule, MPOs, and operators of public transportation are not subject to financial consequences or additional reporting requirements for not achieving established targets. Although there are no financial consequences for failing to meet established performance targets under this final rule, there may be consequences for not meeting the performance-based planning and programming requirements under this final rule and 23 U.S.C. 134 and 135. The consequences might be identified through the STIP approval and statewide transportation planning finding of the FHWA and FTA (23 CFR 450.220); the planning certification reviews of TMAs (23 CFR 450.336); or other means such as transportation planning certification reviews in TMAs.
5. The TIP shall be designed such that once implemented, it makes progress toward achieving the performance targets.' This means that, as the MPO develops the TIP, the program of projects shall be developed such that the investments in the TIP help achieve the performance targets set by the MPO for the region. The final rule also requires that the TIP shall include, to the maximum extent practicable, a description of the anticipated effect of the TIP toward achieving the performance targets identified in the metropolitan plan, linking investment priorities to those performance targets (section 450.326(e)).
6. There is a separate requirement in section 450.324(f)(4) that MPOs include a system performance report in the MTP evaluating the condition and performance of the transportation system with respect to the performance targets described in section 450.306(d) that includes a description of progress achieved by the MPO.

Federal NPRM, April 22, 2016[19] Proposed Performance Measures and Performance Targets

This 2016 NPRM is the third in a series of three related NPRMs that propose a set of performance measures for State departments of transportation and Metropolitan Planning Organizations (MPOs). "The measures proposed… would be used to assess the performance of the Interstate and non-interstate National Highway System (NHS) for the purpose of carrying out the National Highway Performance Program (NHPP); to assess freight movement on the Interstate System; and to assess traffic congestion and on-road mobile source emissions for the purpose of carrying out the Congestion Mitigation and Air Quality Improvement (CMAQ) Program."[20]

[19] *National Performance Management Measures; Assessing Performance of the National Highway System, Freight Movement on the Interstate System, and Congestion Mitigation and Air Quality Improvement Program,* Federal Highway Administration, 23 CFR Part 490, Notice of Proposed Rule Making, April 22, 2016. https://www.fhwa.dot.gov/tpm/rule/pm3_nprm.pdf

[20] *Ibid,* Summary.

FHWA proposes to amend 23 CFR Part 490 – National Performance Management Measures as documented in the April 22, 2016 publication. A summary of some of the key elements relating to congestion management in the proposed Part 490 is provided below.

1. MPOs shall establish performance measures and performance targets for:
    a. NHS travel time reliability
    b. Peak hour travel time
    c. Freight movement on the Interstate System
    d. Traffic congestion
    e. On-road mobile source emissions
2. MPOs shall establish metropolitan planning area wide targets that represent the condition/performance of the transportation network or geographic area that are applicable to the performance measures for the following:
    a. NHS travel time reliability measures
    b. Freight movement on the Interstate System
    c. On-road mobile source emissions.
3. MPOs shall establish a single urbanized area target that represents the performance of the transportation network in each area applicable to the measures for:
    a. The peak hour travel time
    b. Traffic congestion
4. State DOTs and MPOs shall coordinate on the selection of targets.
5. MPOs shall establish 4-year targets for the performance measures mentioned above.
6. MPOs with a population of 1 million or more shall establish 2-year targets for peak hour travel time, traffic congestion, and on-road source emissions.
7. Two measures are used to assess reliability using the Level of Travel Time Reliability metric (LOTTR = 80th percentile travel time divided by the 50th percentile travel time for each analysis segment) (Sec. 490.511):
    a. Percent of the Interstate System providing for Reliable Travel Time based on the LOTTR.
    b. Percent of the non-Interstate NHS providing for Reliable Travel Times based on the LOTTR.
8. Two measures are proposed to assess Peak Hour Travel Time in urbanized areas over 1,000,000 in population using the Peak Hour Travel Time Ratio metric (PHTTR = the longest average annual peak hour travel time divided by the either the desired morning or afternoon peak hour travel time corresponding to the hour when the longest average annual peak hour travel time occurred for each analysis segment):
    a. Percent of the Interstate System where Peak Hour Travel Times meet expectations;
    b. Percent of the non-Interstate NHS where Peak Hour Travel Times meet expectations.

    The State DOT, in coordination with the relevant MPOs, shall assign a Desired Peak Period Travel Time for each analysis segment.

    - The State DOTs and MPOs shall aggregate LOTTR and PHTTR for the analysis segments into system performance measures using the procedures described in Sec. 490.513.
    - There are two performance measures to assess freight movement on the Interstate System:
        1. Percent of the Interstate System Mileage providing for Reliable Truck Travel Times, based on the Truck Travel Time Reliability metric (TTTR = 95th percentile truck travel time divided by the Normal Truck Travel Time (50th percentile truck travel time) for each analysis segment).
        2. Percent of the Interstate System Mileage Uncongested, based on the Average Truck Speed for an analysis segment, where segment is considered uncongested when the Average Truck Speed is greater than 50 miles per hour.

The procedures for calculating these measures for individual segments and aggregating them to system performance measures are provided in Sec. 490.611 and Sec. 490.613. Based on these Sections, it will be the State DOT's responsibility to calculate these freight measures for the Interstate System. State DOTs, in agreement with the MPOs shall define the analysis reporting segments to be included in the evaluation of the freight measures.

- The performance measure to assess traffic congestion for the purpose of carrying out the CMAQ program is Annual Hours of Excess Delay Per Capita. This applies to elements of the NHS in urbanized areas with a population over one million that are designated as nonattainment or maintenance areas for ozone (O_3), carbon monoxide (CO), or particulate matter (PM_{10} and $PM_{2.5}$) National Ambient Air Quality Standards (NAAQS). Excess delay means the extra amount of time spent in congested conditions defined by speed thresholds that are lower than a normal delay threshold. The proposed speed threshold is 35 miles per hour (mph) on Interstates (Functional Class 1) and other freeways and expressways (Functional Class 2) and 15 mph on other principal arterials (Functional Class 3) and other roads with lower functional classifications that are included in the NHS. The procedure to calculate this metric is contained in Sec. 490.711 and Sec. 490.713 of the April 22, 1016 NPRM.
- The performance measure for the purpose of carrying out the CMAQ Program and for State DOTs to use to assess on-road mobile source emissions is Total Emissions Reduction. This performance measure does not apply to States and MPOs that do not contain any portion of nonattainment or maintenance areas for the criteria pollutants. The calculation of this performance measure is described in Sec. 490.811 and Sec. 490.813 of the April 22, 2016 NPRM .

A summary of the proposed performance metrics and measures described in the April 22, 2016 NPRM is provided in Exhibit 4. A summary of the proposed performance measure criteria is provided in Exhibit 5. **These measures represent a significant change in FHWA requirements on performance measures in that these performance measures differ in terms of the metrics used to calculate them, and the proposed requirements for their application are not mentioned prior to the April 22, 2016 NPRM.**

Exhibit 4
Summary of 2016 NPRM Proposed Performance Metrics and Measures

Measure Groups in §490.105(c)	Proposed Performance Measures [23 CFR]	Measure Applicability [23 CFR]	Metric Data Source [23 CFR] & Collection Frequency	Metric Reporting	Metric	Measure Calculation
NHS Travel time reliability measures [§490.105(c)(4)]	Percent of the Interstate System providing for Reliable Travel Times [§490.507(a)(1)]	Mainline of the Interstate System [§490.503]	NPMRDS or Equivalent [§490.103] – 5-minute cycle	Annual metric reporting to HPMS [§490.511(d)]	Level of Travel Time Reliability (LOTTR) [§490.511]	Percentage of the Interstate direction-miles of reporting segments with "LOTTR < 1.50" [§490.513]
	Percent of the non-Interstate NHS providing for Reliable Travel Times [§490.507(a)(2)]	Mainline of the non-Interstate NHS [§490.503]	NPMRDS or Equivalent [§490.103] – 5-minute cycle	Annual metric reporting to HPMS [§490.511(d)]	Level of Travel Time Reliability (LOTTR) [§490.511]	Percentage of the Interstate direction-miles of reporting segments with "LOTTR < 1.50" [§490.513]
Peak hour travel time measures [§490.105(c)(5)]	Peak hour travel time measures [§490.105(c)(5)]	Mainline of the Interstate System in urbanized areas with a population over 1 million [§490.503]	NPMRDS or Equivalent [§490.103] – 5-minute cycle	Annual metric reporting to HPMS [§490.511(d)]	Peak Hour Travel Time Ratio (PHTTR) [§490.511]	Percentage of the non-Interstate NHS direction-miles of reporting segments with " PHTTR < 1.50" [§490.513]
	Percent of the non-Interstate NHS where peak hour travel times meet expectations [§490.507(b)(2)]	Mainline of the non-Interstate NHS in urbanized areas with a population over 1 million [§490.503]	NPMRDS or Equivalent [§490.103] – 5-minute cycle	Annual metric reporting to HPMS [§490.611(d)]	Peak Hour Travel Time Ratio (PHTTR) [§490.511]	Percentage of the non-Interstate NHS direction-miles of reporting segments with " PHTTR < 1.50" [§490.513]
Freight movement on the Interstate System measures [§490.105(c)(6)]	Percent of the Interstate System Mileage providing for Reliable Truck Travel Times [§490.607(a)]	Mainline of the Interstate System	NPMRDS or Equivalent [§490.103] – 5-minute cycle	Annual metric reporting to HPMS [§490.611(d)]	Truck Travel Time Reliability [§490.611]	Percentage of the Interstate direction-miles of reporting segments with "Truck Travel Time Reliability < 1.50"
	Percent of the Interstate System Mileage Uncongested [§490.607(b)]	Mainline of the Interstate System	NPMRDS or Equivalent [§490.103] – 5-minute cycle	Annual metric reporting to HPMS [§490. 611(d)]	Average Truck Speed [§490.611]	Percentage of the Interstate direction-miles of reporting segments with "Average Truck Speed≥ 50 mph" [§490.613]
Traffic congestion measure [§490.105(c)(7)]	Annual Hours of Excessive Delay Per Capita [§490.707]	Mainline of NHS in urbanized areas with a population over 1 million in Nonattainment or Maintenance for any of the criteria pollutants under the CMAQ program	NPMRDS or Equivalent [§490.103] – 5-minute cycle. Traffic volume and population data in HPMS	Annual metric reporting to HPMS [§490.711(f)]	Total Excessive Delay [§490.711]	Annual Hours of Excessive Delay per Capita = (Total Excessive delay)/(total population of UZA) [§490.713]

Exhibit 4 Continued
Summary of 2016 NPRM Proposed Performance Metrics and Measure

Measure Groups in §490.105(c)	Proposed Performance Measures [23 CFR]	Measure Applicability [23 CFR]	Metric Data Source [23 CFR] & Collection Frequency	Metric Reporting	Metric	Measure Calculation
On-road mobile source emissions measure [§490.105(c)(8)]	Total Emission Reductions for applicable criteria pollutants [§490.807]	All Nonattainment and Maintenance areas for CMAQ criteria pollutants [§490.803]	CMAQ Public Access System	CMAQ Public Access System [§490.809]	Annual Project Emission Reductions [§490.811]	Cumulative emission reduction due to all projects for each of the criteria pollutant or precursor for which the area is in nonattainment or maintenance (PM2.5, PM10, CO, VOC and NOx). [§490.813]

Source: *National Performance Management Measures; Assessing Performance of the National Highway System, Freight Movement on the Interstate System, and Congestion Mitigation and Air Quality Improvement Program,* Federal Highway Administration, 23 CFR Part 490, Notice of Proposed Rule Making, April 22, 2016, Table 9, pages 129, 130 and 131. https://www.fhwa.dot.gov/tpm/rule/pm3_nprm.pdf

Exhibit 5
Summary of 2016 NPRM Proposed Performance Measure Criteria

Measure	Metric & Measure	Applicable Transportation Network/Geographic Area
490.507(a)(1) Percent of the Interstate System providing for reliable travel times (calculation proposed in 490.513(b))	LOTTR < 1.50	• Interstate System
490.507(a)(2) Percent of the non-Interstate NHS providing for reliable travel times (calculation proposed in 490.513(c))	LOTTR < 1.50	• Non-Interstate NHS
490.507(b)(1) Percent of the Interstate System where peak hour travel times meet expectations (calculation proposed in 490.513(d))	PHTTR < 1.50	• Interstate System in each urbanized area† with a population > 1 M
490.507(b)(2) Percent of the non-Interstate NHS where peak hour travel times meet expectations (calculation proposed in 490.513(e))	PHTTR < 1.50	• Non-Interstate NHS in each urbanized area† with a population > 1 M

†One measure would be calculated for each urbanized area, including those urbanized areas that intersect with multiple State and metropolitan planning area boundaries.
Source: *National Performance Management Measures; Assessing Performance of the National Highway System, Freight Movement on the Interstate System, and Congestion Mitigation and Air Quality Improvement Program,* Federal Highway Administration, 23 CFR Part 490, Notice of Proposed Rule Making, April 22, 2016, Table 12, page 278.
https://www.fhwa.dot.gov/tpm/rule/pm3_nprm.pdf

3. THE PAG CMP

EVOLUTION OF THE PAG CMP PERFORMANCE MEASURES AND PERFORMANCE TARGET DEVELOPMENT

The 2010 PAG CMP does not mention performance targets as this concept was not specifically discussed in the reference materials available at that time. Both the 2010 PAG CMP and the FHWA's 2011 CMP Guidebook specifically refer to an objectives driven approach for the CMP, where objectives are specific, measurable statements relating to the attainment of goals. Ideal objectives were defined as "SMART", **Specific, Measurable, Agreed, Realistic, Time-bound.** A time-bound objective identifies a timeframe within which it will be achieved (e.g., year 2020). The characteristics of SMART objectives with the inclusion of a specific level of performance to be achieved in a given time period would affectively provide performance targets. An example of potential performance targets for a sample of the 2010 PAG CMP performance measures is provided in Exhibit 6.

Exhibit 6
Example Performance Measure Targets for Congestion Management

2040 PAG RTP Goal	2010 CMP Objective	2010 CMP Performance Measure	Example Performance Target
Increase Accessibility	Address the needs of population groups with special transportation needs.	Percent of pedestrian facility completeness.	Reduce the number of ADA non-compliant intersection crossings by 50 percent by year 2020.
Optimize Transportation System Performance	Provide reasonable and reliable travel time and level of service …	Number of traffic signals retimed.	Optimize traffic signal timing and coordination at 80 percent of traffic signals by year 2020.

The 2010 PAG Congestion Management Process contains a host of performance measures divided into the following categories:

- Roadway system
  - System size /extent
  - Level of use
  - System performance (including Safety and System Integration)
- Fixed route transit system
  - System size / extent
  - Level of use
  - System performance
- Paratransit system
  - System size / extent
  - Level of use

  - System performance
- Bicycle facilities
  - System size / extent
  - Accessibility and constraints (to use)
  - Level of use
  - System performance
- Pedestrian facilities
  - System size / extent
  - Accessibility and constraints (to use)
  - Level of use
  - System performance

The recommended roadway system performance measures were categorized as "primary" measures, those considered to provide the most information regarding system performance, and "secondary" measures, those which supported the primary measures and provided additional detail on system performance. The performance of the roadway system with regard to freight traffic was not specifically addressed in the 2010 CMP, but was indirectly addressed through the detailed recommendations for the roadway system performance assessment and congestion measures which apply to all roadway traffic including freight. However, the collection and analysis of freight traffic volume data was not included in the 2010 CMP recommendations.

Fixed-route transit performance measures were identified for the system, route, and individual stop level of operation. The recommended fixed-route transit system performance measures were coordinated with and in most cases based on:

- Mobility and level of service related measures collected by Sun Tran, the fixed-route service provider, and
- Service measures and standards for the Sun Tran fixed-route service.

Paratransit system performance measures were identified for the system overall and at the trip level. The recommended paratransit system performance measures were coordinated with and based on:

- Service measures and standards for Sun Van (the City of Tucson ADA Paratransit service), and
- Service measures and standards for the Pima County Rural Transit service.

Bicycle facility and pedestrian facility performance measures were identified for the system and subarea levels of application. This approach for alternative modes provided the most efficient use of already available data for measuring and monitoring system performance and accessibility. Implementation priorities and recommendations for updating data requirements were also included.

Certification that the performance measures and targets comply with Federal rules is required by the United States Department of Transportation (USDOT). Metropolitan Planning Organization (MPO) certification[21]:

- Applies to MPOs serving a transportation management area with a population over 200,000 (this includes PAG).
- Is conducted by the USDOT to determine that the planning process complies with the requirements.

[21] MAP-21 Performance Management Overview, prepared by FHWA, undated.

- Failure to certify – USDOT may withhold up to 20% of funds attributable to the metropolitan planning area.
- Recertification is required at least every 4 years.

A Metropolitan System Performance Report is required in the transportation plan every 4 or 5 years. The report should include[22]:

- An evaluation of conditions and performance of the transportation system.
- Progress achieved in meeting performance targets in comparison with the performance in previous reports.
- An evaluation of how the preferred scenario has improved conditions and performance, where applicable.
- An evaluation of how local policies and investments have impacted costs necessary to achieve performance targets, where applicable.

Incorporation of FHWA Emphasis and Requirements into the PAG CMP

Through this project and other previous activities, PAG has expended significant resources in the refinement of the regional transportation system vision, goals, performance measures, and strategies. The PAG 2045 Regional Mobility and Accessibility Plan (RMAP)[23] contains 48 performance measures with year 2020 benchmarks and year 2045 targets for the following seven analysis areas.

1. System Maintenance (3 measures)
2. Safety (12 measures)
3. Multi-modal Choices (14 measures)
4. System Performance (5 measures)
5. Environmental Stewardship (6 measures)
6. Land Use and Transportation (5 measures)
7. Freight and Economic Growth (3 measures)

The PAG 2045 RMAP performance measures and performance targets in these seven areas are provided in Appendix A of this report as excerpted from the PAG 2045 RMAP Appendix 1: Vision, Goals, Performance Measures and Strategies.

In addition to the performance measures and targets excerpted from the 2045 RMAP, PAG has developed an additional multimodal set of performance measures for the CMP (see Appendix A) that address the following areas:

- Congestion
- Variability and Reliability
- Travel Time
- Volume and Capacity
- Accessibility
- Multi-modal Availability
- Land Use
- Freight
- Incident Duration

[22] Ibid, undated.
[23] *2045 Regional Mobility and Accessibility Plan,* Pima Association of Governments, May, 26 2016, Appendix 1.

The following activities have been conducted or are ongoing in the process of PAG refining these performance measures and developing performance targets for the planning region:

- Review of FHWA requirements and coordination with FHWA in the selection of performance measures and targets.
- Coordination with the vision and goals contained in the PAG long-range regional transportation plan.
- Identification of a few key performance measures and targets that will effectively support performance based planning and project development for the region, including any performance measures and targets mandated by FHWA and FTA.
- Working with a Technical Advisory Committee (TAC), which includes providers of public transportation, to define a set of multimodal "SMART" performance measures and initial set of targets for the CMP.
- Evaluation of the data needs, availability, and existing data resources to support implementation of the performance measures.
- Requirements for new data collection and data update requirements.
- Analysis requirements to produce the performance measures.
- Definition of how often the performance measures will be updated and the performance targets assessed.
- Determination of how performance measure and performance target information will be disseminated to decision makers and the public.
- Assessment of the data structure as it would apply to visualization of the performance measures.
- Assessment of the potential visualization techniques for the data and the performance measure.
- Coordination with ADOT on data collection, data process, and target setting.
- Coordination with the PAG TIP project development process.

The CMP and the Planning Process

PAG's CMP is fully coordinated and integrated into the PAG planning process and development of the RMAP and TIP. The following materials, excerpted from the 2045 RMAP highlight how the PAG CMP relates to the RMAP and the TIP.

- The CMP furthers the goals and objectives of the 2045 RMAP through performance monitoring in the years following the 2045 RMAP's completion. The CMP also informs the TIP process of system performance and appropriate congestion management strategies.
- The CMP incorporates the 2045 RMAP goals and objectives as the 2045 RMAP incorporates the CMP congestion management strategies.
- PAG uses the CMP as a primary mechanism for assessing and recommending management and operations strategies for planning and programming.
- The CMP is also a device that coordinates the 2045 RMAP and the TIP. The performance measures identified in the RMAP and the more specific performance measures in the CMP are updated annually and presented to the TIP Subcommittee during the project development phase.
- The CMP updates its performance measures annually in coordination with the TIP cycle.
- The CMP receives a thorough review every four years with the long-range plan cycle.
- The review of the CMP with this 2045 RMAP has resulted in enhanced integration of the CMP and 2045 RMAP via targeted performance measures, goals and objectives.

- Enhanced integration of the CMP and TIP has occurred via a refined annual performance update, updated recurring and non-recurring delay identification, more strategy implementations, more trackable objectives performance tracking via online data visualization and improvement in the evaluation of strategy effectiveness.

VISUALIZATION TECHNIQUES

Since the 2010 PAG CMP was developed there has been added emphasis on the use of visualization techniques to provide for the effective communication of congestion information to decision makers, the public, and other stakeholders. The role of visualizations in the congestion management process is described as the following in two prior studies completed in 2011.[24,25]

Visualization:

- Facilitates analysis of congestion problems by technical staff through the "mining" of data sources for pertinent information about congestion, such as location, extent, intensity, duration, and causality, and through organization of congestion-related data, as maps, graphs, and charts, for analysis purposes;
- Enables the professional staff involved in the CMP to more effectively discuss congestion problems and develop solutions with a mutual and more informed understanding of the congested conditions throughout the region; and
- Provides a means to effectively communicate that information to decision-makers and public about the status of congestion and the need for congestion management strategies in the metropolitan area.

A major portion of this project is devoted to the development of visualizations for the CMP to support technical staff and inform the public while addressing Federal requirements. The documentation and presentation of these visualizations are presented through other sources. As an element of the development of the CMP Addendum, a comprehensive list of performance measures and targets has been developed and is presented in Appendix E. Many of these performance measures have been integrated into the PAG visualization process and on online data dashboard. The materials contained in Appendix E are prepared directly from the new PAG Transportation Network Data Portal (TNDP) that has been developed in conjunction with the PAG online data dashboard and is discussed later in this report.

[24] *Congestion Management Process: A Guidebook*, USDOT, FHWA, April 2011, prepared by ICF International, Inc. et. al.

[25] *Showcasing Visualization Tools in Congestion Management,* USDOT, FHWA, April 2011, prepared by ICF International, Inc. et. al.

4. ROADWAY CONGESTION

OVERVIEW

A 2015 study prepared by the Texas Transportation Institute[26] using an expanded 2014 travel time data set for 471 U.S. urban areas provided by INRIX[27], a private sector provider of travel time data, indicates the following:

> "The national congestion recession is over. Urban areas of all sizes are experiencing the challenges seen in the early 2000s – population, jobs and therefore congestion are increasing. The U.S. economy has regained nearly all of the 9 million jobs lost during the recession and the total congestion problem is larger than the pre-recession levels. The data from 1982 to 2014 (see Exhibit 7) show that, short of major economic problems, congestion will continue to increase if projects, programs and policies are not expanded.
>
> - The problem is very large. In 2014, congestion caused urban Americans to travel an extra 6.9 billion hours and purchase an extra 3.1 billion gallons of fuel for a congestion cost of $160 billion. Trucks account for $28 billion (17 percent) of that cost, much more than their 7 percent of traffic.
> - From 2013 to 2014, 95 of America's 100 largest metro areas saw increased traffic congestion, from 2012 to 2013 only 61 cities experienced increases.
> - In order to reliably arrive on time for important freeway trips, travelers had to allow 48 minutes to make a trip that takes 20 minutes in light traffic.
> - Employment was up by more than 500,000 jobs from 2013 to 2014[28]; if transportation investment continues to lag, congestion will get worse.
> - More detailed speed data on more roads and more hours of the day from INRIX have caused congestion estimates in most urban areas to be higher than in previous *Urban Mobility Scorecards*.
>
> The best mobility improvement programs involve a mix of strategies – adding capacity of all kinds, operating the system to get the 'best bang for the buck,' travel and work schedule options and encouraging homes and jobs to be closer. This involves everyone - agencies, businesses, manufacturers, commuters and travelers. Each region should use the **combination of strategies that match its goals and vision**. The recovery from economic recession has proven that the problem will not solve itself."

The *2015 Urban Mobility Scorecard* (UMS) provides a summary of several congestion indices for 101 of the 471 urban areas categorized by population:

- 15 Very Large Urban Areas (over 3 million population)
- 31 Large Urban Areas (over 1 million and less than 3 million population)
- 33 Medium Urban Areas (over 500,000 and less than 1 million population)
- 22 Small Urban Areas (less than 500,000 population)

[26] *2015 Urban Mobility Scorecard,* Texas Transportation Institute, Schrank, D., et.al., August 2015.
[27] *National Average Speed Database*, 2009 to 2014. INRIX. Kirkland, WA. www.inrix.com
[28] *Current Employment Statistics,* U.S. Bureau of Labor Statistics, U.S. Department of Labor, Washington D.C., http://www.bls.gov/ces/home.htm

Exhibit 7
Major Findings of the 2015 Urban Mobility Scorecard (471 U.S. Urban Areas)

Measures of…	1982	2000	2010	2013	2014
… Individual Congestion					
Yearly delay per auto commuter (hours)	18	37	40	42	42
Travel Time Index	1.09	1.19	1.20	1.21	1.22
Planning Time Index (Freeway only)	--	--	--	--	2.41
"Wasted" fuel per auto commuter (gallons)	4	15	15	19	19
Congestion cost per auto commuter (2014 $)	$400	$810	$930	$950	$960
… The Nation's Congestion Problem					
Travel delay (billion hours)	1.8	5.2	6.4	6.8	6.9
"Wasted" fuel (billion gallons)	0.5	2.1	2.5	3.1	3.1
Truck congestion cost (billions of 2014 dollars)	--	-	--	--	$28
Congestion cost (billions of 2014 dollars)	$42	$114	$149	$156	$160

Yearly delay per auto commuter – The extra time spent during the year traveling at congested speeds rather than free-flow speeds by private vehicle drivers and passengers who typically travel in the peak periods.
Travel Time Index (TTI) – The ratio of travel time in the peak period to travel time at free-flow conditions. A Travel Time Index of 1.30 indicates a 20-minute free-flow trip takes 26 minutes in the peak period.
Planning Time Index (PTI) – The ratio of travel time on the worst day of the month to travel time in free-flow conditions.
Wasted fuel – Extra fuel consumed during congested travel.
Congestion cost – The yearly value of delay time and wasted fuel by all vehicles.
Truck congestion cost - The yearly value of operating time and wasted fuel for commercial trucks.

Source: *2015 Urban Mobility Scorecard,* Texas Transportation Institute, Schrank, D., et.al., August 2015, pg. 1.

The Tucson, Arizona metropolitan area was categorized as a medium urban area. A summary of congestion statistics and costs for the Tucson metro area is provided in Exhibit 8. The 2015 UMS provides a summary of the 101 urban areas, and also provides a ranking for each urban area by the value of each congestion index relative to the other areas. For example, for the index Yearly Delay per Auto Commuter, Washington DC-VA-MD, a very large urban area, is ranked No. 1 overall with a value of 82 hours, while Indio-Cathedral City, CA, a small urban area, is ranked 101 with a value of 6 hours. For each index, the ranking is from highest value to lowest value. Excerpts from the summary for 33 medium urban areas, which includes Tucson are provided in Exhibit 9.

Exhibit 10 provides additional summary information from the *2015 Urban Mobility Scorecard* with comparisons of Tucson to Phoenix (a very large urban area) and the 101 and 471 urban area averages. The data in Exhibits 9 and 10 indicate the following regarding the Tucson metro area:

- Tucson ranks worse than the average for a medium sized urban area for 10 of the 11 congestion measures. Tucson ranks average for the freeway travel time index.
- Tucson ranks better than the average for the 101 urban areas in 8 categories, worse than the average in 2 categories (travel time index and freeway commuter stress index), and ranks average for one category (excess fuel per auto commuter).
- Tucson ranks worse than the average for the 471 urban areas in 8 categories, better than the average in 2 categories (freeway planning time index and freeway travel time index), and ranks average for one category (travel time index).
- Tucson ranks better than the Phoenix-Mesa metro area in 10 of 11 categories, but ranks worse in one category (freeway stress index).

Exhibit 8
Urban Mobility Study Congestion Statistics and Costs for Tucson, Arizona

Measures of	1982	2000	2005	2010	2014
…Individual Congestion					
Yearly delay per auto commuter (hours)	18	42	46	47	47
Travel Time Index	1.08	1.20	1.21	1.22	1.22
Commuter Stress Index	1.10	1.21	1.23	1.23	1.23
"Wasted" fuel per auto commuter (gallons)	4	15	18	21	21
Congestion Cost per auto commuter (2014 $)	$467	$982	$1,083	$1,124	$1,128
Travel Delay (million hours)	6.1	22.8	28.5	33.0	36.0
Total "Wasted" Fuel (millions of gallons)	2.9	11.1	13.8	16.0	17.5
Congestion cost (millions of 2014 $)	$354	$745	$822	$853	$856

Yearly delay per auto commuter – The extra time spent traveling at congested speeds rather than free-flow speeds by private vehicle drivers and passengers who typically travel in the peak periods.
Travel Time Index (TTI) – The ratio of travel time in the peak period to travel time at free-flow conditions. A Travel Time Index of 1.30 indicates a 20-minute free-flow trip takes 26 minutes in the peak period.
Commuter Stress Index – The ratio of travel time for the peak direction to travel time at free-flow conditions. A TTI calculation for only the most congested direction in both peak periods.
Wasted fuel – Extra fuel consumed during congested travel.
Congestion cost – The yearly value of delay time and wasted fuel.

2015 Urban Mobility Scorecard, Texas Transportation Institute, Schrank, D., et.al., August 2015, compete data spreadsheet.

Exhibit 9
2014 Congestion Indices for Select Medium Sized Urban Areas Including Tucson, AZ

Urban Area	Yearly Delay per Auto Commuter		Travel Time Index		Excess Fuel per Auto Commuter		Congestion Cost per Auto Commuter	
	Hours	Rank	Value	Rank	Gallons	Rank	Dollars	Rank
Medium Average (33 areas)	**37**		**1.18**		**18**		**$870**	
Honolulu HI	50	18	1.37	5	26	10	1,125	24
Bridgeport-Stamford CT-NY	49	19	1.36	6	22	23	1,174	16
Baton Rouge LA	47	23	1.22	32	25	11	1,262	12
Tucson AZ	47	23	1.22	32	23	18	1,128	23

Urban Area	Travel Delay		Excess Fuel Consumed		Truck Congestion Cost		Total Congestion Cost	
	(1,000 Hours)	Rank	(1,000 Gallons)	Rank	($ million)	Rank	($ million)	Rank
Medium Average (33 areas)	**20,000**		**9,815**		**$94**		**$475**	
New Orleans LA	39,159	38	18,895	40	281	23	1,014	37
Bridgeport-Stamford CT-NY	37,119	43	16,586	45	194	34	898	42
Tucson AZ	35,993	44	17,477	44	176	41	856	44
Tulsa OK	30,341	47	14,128	47	107	54	682	48
Hartford CT	28,296	49	13,406	51	115	50	656	50

Urban Area	Freeway Planning Time Index		Freeway Travel Time Index		Freeway Commuter Stress Index	
	Value	Rank	Value	Rank	Value	Rank
Medium Average (33 areas)	**2.08**		**1.14**		**1.38**	
Hartford CT	2.30	38	1.16	40	1.20	91
Colorado Springs CO	2.21	44	1.13	54	1.39	46
Buffalo NY	2.13	49	1.12	58	1.41	27
Raleigh NC	2.11	53	1.12	58	1.40	34
Tucson AZ	2.11	53	1.14	50	1.47	13

Medium Urban Areas—over 500,000 and less than 1 million population.
Yearly Delay per Auto Commuter—Extra travel time during the year divided by the number of people who commute in private vehicles in the urban area.
Travel Time Index—A value of 1.30 indicates a 20-minute free-flow trip takes 26 minutes in the peak period.
Excess Fuel Consumed—Increased fuel consumption due to travel in congested conditions rather than free-flow conditions.
Congestion Cost—Value of travel time delay and excess fuel consumption (estimated using state average cost per gallon for gasoline and diesel).
Travel Delay—Extra travel time during the year.
Excess Fuel Consumed—Value of increased fuel consumption due to travel in congested conditions rather than free-flow conditions (using state average cost per gallon).
Truck Congestion Cost—Value of increased travel time and other operating costs of large trucks (estimated at $94.04 per hour of truck time) and the extra diesel consumed (using state average cost per gallon).
Congestion Cost—Value of delay and fuel cost (estimated at $17.67 per hour of person travel, $94.04 per hour of truck time and state average fuel cost).
Freeway Planning Time Index—A PTI of 2.00 means that 40 minutes should be planned for a 20-minute trip in light traffic (20 minutes x 2.00 = 40 minutes).
Freeway Travel Time Index—A value of 1.30 indicates a 20-minute free-flow trip takes 26 minutes in the peak period (20 minutes x 1.30 = 26 minutes).
Freeway Commuter Stress Index – The travel time index calculated for only the peak direction in each peak period (a measure of the extra travel time for a commuter).
Note: Please do not place too much emphasis on small differences in the rankings. There may be little difference in congestion between areas ranked (for example) 6th and 12th. The actual measure values should also be examined.

Source: *2015 Urban Mobility Scorecard,* Texas Transportation Institute, Schrank, D., et.al., August 2015, Tables 1, 2 and 3.

Exhibit 10
Summary of *2015 Urban Mobility Scorecard* Congestion Measures

	Yearly Delay per Auto Commuter		Travel Time Index		Excess Fuel per Auto Commuter		Congestion Cost per Auto Commuter	
Urban Area	**Hours**	**Rank**	**Value**	**Rank**	**Gallons**	**Rank**	**Dollars**	**Rank**
Tucson AZ	47	23	1.22	32	23	18	1,128	23
Phoenix-Mesa AZ	51	17	1.27	19	25	11	1,201	13
Medium Area Average	37		1.18		18		870	
101 Area Average	52		1.16		23		1,190	
471 Area Average	42		1.22		19		960	

	Annual Travel Delay		Excess Fuel Consumed		Truck Congestion Cost		Total Congestion Cost	
Urban Area	**Hours (1,000)**	**Rank**	**Gallons (1,000)**	**Rank**	**Million Dollars**	**Rank**	**Million Dollars**	**Rank**
Tucson AZ	35,993	44	17,477	44	176	41	856	44
Phoenix-Mesa AZ	155,730	9	75,938	9	692	8	3,641	9
Medium Area Average	20,000		9,815		94		475	
101 Area Average	59,800		26,700		240		1,370	
471 Area Average	14,710		6,610		60		340	

	Freeway Planning Time Index		Freeway Travel Time Index		Freeway Commuter Stress Index	
Urban Area	**Value**	**Rank**	**Value**	**Rank**	**Value**	**Rank**
Tucson AZ	2.11	53	1.14	50	1.47	13
Phoenix-Mesa AZ	2.66	21	1.24	28	1.34	64
Medium Area Average	2.08		1.14		1.38	
101 Area Average	2.66		1.28		1.40	
471 Area Average	2.41		1.23		1.35	

RECURRING CONGESTION

Critical to the CMP is the process of monitoring and measuring roadway congestion. The information and congestion indices from the *2015 Urban Mobility Scorecard* represent total congestion measures. However congestion is generally considered to be made up of two separate components: recurring and non-recurring. This is done because the strategies to address each type of congestion differ significantly and have different impacts on motorists. Recurring congestion refers to the condition when travel demand exceeds the available roadway capacity. Recurring congestion and the resulting increase in travel time are typically taken into consideration by motorists in an urban area when planning trip departure and travel times because this is a daily, recognizable occurrence, particularly during the weekday peak travel hours. With typical recurring congestion motorists generally encounter a predictable, although longer travel time and can plan trips accordingly.

Quantifying recurring congestion is relatively easy based travel time data or based on traffic demand and roadway characteristics using procedures from the Highway Capacity Manual or traffic simulation software specifically developed for this purpose. PAG currently uses a regional Synchro® model to calculate recurring traffic congestion levels for all of the arterial roadways within the region. This model employs Highway Capacity Manual procedures to provide peak-hour traffic congestion estimates for all of the signalized intersections on regional arterials using peak-hour turning movement data collected and updated on a rotating basis. PAG updates a portion of the traffic counts for the model each year with a goal to refresh the database every three to five years depending on the regional growth. The Synchro model provides information on the number of signalized intersections operating under poor level of service conditions during the peak-hours and identifies congestion bottlenecks in the region. This information is used to assist in identifying strategies to address the areas with high levels of recurring congestion. Included among these strategies are the following:

- Application of indirect left-turn intersection geometry at Oracle Road/Ina Road and Oracle Road/Grant Road, with a current design underway for application at the Valencia Road/Kolb Road intersection. Additional applications of the indirect left-turn concept are in various stages of planning and design along the Grant Road corridor. These improvements are specifically designed to reduce recurring delay and improve safety, reducing non-recurring delay.
- Corridor signal timing improvements based on Synchro modelled data and using passively collected speed data to supplement modelled data and further improve results. PAG offers signal timing program assistance to local jurisdictions.
- Roadway capacity improvements including exclusive left-turn and right-turn lanes at signalized intersection and roadway widening projects.

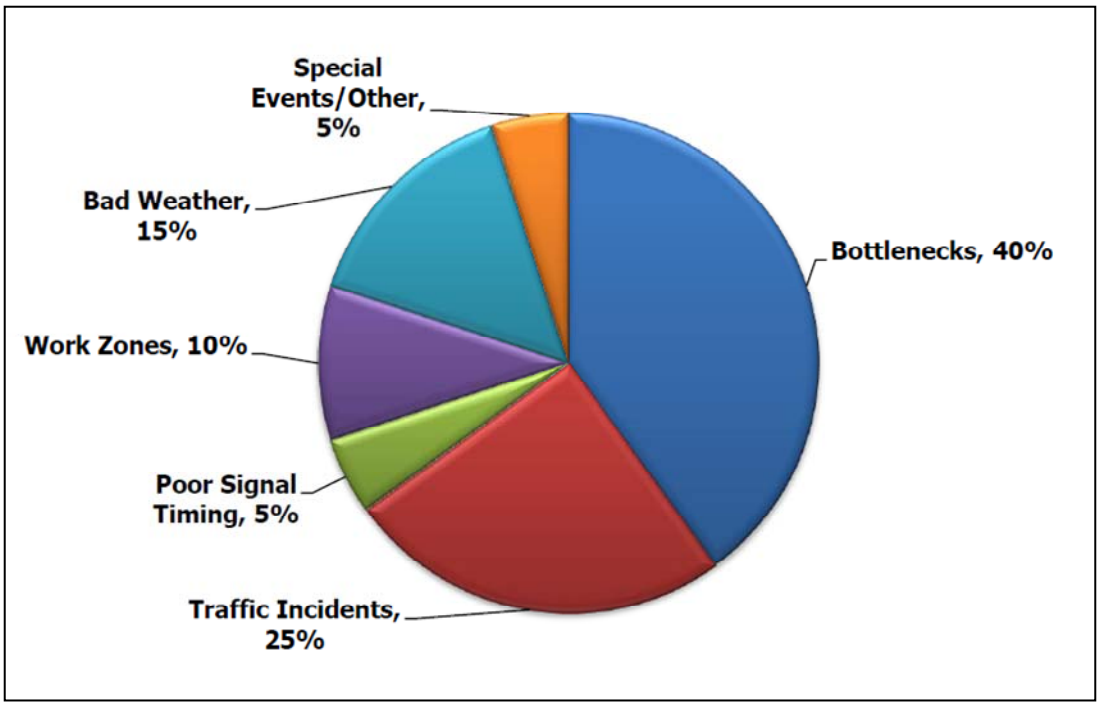
PAG also uses the regional traffic forecasting model to provide regional-level information on recurring congestion conditions and to model the potential congestion mitigation impact of projects in the TIP and the RMAP.

PAG is currently developing a comprehensive list of CMP performance measures for implementation (see Appendix A), several of which address measuring recurring congestion. These measures will either be based on modelled estimates or estimates based on travel time data provided by the FHWA through the NPMRDS for elements of the NHS, which includes the interstate freeway system and limited portions of the regional arterial roadway system. Among these measures are the Travel Time Index and Planning Time Index which will rely on NPMRDS data.

NON-RECURRING CONGESTION

The term non-recurring congestion refers to the additional congestion due to causes such as crashes, disabled vehicles, work zones, adverse weather events, and planned special events. Non-recurring events can dramatically reduce the available capacity and reliability of the transportation system. The travel times associated with non-recurring congestion are much less predictable and difficult to plan against. Travelers and shippers are especially sensitive to the unanticipated disruptions in scheduled activities and manufacturing distribution procedures. Non-recurring congestion is also much more difficult to measure because the majority of these events tend to be random and the time, location, and duration of these events cannot be predicted beforehand. Data published by FHWA indicates that as much as 55 percent of total roadway congestion is a result of non-recurring congestion events (see Exhibit 11) excluding poor signal timing (5% contribution to total congestion).

Exhibit 11
Sources of Total Congestion



Sources: *Traffic Congestion and Reliability: Linking Solutions to Problems,* prepared by Cambridge Systematics, prepared for FHWA, July 2004. Exhibit from *MAG Non-Recurring Congestion Study,* Final Report, Maricopa Association of Governments, October 2011.

Oak Ridge National Laboratory Study

Results from a 2004 Oak Ridge National Laboratory study[29] representing 1999 conditions indicate that non-recurring congestion accounted for 62 percent of total congestion (excluding poor signal timing at

[29] *Temporary Losses of Highway Capacity and Impacts on Performance: Phase 2 (TLC2), Chin, S. M., et.al., Oak Ridge National Laboratory, Oak Ridge, Tennessee, ORNL/TM-2004/209, prepared for the US Department of Energy, November 2004.*

5%), with recurring delay at 33 percent. The ORNL study used various modeling and analysis techniques to estimate vehicle-hours of delay for freeways and expressways, and principal arterials in urban and rural areas, for peak and off-peak conditions. This analysis was conducted using various national data sources and traffic analysis models. No actual field data collection was conducted to measure non-recurring delay as a result of actual traffic incidents. A summary of the ORNL study results is provided in Exhibit 12.

Exhibit 12
Summary of TLC2 Study Results

	Share of total	Delay in million vehicle hours									
		Total	Fatal crashes	Non-fatal crashes	Break-downs	Work zones	Weather	Signal timings	Railroad crossings	Urban PUD	Toll facilities
Total	100%	3,657.9	13.7	1,664.2	440.0	889.0	330.1	295.8	2.9	0.95	21.0
By area type & size*											
Urban - Very large	38%	1,372.6	2.5	808.8	155.3	169.3	122.2	112.9	0.7	0.9	--
Urban - Large	28%	1,041.0	8.4	520.6	91.6	282.6	80.5	56.8	0.4	0.09	--
Urban - Medium	8%	295.2	0.1	106.2	24.5	106.3	29.6	28.2	0.2	0.001	--
Urban - Small	15%	547.1	2.1	128.0	72.9	181.8	71.3	89.7	1.4	0.01	--
Rural	10%	380.9	0.6	100.5	95.7	149.0	26.5	8.2	0.3	--	--
By highway type											
Urban freeways & expressways	56%	2,036.4	6.1	1,196.1	12.1	730.2	91.8	--	--	--	--
Urban other principal arterials	33%	1,219.5	7.0	367.5	332.2	9.7	211.8	287.6	2.7	1.0	--
Rural Freeways	5%	165.5	0.2	16.2	0.4	136.5	12.2	--	--	--	--
Rural other principal arterials	6%	215.4	0.4	84.3	95.3	12.5	14.3	8.2	0.3	--	--
By period & congestion level†											
Peak - Congested	13%	462.8	0.1	201.9	30.2	98.9	80.1	51.3	0.1	0.1	--
Peak - Not congested	27%	992.5	3.6	495.4	133.5	243.6	50.6	64.8	0.8	0.2	--
Off-peak	60%	2,181.5	10.0	966.9	276.3	546.5	199.5	179.7	2.0	0.6	--

* Urban area size categories are based on population: very large – more than 3 million; large – 1 to 3 million; medium 0.5 to 1 million; small – less than 0.5 million.

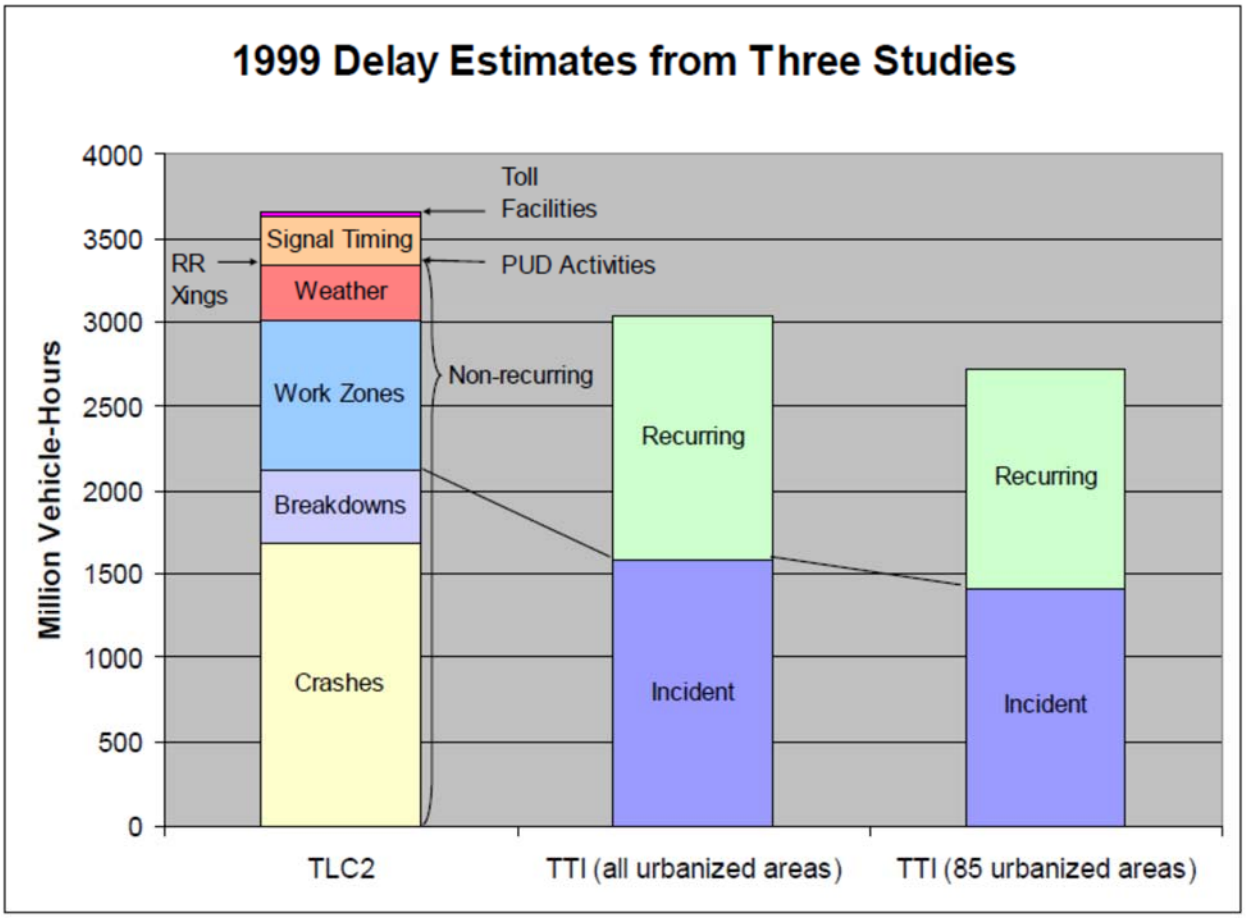
† Peak periods: 6:00 am to 9:30 am and 3:30 pm to 7:00 pm Monday through Friday; all others considered non-peak. A roadway section is considered congested during the peak periods if its Volume/Service Flow Ratio (V/SF) is greater than 95%.

Source: *Temporary Losses of Highway Capacity and Impacts on Performance: Phase 2 (TLC2),* Chin, S. M., et.al., Oak Ridge National Laboratory, Oak Ridge, Tennessee, ORNL/TM-2004/209, prepared for the US Department of Energy, November 2004, Table ES-2.

The ORNL TLC2 study also provides a comparison of recurring and non-recurring delay from three studies: the TLC2 study, the TTI *Urban Mobility Report*[30] for 85 urbanized areas, and the TTI estimate for the FHWA Office of Operations for all urbanized areas using 1999 data. This comparison is provided in Exhibit 13. The TLC2 study estimates that non-recurring congestion due to crashes and breakdowns is 35 to 40 percent higher than that estimated for incidents in the TTI studies. The TCL2 study also estimates that non-recurring congestion results in more delay than the total congestion from incidents and non-recurring congestion from the TTI studies.

[30] *2004 Urban Mobility Study Data,* Texas Transportation Institute, 2004.

Exhibit 13
TLC2 Study Comparison of Delay Estimates

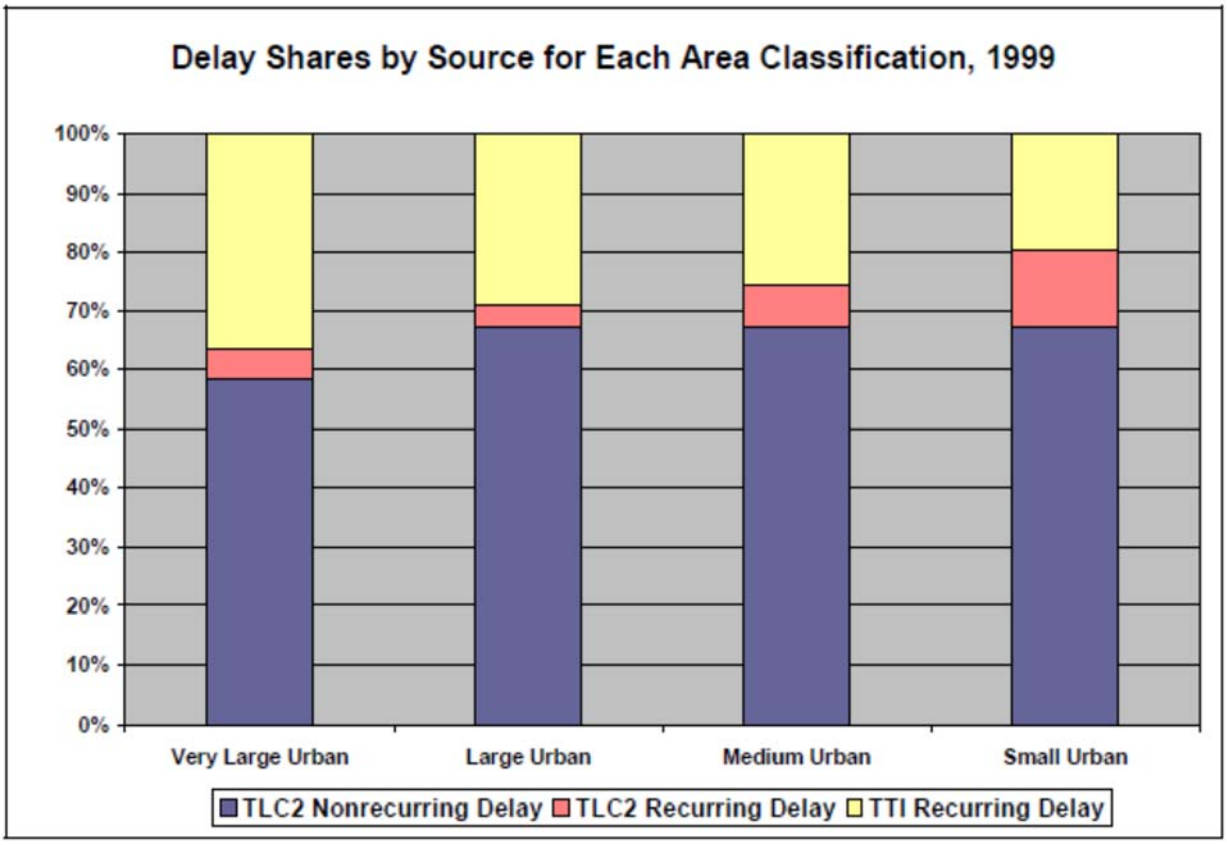


Source: *Temporary Losses of Highway Capacity and Impacts on Performance: Phase 2 (TLC2),* Chin, S. M., et.al., Oak Ridge National Laboratory, Oak Ridge, Tennessee, ORNL/TM-2004/209, prepared for the US Department of Energy, November 2004, Figure 36.

The ORNL TLC2 study developed a "composite picture of delay" by combining elements from their study with estimates prepared by the Texas Transportation Institute (TTI) for FHWA's annual *Performance and Accountability Report.* "The resulting picture is a very approximate composite because very different methods are used in TLC2 and the TTI studies. TTI estimates recurring delay from weekday commuting peaks, while TLC2 estimates recurring delay from two elements (suboptimal signal timing and tollbooths) not covered by TTI. TTI estimates non-recurring delay from relationships between incident delay and recurring delay in urban areas, while TLC2 uses a bottom-up approach to estimating nonrecurring delay from a variety of sources in both urban and rural areas."[31] The results of the composite process are provided in Exhibit 14. The composite uses TTI's estimate of recurring delay for all urban areas. The resulting 5.1 billion hours of delay is on average 35 percent recurring and 65 percent non-recurring.

[31] *Temporary Losses of Highway Capacity and Impacts on Performance: Phase 2 (TLC2), Chin, S. M., et.al., Oak Ridge National Laboratory, Oak Ridge, Tennessee, ORNL/TM-2004/209, prepared for the US Department of Energy, November 2004, page 100.*

Exhibit 14
Composite Picture of Delay from TLC2 Study



Source: *Temporary Losses of Highway Capacity and Impacts on Performance: Phase 2 (TLC2),* Chin, S. M., et.al., Oak Ridge National Laboratory, Oak Ridge, Tennessee, ORNL/TM-2004/209, prepared for the US Department of Energy, November 2004, Figure 38.

The data from the various sources described above indicate that non-recurring congestion can account for between 55 percent and 65 percent of total congestion related delay for urban area roadway travel. It is obvious from these studies that non-recurring congestion is a major source of urban travel delay. **For a medium sized urban area such as Tucson, Exhibit 14 indicates that approximately 65 percent of total delay is from non-recurring congestion.**

Washington State Transportation Commission Study

A 2003 study for the Washington State Transportation Commission[32] (WSTC) conducted an analysis of recurring and non-recurring congestion for the following conditions (additional details of the analysis procedure are contained in the referenced document):

- Urban freeway segments only in central Puget Sound metro area. Five freeways and approximately 100 center-line miles of roadway.
- Weekdays, Tuesday through Thursday.

[32] *Measurement of Recurring Versus Non-Recurring Congestion,* Hallenbeck, M.E., et.al., Washington State Transportation Center, University of Washington, Washington State Transportation Commission, Department of Transportation, October 2003. http://depts.washington.edu/trac/bulkdisk/pdf/568.2.pdf

- Four specific time periods: AM peak (6:00 to 9:00 AM), midday (9:00 AM to 3:00 PM), PM peak 3:00 to 7:00 PM) and night.
- Data from two months: September and October 2002.
- Non-recurring congestion defined as all congestion that occurs when conditions were significantly worse than expected, routine operating conditions. Recurring congestion was all other congestion.
- Routine operation conditions were considered as the median operating condition for that time and location on the roadway network.
- The congestion metric used was the percentage of lane occupancy, aggregated at 5-minute intervals across all (directional) lanes of the freeway at each data collection location, along with volume and speed.
- Non-recurring congestion was considered to be occurring when lane occupancy was 5 or more percentage points higher than the median operating condition (expressed in percentage of lane occupancy) for a time and location for all days being studied that did not contain a lane blocking incident. For example, if between 6:00 and 6:05 AM, at milepost 100, the roadway routinely operates with a median lane occupancy of 10 percent, non-recurring congestion was considered to exist when measured lane occupancy exceeded 14.9 percent.
- The amount of congestion was estimated at a point in time and space based on the volume and speed of vehicles present at each loop-detector measurement location every 5 minutes. The speed of vehicles was compared to a reference speed (60 mph speed limit, and the speed at which the Highway Capacity Manual indicates that maximum facility flow can be maintained, which is 50 mph).
- The days which were affected by lane blocking incidents were identified for each analysis time period, and the median condition for all days when lane blocking did not occur was determined. The median condition served as the expected, recurring condition.
- Where congestion was determined to be significantly worse (i.e., a change in lane occupancy of greater than 5 percent from the median) were defined as sites of non-recurring congestion.
- The time, location, and duration of major lane blocking incidents were recorded, and the geographic and temporal extent of non-recurring delay was determined using the baseline reference speeds described above. These data were aggregated for all times and locations to estimate total non-recurring delay.
- Total delay (recurring + non-recurring) was determined assuming delay was any travel slower than free flow conditions (60 mph). Recurring delay was taken as the difference between total delay and non-recurring delay.

The following represents a brief summary of the results and conclusions of the WSTC study:

- Lane blocking incidents accounted for between 2 and 20 percent of total daily delay, and between 10 and 35 percent of all non-recurring delay. For most corridors, lane blocking incidents accounted for only between 1 and 10 percent of peak period delay.
- Non-recurring delay generally ranged between 30 to 50 percent of all peak period, peak direction delay, but was between 30 and 70 percent of total daily delay.
- For all study roadways, the higher the levels of recurring congestion, the lower the percentage of non-recurring congestion from all sources. The opposite was also true.
- Even though the percentage of congestion that is non-recurring decreases as traffic volume on a facility increases, the absolute number of vehicle hours of delay due to non-recurring events can increase significantly.

- In peak periods, a lane blocking incident of even a short duration tends to result in substantial delay.

Maricopa Association of Governments Study

A 2011 study was conducted for the Maricopa Association of Governments[33] (MAG) to measure non-recurring congestion on freeways and arterials in the Phoenix, AZ metro area. The study focused on five freeway segments and five arterial segments and calculated non-recurring congestion, recurring congestion, and total congestion in vehicle-hours (veh-hrs) for weekday and weekend conditions. The following provides a brief summary of the study approach (additional details on the data collection and analysis approach are available in the referenced final report).

- Travel time and speed data were collected and analyzed for the five freeway and five arterial roadway segments.
- Data for the freeway segments were obtained for calendar year 2009 from the Arizona Department of Transportation's Freeway Management System (FMS) database. These data are provided by the lane-specific freeway sensors that are part of the FMS. These sensors are spaced between 1 mile and one-third of a mile.
    - These data were aggregated into morning peak period, evening peak period, and off-peak time periods. Time periods without non-recurring events were identified and considered "normal" with regard to recurring congestion, and the levels of congestion during the "normal" time periods was estimated for each corridor.
    - The congestion for the time periods with non-recurring events was calculated and the difference between this level of congestion and the congestion during "normal" periods was considered as the non-recurring congestion.
- Arterial speed and travel time data were obtained through a combination of new field travel time data collection and historical data provided by MAG.
    - The newly collected arterial travel time data were obtained through the use of devices to anonymously monitor the location of media access control (MAC) addresses from in-vehicle Bluetooth® devices within the traffic stream. These data were captured continuously for a 20-week period from June 2010 through October 2010.
    - Similar to the freeway methodology, a baseline computation of the average delay incurred on the roadway was compared against the data collected during non-recurring congestion events, with the difference representing the estimate of the delay attributable to the non-recurring congestion event.
- Non-recurring event information, including time of day and location, was available from the following sources:
    - Incidents – Private Data Sources in conjunction with the Arizona Location Identification Surveillance System (ALISS) and ADOT's Highway Condition Reporting System (HCRS).
    - Work Zones – ADOT's HCRS, Phoenix's Temporary Restriction and Closure System (TRACS).
    - Poor Traffic Control/Signal Operation – Agency signal maintenance records.
    - Inclement Weather – National Climatic Data Center, Weather Underground website.
    - Special Events – published schedules of major sporting and festival events.

[33] *MAG Non-Recurring Congestion Study,* Maricopa Association of Governments, prepared by Lee Engineering, with the Texas Transportation Institute, Final Report, October 2011.
https://www.azmag.gov/Projects/Project.asp?CMSID=1108

A summary of the MAG study results for the freeway segments and arterial segments for both weekdays and weekends is provided in Exhibit 15. The data in Exhibit 15 indicates:

- For freeways:
  - 96 percent of total congestion occurs on weekdays, and was on average 46 percent non-recurring.
  - Non-recurring congestion ranged from 22 percent to 83 percent for weekdays on the freeway segments.
  - 100 percent of weekend congestion was non-recurring, but this amounts to only 4 percent of total weekly freeway congestion.
  - Overall, 48 percent freeway congestion was non-recurring, and 52 percent recurring.
- For arterials:
  - 72 percent of total congestion occurs on weekdays, and is on average 9 percent non-recurring.
  - Non-recurring congestion ranged from 2 percent to 20 percent for weekdays on the arterial segments.
  - 15 percent of weekend congestion is non-recurring, and this amounts to 28 percent of total weekly arterial congestion.
  - Overall, 11 percent of congestion on arterials was non-recurring, and 89 percent recurring.

A breakdown and distribution of the causes of non-recurring congestion found in the MAG Study are provided in Exhibit 16. The information in Exhibit 16 indicates the following:

- Vehicular incidents and construction are the two major causes of non-recurring delay on both freeways and arterials.
- On freeways during the week, as much as 80 percent of non-recurring congestion is caused by vehicular incidents, while 16 percent is construction related.
- On freeways during the weekend, 45 percent of non-recurring congestion is caused by vehicular incidents, while 46 percent is construction related.
- On arterials during the week, 47 percent of non-recurring congestion is caused by vehicular incidents, while 34 percent is construction related.
- On arterials during the weekend, 30 percent of non-recurring congestion is caused by vehicular incidents, while 42 percent is construction related.

The MAG Study expanded their results from the study roadway sections to represent an estimate of congestion levels for recurring, non-recurring, and total congestion for the entire region at an annual level. A summary of the expansion of the study results to annual regional levels of congestion is provided in Exhibit 17. The results in Exhibit 17 indicate that arterials carry the bulk of total annual congestion (88 percent), and contribute 62 percent of the regional non-recurring congestion annually. Freeways contribute only 12 percent of the total annual congestion, but contribute 38 percent of the non-recurring congestion. This is for a region where arterials comprise 73 percent of the total roadway lane miles and carry nearly 67 percent of all regional travel.

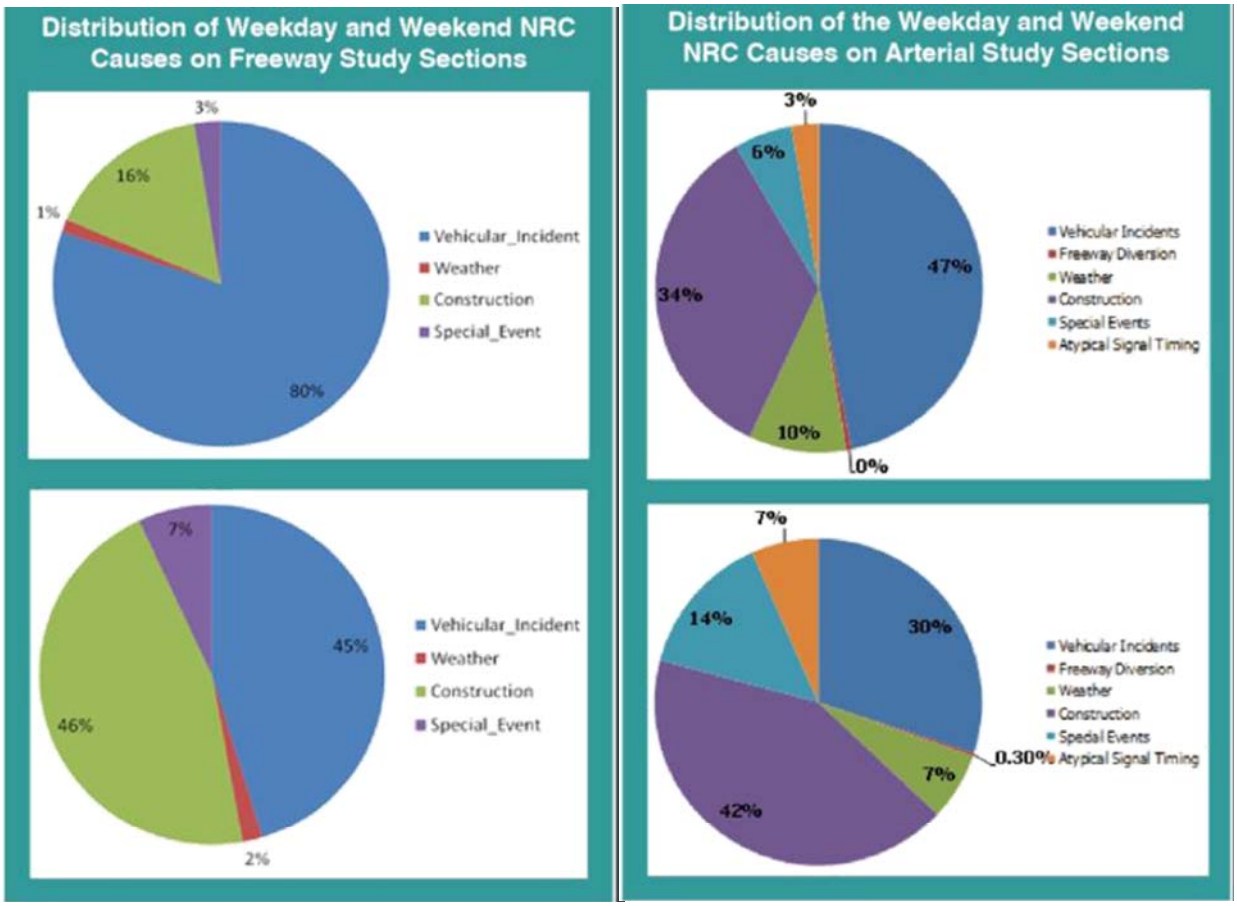
Exhibit 15
Freeway and Arterial Congestion from the 2011 MAG Study

FREEWAY STUDY SECTIONS	Recurring Congestion (veh-hrs)	Non-Recurring Congestion (veh-hrs)	Total (veh-hrs)	% NRC
Weekday Conditions (from 2009)				
I-10 WB: SR 51 to I-17	89,167	97,491	186,658	52%
I-17 SB: I-10 to I-10	2,874	13,822	16,696	83%
Loop 202 WB: 46th St to 22nd St	68,514	40,407	108,921	37%
I-10 WB: Ray to Southern Ave	140,080	39,324	179,404	22%
US 60 EB: I-10 to Loop 101	23,299	82,017	105,316	78%
Total for Weekday	**323,933**	**273,062**	**596,994**	**46%**
Weekend Conditions (from 2009)				
I-10 WB: SR 51 to I-17	-	2,097	2,097	100%
I-17 SB: I-10 to I-10	-	2,567	2,567	100%
Loop 202 WB: 46th St to 22nd St	-	2,741	2,741	100%
I-10 WB: Ray to Southern Ave	-	74	74	100%
US 60 EB: I-10 to Loop 101	-	18,167	18,167	100%
Total for Weekend	**-**	**25,645**	**25,645**	**100%**

ARTERIAL STUDY SECTIONS	Recurring Congestion (veh-hrs)	Non-Recurring Congestion (veh-hrs)	Total (veh-hrs)	% NRC
Weekday Conditions (various durations in 2010)				
35th Ave Corridor (w/Bell Rd)	87,914	103,393	98,307	11%
51st Ave Corridor (w/T-Bird, Peoria & Northern)	84,024	3,250	87,274	4%
Indian School Rd Corridor	48,526	11,951	60,477	20%
7th St Corridor	53,701	6,087	59,788	10%
Rural Rd Corridor (w/Rio Salado, Mill & University)	72,882	1,404	74,286	2%
Total for Weekday	**347,047**	**33,085**	**380,132**	**9%**
Weekend Conditions (various durations in 2010)				
35th Ave Corridor (w/Bell Rd)	25,144	4,620	29,764	16%
51st Ave Corridor (w/T-Bird, Peoria & Northern)	27,618	2,133	29,751	7%
Indian School Rd Corridor	26,164	4,969	31,133	16%
7th St Corridor	15,901	5,906	21,807	27%
Rural Rd Corridor (w/Rio Salado, Mill & University)	30,167	4,397	34,564	13%
Total for Weekend	**124,994**	**22,025**	**147,019**	**15%**

Source: *MAG Non-Recurring Congestion Study,* Maricopa Association of Governments, prepared by Lee Engineering, with the Texas Transportation Institute, Final Report, October 2011, Tables 1 and 2.

Exhibit 16
Distribution of Weekday and Weekend Causes of Non-Recurring Congestion by Roadway Type from the MAG Study



Source: *MAG Non-Recurring Congestion Study,* Maricopa Association of Governments, prepared by Lee Engineering, with the Texas Transportation Institute, Final Report, October 2011, Figures 1 and 2.

Exhibit 17
Annual Congestion Estimates for the Entire MAG Region from the MAG Study

Annual Percent of Congestion			
Roadway Type	**Recurring**	**Non-Recurring**	**Total (% and Veh-Hrs)**
Freeways	62%	38%	12% (10,584,875)
Arterials	38%	62%	88% (77,946,262)
Total	100%	100%	100% (88,5331,137)

Source: *MAG Non-Recurring Congestion Study,* Maricopa Association of Governments, prepared by Lee Engineering, with the Texas Transportation Institute, Final Report, October 2011.

PAG CMP STEPS FOR ADDRESSING CONGESTION

PAG has already taken considerable steps to monitor, evaluate, and report on recurring congestion issues for the region as described above. The PAG process uses state-of-the art computer models to measure recurring congestion and identify problem areas. The regional Synchro model is also used to update and optimize traffic signal timing along major arterial corridors. These methods and the data

collection process to support the computer models should be continued as they provide a valuable resource to the community.

PAG may be able to use the results of the MAG Study to provide an estimate of recurring, non-recurring, and total congestion for the PAG region. It should be possible to factor the MAG Study results based on a comparison of lane-miles of arterials and freeways in the two areas and a comparison of vehicle-miles travelled on each roadway type in each region. This process would assume that the relationship between recurring and non-recurring congestion for each roadway type would remain the same as that shown in Exhibit 15, and that the magnitude of the total congestion by roadway type could be estimated based on the comparison of lane-miles and vehicle-miles travelled between the PAG and MAG regions. This simplistic process would also assume that freeways and arterials in the PAG region operate at levels of congestion that are similar in general to those in the MAG area and that traffic incidents and construction activities are also similar. Field measurement of recurring and non-recurring congestion may be prohibitive due to cost. The MAG study cost was $298,954, but it also included significantly more study elements than the field measurement of congestion.

The CMP should have methods in place to identify the root causes of nonrecurring congestion, including location, duration, and intensity. The most frequent locations of nonrecurring congestion due to crashes can be ascertained from a geographic summary of crash reports for the region. This information, along with the analysis of crash types and crash rates at high frequency or high crash rate locations, can be used to identify safety projects and improvements to reduce the number of crashes.

The CMP should have procedures in place to quickly identify that an event has occurred (or will occur as in the case of a work zone or special event) and disseminate this information to the public. For crashes, the CMP should have procedures in place to collect data to monitor and evaluate event duration so that performance on reducing this type of congestion can be measured. The use of roadway response teams to help reduce the duration of nonrecurring congestion due to crashes or vehicle breakdowns is described in next section of this report. Additional congestion management strategies that PAG should consider adding to their congestion management tool box are also provided in the next section of this report.

5. CONGESTION MANAGEMENT STRATEGIES

CURRENT PAG CONGESTION MANAGEMENT PROJECTS AND PROGRAMS

PAG and its member jurisdiction currently implement a variety of congestion management strategies through ongoing programs, systems, and projects. The following are notable ongoing programs, systems and projects within the PAG region identified in the Transportation Improvement Program (TIP) and the Draft 2045 Regional Mobility and Accessibility Plan (RMAP). **Note that the level of funding in the Draft 2045 RMAP anticipated for these projects at the time this evaluation was conducted are subject to change in the Final 2045 RMAP.**

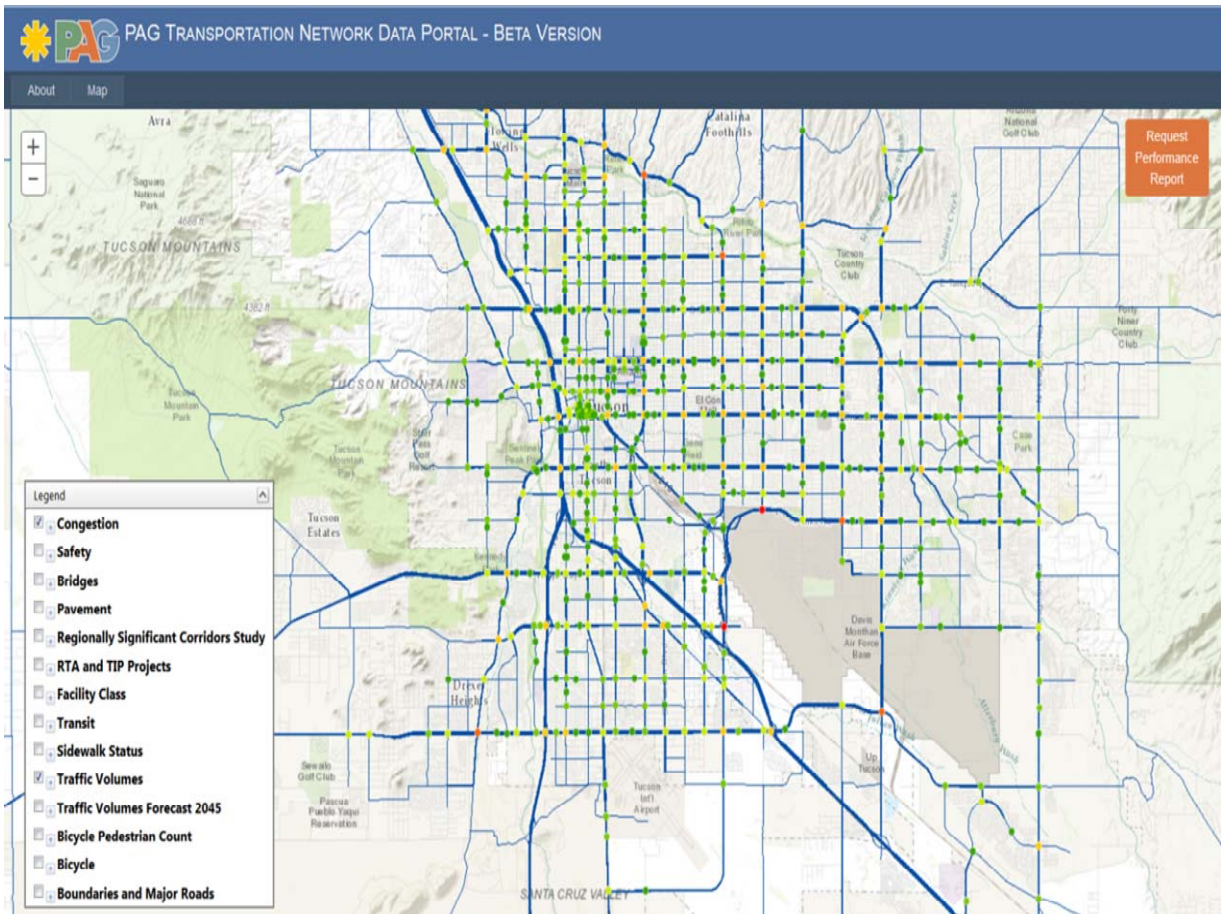
The Current PAG Congestion Management Process (CMP)

The federally mandated PAG Congestion Management Process (CMP) serves as an effective tool to address traffic congestion throughout the region by enabling PAG and its partners to define, identify and measure congestion and develop and select appropriate strategies to reduce it. The PAG CMP is fully integrated into the region's planning and programming processes, and provides periodic assessment of the effectiveness of implemented strategies and progress towards regionally adopted targets through a series of performance measures. This process assists in identification of system deficiencies, and analysis and selection of alternative strategies to address congestion for inclusion in the Regional Accessibility and Mobility Plan (RMAP), the region's long-range transportation plan, and the short-range transportation improvement program (TIP). A more detailed description of how the PAG CMP has been constructed to enhance the TIP implementation process is provided in Appendix B.

The 2045 RMAP is a performance-based long-range transportation plan that includes a series of goals, objectives, performance measures and targets. The performance measures included in the final plan drew extensively from the 2010 CMP Final Report. CMP-focused performance measures are integrated into the goal areas of Land use and Transportation, Multimodal Choices, Transportation Safety and System Performance. A diverse group of stakeholders developed targets for each performance measure. The stakeholders included member jurisdiction representatives, travel reduction program staff, alternative mode representatives and major employers. Progress on each performance measure is being tracked by PAG staff to assist in future planning and programming efforts.

The programming process at PAG includes an online data map viewer that assists jurisdictions in identifying candidate projects and streamlines the application process. This website, the Transportation Network Data Portal (TNDP) is an interactive map displaying existing conditions using regional transportation datasets. There are more than a dozen datasets within TNDP many of which are CMP related such as intersection congestion, current and forecasted traffic volumes, alternative mode routes and counts, crash data and programmed projects. These datasets can be turned on and off by the user. Jurisdictions are invited to perform network screenings of their facilities to help identify potential future projects. Additionally, a click on any of the map features provides a call out box with the details on all enabled datasets. An example of information available from the PAG TNDP through an interactive web-map showing regional spatial data for network screening, PAG Performance Report request, and project application processes is provided in Exhibit 18.

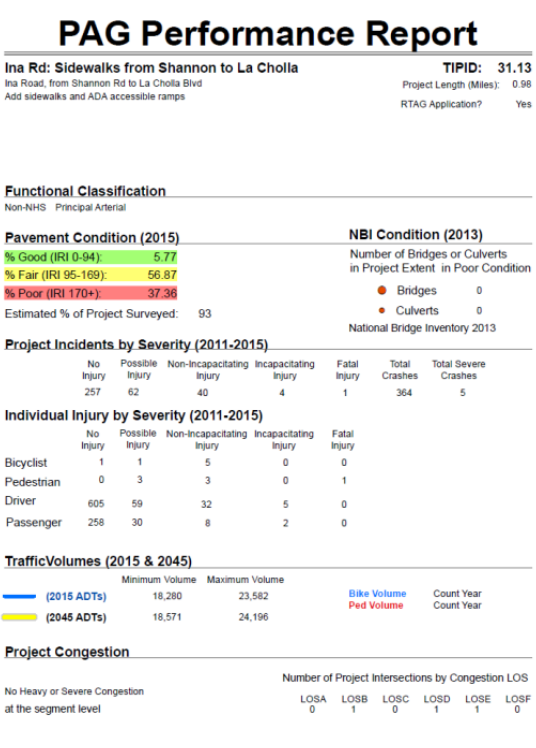
Exhibit 18
Example PAG Transportation Network Data Portal (TNDP) Interactive Web-Map



Source: Pima Association of Governments Network Data Portal (TNDP), March 2017.

The TNDP is an effective use of existing conditions data in the programming process by helping identify areas of need and simplifying the application process. When a jurisdiction identifies a candidate project, the user draws the project extent on the website with a built-in map tool and a Performance Report is generated. The Performance Report summarizes the project area's existing performance, displayed both spatially and with descriptive statistics. A summary cover sheet presents key statistics and is followed by detailed pages for each dataset. Examples of these pages are provided in Exhibit 19.

Exhibit 19
Example of PAG Performance Report Available Through the PAG TNDP



PAG Performance Report

Ina Rd: Sidewalks from Shannon to La Cholla — TIPID: 31.13
Ina Road, from Shannon Rd to La Cholla Blvd — Project Length (Miles): 0.98
Add sidewalks and ADA accessible ramps — RTAG Application? Yes

Functional Classification
Non-NHS Principal Arterial

Pavement Condition (2015)

% Good (IRI 0-94):	5.77
% Fair (IRI 95-169):	56.87
% Poor (IRI 170+):	37.36
Estimated % of Project Surveyed:	93

NBI Condition (2013)
Number of Bridges or Culverts in Project Extent in Poor Condition
Bridges 0
Culverts 0
National Bridge Inventory 2013

Project Incidents by Severity (2011-2015)

No Injury	Possible Injury	Non-Incapacitating Injury	Incapacitating Injury	Fatal Injury	Total Crashes	Total Severe Crashes
257	62	40	4	1	364	5

Individual Injury by Severity (2011-2015)

	No Injury	Possible Injury	Non-Incapacitating Injury	Incapacitating Injury	Fatal Injury
Bicyclist	1	1	5	0	0
Pedestrian	0	3	3	0	1
Driver	605	59	32	5	0
Passenger	258	30	8	2	0

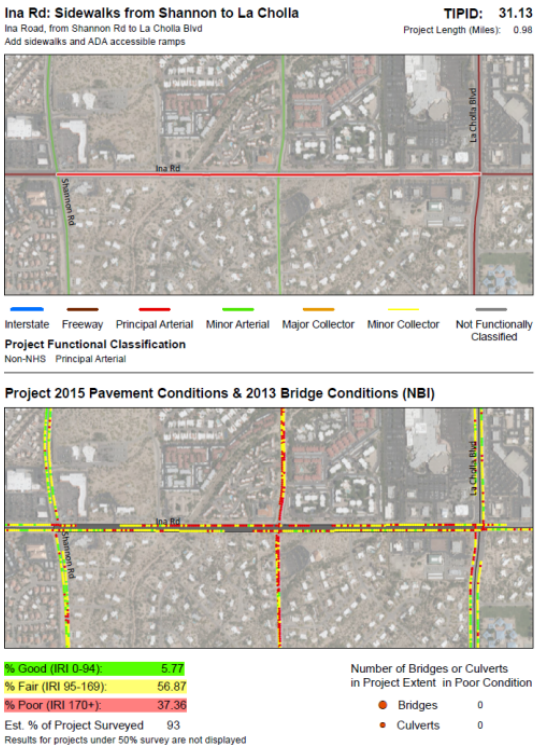
TrafficVolumes (2015 & 2045)

	Minimum Volume	Maximum Volume		
(2015 ADTs)	18,280	23,582	Bike Volume	Count Year
(2045 ADTs)	18,571	24,196	Ped Volume	Count Year

Project Congestion
No Heavy or Severe Congestion at the segment level

Number of Project Intersections by Congestion LOS

LOSA	LOSB	LOSC	LOSD	LOSE	LOSF
0	1	0	1	1	0



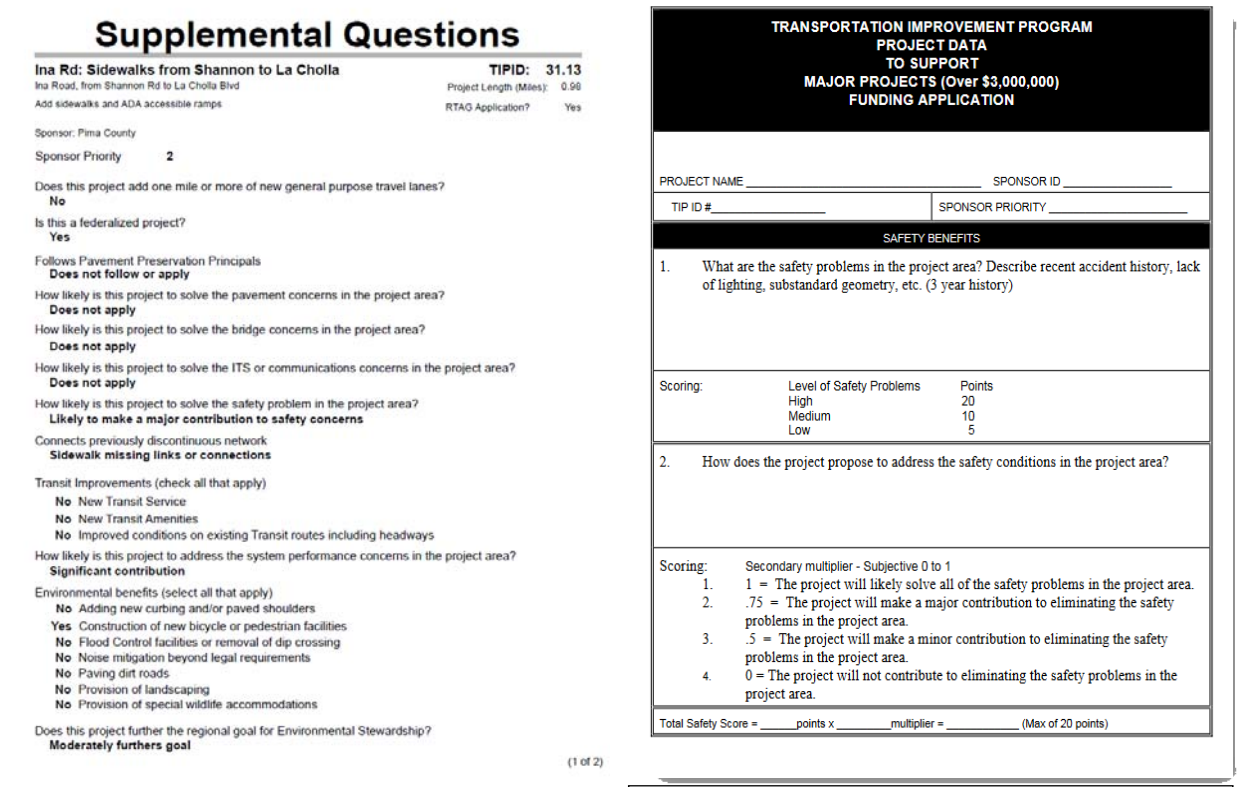
PAG Performance Report cover sheet with summary statistics of key existing conditions on proposed project extent.

PAG Performance Report detailed sheets that spatially display data along the proposed project extent.

The regional data from the Performance Report is used in generating a completed Criteria Sheet, which helps inform programming discussions. Criteria Sheets are a regionally adopted tool that help assess conditions in the project area. The 2010 CMP Final Report expanded the use of congestion data within the Criteria Sheets and further integrated CMP into the programming process. The Criteria Sheet categories are structured around the goal areas within the long range transportation plan maintaining the link between planning and programming. The 2045 RMAP has maintained this connection.

With this new application process, all jurisdictions have access to the same regional transportation datasets to assist them in their analysis and selection of future projects. Questions from the Criteria Sheet not addressed by TNDP, or which cannot be quantified, are covered with a series of supplemental questions completed by the project sponsor. The Supplemental Questions sheet provides greater insight into expected project impacts including effects on system performance, transportation systems communication and technology, network density, transportation safety, and alternative modes. An example of the Supplemental Questions and Criteria sheets are provided in Exhibit 20.

Exhibit 20
Example of PAG Supplemental Questions and Criteria Sheets



Supplemental Questions

Ina Rd: Sidewalks from Shannon to La Cholla **TIPID: 31.13**

Ina Road, from Shannon Rd to La Cholla Blvd — Project Length (Miles): 0.98

Add sidewalks and ADA accessible ramps — RTAG Application? Yes

Sponsor: Pima County

Sponsor Priority **2**

Does this project add one mile or more of new general purpose travel lanes?
No

Is this a federalized project?
Yes

Follows Pavement Preservation Principals
Does not follow or apply

How likely is this project to solve the pavement concerns in the project area?
Does not apply

How likely is this project to solve the bridge concerns in the project area?
Does not apply

How likely is this project to solve the ITS or communications concerns in the project area?
Does not apply

How likely is this project to solve the safety problem in the project area?
Likely to make a major contribution to safety concerns

Connects previously discontinuous network
Sidewalk missing links or connections

Transit Improvements (check all that apply)
No New Transit Service
No New Transit Amenities
No Improved conditions on existing Transit routes including headways

How likely is this project to address the system performance concerns in the project area?
Significant contribution

Environmental benefits (select all that apply)
No Adding new curbing and/or paved shoulders
Yes Construction of new bicycle or pedestrian facilities
No Flood Control facilities or removal of dip crossing
No Noise mitigation beyond legal requirements
No Paving dirt roads
No Provision of landscaping
No Provision of special wildlife accommodations

Does this project further the regional goal for Environmental Stewardship?
Moderately furthers goal

(1 of 2)

TRANSPORTATION IMPROVEMENT PROGRAM
PROJECT DATA
TO SUPPORT
MAJOR PROJECTS (Over $3,000,000)
FUNDING APPLICATION

PROJECT NAME _____ SPONSOR ID _____

TIP ID #_____ SPONSOR PRIORITY _____

SAFETY BENEFITS

1. What are the safety problems in the project area? Describe recent accident history, lack of lighting, substandard geometry, etc. (3 year history)

Scoring:	Level of Safety Problems	Points
	High	20
	Medium	10
	Low	5

2. How does the project propose to address the safety conditions in the project area?

Scoring: Secondary multiplier - Subjective 0 to 1

1. 1 = The project will likely solve all of the safety problems in the project area.
2. .75 = The project will make a major contribution to eliminating the safety problems in the project area.
3. .5 = The project will make a minor contribution to eliminating the safety problems in the project area.
4. 0 = The project will not contribute to eliminating the safety problems in the project area.

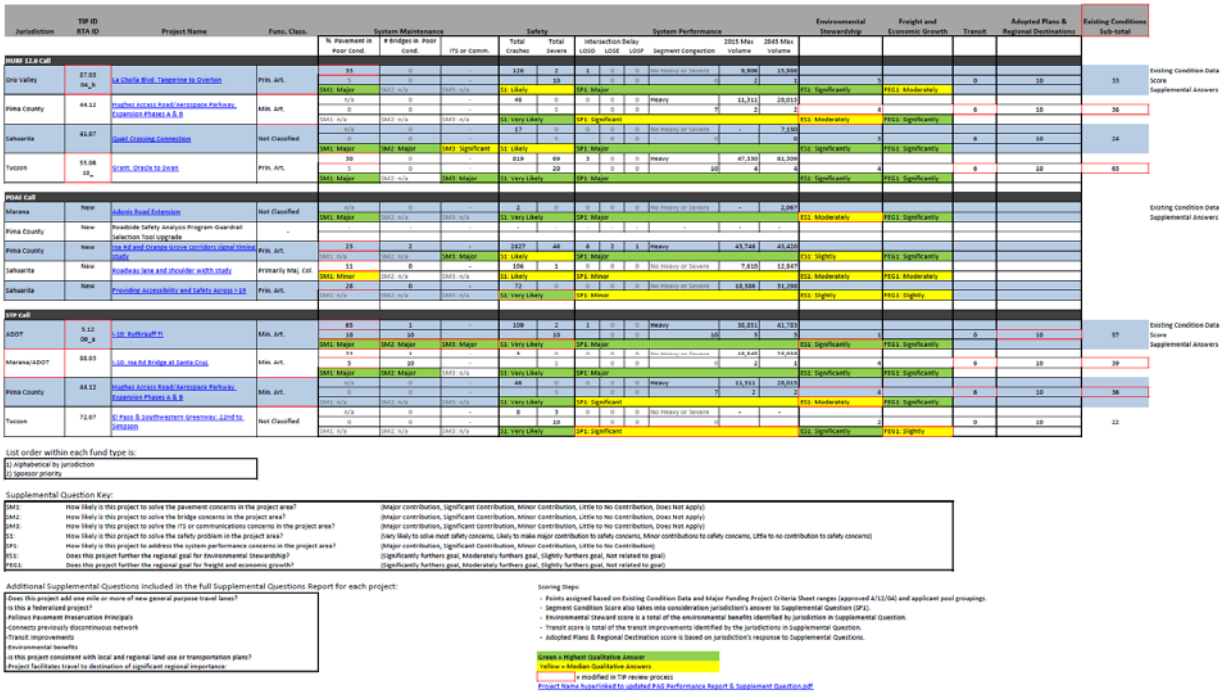
Total Safety Score = _____points x _____multiplier = _____ (Max of 20 points)

Supplemental Questions sheets: completed by project sponsor to capture anticipated project impacts .

Criteria Sheets: project evaluation tool completed in application process using Performance Report and Supplemental Questions data.

The information from the Performance Reports and the Supplemental Questions is synthesized into a matrix which can be used in programming discussions to identify projects that best fulfill the needs of the region. An example Performance Matrix is provided in Exhibit 21.

Exhibit 21
Example Performance Matrix from the PAG CMP Procedure



Performance Matrix containing Performance Report and Supplemental Question Data for multiple projects allowing for side-by-side comparison.

The PAG CMP also produces a comprehensive multi-modal transportation system performance report which provides an assessment of system usage, congestion, safety and other factors for a 5-year period. The PAG *Regional Transportation System Assessment* is one of several tools used by PAG to inform the public regarding the state of the transportation system and assist in guiding decisions for future transportation system improvements. This adds an important element to assist PAG in performance based planning. The latest report covers the period from 2005 to 2010.[34] These reports provide a comprehensive overview and comparison of changes and trends in the following factors and characteristics:

- Housing, Population and Employment
- Traffic Growth
- Daily Traffic Volume, Peak-Hour Bicycle Traffic, Bus Ridership by Route
- Transportation Funding Revenue
- Transportation Expenditures for Operations and Maintenance, and New Projects
- Roadway Congestion (regionally and for congested intersections)
- Pavement Condition
- Transit, Bike, and Pedestrian Performance
- Environment (Air Quality, and Pollution Control Measures)
- Safety

[34] *2005 -2010 Regional Transportation System Performance Assessment,* Pima Association of Governments, February 2013.

This process also identifies projects that qualify as "significant" capacity increasing, that is, projects which add at least one lane-mile of new general purpose roadway. The PAG CMP procedure requires that new "significant" capacity increasing projects provide CMP related information as part of the TIP project application. Local jurisdictional project sponsors answer CMP questions below and fill out a one-page CMP Strategies Toolbox Worksheet to identify CMP strategies that will be delivered as part of the project. The following elements of the CMP Strategies Toolbox Worksheet must be addressed by the project applicant.

- Is the project considered to be a "significant" project according to PAG's Congestion Management Process (CMP)?
- Are Federal funds being used or requested to support the project?
- Is the project a significant increase in SOV capacity?
- Does the project address a congestion issue as identified by PAG's transportation system reporting or other source?
- Does the project incorporate congestion management strategies as identified in the PAG CMP Strategies Toolbox or otherwise?
- Identify the congestion management strategies included as part of the project using the "PAG CMP Strategies Toolbox Worksheet."

The procedure developed to review all "significant" SOV projects is designed to help:

- Ensure that significant SOV projects consider, and when applicable include congestion management strategies as part of the project development process.
- Document the congestion management strategies to be included with the significant SOV project.

The PAG Congestion Management Strategies Toolbox Worksheet is a checklist of congestion management strategies that are considered appropriate and applicable to the region. This checklist is designed to easily facilitate the documentation of strategies to be included with the significant SOV project, but it is not necessarily all inclusive of the strategies that may be used. Local agencies have complete flexibility and latitude to include any additional congestion management strategies into their project, and this is encouraged by PAG. Agencies are also encouraged to consider congestion management strategies as part of non-capacity increasing projects. Existing congestion management and alternative mode strategies implemented within the region are described in the following sections, followed by a brief description of planned improvements contained in the 2045 RMAP.

PAG's Travel Reduction Program (TRP)

The Travel Reduction Ordinances (TROs), which created the regional Travel Reduction Program (TRP), are in place for Pima County, the cities of Tucson and South Tucson and the towns of Oro Valley, Marana and Sahuarita. The TROs specify that employers with 100 or more full-time equivalent employees at a single or contiguous worksite must participate in the TRP. Employers with fewer than 100 employees can participate voluntarily. The goals of the ordinances are to reduce traffic congestion, reduce fuel consumption and improve air quality. This program is estimated by PAG to have reduced annual vehicle-miles traveled in the region by an average of over 56 million for 2014 and 2015.[35]

The 2015 survey of employees indicated the following:

[35] Draft *2017 – 2021 TIP, 5-year Regional Transportation Program,* Pima Association of Governments.

"Comparing the results over the last four years, there is a significant increase in alternative mode usage and a reduction in vehicle miles traveled for the first time in four years. Carpooling, bus ridership and bike use are showing the largest increases as compared to 2014. This large increase in alternative mode usage can be attributed to the new TRP initiatives and the Sun Rideshare marketing campaign described below."[36]

Sun Rideshare and Vanpool Programs

The Rideshare Program was established in 1974 and is administered by PAG. The following represent significant milestones in the ongoing program growth and increase in employee participation:

- In 2007 the Rideshare Program was expanded to serve all employers and commuters. The number of registrants more than doubled from 224 to 483.
- In 2008 Rideshare installed a new interactive carpool matching system that allows commuters to find carpool partners, vanpool routes, bike buddies, convenient par-and-ride lots, transit routes and schedules on one web site. By the end of 2008 active commuters in the database had grown from 1,290 to 2,836.
- In 2009 the program was renamed Sun Rideshare, reflecting its assimilation into the regional transit system.
- In 2014 the Sun Rideshare website and marketing materials were revamped with new graphics and tag line, "Drive Less. Save More."
- In 2014 a new infomercial was distributed to area employers and social service organization to increase awareness of Sun rideshare services and benefits.
- In 2014 the Sun Rideshare Rewards Program began and will continue through 2016. Rideshare participants can qualify for monthly prize drawings through the program's point system. Non-commuters can also participate with non-commute trips to earn points. In 2015 939 people participated in the Rewards Program.

Park & Ride Lots

The regional transit system currently provides 27 free Park and Ride lots across the region. The Sun Tran website provides information on the location of each lot and the transit routes serving them.[37] The Draft 2045 RMAP includes $20 million for the development of new Park and Ride lots throughout the region.

Regional Traffic Signal System

The City of Tucson, Arizona Department of Transportation, Pima County, Marana, Oro Valley, Sahuarita, the City of South Tucson, the Pascua Yaqui Tribe and the Tohono O'odham Nation are in partnership to provide "seamless" traffic signal operations across jurisdictional boundaries. This has resulted in the interconnection of traffic signals into a centrally coordinated operation. This system has been expanded to encompass all the traffic signals in the Tucson metro area, making Tucson one of the few, if not only,

[36] Draft *2017 – 2021 TIP, 5-year Regional Transportation Program,* Pima Association of Governments, pg. 35.
[37] http://www.suntran.com/commuter_park.php

metropolitan areas of its size with of the majority of its signals from multiple jurisdictions controlled from a single center. Currently over 600 traffic signals from throughout the region are actively monitored and controlled from the City of Tucson Transportation Control Center on behalf of the region. In a multi-jurisdictional coordinated effort, the region's signals use multiple signal timing patterns in order to maximize the efficiency of the network as a whole. This type of signal coordination being implemented in the Tucson area is providing for improved traffic flow. Such improvements tend to be most effective in locally congested areas, where progressive flows can reduce stops and signal delay.[38]

PAG's regional traffic signal program has resulted in the updating of over 1,000 traffic signal timing plans throughout the region including I-10 frontage road signals, stand-alone signalized intersections, special event time plans, pedestrian beacon signals and adjustments to accommodate the pedestrian walk speed in the national Manual for Uniform Traffic Control Devices (MUTCD). These efforts are allowing the jurisdictions of the region to move from a reactive signal timing approach to a proactive one, where signal time plans are reviewed and adjusted regularly. Benefits of the program included reduced delay and congestion, reduced fuel consumption and emissions, improved safety, and "seamless" traffic signal operation throughout the region.[39]

Recent retiming efforts of 133 traffic signals throughout the region focused on extensive timing plan modifications, extra vehicle throughput capacity and smoother traffic flow without negatively impacting pedestrian mobility. This resulted in just under a 10 percent reduction in vehicle delay and a 3 percent reduction in fuel consumption.[40]

Sun Tran

Sun Tran provides fixed route transit service within the City of Tucson, and through intergovernmental agreements, delivers service into Pima County, the City of South Tucson, the Town of Marana, the Town of Oro Valley, the Tohono O'Odham Nation and the Pascua Yaqui Tribe. Sun Tran currently has a fleet consisting of 252 buses, which is 26 more than in 2010 (a 10 percent increase). The system's 43 fixed routes (3 more than in 2010) cover a 296 square-mile area.

Annual Sun Tran ridership peaked in 2009 with over 21.6 million riders. Ridership has declined slightly since then with 2015 ridership at over 19.6 million annually (9 percent decline from the peak).

The Regional Transportation Authority (RTA) has made a firm commitment to expanding Sun Tran services. Over the last 10 years the following notable improvements/programs have been implemented:[41]

- Sun Tran implemented the first fixed-route improvements funded by the RTA in fall 2006, when buses were deployed on key routes to relieve a portion of the overcrowding.
- In May 2007, the Arizona Department of Transportation provided funding for Sun Tran to begin a new express route from Marana to downtown Tucson to provide a commuting alternative during the I-10 Widening Project. Additionally, Sun Tran worked with the Town of Marana to secure a Park and Ride lot at Arizona Pavilions.

[38] Draft *2017 – 2021 TIP, 5-year Regional Transportation Program,* Pima Association of Governments.
[39] Ibid.
[40] Ibid.
[41] Ibid.

- In 2009, RTA-funded fleet expansion enabled Sun Tran to launch three express routes serving Oro Valley and Rita Ranch to Downtown Tucson, and from Oro Valley to the Aero Park area. Also in 2009, Routes 27 and 312X were extended, additional Park and Ride lots were established, and additional trips were provided on Routes 103X and 105X to better meet passenger needs. Additionally, construction was completed on the new Northwest Bus Storage and Maintenance facility designed to accommodate an additional 150 buses.
- In 2010, RTA funding provided additional trips for Sun Express Routes 109X and 110X.
- In 2013, bus frequency was improved on two high demand routes – Route 7 and Route 16.
- In May 2015, the Broadway/Houghton Park and Ride lot opened, providing a transit hub on the eastside and serving Routes 4, 8 and 108X.
- In 2009 the RTA introduced the formation of a seamless regional transit system which consolidated customer service information for the various elements of regional transit. Elements included a website featuring trip planning, schedules, maps and fare information, and a single customer service center with one phone number.
- Sun Tran has recently added four new Park and Ride lots in outlying communities to attract additional riders.
- Commuters can bike and ride on Sun Tran at no additional charge. Each coach is equipped with bike racks, and folding bicycles are accommodated on board. Rental bike lockers are available at a nominal charge at five of the Park and Ride lots and other select bus stop locations.
- The University of Arizona (UA) offers subsidized bus passes to students, faculty and staff through the U-Pass program. In 2015 a promotional campaign was launched to promote the use of the GoTucson mobile app as a way to purchase the discounted passes.
- Most governmental employers in Tucson offer reduced-cost bus passes through Sun Tran's commuter pass program, Get on Board.

Sun Van

Sun Van has provided paratransit service to the Tucson Metropolitan area and portions of Pima County and South Tucson since 1987. Sun Van has a fleet of 128 vehicles (an increase of 9 vehicles since 2010), which includes 108 cut-away vans, as well as 10 accessible minivans and 10 sedans to transport ambulatory passengers. Ridership has increased 29 percent over the 10 year period from FY 2006 to FY 2015. FY 2015 ridership was 553,352, which was a 1.2 percent decline from the previous year.[42]

Sun Link Streetcar

The Sun Link streetcar launched on July 25, 2014 and provides service seven days a week to five of Tucson's key entertainment districts along a 4-mile route including the Mercado, Downtown Tucson, Fourth Avenue, Main Gate Square and the University of Arizona.

Since launching in July 2014, ridership has exceeded pre-launch projections with an average daily ridership of approximately 4,000 passenger trips provided. Sun Link's millionth rider was celebrated on May 21, 2015, which occurred 44 days ahead of the projected ridership numbers. In the first year of service, Sun Link provided 1.1 million passenger trips, with that number expected to reach 1.2 million passenger trips in FY 2016.[43]

[42] Draft *2017 – 2021 TIP, 5-year Regional Transportation Program,* Pima Association of Governments.
[43] Ibid.

Sun Shuttle

In May 2009, with funding provided by the Regional Transportation Authority (RTA), Sun Shuttle launched neighborhood fixed-route transit services in Marana, Oro Valley, Catalina, Sahuarita and Green Valley. In November 2009, the RTA assumed operations of Pima County Rural Transit (PCRT) routes in San Xavier, Tucson Estates and Marana. In December 2012, a new Sun Shuttle route was launched serving Southeast Tucson and Rita Ranch. Sun Shuttle routes offer transportation to passengers within their own community and connections to Sun Tran and Sun Link services, providing an important link to the Tucson Metropolitan area from the rural and suburban communities.

Bus Pullouts

Nearly 100 bus pullouts have been built region wide over the past few years. The pullouts were installed on arterials and collectors with both high vehicular volume and high bus boardings and alightings. These pullouts help reduce corridor congestion.[44]

Transit Boarding Efficiencies

Sun Tran's adoption of a smart card system allows prepaid fare usage reducing stop time while providing additional rider information. Sun Tran has also launched a Smartphone app as an additional means of pre-purchasing fares. Sun Link allows front and rear access to vehicles, increasing boarding and alighting efficiency, reducing stop time and improving headways.

2045 RMAP Transit Projects

The majority of transit funding in the 2045 RMAP, about 68 percent or $3 billion, is for maintaining current levels of transit service for the next 30 years. This includes maintaining existing Sun Tran fixed-route bus service, Sun Van paratransit (both required complementary service and optional service areas), RTA-funded Sun Shuttle circulator service, and RTA regional paratransit.[45]

In addition to maintaining the existing transit system, the 2045 RMAP proposes roughly $1.3 billion in transit improvements over the next 30 years to increase transit access, convenience and expand transportation choices in the region. These transit improvements include:

- Fixed route bus frequency improvements.
- Bus rapid transit enhancements.
- Streetcar extension.

A review of the 2045 RMAP list of projects indicates that transit expenditures, including improvements and operating costs, but excluding maintenance, will total nearly $4 billion over the 30-year plan.

Pedestrian and Bicycle Facilities

Currently, approximately 10 percent of all trips are made on foot and 2 percent by bicycle, indicating that a significant share of the region's population either walks or rides to make at least some of their weekly trips. The mileage of bike facilities, including striped bike lanes, shared-use paths, signed bike

[44] *2045 Regional Mobility and Accessibility Plan,* Pima Association of Governments, May 26, 2016, Appendix 2.
[45] *2045 Regional Mobility and Accessibility Plan,* Pima Association of Governments, May 26, 2016.

routes and bike boulevards, has grown by nearly 200 percent since 2004; there are now over 1,000 miles of identified bike facilities in Pima County. Bike commuting has increased substantially in the past decade, with the number of bike commuters growing by 122 percent between 2006 and 2014.

As the region has made great strides in becoming a first rate bicycle-friendly community, the pedestrian network, however, continues to have many gaps. As of 2012, it was estimated that roughly 75 percent of roadsides on major roadways in the urban area were either inaccessible to persons with disabilities or they lacked sidewalks entirely.[46] Pedestrian safety also continues to be an issue that is being addressed.

Now, most roadway improvements include pedestrian improvements and the region's jurisdictions have made considerable progress in retrofitting the existing system to close gaps in the pedestrian network. The RTA also funded installation of more than 50 High Intensity Activated Crosswalk (HAWK) lights in the past 10 years to provide safer crossing opportunities on the region's high-speed, high-volume roadways.

A review of the 2045 RMAP indicates that a total of 84 significant arterial SOV projects, 10 of which are ADOT projects not subject to the PAG congestion management strategy review. Of the 74 remaining local jurisdiction projects, 54 include bike lanes and sidewalks (73 percent), three of which also include bus pullouts, and 11 more include only bike lanes (15 percent). Therefore, a total of 88 percent of local jurisdiction significant SOV projects include some alternative mode aspects as part of the congestion management strategy. The nine arterial significant SOV projects that do not include alternative congestion management strategies are in less populated areas.

PAG estimates that the cost of the bike lanes and sidewalks accounts for between 20 and 25 percent of corridor improvement costs. The 2045 RMAP indicates that corridor improvements which include bicycle and pedestrian facilities amount to $2.79 billion dollars in cost over 30 years. Twenty to 25 percent of this would mean an expenditure of between $558 million and $698 million for new pedestrian and bicycle facilities. Stand-alone pedestrian and bicycle projects contained in the 2045 RMAP amount to an additional $284 million. This yields a total between $842 million and $982 million over 30 years.

Roadway Capacity Improvements

The 2045 RMAP contains over 100 roadway corridor and capacity improvement projects to address existing congestion and future anticipated congestion problems. Twenty-two of these projects are ADOT freeway improvement projects and 10 more are ADOT non-freeway corridor improvements. As noted early, a significant portion of the local jurisdiction projects contain pedestrian and bicycle facilities. The estimated total cost of the arterial roadway capacity improvements is $2.79 billion, and the cost of the freeway improvements is $3.33 billion over the 30-year RMAP. These improvements include general use lane additions, additional turn lanes at signalized intersection, interchange improvements, and unconventional intersection designs (e.g., the use of indirect left-turns) to improve capacity, traffic operations, and safety, and reduce congestion.

Recently, the use of indirect left-turns has been implemented at two major intersections within the region – the Ina Road/Oracle Road intersection and the Grant Road/Oracle Road intersection. These two intersections use indirect left-turns on the east-west intersection approaches, while the north-south approaches use conventional left-turns. This reduces traffic signal operation to 3-phases, providing

[46] *2045 Regional Mobility and Accessibility Plan,* Pima Association of Governments, May 26, 2016.

more green time for all movements. The result is an increase in capacity, reduced delay, and improved safety. A third application in the region (Valencia Road/Kolb Road intersection) is under design along major commuter routes that will employ indirect left-turns on all four intersection approaches. The highest volume left-turn movements will also use ramps for the left-turns to merge with cross street traffic, thus eliminating the need for these movements to travel through the main intersection twice. This intersection will operate under 2-phase signal control, which will increase capacity, reduce delay, and improve safety at the location. A detailed study analysis of over 35 alternative designs, including grade separations, found that this design concept provided the overall best traffic operations and lowest levels of congestion and delay. Other locations in the metro-area (e.g., Grant Road corridor) are also in various stages of planning and design for the implementation of indirect left-turn intersection applications.

Summary of the 2045 RMAP Congestion Related Project Planned Expenditures

Exhibit 18 provides a brief summary of the planned expenditures contained in the 2045 RMAP that are considered to related to congestion management. The information in Exhibit 22 indicates that $10.7 billion (62 percent) of the planned total 2045 RMAP expenditures relate directly to congestion management for either existing or anticipated future congestion issues.

Exhibit 22
2045 RMAP Planned Expenditures on Congestion Management (CM) Projects

Project/Program Type	Project/Program Cost (000s) [2]	Percent of CM Total Cost
Arterial Capacity [1]	$2,786,931	26.0
Freeway/Interchange Capacity	$3,331,588	31.1
Transit (includes operating cost)	$3,993,980	37.3
Bicycle & Pedestrian (stand-alone projects)	$283,540	2.6
Traffic Management	$264,375	2.5
Other Alternative Modes	$44,700	0.4
Total for CM Related Projects/Programs	$10,705,114	100.0
Total 2045 RMAP Funding	$17,283,637	
CM Related Project Cost % of RMAP Total	62	

1. Note that the vast majority of these projects include bicycle lanes and sidewalks. Bicycle and pedestrian improvements are estimated by PAG to be as much as 20 to 25 percent of the total cost of corridor improvement.
2. Only projects /programs that were considered to contribute to congestion management were included.

Source: PAG *2045 RMAP, May 26, 2016,* Appendix 3.

TOOLBOX OF POTENTIAL CM STRATEGIES

Appendix C of the 2010 PAG CMP[47] contains a list of 80 congestion management strategies in five general categories of application based on how a strategy would affect trip making and thus congestion. Those general categories are:

1. Eliminate person trips or reduce VMT during the peak hours (e.g., coordination land use/transportation policies, travel demand management, and congestion pricing).
2. Shift trips from automobile to other modes (e.g., expansion of transit service, improvement of pedestrian and bicycle facilities).
3. Shift trips from single-occupant vehicles (SOV) to high occupant vehicles (HOV) (e.g., use of HOV lanes, rideshare programs, and employer trip programs).
4. Improve roadway operations (e.g., access management, incident management, improved traffic signal timing, intersection improvements, and Intelligent Transportation System applications like freeway management).
5. Add roadway capacity (e.g., adding additional general purpose traffic lane to existing roadways, or building new roadways on new alignments).

Based on the previous review of the regional congestion management efforts, it is clear that PAG, along with the local jurisdictions, and ADOT have made, and are committed to the continuing implementation of CM strategies from each of the above categories. In this effort, it is critical for PAG to keep up with the state of the practice with an understanding of which strategies have proven to be cost-effective, and to understand whether other strategies have been identified as effective since the 2010 CMP was prepared.

Texas Transportation Institute (TTI) Study

A 2011 study prepared by the Texas Transportation Institute[48] was conducted for the State of Michigan to prepare desk reference for practitioners to better understand the development, planning, and implementation of congestion mitigation strategies. The TTI study conducted a web-based survey of MPOs across the nation in 2011, to assess which types of congestion mitigation strategies were most often used, which were considered most successful, and which were considered least successful. Six percent (22) of the potential respondents completed the survey. Responses were received primarily from the Midwest and Northeast regions over a wide range of populations representing small, mid-, and large size MPOs. Exhibit 23 provides a summary of the types of congestion management strategies addressed. Survey respondents were asked to identify congestion management strategies that had been implemented and rate each strategy based on implementation cost, implementation time, and project life (see Appendix C). The study ranked the strategies based on these responses. Exhibits 24, 25, and 26 present the results from the survey of MPOs. The congestion mitigation effectiveness of strategies was not directly measured by the TTI study team, but was based, in part, on survey responses, and on the review of other reported estimates found in various sources.

[47] *Congestion Management Process,* Pima Association of Governments, Final Report, June 2010, prepared by Morrison Maierle, Inc.
[48] Crawford, J.A., et.al., *A Michigan Toolbox for Mitigating Traffic Congestion,* prepared for the Michigan Department of Transportation, prepared by the Texas Transportation Institute, September 30, 2011.

Exhibit 23
Congestion Mitigation Strategies Addressed in the TTI Study

1. Supply/System Management
    a. Traffic Operations
        i. Increasing number of lanes without widening
        ii. Increase number of lanes by widening/lane additions
        iii. Highway ramp closures/reconfigurations
            1. Diverging diamonds
            2. Loop ramps eliminating left turns
            3. Deceleration/Acceleration Auxiliary Lanes
        iv. Bottleneck removal
        v. Geometric design improvements
            1. Intersection improvements
            2. Auxiliary lanes for merging and diverging
            3. Acceleration/deceleration lanes
            4. Intersection channelization
            5. Commercial vehicles accommodations
            6. One-way streets
        vi. Super street arterials (grade-separated intersections)
        vii. Complete streets
        viii. Improving street continuity
        ix. Vehicle use restrictions
        x. Access management
        xi. Active traffic management
            1. Speed harmonization
            2. Temporary shoulder use
            3. Queue warning
            4. Dynamic merge control
            5. Construction site management
            6. Dynamic truck restrictions
            7. Dynamic traveler information and rerouting
            8. Automated enforcement
        xii. Intelligent Transportation Systems
            1. Advanced traveler information systems
            2. Performance measurement
        xiii. Traffic signals
        xiv. Reversible traffic lanes/changeable lane assignments
        xv. Exclusive lanes
        xvi. Incident management
            1. Service/courtesy patrols
        xvii. Special event management
        xviii. Road weather management
    b. Transit
        i. Park-and-ride lots
    c. Multimodal transportation centers
    d. Freight rail improvements
    e. Bicycle and pedestrian
    f. Reducing construction/maintenance interference
2. Demand Management
    a. Work schedule changes
    b. Land use development
    c. Ridesharing/vanpools
    d. Diversified development patterns
    e. New community design (smart growth)
        i. Compact Development
        ii. Redevelopment and Infill redevelopment
        iii. Mixed use Development
        iv. Jobs/Housing balance
        v. Transit-Oriented Development
        vi. Corridor Land Use and Transportation Coordination
    f. Car sharing
    g. Trip reduction ordinances

Source: Crawford, J.A., et.al., *A Michigan Toolbox for Mitigating Traffic Congestion,* prepared for the Michigan Department of Transportation, prepared by the Texas Transportation Institute, September 30, 2011.

The TTI survey provides some very useful information:

- Traffic signal strategies are among the most often used, most successful, and easiest to implement strategies. The use of adaptive signal controls/demand responsive signals is a strategy that was not specifically included in the 2010 PAG CMP toolbox, but it should be added.
- Incident management strategies were among the most often used and were considered to be among the most successful.
- Bicycle/pedestrian support services were one of the most used and easiest to use, but were considered one of the least successful strategies.
- Geometric design improvements were one of the most used and most successful, but considered one of the most difficult to implement.
- Workzone strategies were among the most often used and were considered among the easiest to implement.
- Work schedule changes were among the most often used and were considered among the easiest to implement.
- Land use strategies were among the most often used but were considered among the most difficult to implement.
- While the TTI report indicates that freeway ramp metering can provide significant benefits for freeway traffic operations[49], this strategy was identified by survey respondents as one of the least effective.

[49] Crawford, J.A., et.al., *A Michigan Toolbox for Mitigating Traffic Congestion,* prepared for the Michigan Department of Transportation, prepared by the Texas Transportation Institute, September 30, 2011, pg. 51.

Exhibit 24
Top 20 Most Implemented or Planned Congestion Mitigation Strategies Among Respondents in TTI Study Survey

Group	Action	% of Respondents
Geometric Design Improvements	Additional turn lanes at intersections	96%
	Lengthened turn lanes at intersection for queuing	88%
Access Management	Two-way-left-turn-lanes	88%
	Raised median installation	83%
	Left-turn restrictions	83%
Traffic Signal Strategies	Coordination	100%
	Retiming	95%
	Equipment upgrade	95%
	Adaptive signal controls/demand responsive	82%
Incident Management Strategies	Variable message signs	86%
	Camera monitoring	82%
Transit Capital Improvements	Vehicle replacement/upgrade	91%
Transit Support Facilities	Park-and-Ride lots	82%
	Paratransit	82%
Bicycle/Pedestrian Improvements	Improved facilities (lighting, signing, etc)	95%
	New sidewalks	91%
	Rails to trails developments	86%
Bicycle/Pedestrian Support Services	Bike racks at transit vehicles	100%
	Bike racks on transit stations	91%
	Bike racks at destinations	91%
	Route maps	82%
	Promotional campaigns	82%
	Educational outreach	86%
Workzone Strategies	Work zone management	82%
Work Schedule Changes	Telecommuting	82%
Land Use Strategies	Mixed-use developments	82%
	Infill and densification	82%
Ridesharing/Vanpool Strategies	Marketing and promotions	86%
	Ridematching services	82%
	Guaranteed ride home	82%

Source: Crawford, J.A., et.al., *A Michigan Toolbox for Mitigating Traffic Congestion,* prepared for the Michigan Department of Transportation, prepared by the Texas Transportation Institute, September 30, 2011.

Exhibit 25
Most Successful and Least Successful Mitigation Strategies as Identified by Respondents in the TTI Study Survey

Ten Most Successful Congestion Mitigation Strategies

Group	Action	Success: Rating (1-5, 3=avg)	Success: Strength From Average	n
Lanes without Widening	Shoulder used for part-time travel lane	4.50	1.50	2
Geometric Design Improvements	Grade separations (street-rail)	4.40	1.40	10
	Grade separations (street-street)	4.20	1.20	10
Traffic Signal Strategies	Coordination	4.35	1.35	20
	Retiming	4.30	1.30	20
	Adaptive signal controls/demand responsive	4.23	1.23	13
	Equipment upgrade	4.15	1.15	20
Incident Management Strategies	Traffic/courtesy patrols	4.25	1.25	12
	Response teams	4.14	1.14	14
Contracting Strategies	Allowable working days and working hours	4.14	1.14	7

Eight Least Successful Congestion Mitigation Strategies

Group	Action	Success: Rating (1-5, 3=avg)	Success: Strength from Average	n
Time-of-Day Policies	Truck peak period bans on arterials	2.67	-0.33	3
Ramp Metering Systems	Ramp metering - HOV bypass	2.50	-0.50	2
Freeway HOV	Contraflow - barrier separated	2.50	-0.50	2
Bicycle/Pedestrian Support Services	Lockers at transit stations	2.90	-0.10	10
	Lockers at destinations	2.75	-0.25	8
	Shower facilities at transit stations	2.60	-0.40	5
New Community Design	Transit oriented development design requirements	2.83	-0.17	6
Trip Reduction Ordinances	Trip reduction goal programs	2.80	-0.20	5

Source: Crawford, J.A., et.al., *A Michigan Toolbox for Mitigating Traffic Congestion,* prepared for the Michigan Department of Transportation, prepared by the Texas Transportation Institute, September 30, 2011.

Exhibit 26
Easiest and Most Difficult Congestion Mitigation Strategies to Implement as Identified by Respondents in TTI Study Survey

Ten Easiest Congestion Mitigation Strategies to Implement

		Ease of Implementation		
Group	Action	Rating (3=neutral)	Strength from Neutral	n
Traffic Signal Strategies	Retiming	4.05	1.05	20
	Coordination	3.70	0.70	20
Reversible Lanes	Reversible Lanes	3.71	0.71	7
Bicycle/Pedestrian Support Services	Bike racks at transit stations	3.94	0.94	18
	Route maps	3.89	0.89	18
	Promotional campaigns	3.88	0.88	16
	Bike racks on transit vehicles	3.75	0.75	20
	Educational outreach	3.71	0.71	17
Work Zone Strategies	Advance information	3.83	0.83	12
	Trailblazing/detours	3.70	0.70	10
Work Schedule Changes	Flextime	3.71	0.71	14

Ten Most Difficult Congestion Mitigation Strategies to Implement

		Ease of Implementation		
Group	Action	Rating (3=neutral)	Strength from Neutral	n
Ramp Removal/Reconfiguration	Freeway ramp removals	1.71	-1.29	7
Geometric Design Improvements	Grade separations (street-street)	1.70	-1.17	6
	Grade separations (street-rail)	1.73	-1.30	10
	Diverging diamond intersections	1.83	-1.27	11
Active Traffic Management	Interchange modifications	1.91	-1.09	11
	Dynamic truck restrictions	2.00	-1.00	2
Land Use Strategies	Shower facilities at transit stations	2.00	-1.00	7
	Transit-oriented developments	2.23	-0.77	13
Trip Reduction Ordinances	Mandated programs	2.00	-1.00	4
	Transportation management districts	2.00	-1.00	5

Source: Crawford, J.A., et.al., *A Michigan Toolbox for Mitigating Traffic Congestion,* prepared for the Michigan Department of Transportation, prepared by the Texas Transportation Institute, September 30, 2011.

It is notable that PAG region has implemented to various degrees five of the 10 strategies identified by survey respondents as being most successful. The five most successful strategies that have not been implemented in the PAG region are the following:

- Shoulder use for part-time travel lane.
- Adaptive signal controls/demand responsive.
- Traffic /courtesy patrols.
- Response teams.
- Allowable working days and working hours for contractors.

Incident management has become a major weapon against non-recurring congestion due to traffic incidents in larger metro areas. Notable among various programs is the Highway Emergency Response

Operators (HEROs) in the Atlanta, Georgia metro area.[50] This program is considered a key component of the Georgia DOT Incident Management Program. Those responsible for responding to traffic incidents are not police officers.

The goals of the HERO program are to:

- Minimize major disruption of freeway traffic flow at incident locations.
- Focus on the factors that cause disruption in the flow of traffic and remove those factors.
- Relieve congestion and maintain the consistent flow of traffic at incident locations.
- Reduce response time to traffic-related incidents.

The duties of the HERO responders are:

- Patrol the Atlanta-area freeways 24/7
- Initiate measures to reduce traffic congestion and delays
- Provide support to law enforcement, first-response and other emergency agencies
- Assist in clearing stalled vehicles from the travel lanes
- Help stranded motorists with minor mechanical problems including:
    - Change flat tires
    - Jump start weak batteries
    - Provide gas and water
    - Provide road and travel information
    - Provide transportation to safer areas
    - Provide courtesy use of a telephone

Funding for the HERO program has been provided by Congestion Mitigation/Air Quality (CM/AQ) Fund under the guidance of the Atlanta Regional Commission's (ARC) Incident Management Taskforce. The Taskforce members include the Federal Highway Administration (FHWA), GDOT, traffic reporters, emergency and first-response agencies and the private sector. State Farm® also provides funding support to the HERO program through sponsorship. The HEROs currently patrol select portions of 10 major routes in the Atlanta metro area, including interstate freeways, and state/US routes. A similar program is operating in Austin, Texas.[51]

[50] http://www.511ga.org/static/hero.html
[51] http://www.mobilityauthority.com/information/hero-program.php

MAG Non-Recurring Congestion Study Relevant Countermeasures

The MAG Non-recurring Congestion Study[52] provided a list of relevant congestion countermeasures for the MAG region. These countermeasures were specifically selected to target non-recurring congestion on freeways and arterials. A summary of these measures is provided in Exhibit 27. More detailed lists of non-recurring congestion countermeasures from the MAG study can be found in the Appendix D of this report.

Exhibit 27
Non-Recurring Congestion Countermeasures from the MAG Study

Freeways	Arterials
• Enhanced traffic incident management programs and strategies. • Installation and monitoring of vehicle sensors, and dissemination of resulting traffic information. • Improved information dissemination via existing permanent dynamic message signs (DMS). • Enhanced ramp metering system. • Use of dynamic lane merge control within construction zones. • Implementation of Active Traffic Management strategies (e.g., dynamic lane assignment and/or variable speed limits).	• Enhanced traffic incident management programs and strategies. • Installation and monitoring of vehicle sensors, and dissemination of resulting traffic information. • Improved information dissemination via existing permanent DMS. • Use of portable DMS to disseminate immediate information concerning non-recurring congestion events. • Dynamic/adaptive traffic signal control that adjusts traffic control during non-recurring congestion events.

Source: *MAG Non-Recurring Congestion Study,* Maricopa Association of Governments, prepared by Lee Engineering, with the Texas Transportation Institute, Final Report, October 2011.

[52] *MAG Non-Recurring Congestion Study,* Maricopa Association of Governments, prepared by Lee Engineering, with the Texas Transportation Institute, Final Report, October 2011.

6. FEDERAL REQUIREMENTS FOR NONATTAINMENT TMAs

CONGESTION MANAGEMENT PROCESS IN TRANSPORTATION MANAGEMENT AREAS

The 2016 Transportation Planning Final Rule[53] stipulates additional requirements for states and MPOs regarding the planning process, transportation plans, STIPs and TIPs, and the congestion management process for nonattainment areas. According to the 2016 Transportation Planning Final Rule, nonattainment area means any geographic region of the United States that EPA designates as a nonattainment area under section 107 of the Clean Air Act (42 U.S.C. 7407) for any pollutants for which a National Ambient Air Quality Standard (NAAQS) exists (e.g., ozone, carbon monoxide, PM10, PM2.5, and nitrogen dioxide).

Only those requirements specific to the CMP are addressed here. These requirements would have to be addressed through PAG policies and procedures if the PAG area were to be designated as nonattainment. The following materials were taken directly from the 2016 Transportation Planning Final Rule.

A Transportation Management Area (TMA) means an urbanized area with a population over 200,000, as defined by the Bureau of the Census and designated by the Secretary of Transportation, or any additional area where TMA designation is requested by the Governor and the MPO and designated by the Secretary of Transportation. The Tucson metropolitan area is a designated TMA.

In a TMA designated as nonattainment area for ozone or carbon monoxide pursuant to the Clean Air Act, Federal funds may not be programmed for any project that will result in a significant increase in the carrying capacity for single occupant vehicles (SOVs) (*i.e.,* a new general purpose highway on a new location or adding general purpose lanes, with the exception of safety improvements or the elimination of bottlenecks), unless the project is addressed through a congestion management process.

In TMAs designated as nonattainment for ozone or carbon monoxide, the congestion management process shall provide an appropriate analysis of reasonable (including multimodal) travel demand reduction and operational management strategies for the corridor in which a project that will result in a significant increase in capacity for SOVs (as described above) is proposed to be advanced with Federal funds. If the analysis demonstrates that travel demand reduction and operational management strategies cannot fully satisfy the need for additional capacity in the corridor and additional SOV capacity is warranted, then the congestion management process shall identify all reasonable strategies to manage the SOV facility safely and effectively (or to facilitate its management in the future). Other travel demand reduction and operational management strategies appropriate for the corridor, but not appropriate for incorporation into the SOV facility itself, shall also be identified through the congestion management process. All identified reasonable travel demand reduction and operational management strategies shall be incorporated into the SOV project or committed to by the State and MPO for implementation.

[53] *Federal Register, Vol. 81, No. 103, May 27, 2016, Statewide and Nonmetropolitan Transportation Planning: Metropolitan Transportation Planning, Final Rule*, Federal Highway Administration, Federal Transit Administration.

In metropolitan areas that are in nonattainment for ozone or carbon monoxide, the MPO shall coordinate the development of the metropolitan transportation plan with the process for developing transportation control measures (TCMs) in a State Implementation Plan (SIP).

In TMAs that are in nonattainment for ozone or carbon monoxide, the metropolitan transportation plan shall include consideration of the results of the congestion management process, including the identification of SOV projects that result from a CMP. In addition, in nonattainment area TMAs, the MPO shall provide at least one formal public meeting during the TIP development process.

2016 NPRM – NATIONAL PERFORMANCE MANAGEMENT MEASURES

The 2016 NPRM on National Performance Management Measures[54] proposes significant new requirements for nonattainment areas (see Secs. 490.105, 490.703, 490.803, 490.807, 490.809 of the NPRM). It should be noted that these are only proposed requirements at this time, which may change when the final rule is published. While these requirements do not directly impact the CMP procedures, they do represent significant requirements for States and MPOs regarding the reporting requirements for nonattainment areas. The following materials are taken directly for the 2016 NPRM.

- MPOs serving a TMA with a population over one million representing nonattainment and maintenance areas for ozone, CO, or PM NAAQS shall develop a CMAQ performance plan as required by 23 U.S.C. 149(l). The CMAQ performance plan is not required when the MPO does not serve a TMA with a population over one million; the MPO is attainment for ozone, CO, and PM NAAQS; or the MPO's nonattainment or maintenance area for ozone, CO, or PM NAAQS is outside the urbanized area boundary of the TMA with a population over one million.
- The performance measure to assess traffic congestion for the purpose of carrying out the CMAQ program is "Annual Hours of Excessive Delay Per Capita" (see Exhibit 4 above). The performance measure is applicable to all of the National Highway System in urbanized areas with a population over one million that are, in all or part, designated as nonattainment or maintenance areas for ozone (O_3), carbon monoxide (CO), or particulate matter (PM_{10} and $PM_{2.5}$) (based on) National Ambient Air Quality Standards (NAAQS).
    - State DOTs, in coordination with MPOs, shall define highway reporting segments.
    - State DOTs shall develop hourly traffic volume data for each highway reporting segment.
    - Nonattainment and maintenance areas shall be identified based on the U.S. Environmental Protection Agency's designation of the area under the NAAQS at the time when the State DOT Baseline Performance Period Report is due to FHWA.
- Performance targets for on-road mobile source emission measures shall be established for all nonattainment and maintenance areas.
    - The State DOTs shall establish statewide targets for the on-road mobile source emissions measure for all nonattainment and maintenance areas for all applicable criteria pollutants and precursors.
    - For all nonattainment and maintenance areas within the State geographic boundary, the State DOT shall establish separate statewide targets for each of the applicable criteria pollutants and precursors.

[54] *National Performance Management Measures; Assessing Performance of the National Highway System, Freight Movement on the Interstate System, and Congestion Mitigation and Air Quality Improvement Program,* Federal Highway Administration, 23 CFR Part 490, Notice of Proposed Rule Making, April 22, 2016.

  - In addition to the statewide targets…, State DOTs may, as appropriate, establish additional targets for any number and combination of nonattainment and maintenance areas by applicable criteria pollutant within the geographic boundary of the State.
- The performance measure for the purpose of carrying out the CMAQ Program and for State DOTs to use to assess on-road mobile source emissions is, "Total Emissions Reduction" (see Exhibit 4 above), which is the 2-year and 4-year cumulative reported emission reductions, for all projects funded by CMAQ funds, of each criteria pollutant and applicable precursors ($PM_{2.5}$, PM_{10}, CO, VOC, and NOx) under the CMAQ program for which the area is designated nonattainment or maintenance.
  - The performance measure is applicable to all of the National Highway System in urbanized areas with a population over one million that are, in all or part, designated as nonattainment or maintenance areas for ozone (O_3), carbon monoxide (CO), or particulate matter (PM_{10} and $PM_{2.5}$) National Ambient Air Quality Standards (NAAQS).
  - MPOs shall establish targets for the measure of Total Emission Reduction when mainline highways on the NHS within their metropolitan planning area boundary cross any part of an urbanized area with a population more than 1 million, and that portion of their metropolitan planning area boundary also contains any portion of a nonattainment or maintenance area for any one of the criteria pollutants.
  - The MPO shall establish targets for each of the applicable criteria pollutants and precursors, …, for which it is in nonattainment or maintenance, within its metropolitan planning area boundary.
  - The data needed to calculate the Total Emission Reduction measure shall come from the CMAQ Public Access System and includes:
    - The applicable nonattainment or maintenance area;
    - The applicable MPO; and
    - The emissions reduction estimated for each CMAQ funded project for each of the applicable criteria pollutants and their precursors for which the area is nonattainment or maintenance.

PAG STEPS IF AREA BECOMES NONATTAINMENT

The 2010 Census indicates that the population of the Tucson metro area was then 980,263. It is very likely that the metro area population will soon exceed the 1 million level triggering additional requirements for nonattainment areas. Even before PAG is designated as nonattainment, PAG staff should carefully review the FHWA National Performance Measure Final Rule when it is published to determine whether the above materials from the NPRM are still relevant and whether new requirements have been established for nonattainment areas. The following provides guidance on steps that should be taken if the PAG area is designated as nonattainment:

- Assure that within the CMP, procedures are in place to address the requirements in the 2016 Transportation Planning Final Rule for the analysis of reasonable (including multimodal) travel demand reduction and operational management strategies for potential inclusion with significant SOV projects which are to be advanced with Federal funding.
- Develop and implement any additional policies and procedures to ensure that the development of the metropolitan transportation plan is appropriately coordinated with the process for developing transportation control measures (TCMs) in a State Implementation Plan (SIP).

- Develop and implement policies and procedures necessary to ensure that the metropolitan transportation plan includes consideration of the results of the congestion management process, including the identification of SOV projects that result from a CMP.
- Make sure that PAG provides at least one formal public meeting during the TIP development process.
- Review and understand the requirements for developing a CMAQ Performance Plan. Prepare a CMAQ Performance Plan should the PAG area be designated as nonattainment. A summary of updated performance and reporting requirements for nonattainment areas can be found at the following FHWA website: https://www.fhwa.dot.gov/tpm/about/cmaq.cfm.
- Understand the analytical and data requirements to compute levels and establish targets for the measure of Total Emission Reduction. Evaluate and document these targets and the Total Emission Reduction metric.
- Understand the analytical and data requirements to compute the levels and establish targets for each of the applicable criteria pollutants and precursors, for which it is in nonattainment or maintenance, within its metropolitan planning area boundary. Evaluate and document these targets and pollutant levels as required by Federal Rules.

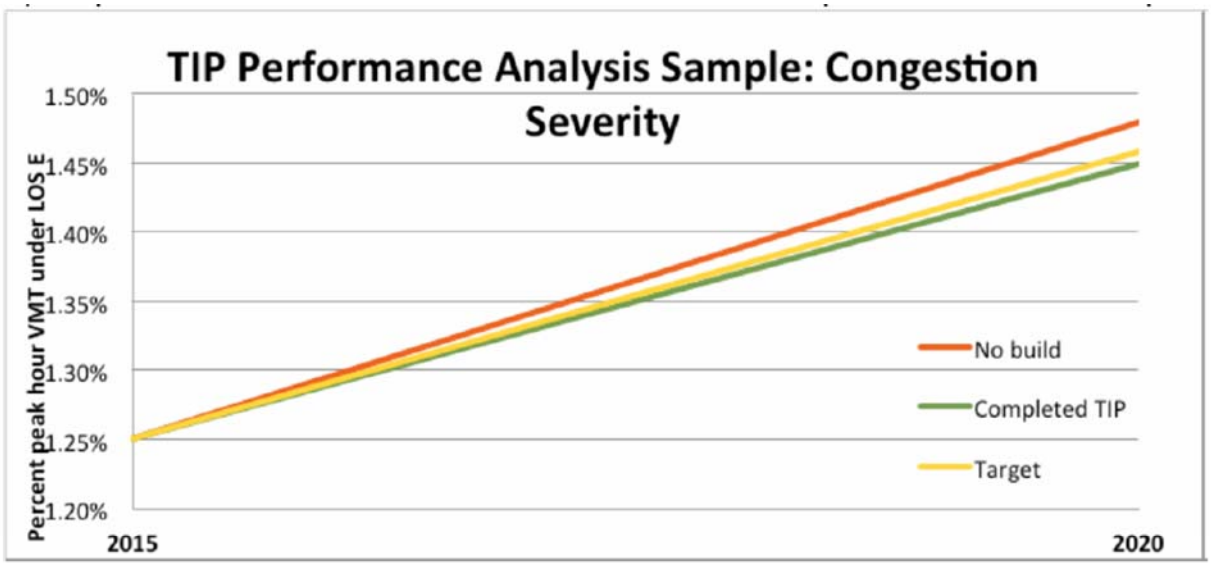
7. MONITORING SYSTEM PERFORMANCE

The previous sections of this report discussing the 2016 Transportation Planning Final Rule on transportation planning makes it clear that transportation system performance report using the agreed upon performance measures, and based on the achievement of the selected performance targets, is required for the TIP and the PAG RMAP. The performance analysis relative to the performance targets should be based on the following general approach:

- An assessment of the baseline or existing condition of the performance measures. The existing condition assessment should be updated biennially and the basic trends in the performance measures reported in the performance report.
- An assessment of the performance measures for a future forecast "no build" condition. This provides for a trend comparison to the baseline condition and performance targets. It will also provide the basis for a comparison to the impacts of the TIP and RMAP projects.
- As assessment of the performance measures for a future forecast condition assuming the TIP and/or RMAP projects are in place. This will provide for a comparison to both the "no build" condition and the performance target.

PAG has already developed a two-dimensional representation of how such a comparison could look for each selected performance measure as shown in Exhibit 28, which was taken from the 2045 Draft RMAP appendix. This type of presentation could be used for each selected performance measure and the associated performance target.

Exhibit 28
Sample Comparison of Transportation System Performance to Performance Target



Source: *2045 Regional Mobility and Accessibility Plan,* Pima Association of Governments, May 26, 2016, Appendix 2.

This two-dimensional representation could be expanded to three dimensions similar to the representation shown in Exhibit 1 of this report. This could be accomplished by plotting a different performance measure or performance target on each axis. Each performance measure should represent a different element of congestion, e.g., duration, extent, intensity. The advantage of the 3-

dimensional representation is that not all three of the performance measures would have to meet or exceed the target values in order for the overall size of the cube represented to be better (i.e., smaller) than the cube represented by the performance targets. This would provide a better visual interpretation of how the overall system performance is progressing.

APPENDIX A

PAG 2045 RMAP Vision, Goals, Performance Measures and Strategies, and PAG Congestion Management Process

CONNECT | MOVE | THRIVE

2045 VISION

The 2045 RMAP envisions a state-of-the-art, reliable, multimodal and environmentally responsible regional transportation system that is continuously maintained, interconnected and integrated with sustainable land use patterns to support a high quality of life and a healthy, safe and economically vibrant region.

System Maintenance: Roadways, bike and pedestrian infrastructure, and transit systems that are rehabilitated, complete, and maintained in a state of good repair

Objective	Performance Measure	Current	2020 Benchmark	2045 Plan Target
Improve the condition of roadways in the Tucson region	Percentage of federal-aid roadways rated in "poor" condition based on International Roughness Index	37% in poor condition	Under 30% in poor condition by 2020	Below 20% poor by 2045
Maintain the share of structurally deficient bridges	Percentage of bridges rated as structurally deficient	8%	8%	Maintain below 10%
Maintain the regional transit fleet in a state of good repair	Average age of buses	6.5 years	6.5 years	Maintain under 7 year average age

System Maintenance Strategies

1) *Develop and support uniform system performance planning tools that assist local agencies and establish consistent reporting standards region-wide.*

2) *Incorporate best practices in pavement management systems and encourage communication across jurisdictions about successful strategies.*

3) *Encourage the programming of regional funding for pavement preservation.*

4) *Explore sustainable local funding solutions to maintain the region's transportation assets.*

Safety: Safety and security for all transportation users across the region

Objective	Performance Measure	Current	2020 Benchmark	2045 Plan Target
Reduce total roadway injuries and fatalities	Total 5-year average of incapacitating injuries	675	640	Reduce by 25%
	Rate of 5-year average incapacitating injuries per 100 million Vehicle Miles Traveled (VMT)	8.09	7.75	Reduce by 45%
	Total 5-year average of roadway fatalities	100	95	Reduce by 25%
	Rate of 5-year average fatalities per 100 million VMT	1.2	1.11	Reduce by 45%
Reduce pedestrian injuries and fatalities	Total 5-year average of pedestrian incapacitating injuries	59.6	56	Reduce by 33%
	Rate of 5-year average incapacitating pedestrian injuries per 10,000 walk commuters	57.12	51	Reduce by 70%
	Total 5-year average of pedestrian fatalities	22	20	Reduce by 33%
	Rate of 5-year average pedestrian fatalities per10,000 walk commuters	21.08	18.5	Reduce by 70%
Reduce bicyclist injuries and fatalities	Total 5-year average of bicyclist incapacitating injuries	39.2	37	Reduce by 33%
	Rate of 5-year average incapacitating bicyclist injuries per 10,000 bike commuters	57.67	51	Reduce by 70%
	Total 5-year average of bicyclist fatalities	2.8	2.6	Reduce by 33%
	Rate of 5-year average bicyclist fatalities per 10,000 bike commuters	4.12	3.65	Reduce by 70%
Maintain a low rate of transit vehicle crashes	Vehicle accidents per 100,000 miles	1.7	1.5	Reduce by 10%

Safety Strategies

1) *Integrate Vision Zero into all levels of transportation planning with the aim of ultimately eliminating all roadway fatalities.*

2) *Promote safe and efficient incident response and clearance through development and implementation of a formalized regional incident management program.*

3) *Maintain the roadways, sidewalks, bicycle and transit facilities through filling potholes, sweeping debris and maintaining traffic signals. Execute timely responses to safety concerns regarding the transportation network.*

4) *Support the development of a comprehensive performance measurement program for the region whereby safety and security issues are identified and addressed promptly.*

5) *Incorporate emergency service agencies in the transportation planning and implementation processes in order to ensure delivery of transportation security to the traveling public.*

6) *Evaluate and encourage the installation of applicable emergency traffic signal preemption equipment at signalized intersections, fire station roadway access points and other locations.*

7) *Include Roadway Safety Assessments (RSA) as part of projects addressing safety issues. RSAs should be addressed during the scoping and design process to incorporate safety features in all projects as early as possible and in order to avoid project retrofits.*

8) *Increase the use of Intelligent Transportation System (ITS) strategies in work zones, such as dynamic message signs and dynamic lane merge systems that provide real-time traveler information and real-time response to lane merging conditions. Use of ITS strategies in work zones are intended to improve safety and operations.*

9) *Prioritize funding for safety improvement projects as a key component of transportation project development through the TIP and RMAP processes and ensure that HSIP funding is fully utilized in the region consistent with the emphasis areas of the regional Strategic Transportation Safety Plan.*

10) *Develop strategies to improve safety for drivers, bicyclists and pedestrians at major intersections. Add more bicycle and pedestrian friendly features, such as islands and where appropriate, to slow traffic and provide pedestrian refuge and bikeways in large intersections.*

11) *Investigate reducing vehicle travel speeds in areas where drivers and pedestrians interact and where older drivers and pedestrians need more time to make decisions.*

12) *Make it easier for drivers and pedestrians to notice, read and understand visual information by reducing the clutter of signs, creating better access management, and improving signs and lighting to make the roadway more intuitive.*

13) *Support an education and outreach campaign that creates a serious dialogue about "traffic safety culture" within the region with a goal toward affecting behavior and improving safety by reducing indifference or complacency.*

14) *Improve roadway lighting, particularly in areas with high levels of bicycle and pedestrian activity, using dark sky compliant luminaires such as full cut-off fixtures where appropriate.*

15) *Continue to expand the use of bike and pedestrian signals (such as HAWKs) in order to improve road safety and increase crossing opportunities on arterial roads.*

Multimodal Choices: A variety of integrated, high-quality, accessible and interconnected transportation choices to meet all mobility needs and changing travel preferences

Objective	Performance Measure	Current	2020 Benchmark	2045 Plan Target
Increase the mode share of walking, biking and transit	5-year average walk, bike or transit to work rate (American Community Survey)	6.7%	7.25%	Increase to over 10%
	Walk, bike and transit mode share for all trips (National Household Travel Survey)	16.4%	17%	Increase to over 20%
Increase transit ridership	Annual unlinked passenger trips	19.7 million	22 million	Increase by 75%
Reduce transit travel time	Average transit travel time for all trips door-to-door (minutes)	50.81	50.5	Below 50
	Average transit travel speed	13.25	13.75	Over 15 mph
Increase availability of bike and pedestrian infrastructure	Total miles of complete and accessible pedestrian facilities on major urban roadways	442	560	1200
	Pedestrian accessibility ratio (ratio of accessible to inaccessible sidewalks on major roadways in urban area)	33%	40%	80%
	Total miles of bike facilities by type	1010	1130	1720
	Bike Route/Signed Bike Route	92	100	150
	Bike Route with Striped Shoulder / Signed Bike Route w/On-Street Bike Lane	707	760	1000
	Shared-use Path	203	220	350
	Bicycle Boulevards	8	35	170
	Protected Bike lanes	0.5	8	50
	Bike facility miles per 100,000 residents	1	1.05	1.2

Multimodal Strategies

1) *Continue implementation of Complete Streets practices in the region.*

2) *Retain the quality of the current public transit system, expand access and services, and implement high capacity transit.*

3) *Implement a seamless regional transit system and identify a regional dedicated revenue source for transit.*

4) *Fill gaps in the region's sidewalk network.*

5) *Expand the variety of transit services and other modes of transportation available to meet the needs of non-driving populations, including children, disabled and older adults, such as volunteer driver programs, carpooling and paratransit services.*

6) *Improve bicycle planning efforts by focusing on the League of American Bicyclists' critique of the region's 2012 platinum application for bicycle-friendly communities.*

7) *Expand the network of enhanced bikeways, including bike boulevards, protected bike lanes, crossing opportunities, shared use paths, wide paved shoulders*

on rural routes, and others.

8) *Develop a regional Safe Routes to School Plan.*

9) *Develop incentives to promote non-vehicular trips.*

10) *Expand the ADA sidewalk network and include features that assist persons with disabilities such as 5-foot wide sidewalks, curb ramps, detectable warnings in the sidewalk surface to alert individuals to driveways and intersections, and reduced obstructions such as poles and signage.*

11) *Elevate pedestrian amenities to become a priority in sidewalk projects and roadway projects that include sidewalk elements. Pedestrian amenities include street lighting, shading, seating, traffic signalization, and incorporating national best practices for pedestrian crossing treatments, such as HAWK signals.*

12) *Improve the quantity and quality of bus shelters and bus stop facilities including lighting, seating, bicycle parking, public art, drinking fountains, real time arrival signs, etc. in order to increase the convenience, accessibility and comfort of transit.*

13) *Consider new shared-use path development, with an emphasis on creating links from residential to employment, commercial and recreation areas. Support new development areas at trail nodes, in conjunction with transit station development.*

14) *Incorporate green infrastructure elements into transportation projects in order to enhance the aesthetics of the community, improve shade, encourage active transportation and provide improved stormwater management.*

System Performance: Improved regional mobility, congestion management, and travel time reliability through reducing travel demand, enhancing operations, and adding system capacity for all modes where necessary

Objective	Performance Measure	Current	2020 Benchmark	2045 Plan Target
Reduce the number of miles and hours that the average resident in the region drives	VMT per capita	20.6	No Change	Reduce by 10%
	Daily Vehicle Hours Traveled per Capita (minutes)	32:23	No Change	Reduce by 5%
Improve (maintain) reliability of the transportation system on major roadways	Planning Time Index on NHS	Data Currently Unavailable	Data Currently Unavailable	Data Currently Unavailable
Minimize increase in congestion on the arterial and freeway network	Weighted Travel Time Index	1.44	1.48	Minimize increase to below 10%
	Percent of peak hour VMT travelled under Level of Service E or F	1.15%	1.2%	1.8%

System Performance Strategies

1) *Support a comprehensive performance measurement program of the transportation network whereby mobility issues are identified and addressed promptly through a program of expanded data collection and analysis.*

2) *Evaluate and incorporate applicable Intelligent Transportation System features for all transportation projects during project scoping or early design process.*

3) *Include evaluation of applicable telecommunications equipment and infrastructure for all projects during the project scoping and early design process. Installation of conduit for fiber optic cable and other telecommunications can provide cost effective improvements in transportation and other public services.*

4) *Include traffic signal timing review and adjustment as part of the construction process of corridor road projects.*

5) *Include regional service patrols as part of major construction projects to assist stranded motorists, remove debris from the roadway and ensure smooth flow of the selected network corridors during construction.*

6) *Encourage appropriate funding levels for system management and operations. Optimal mobility only can be maintained when the components of the system are in good repair and operating as intended.*

7) *Support multi-agency coordination for large-scale work zones through construction planning and phasing which limits the impacts of construction on parallel routes.*

8) *Consider alternative congestion management strategies such as bike, pedestrian, transit, ridesharing, signal coordination and various operational strategies that best address the causes and impacts of congestion. Such strategies should be considered as part of the project development process so that congestion mitigation features can be included as part of larger projects. Congestion management strategies also should be considered prior to determination of capacity increasing projects as part of the regional project development process.*

9) *Improve the existing arterial roadway network to meet the needs and desires of the driving public, including expansion and maintenance of roadways as well as operational improvements.*

10) *Encourage the region to set aside funds to conduct corridor studies to determine the best strategies to improve safety and optimize performance including better access management practices, widening or reducing lanes, and lane widths and intersection improvements.*

11) *Regularly update PAG plans and studies such as the Regionally Significant Corridors Study, the High Capacity Transit Study, and the Regional Plan for Bicycling, to ensure continual improvements to the transportation network. Coordinate the timing of plan updates to increase planning effectiveness.*

12) *Develop and promote access management policies, standards and strategies that can be adopted and implemented by jurisdictions throughout the region and incorporated into corridor projects and local design review processes for development and land use plans. Promote opportunities for jurisdictions, developers, businesses and the public to better understand the benefits of and support the implementation of access management principles.*

13) *Consider additional strategies, such as identifying additional corridors, transit, travel demand management, and others, to address the projected future travel demand of people and freight between Tucson and Phoenix.*

14) *Continue to identify future potential grade-separated rail crossings and determine long-term funding for their construction.*

Environmental Stewardship: Environmental stewardship, natural resource protection and energy efficiency in transportation planning, design, construction and management

Objective	Performance Measure	Current	2020 Benchmark	2045 Plan Target
Reduce per capita annual on-road greenhouse gas emissions	Annual per capita on-road greenhouse gas emissions	3.63 tons per person annually	Reduce by 5%	Reduce by over 30%
Reduce on-road emissions	Weekday metric tons of NOx emissions	22.8	Reduce by 13%	Reduce by 80%
	Weekday metric tons of VOC emissions	18.3	Reduce by 12%	Reduce by 75%
	Weekday metric tons of CO emissions	164	Reduce by 12%	Reduce by 70%
	Weekday metric tons of $PM_{2.5}$ emissions	0.5	Maintain Current	Maintain Current
	Weekday metric tons of PM_{10} emissions	1.3	Maintain Current	Maintain Current

Environmental Stewardship Strategies

1) *Pave dirt roads with average daily traffic greater than 500 vehicles per day in order to abate dust pollution.*

2) *Include removal of buffelgrass, and other invasive species, as part of jurisdictions' road improvement and maintenance efforts.*

3) *Support rainwater harvesting efforts along roadways and at commercial sites to reduce stormwater peak flows and reduce stormwater pollution.*

4) *Provide alternate mode options, such as bike, pedestrian and transit to decrease vehicle miles traveled and reduce air pollution.*

5) *Protect the movement of wildlife and connect critical habitat areas by pursuing local initiatives to create wildlife crossings on major roadways especially along wildlife corridors between mountain ranges.*

6) *Improve monitoring to assess the impacts of wildlife crossing projects to better gauge effectiveness.*

7) *Use recycled materials including rubberized asphalt for constructing roadways.*

8) *Incorporate environmental enhancements to preserve*

open space, create urban pathways and improve bicycle and pedestrian connectivity throughout the region.

9) *Ensure consistency between PAG region transportation plans, such as the RMAP and local circulation plans, and adopted conservation plans, such as the Sonoran Desert Conservation Plan and others, so that they may avoid further habitat fragmentation.*

10) *Monitor greenhouse gas (GHG) emissions and develop strategies to reduce the effect of transportation-related GHG emissions; currently, it is estimated 1/3 of all GHG come from transportation sources.*

11) *Support the preservation of open spaces including undeveloped land, habitats for plants and animals, places of natural beauty and critical environmental areas.*

12) *Adopt environmentally sensitive roadway design guidelines.*

13) *Explore a funding mechanism to better mitigate the environmental impacts of transportation investments.*

14) *Support increased use of renewable energy sources to power roadside infrastructure, such as lighting and signage.*

15) *Support expansion of alternative fuel vehicles to reduce regional on-road emissions.*

Land Use and Transportation: Land use decisions and transportation investments that are complementary and result in improved access to important destinations and vibrant and healthy communities

Objective	Performance Measure	Current	2020 Benchmark	2045 Plan Target
Improve regional access to jobs and other essential services, such as medical, shopping, and recreation	Number of regional jobs the average person can reach in 30 minutes by automobile	240,221	Increase by 7%	Increase by 45%
	Accessibility index for all modes	57,142	Increase 3%	Increase by 15%
Improve access by transit	Number of regional jobs the average employee can reach in 45 minutes by transit	26,332	Increase by 10%	Increase by 50%
	Percent of residents living within ¼ mile of a transit stop	42.6%	43%	More than 45%
	Percent of jobs within ¼ mile of a transit stop	58.9%	59%	More than 60%

Land Use and Transportation Strategies

1) *Encourage development practices that provide direct access from neighborhoods and subdivisions to arterial streets, commercial centers and community facilities by expanding the network of safe and convenient bicycle, pedestrian and other facilities.*

2) *Support the creation of neighborhood-oriented retail development with pedestrian access from surrounding neighborhoods as well as pedestrian shopping districts that encourage a walkable environment.*

3) *Commit to future development patterns that provide safe, easy and convenient access to alternative mode transportation options and support high-capacity transit investment.*

4) *Develop a regional strategy that links land use and transportation by targeting transportation investment in designated growth areas in jurisdictions' adopted land use plans.*

5. *To increase commerce while also enhancing livability, continue to support projects and initiatives that increase pedestrian activity near commercial nodes and corridors.*

6) *Support the development of a range of housing options during new construction to provide quality housing for people of all income levels.*

7) *Promote Transit-Oriented Development (TOD) by building higher-intensity mixed-use communities near transit centers and locating new transit facilities along major corridors. Work with jurisdictions to customize TOD facilities and features to meet community needs.*

8) *Promote the mixture of land uses and higher density development, where appropriate, to create livable neighborhoods so that housing, work and shopping destinations are in close proximity to each other and residents have alternatives to driving such as walking, biking or transit. Activities include:*

- *Develop neighborhood-oriented commercial centers on minor, not major, arterials.*
- *Create nodes of development that are recognizable, high density hubs.*
- *Increase density on targeted transit corridors to increase convenient use for more people.*
- *Provide assistance to communities to plan for and develop mixed use areas that can serve as models for the region.*
- *Assist communities with corridor planning projects efforts that help to improve selected commercial corridors into desirable environments.*

Freight and Economic Growth: Regional freight transportation infrastructure that supports global competitiveness, economic activity and job growth by providing for the efficient movement of goods within our region, giving access to national and international markets, and improving intermodal connections

Objective	Performance Measure	Current	2020 Benchmark	2045 Plan Target
Minimize commercial vehicle delay on the interstate system	Commercial vehicle delay on the interstate system	Data Currently Unavailable	Data Currently Unavailable	Data Currently Unavailable
	Share of commercial vehicles on the interstate	Data Currently Unavailable	Data Currently Unavailable	Data Currently Unavailable
Maintain reliable travel times for commercial vehicles on the interstate system	80th percentile travel time of commercial vehicles on the interstate system	Data Currently Unavailable	Data Currently Unavailable	Data Currently Unavailable

Freight and Economic Growth Strategies

1) *Recognizing the connection between transportation infrastructure and economic activity, continue to foster broad political alignment and support of freight, trade and economic development priorities across the region, interregionally, statewide and binationally.*
2) *Continue to support transportation infrastructure studies, initiatives and projects that could ultimately increase job opportunities in the community.*
3) *Continue to coordinate transportation planning with adjoining counties, regions and councils of government for transportation needs and improvements beyond those in our region.*
4) *As a decision support input, consider economic benefits when prioritizing transportation projects. New or enhanced transportation facilities can stimulate commercial activity, increase tourism revenue and/or increase export-related trade.*
5) *Support efforts to integrate freight movement and land use planning to encourage the development of regional, multimodal logistics hubs.*
6) *Identify and designate routes and connectors with heavy freight movements as freight priority corridors.*
7) *Work with airports to facilitate connections between air and ground travel both to address infrastructure gaps as well as to improve efficient mobility of people and goods.*
8) *Support the collection of high quality commercial vehicle data including that for trucks, trains and cargo airplanes to inform decision making.*
9) *Support infrastructure improvements, such as road improvements and expanded utility lines, near existing or potential businesses to increase their business capacity and public access to facilities.*
10) *Develop meaningful incentives that encourage businesses to locate near transit hubs.*
11) *Continue efforts to provide assistance to businesses impacted by transportation projects.*

Public Involvement: Continued outreach and involvement of all users in transportation decision-making

Strategies

1) *Include broad, geographically dispersed populations in developing plans and projects, including significant participation from traditionally under-represented groups.*

2) *Support PAG and jurisdictional efforts to offer repeated opportunities for substantive public input during project planning and development.*

3) *Encourage project planners to provide public input results to decision-makers in a timely manner and to explicitly consider and respond to public comments.*

4) *Work with neighborhoods to take ownership of transportation projects and programs within their community. For example, expand the "Adopt-a-Road" program and work with neighborhood associations to initiate new projects and elements of the system such as landscaping within traffic circles.*

5) *Develop strategies to gain more buy-in and use of the public transit system. For example, if schools are teaching a module about geography or transportation, they can include a session on teaching students (of a certain age) how to ride the bus.*

6) *Support the development of educational programs to teach the public about sustainable land use, transit-oriented development and successful, mixed-use communities.*

7) *Conduct education and outreach to youth and adults on the value of the region's transportation network and the importance of transportation improvements, including the importance of the Regional Transportation Authority's ½-cent excise tax.*

Advanced Technologies: State-of-the-art, cost-effective delivery of transportation services and facilities

Strategies

1) *Upgrade traffic signal control equipment, signal power supply and communications connections, and intersection and midblock detection equipment on arterial roadways.*

2) *Innovate and pilot new technologies that have potential for creating a safer and better performing system. An example of how this has already been done in Tucson is the HAWK (High Intensity Activated Cross Walk) pedestrian signals. They were created by a City of Tucson engineer and are now included in the manual for uniform traffic control devices (MUTCD) and are used nationally.*

Funding and Implementation: Revenue sources and strategies that ensure ample funding and timely project development

Strategies

1) *Monitor the proposed extension of the half-cent excise tax and the Regional Transportation Authority (RTA) past its current expiration in 2026 and continue to provide information on the value of dedicated transportation funding sources.*

2) *Explore new sources of funding such as public and private partnerships, congestion pricing, vehicle miles traveled fees, etc. in order to develop a diversified funding stream that will adequately meet transportation needs in the future.*

3) *Set targets for project delivery and the implementation of the projects in the 5-year Transportation Improvement Program (TIP).*

4) *Establish a structure for tracking performance measures to assess the progress of the implementation of the 2045 Regional Mobility and Accessibility Plan.*

5) *Develop jurisdiction-specific alternatives to regional policies and programs, particularly for land use, so that jurisdictions are a part of developing the programs that affect their communities. In regional plans, include choices and opportunities to suggest modifications that fit jurisdictions' needs. While suggested modifications may ultimately deviate too much from the overall goal, there is value in proposing creative alternatives.*

6) *Encourage proper maintenance and upkeep of the existing transportation network by setting aside a sufficient funding allocation for maintenance in regional plans, as well as encourage jurisdictions to do so in their annual budgets. As pavement degrades, repairs become exponentially more costly; one of the best uses of transportation funds is to protect the investment made in the existing system, which also will build public support for future expansions of the network as needed.*

Accountability: Continued transparency, responsiveness and coordination to meet transportation needs throughout the region

Strategies

1) *Track the implementation of projects and regularly update the public on the status of projects, programs and finances.*

2) *Encourage jurisdictions to provide information on recently completed projects when conducting public outreach on developing projects. Explain the benefits of completed projects to better educate the public about transportation improvements and solicit input on developing projects.*

The CMP and the planning process

PAG's Congestion Management Process (CMP) is a tool to address congestion by enabling PAG and its partners to identify and measure congestion and develop and select appropriate strategies to reduce it. However, the CMP is not intended to be a standalone process. At PAG, the CMP is intimately linked to both the 2045 RMAP and TIP. The CMP furthers the goals and objectives of the 2045 RMAP through performance monitoring in the years following the 2045 RMAP's completion. Likewise, the CMP informs the TIP process of system performance and appropriate congestion management strategies. The CMP, 2045 RMAP and TIP act together to bring into fruition the long-range goals of the 2045 RMAP via the construction of projects and funding of programs. This model aids in ensuring investment decisions are made with a clear focus on desired outcomes.

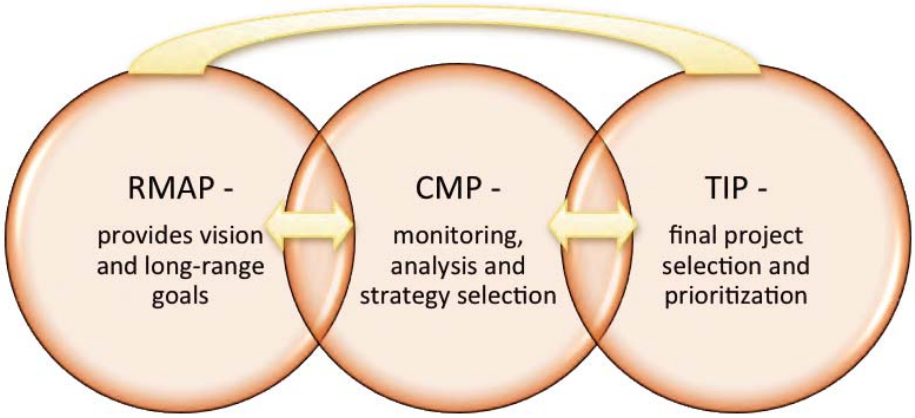
The CMP is aimed specifically at transportation performance and reliability, nevertheless, the CMP and 2045 RMAP share a considerable amount in terms of overall structure and purpose. They are both performance-based and outcome-oriented approaches that include multimodal goals, objectives, targets and performance measures. They both strive to effectively utilize the region's resources to manage congestion through a variety of tools.

On the performance measurement side, the CMP differs from the 2045 RMAP in the level of detail it contains in order to address congestion. In general, the 2045 RMAP has a system or regionwide view of congestion. The CMP, while including the systemwide view, adds specifics for sub-regions, corridors and site specifics. Additionally, the CMP continually tracks the progress toward targets using performance measures. On the implementation side, the CMP contains necessary detail to select appropriate congestion management strategies and to apply the desired changes to the network. Thus the CMP is a continuation of the 2045 RMAP with a refined focus on performance and reliability management and strategy implementation.

The CMP and 2045 RMAP have a reciprocal relationship with goals, objectives and congestion management strategies. The CMP incorporates the 2045 RMAP goals and objectives as the 2045 RMAP incorporates the CMP congestion management strategies. The benefits of the CMP incorporating the RMAP goals and objectives are that they reflect the region's most current desired outcomes derived from the most recent public outreach. The 2045 RMAP objectives are written generally. However, when coupled with the targets and performance measures associated with them they become SMART objectives. The benefits of the 2045 RMAP incorporating the CMP's congestion management strategies include the development of a pool of options to draw from that are eligible for programming in the TIP. Therefore, CMP is a primary mechanism for assessing and recommending management and operations strategies for planning and programming.

The CMP is also one of the devices that coordinates the 2045 RMAP and the TIP. The performance measures identified in the RMAP and the more specific performance measures in the CMP are updated annually and presented to the TIP Subcommittee during the project development phase. This analytical information shows the current condition of the region with respect to each performance area and how the region is performing in relation to the targets established in the RMAP. This is a critical step in tracking to target process.

Due to the linkages between the CMP, 2045 RMAP and TIP, the CMP updates its performance measures annually in coordination with the TIP cycle. The CMP receives a thorough review every four years with the long-range

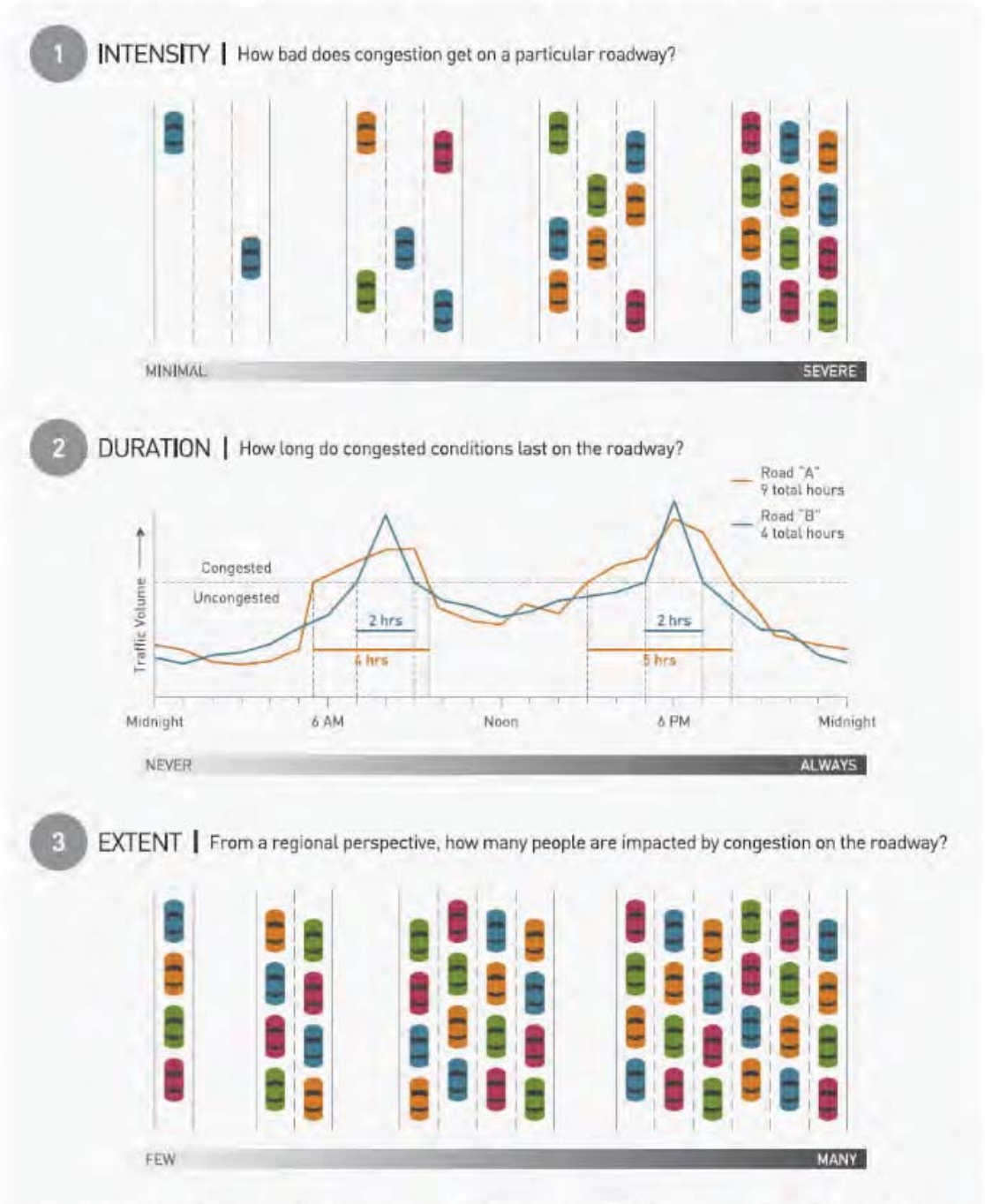


plan cycle. This process of revisiting and re-evaluating the CMP is crucial as regional priorities, technologies and methodologies change. The review of the CMP with this 2045 RMAP has resulted in enhanced integration of the CMP and 2045 RMAP via targeted performance measures, goals and objectives. Additionally, enhanced integration of the CMP and TIP has occurred via a refined annual performance update, updated recurring and non-recurring delay identification, more strategy implementations, more trackable objectives performance tracking via online data visualization and improvement in the evaluation of strategy effectiveness.

CMP specifics:

The PAG CMP tracks the system level performance measurement established in the 2045 RMAP in addition to tracking other corridor and site specific congestion-

Three Dimensions of Congestion



Source: Atlanta Regional Commission, Congestion Management Process, 2006

PAG CMP PERFORMANCE MEASURES

AREA	DESCRIPTION	DETAILS	DATA & DATES
Congestion	Person hours of delay	On selected corridors, occupancy rate from NHTS 09	PAG, needs data: Annual
	Congestion Extent: vehicle measures	Percent of peak hour VMT travelled under LOS 'x' 2	Modeled: Annual
	Congestion duration	Annual hours of travel at LOS 'x' 2 Annual per capita hours of travel at LOS 'x' 2	Modeled: Annual
	Congestion intensity	Mapped, & Percent of roadways or intersections operating at LOS 'x' 2	Modeled: Annual
	Extent of congestion (spatial)	Mapped, & Percent of lane miles operating at or below LOS 'x' 2	Modeled: Annual
	Congestion Costs	Mapped, & Percent of intersections operating at or below LOS 'x' 2 Wasted fuel (Fleet mpg * excess delay) Wasted money (fuel +value of travel time)	Modeled: Annual
	Average transit speed	Separate express, local and selected corridors	Modeled: Annual
Variability and Reliability	Travel time – transit to Auto	During peak travel times, along specified corridors	Modeled: Annual
	Reliability	PTI: (95th percentile travel time /free-flow travel time) On selected corridors1 % network above PTI of 'x' 2	PTI needs data: possibly HERE (NPMRDS) aggregated to biweekly or month only on NHS
	Variability	TTI: (peak travel time/free flow travel time) On selected corridors % network above TTI of 'x'	TTI Modeled: Annual for selected corridors and % of CMP network with TTI > 'x'
	Crash Totals Crash Rate	Severity 4 and above Regional severity 4 and above by 1 million vmt	FARS and ALICE HPMS, FARS and ALICE
Travel time	Average travel time	On selected corridors/routes	Modeled: Annual
		Commute travel time	ACS by mode
	Vehicle Hours of travel per capita	Hours of vehicle travel/population	Modeled: Annual
	Average transit time	Selected Routes, door-to-door For all trips, door-to-door	Modeled: Annual
Volume and capacity	Demand and Volume to Capacity Ratio	Demand shows need or desire over current use	Modeled: Annual
	Person Throughput	On selected corridors, all modes, Automated intersection counts, vehicle occupancy rate from NHTS 09	PAG: Annual
Accessibility	Pedestrian accessibility ratio	Ratio of accessible to inaccessible sidewalks on major roadways in urban areas	Special Collection: 5yr
	Accessibility Index	Impedance and opportunities by TAZ	Modeled: Annual
Multi-modal availability	Ridership	As percent of population (all boardings, not unique)	Sun Tran: Annual
	5yr avg walk, bike or transit to work	As percent of population	ACS data 5yr avg: Annual
	Miles of pedestrian facilities	Total miles of complete and accessible pedestrian facilities on major roadways (Per 100,000 residents?)	Special Collection: 5yr
	Bicycle lane miles	Per 100,000 residents	PAG : Annually
	Bike and Pedestrian usage	Volunteer and Automated count data	PAG: Annual
Land use	Jobs-housing ratio of urban TAZs	Historic trends coupled with population projections	Modeled: Annual
Freight	Ton miles of delay	FAF 3.4: tonnage, by rail, truck and air	Corresponding to FAF updates
Incident duration	Mean clearance time	Scene cleared-arrival on scene	TIM
Mode Color Code	SOV and transit	Transit / Freight / ALL	Pedestrian and Bicycle

related performance measures and monitoring system for regional multimodal transportation planning, programming and reporting for congestion management. The table at left lists CMP specific performance measures, the performance areas they cover and details about each. PAG has begun tracking many of these performance measures. However, other performance measures require additional processing and/or data and will be the subject of ongoing work with the CMP.

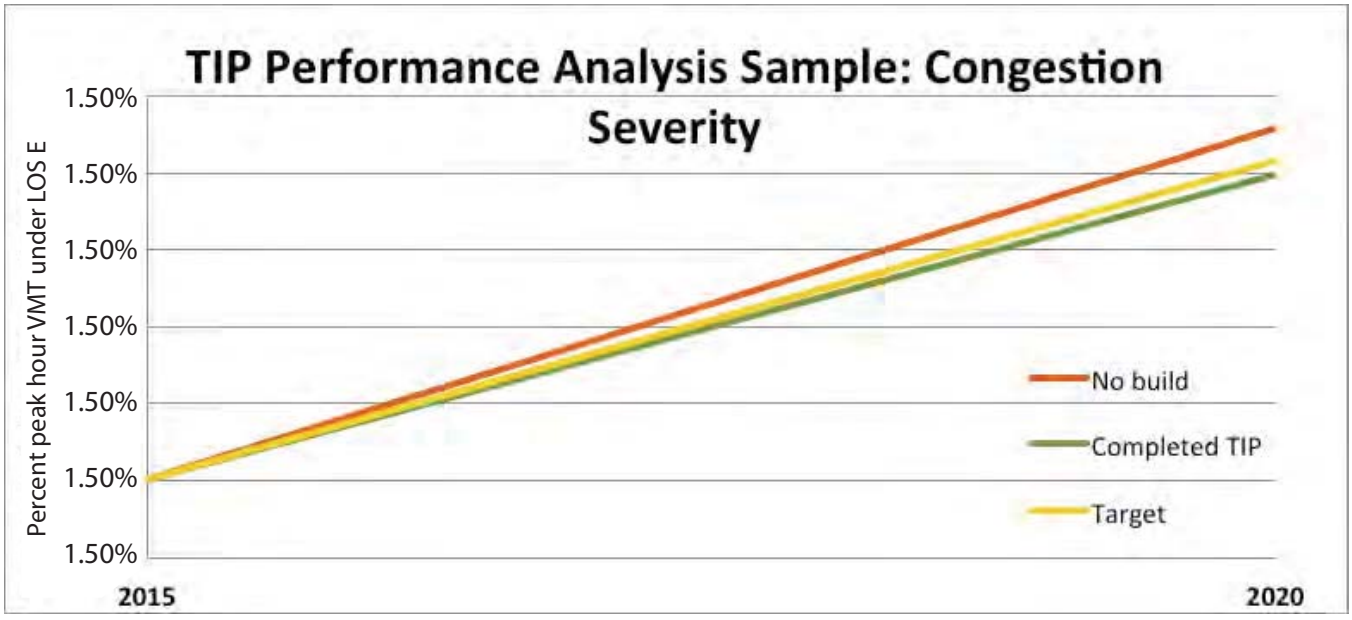
Many of the performance areas include several performance measures. These are needed due to the complexity of particular areas. For instance, as illustrated by Atlanta Regional Council's graphic (page A16), congestion has three dimensions. It is necessary to monitor each of these aspects of congestion (intensity, duration and extent) to better System performance monitoring needs to go beyond when and where to include additional metrics such as how long, how many travelers are affected, and whether is it recurring or non-recurring and so forth.

One area that PAG is focused on improving is the identification of causes of recurring and non-recurring delay. Recurring delay is typically the result of demand exceeding the network's capacity as it is currently designed and operated. Although problematic and inefficient, travelers generally are prepared to experience some recurring delay especially near an urban center. Non-recurring delay can be more problematic for the traveling public. Non-recurring delay may be caused by a special event, construction, traffic incident, adverse weather, etc. To the typical traveler, this is challenging because s/he is uncertain about how much extra time to plan into their trip to arrive on time. For this reason, PAG continues to explore opportunities to improve its process for identifying causes of both types of delay in order to appropriately address them. Current efforts include the logging of traffic incidents and construction projects, and monitoring of speed data.

The PAG CMP has developed regional congestion management and operations' objectives that are directly linked back to the vision and goals of the 2045 RMAP and linked to specific performance measures that are part of the CMP. Ultimately, the objectives-driven, performance-based process for managing congestion of the regional transportation system will lead to more efficient use of transportation dollars and result in a reduction of transportation network congestion.

The goal of the CMP is effective management of new and existing transportation facilities using both operational and travel demand management strategies. For example, the improvement of a congested corridor might incorporate strategies that augment or reduce the need to widen the roadway by providing more transit and alternate mode options, utilizing new technologies such as signal timing or managing access to business and residential areas to make the existing facility work better.

The following chart is illustrative of the TIP briefing process. This chart represents the monitoring of one performance measure and graphically depicts the region's current performance and what performance could be expected with the completion of the current TIP and the performance that could be expected with a no-build scenario. Additionally, the chart shows where, according to the 2045 RMAP targets, the region should be in five years from tracking to the 2045 RMAP target. Accordingly, this chart shows that the current projects in the TIP are reducing the growth of congestion severity but are slightly off target to track to the 2045 RMAP objective. This process assists in identification of system deficiencies, and analysis and selection of alternative strategies to address congestion for inclusion in the long-range regional



Source: PAG

mobility and accessibility plan (RMAP) and the short-range transportation program (TIP).

Congestion management strategies in our region:

In recent years, the PAG region has completed several projects aimed at improving system performance and reliability. Below are brief summaries of a few of these projects.

Indirect left turn intersection geometry at Oracle and Ina roads:

- An alternatives assessment found that an indirect left turn in addition to other improvements would increase movement through the intersection and improve safety.

Transit boarding efficiencies

- Sun Tran's adoption of a smart card system allows for prepaid fare usage reducing stop time while providing additional rider information.
- Sun Link allows front and rear boardings, increasing boarding and alighting efficiency, reducing stop time and improving headways.
- Sun Tran has launched a Smartphone application as an additional means of pre-purchasing fares.

Corridor signal timing with observed data

- The use of passively collected vehicle speed data is being tested to supplement modeled data and further improve signal timing along key corridors.
- This has resulted in improved corridor throughput by reducing intersection delay without adversely impacting intersecting cross streets.
- Resulting data allow for improved model runs and validation of signal timing changes with observed vehicle speeds.

Nearly 100 bus pullouts built region wide

- Bus pullouts reduce corridor congestion.
- Bus pullouts were installed on arterials and collectors with both high vehicular volume and bus boardings and alightings.

APPENDIX B

Appendix to CMP to Enhance TIP Implementation Process

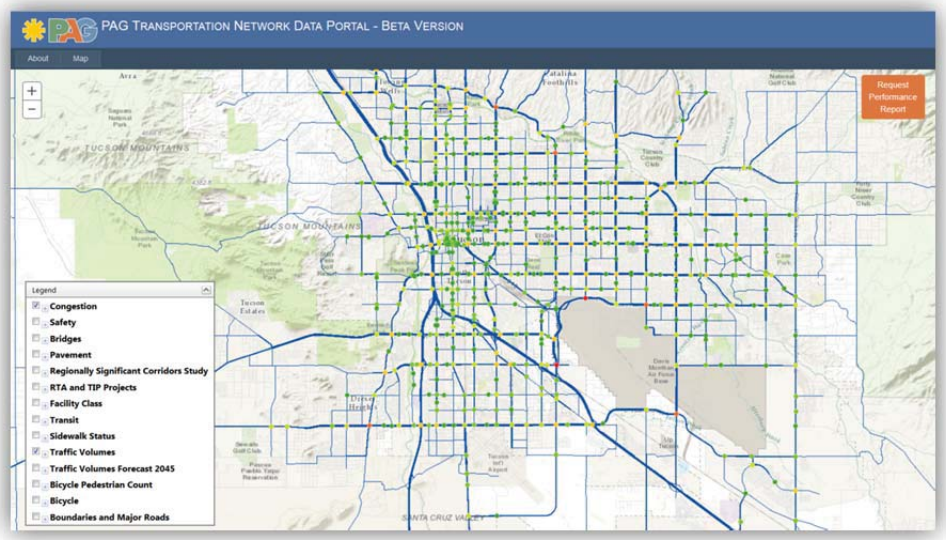
TASK 4: APPENDIX TO CMP ADDENDUM TO ENHANCE TIP IMPLEMENTATION PROCESS

EXISTING TIP IMPLEMENTATION PROCESS

The PAG CMP is fully integrated into the region's planning and programming processes and provides periodic assessment of the effectiveness of implemented strategies and progress towards regionally adopted targets through a series of performance measures. This process assists in identification of system deficiencies, and analysis and selection of alternative strategies to track progress on adopted performance targets from the 2045 Regional Accessibility and Mobility Plan (RMAP) the region's long-range transportation plan, for inclusion in the subsequent RMAP, and the short-range transportation program (TIP).

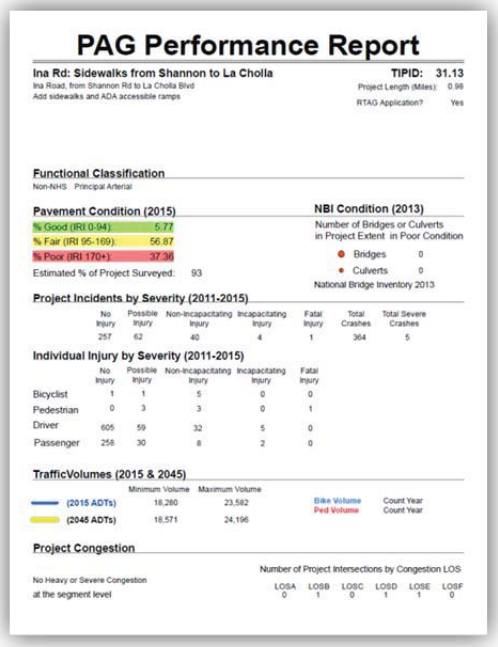
The 2045 RMAP is a performance-based long-range transportation plan that includes a series of goals, objectives, performance measures and targets. The performance measures included in the final plan drew extensively from the 2010 CMP Final Report. CMP-focused performance measures are integrated into the goal areas of Land use and Transportation, Multimodal Choices, Transportation Safety and System Performance. A diverse group of stakeholders developed targets for each performance measure. The stakeholders included member jurisdiction representatives, travel reduction program staff, alternative mode representatives and major employers. Progress on each performance measure is being tracked by PAG staff to assist in future planning and programming efforts.

The programming process at PAG includes an online data map viewer that assists jurisdictions in identifying candidate projects and streamlines the application process. This website, the Transportation Network Data Portal (TNDP) is an interactive map displaying existing conditions using regional transportation datasets. There are more than a dozen datasets within TNDP many of which are CMP related such as intersection congestion, current and forecasted traffic volumes, alternative mode routes and counts, crash data and programmed projects. These datasets can be turned on and off by the user. Jurisdictions are invited to perform network screenings of their facilities to help identify potential future projects. Additionally, a click on any of the map features provides a call out box with the details on all enabled datasets.



PAG Transportation Network Data Portal (TNDP): interactive web-map showing regional spatial data for network screening, PAG Performance Report request and project application processes.

The TNDP is an effective use of existing conditions data in the programming process by helping identify areas of need and simplifying the application process. When a jurisdiction identifies a candidate project, the user draws the project extent on the website with a built-in map tool and a Performance Report is generated. The Performance Report summarizes the project area's existing performance, displayed both spatially and with descriptive statistics. A summary cover sheet presents key statistics and is followed by detailed pages for each dataset.



PAG Performance Report

Ina Rd: Sidewalks from Shannon to La Cholla — TIPID: 31.13

Ina Road, from Shannon Rd to La Cholla Blvd — Project Length (Miles): 0.98

Add sidewalks and ADA accessible ramps — RTAG Application? Yes

Functional Classification

Non-NHS Principal Arterial

Pavement Condition (2015)

% Good (IRI 0-94):	5.77
% Fair (IRI 95-169):	56.87
% Poor (IRI 170+):	37.36

Estimated % of Project Surveyed: 93

NBI Condition (2013)

Number of Bridges or Culverts in Project Extent in Poor Condition

Bridges 0

Culverts 0

National Bridge Inventory 2013

Project Incidents by Severity (2011-2015)

No Injury	Possible Injury	Non-Incapacitating Injury	Incapacitating Injury	Fatal Injury	Total Crashes	Total Severe Crashes
257	62	40	4	1	364	5

Individual Injury by Severity (2011-2015)

	No Injury	Possible Injury	Non-Incapacitating Injury	Incapacitating Injury	Fatal Injury
Bicyclist	1	1	5	0	0
Pedestrian	0	3	3	0	1
Driver	605	59	32	5	0
Passenger	258	30	8	2	0

TrafficVolumes (2015 & 2045)

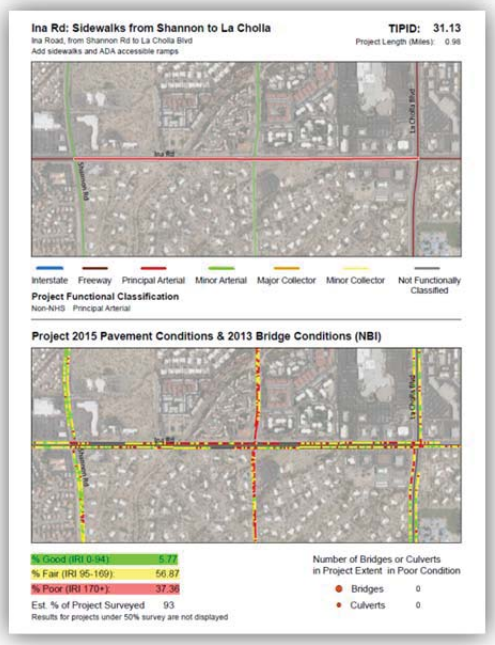
	Minimum Volume	Maximum Volume		
(2015 ADTs)	18,280	23,582	Bike Volume	Count Year
(2045 ADTs)	18,571	24,196	Ped Volume	Count Year

Project Congestion

No Heavy or Severe Congestion at the segment level

Number of Project Intersections by Congestion LOS

LOSA	LOSB	LOSC	LOSD	LOSE	LOSF
0	1	0	1	1	0



Ina Rd: Sidewalks from Shannon to La Cholla — TIPID: 31.13

Ina Road, from Shannon Rd to La Cholla Blvd — Project Length (Miles): 0.98

Add sidewalks and ADA accessible ramps

Interstate Freeway Principal Arterial Minor Arterial Major Collector Minor Collector Not Functionally Classified

Project Functional Classification

Non-NHS Principal Arterial

Project 2015 Pavement Conditions & 2013 Bridge Conditions (NBI)

% Good (IRI 0-94):	5.77
% Fair (IRI 95-169):	56.87
% Poor (IRI 170+):	37.36

Est. % of Project Surveyed 93

Results for projects under 50% survey are not displayed

Number of Bridges or Culverts in Project Extent in Poor Condition

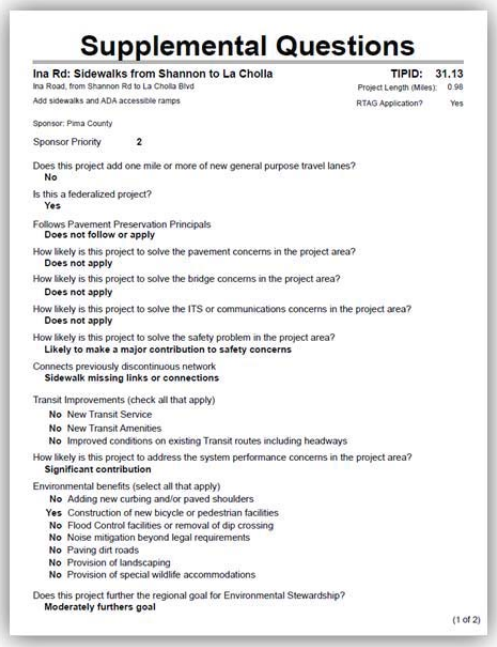
Bridges 0

Culverts 0

PAG Performance Report cover sheet with summary statistics of key existing conditions on proposed project extent	PAG Performance Report detailed sheets that spatially display data along the proposed project extent

The regional data from the Performance Report is used in generating a completed Criteria Sheet, which helps inform programming discussions. Criteria Sheets are a regionally adopted tool that help assess conditions in the project area. The 2010 CMP Final Report expanded the use of congestion data within the Criteria Sheets and further integrated CMP into the programming process. The Criteria Sheet categories are structured around the goal areas within the long range transportation plan maintaining the link between planning and programming. The 2045 RMAP has maintained this connection.

With this new application process, all jurisdictions have access to the same regional transportation datasets to assist them in their analysis and selection of future projects. Questions from the Criteria Sheet not addressed by TNDP, or which cannot be quantified, are covered with a series of supplemental questions completed by the project sponsor. The Supplemental Questions sheet provides greater insight into expected project impacts including effects on system performance, transportation systems communication and technology, network density, transportation safety, and alternative modes.



Supplemental Questions

Ina Rd: Sidewalks from Shannon to La Cholla **TIPID: 31.13**

Ina Road, from Shannon Rd to La Cholla Blvd — Project Length (Miles): 0.98

Add sidewalks and ADA accessible ramps — RTAG Application? Yes

Sponsor: Pima County

Sponsor Priority **2**

Does this project add one mile or more of new general purpose travel lanes?
No

Is this a federalized project?
Yes

Follows Pavement Preservation Principals
Does not follow or apply

How likely is this project to solve the pavement concerns in the project area?
Does not apply

How likely is this project to solve the bridge concerns in the project area?
Does not apply

How likely is this project to solve the ITS or communications concerns in the project area?
Does not apply

How likely is this project to solve the safety problem in the project area?
Likely to make a major contribution to safety concerns

Connects previously discontinuous network
Sidewalk missing links or connections

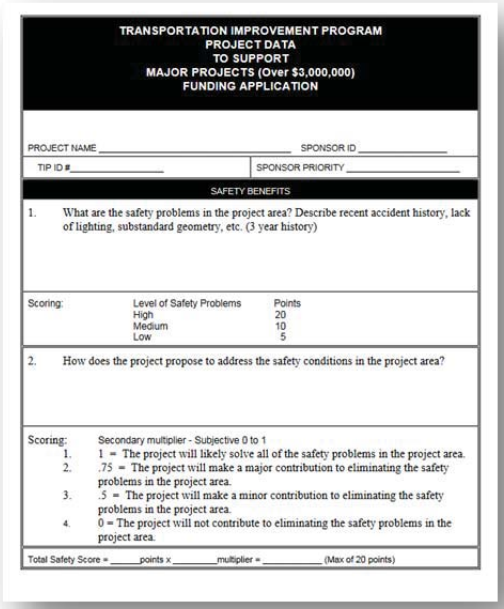
Transit Improvements (check all that apply)
No New Transit Service
No New Transit Amenities
No Improved conditions on existing Transit routes including headways

How likely is this project to address the system performance concerns in the project area?
Significant contribution

Environmental benefits (select all that apply)
No Adding new curbing and/or paved shoulders
Yes Construction of new bicycle or pedestrian facilities
No Flood Control facilities or removal of dip crossing
No Noise mitigation beyond legal requirements
No Paving dirt roads
No Provision of landscaping
No Provision of special wildlife accommodations

Does this project further the regional goal for Environmental Stewardship?
Moderately furthers goal

(1 of 2)



TRANSPORTATION IMPROVEMENT PROGRAM
PROJECT DATA
TO SUPPORT
MAJOR PROJECTS (Over $3,000,000)
FUNDING APPLICATION

PROJECT NAME _____ SPONSOR ID _____

TIP ID #_____ | SPONSOR PRIORITY _____

SAFETY BENEFITS

1. What are the safety problems in the project area? Describe recent accident history, lack of lighting, substandard geometry, etc. (3 year history)

Scoring:

Level of Safety Problems	Points
High	20
Medium	10
Low	5

2. How does the project propose to address the safety conditions in the project area?

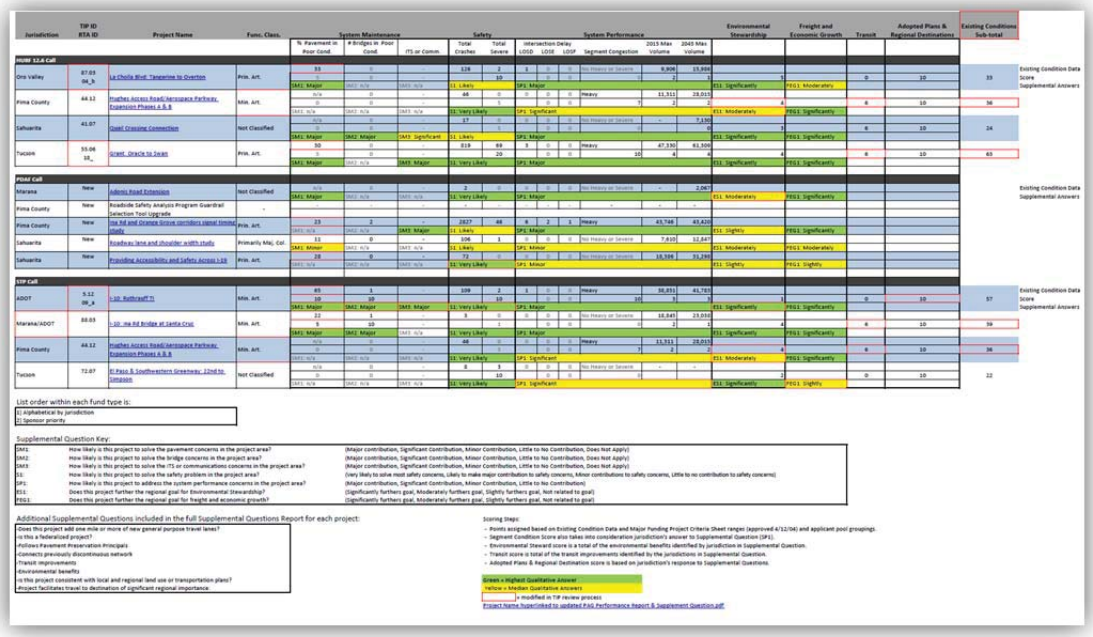
Scoring: Secondary multiplier - Subjective 0 to 1

1. 1 = The project will likely solve all of the safety problems in the project area.
2. .75 = The project will make a major contribution to eliminating the safety problems in the project area.
3. .5 = The project will make a minor contribution to eliminating the safety problems in the project area.
4. 0 = The project will not contribute to eliminating the safety problems in the project area.

Total Safety Score = _____points x _____multiplier = _____ (Max of 20 points)

Supplemental Questions sheets: completed by project sponsor to capture anticipated project impacts	Criteria Sheets: project evaluation tool completed in application process using Performance Report and Supplemental Questions data

The information from the Performance Reports and the Supplemental Questions is synthesized into a matrix which can be used in programming discussions to identify projects that best fulfill the needs of the region.



Performance Matrix containing Performance Report and Supplemental Question Data for multiple projects allowing for side-by-side comparison

This process also identifies projects that qualify as “significant” in their addition of general purpose lane miles. The CMP procedure requires that new significant capacity projects (which add at least one lane mile of new general purpose roadway) provide CMP-related information as part of the TIP application. Local jurisdictional project sponsors fill out a one-page CMP Strategies Toolbox Worksheet to identify CMP strategies that will be delivered as part of the project.

The procedure developed to review all projects adding “significant” general purpose lane miles, is designed to help:

- Ensure that significant SOV projects consider, and when applicable include congestion management strategies as part of the project development process.
- Document the congestion management strategies to be included with the significant SOV project.

The PAG Congestion Management Strategies Toolbox Worksheet is a checklist of congestion management strategies that are considered appropriate and applicable to the region. This checklist is designed to easily facilitate the documentation of strategies to be included with the significant SOV project, but it is not necessarily all inclusive of the strategies that may be used. Local agencies have complete flexibility and latitude to include any additional congestion management strategies into their project, and this is encouraged by PAG. Agencies are also encouraged to consider congestion management strategies as part of non-capacity increasing projects.

Existing congestion management and alternative mode strategies implemented within the region are described in the following sections, followed by a brief description of planned improvements contained in the 2045 RMAP.

RECOMMENDED IMPROVEMENTS

This section contains a list of recommended improvements to enhance the incorporation of the CMP into the TIP implementation process. These recommendations do not need to proceed in any fixed order; however, they are listed in a suggested order that prioritizes regional benefit relative to the level of effort required to complete the proposed improvement. These recommendations span the TIP development cycle and include recommendations to the process and tracking of data, in addition to recommendations on specific documents including the PAG Performance Report, Criteria Sheet, CMP Strategies Checklist, TIP Handbook, and the published TIP. Although not all of these documents are purely CMP-related, each has associated elements that are either reported on or inform processes that affect CMP efforts.

1. Additional display of performance in annual published TIP. A minimum of one example of a CMP-related performance measure and associated target is recommended for inclusion in the published TIP with reference to the CMP section of the online data dashboard. When and where space permits, additional key CMP-related performance measures and targets can be added to improve understanding of the region's goals and progress towards achieving them. Incorporation of select regional performance measures can help inform the process and demonstrate how the region is progressing towards regionally adopted targets.
2. Presentation of regional performance during TIP development process. This can be accomplished via promotion of the data dashboard or through in-person presentations at appropriate meetings to be determined by PAG, either prior to or concurrent with the annual call for projects release.
3. Enhance automation of PAG Performance Report process within the Transportation Network Data Portal (TNDP). Additional automation will relieve staff time requirements and provide real-time PAG Performance Report creation for the requesting jurisdiction. This real-time report generation will promote additional use by jurisdictions to find projects that optimize existing conditions that merit improvement.
4. Improved visualization techniques within the PAG Performance Report to better illustrate existing conditions. Spatial display of the data provides excellent context at the project level, however, comparison to the surrounding facilities and region-wide is limited. Spatial display coupled with summary project statistics and regional statistics can provide additional insights. Additionally, these regional statistical displays can be useful in the development of the matrix to inform the programming discussion.
5. Revisit criteria sheet composition used in structuring and assigning values to project applications. Developed in 2009 in preparation for the 2010 Final CMP Report, the PAG criteria sheet can be revisited to better match changing technologies, land use patterns and regional goals informed by the planning process. Preliminary review suggests that the current criteria sheet structure favors comprehensive projects over mode or subject matter projects (e.g. transit, or IT improvements).
6. Expand the documentation of operational improvements that are part of programmed projects within the TIP. PAG's CMP seeks to maximize the benefit of existing facilities prior to adding general purpose capacity. Operational improvements are a cost-effective approach to enhancing utility of existing facilities, especially along signalized corridors, which are the predominant VMT generator in the PAG region. Documenting these improvements will allow for improved evaluation of the impacts on system performance.
7. Track and display the CMP strategies checked in the CMP Strategies Checklist. This information can be displayed graphically by frequency, absolute number, amount of program, or similar metrics in the annual TIP report, TIP handbook, or complementary webpage. As a history of checked strategies is logged,

patterns of the most and least common elements will emerge. This can be aggregated to the year or the entire program. Any future updates to the checklist will benefit from this usage information.

8. Capture data on projects within the TIP that further CMP-related performance measures. This would include projects related to active transportation, operations, TDM, TRP, and others that might not be flagged as projects adding significant capacity. Data from these projects can be aggregated and displayed as programmed dollars or percentage of TIP furthering the CMP. For additional active transportation, capacity facility miles (bike/ped) and frequency (transit) can be used.
9. Add performance data and programming information for projects on routes parallel to the facility requested in the PAG Performance Report. Currently parallel routes can often be seen in the detailed pages of the PAG Performance Report. Adding parallel route data and programming information can help decision makers understand the adjacent network and assess the proposed improvement relative to the needs or programmed improvements of adjacent facilities.
10. Additional refinement of CMP-related performance measures to corridor and person throughput levels. These refinements will facilitate additional evaluation of project effectiveness. Corridor level metrics can help better understand non-recurring delay and identify their causes. Person level performance measures at the corridor level will add sensitivity to improvements in transit, bike, and pedestrian facilities furthering a multimodal focus.
11. Explore opportunities to flag and track projects that are noted as significant. Tracking these to the construction phase provides opportunity for timely before-and-after studies. As a significant project, defined by the CMP, approaches the construction funding phase in the TIP, an initial performance assessment of the project site can serve as base data for comparison. Once construction is complete, an after performance assessment will help better understand the impact of the improvement.
12. After the completion of a TIP span (5 years), compare the travel demand model outputs from the beginning to the TIP span to the actual conditions after the completion of all projects. This process would require refinement of project lists and scopes as some are likely to change. Additional parameters that should be managed for evaluation include population, land use, and economic conditions.

STEPS FOR ACHIEVING RECOMMENDED IMPROVEMENTS

The following contains generalized steps to help achieve the above-mentioned recommended improvement to the TIP implementation process

1. ADDITIONAL PERFORMANCE DISPLAYED IN PUBLISHED TIP
    a. Identify measure or measures to be included in published TIP
    b. Select desired display of performance (chart type)
    c. Verify or convert to grayscale compatible display
    d. Locate section within the published TIP for inclusion
    e. Generate content to help reader interpret chart(s) and performance tracking process
2. PRESENTATION OF REGIONAL PERFORMANCE DURING TIP DEVELOPMENT
    a. Identify target audience(s)
    b. Select presentation approach: direct interest to data dashboard, in-person presentation, other promotional material, or a hybrid of approaches
    c. Develop material(s) and outreach plan
3. ENHANCE AUTOMATION OF PAG PERFORMANCE REPORTS
    a. Design cover document with regional values in mind
    b. Design detailed sheets

c. Dynamic report creation, or data-driven pages using Crystal Reports or similar program.

4. IMPROVED VISUALIZATION TECHNIQUES WITHIN THE PAG PERFORMANCE REPORT AND MATRIX
    a. Identify content areas that most benefit from improved visualization
    b. Develop and test visualization techniques that are compatible with Performance Report generation and Matrix
    c. Select most appropriate visualizations and add process to automation of Performance Reports
    d. Add visualizations to matrix and adapt as necessary for appropriate display
5. REVISIT CRITERIA SHEET COMPOSITION
    a. Identify content that needs review or new content that needs incorporation
    b. Identify appropriate committee level within the PAG structure or stakeholders for review
    c. Develop alternatives and suggestions with stakeholder input
    d. Test revised composition with historic projects to demonstrate impacts
    e. Modify as needed
    f. Finalize prior to subsequent call for projects
6. EXPAND THE DOCUMENTATION OF OPERATIONAL IMPROVEMENTS
    a. Define operation improvement in a way that can be quickly referenced and understood by project sponsors
    b. Develop categorical lists (general groupings) of operational improvements that project sponsors can select during the application process
    c. Identify project attributes, such as total project cost, that would be meaningful to collect along with the operational improvements
    d. Design data storage structure: table(s), and data relationships capturing identified project attributes (unique ID, all strategies, total project cost, etc)
    e. Generate and test reporting mechanism to capture operation improvement during TIP call for projects phase
7. TRACK AND DISPLAY THE CMP STRATEGIES CHECKED IN THE CMP STRATEGIES CHECKLIST
    a. Select between manual, automated, or hybrid approach to capture the strategies selected in the checklist
    b. Identify project attributes, such as total project cost, that would be meaningful to collect with the CMP Strategies
    c. Design data storage structure: table(s), and data relationships capturing identified project attributes (unique ID, all strategies, total project cost, etc)
    d. Develop display techniques (strategy selected by frequency, by cost, by year)
8. CAPTURE PROJECT'S DATA WITHIN THE TIP THAT FURTHER CMP –
    a. Develop decision mechanism to determine when projects further the CMP (sponsor or staff selection, decision tree, etc)
    b. Identify project attributes, such as total project cost, that would be meaningful to collect
    c. Design a table, database, or spreadsheet with necessary data (unique ID, all strategies, total project cost, etc)
    d. Develop techniques to visualize the data (charts, graphs of costs, proportion of program, etc)
9. ADD ADJACENT/PARALLEL FACILITY PERFORMANCE AND PROGRAMMING DATA
    a. Identify PAG Performance Report content that would benefit from adjacent/parallel facility data
    b. Develop mechanism to capture identified data
    c. Develop techniques to display the data on the PAG Performance Reports
    d. Consider integrating data into the matrix - ?? (reworded to avoid passive voice)

10. ADDITIONAL REFINEMENT OF CMP RELATED PERFORMANCE MEASURES
    a. Identify CMP-related performance measures that correlate to corridor and/or person throughput
    b. Develop a prioritized list of identified performance measures to work through, acknowledging that not all will be developed at the same time
    c. Identify data needs and potential sources
    d. Define corridors: beginning, end, and intermediate locations (if any)
    e. Develop methods to process and store data
11. EXPLORE OPPORTUNITIES TO FLAG AND TRACK PROJECTS THAT ARE SIGNIFICANT
    a. Identify critical timeframe points within the TIP for pre-construction data collection needs
    b. Identify existing performance measure(s) and other data that would be expected to change with the construction
    c. Develop report framework to document pre-construction existing conditions that will be used to compare to post construction conditions
    d. Develop trigger events that will precipitate needed data collection and documentation prior to construction
    e. Develop trigger events that will precipitate needed data collection and documentation after construction and sufficient time has elapsed for traffic to normalize
12. AFTER THE COMPLETION OF A TIP SPAN (5 YEARS), COMPARE THE TRAVEL DEMAND MODEL OUTPUTS
    a. Define metrics that will be used to compare model run pre- and post- TIP suite construction
    b. Capture and store all model information (inputs, parameters, network)
    c. After completion of entire TIP, revisit stored model, update a copy of the model to match actual program constructed.
    d. Update model to match current population, land use, and other variables that can be controlled.
    e. Run model with identified metrics as the critical outputs
    f. Compare the two outputs and document as necessary

PROCEDURE RECOMMENDATIONS

Many of the recommended improvements will require significant staff time to develop. Inclusion of additional improvements to the CMP and TIP integration should be accounted for in any annual workflow documentation to balance staff resources across the many other projects PAG staff assumes at any given time. The order of the recommended improvements seeks to maximize regional benefit while managing demands on PAG resources. Goals within the PAG region may change and require alternative approaches to the recommendation list. The following summarizes opportunities to advance multiple recommendations at a time and considerations that should be made during implementation.

Recommendations 1 and 2 are a natural pair as are improvements 3 and 4. Improvement 5 should be treated on its own. This improvement will take significant staff and stakeholder time to accomplish successfully. Additionally, updates to the criteria sheets will affect the matrix and therefore will necessitate updates to parallel processes.

Recommendations 6, 7, and 8 could potentially use a complementary system of reporting. Each of these three recommendations involves tracking aspect of projects. Once a mechanism is created for tracking one of these

recommendations, the other two could utilize the same mechanism. This would be an effective use of staff time and relieve jurisdiction burden of entering similar data into multiple locations.

Recommendation 9 will significantly add to the complexity of the PAG Performance Report automation and real-time generation, in addition to the matrix of projects. This is principally an IT-related workflow, with assistance from other departments on which category areas would be included.

Recommendations 6 and 10 are complementary efforts. Documenting operational improvements within programmed projects, coupled with enhanced performance monitoring along corridors, can improve evaluation of the impacts of the operational improvements.

Recommendation 11 can use the existing PAG Performance Report as a standard mechanism to assess project impacts. The trigger to run a report just prior to construction is critical. Additionally, a second trigger, outside the TIP timeframe, is needed to perform the second PAG Performance Report. The difference between the two reports will demonstrate the impact of the projects.

Recommendation 12 will require significant planning and coordination over several years to complete. Prior to pursuing this recommendation, an evaluation of the variables that can be controlled should be conducted. A thorough documentation of all inputs and processes will need to be maintained. This will be used later in the test of the model after a suite of TIP projects are complete.

APPENDIX C

2011 TTI Study Congestion Mitigation Strategy Summary

Table 9. Demand Management Strategies by Cost, Implementation Time, and Project Lifetime

Strategy	Cost	Implement Time	Project Lifetime
Redevelopment and Infill Development	●●●●○	Long	30
Land Use Development	●●●○○	Long	30
Diversified Development Patterns	●●●○○	Long	30
Mixed Use Development	●●●○○	Long	30
Transit-Oriented Development	●●●○○	Moderate	30
Parking Management	●●○○○	Short	10
Car Sharing	●●○○○	Short	10
Work Schedule Changes	●●○○○	Short	5
Ridesharing/Vanpools	●●○○○	Short	5
Compact Development	●○○○○	Long	30
Jobs-Housing Balance	●○○○○	Long	30
Corridor Land Use and Transportation Coordination	●○○○○	Long	30
Trip Reduction Ordinances	●○○○○	Short	5

Source: Crawford, J.A., et.al., *A Michigan Toolbox for Mitigating Traffic Congestion,* prepared for the Michigan Department of Transportation, prepared by the Texas Transportation Institute, September 30, 2011.

Table 10. Supply/System Management Strategies by Cost, Implementation Time, and Project Lifetime

Strategy	Cost	Implement Time	Project Lifetime
Freight Rail Improvements	●●●●●	Long	30
Auxiliary Lanes	●●●●○	Long	25
Improving Street Continuity	●●●●○	Long	20
One-Way Streets	●●●●○	Moderate	25
Increase Number of Lanes by Widening/Lane Additions	●●●●○	Moderate	20
Multimodal Transportation Centers	●●●●○	Moderate	20
Park-and-Ride Lots	●●●○○	Moderate	30
Deceleration/Acceleration Lanes	●●●○○	Moderate	25
Access Management	●●●○○	Moderate	25
Speed Harmonization	●●●○○	Moderate	10
Temporary Shoulder Use	●●●○○	Moderate	10
Queue Warning	●●●○○	Moderate	10
Dynamic Merge Control	●●●○○	Moderate	10
Dynamic Truck Restrictions	●●●○○	Moderate	10
Dynamic Rerouting and Traveler Information	●●●○○	Moderate	10
Advanced Traveler Information Systems	●●●○○	Moderate	10
Detection, Response, and Clearance	●●●○○	Moderate	10
Increasing Number of Lanes Without Widening	●●●○○	Short	20
Diverging Diamonds	●●●○○	Short	20
Loop Ramps Eliminating Left Turns	●●●○○	Short	20
Deceleration/Acceleration Auxiliary Lanes	●●●○○	Short	20
Configurations to Increase Queuing Capacity	●●●○○	Short	20
Exclusive Lanes	●●●○○	Short	10
Intersection Improvements	●●●○○	Short	5
Super Street Arterials	●●●○○	Short	5
Traffic Signals	●●●○○	Short	5
Reversible Traffic Lanes	●●●○○	Short	5
Bicycle and Pedestrian	●●○○○	Moderate	25
Bottleneck Removal	●●○○○	Moderate	20
Road Weather Management	●●○○○	Moderate	10
Commercial Vehicles Accommodations	●●○○○	Short	10
Service/Courtesy Patrols	●●○○○	Short	10
Reducing Construction/Maintenance Interference	●●○○○	Short	10
Vehicle Use Restrictions	●●○○○	Short	5
Special Event Management	●●○○○	Short	5
Complete Streets	●○○○○	Long	20
Performance Measurement	●○○○○	Short	10
Information/Routing and Interagency Cooperation	●○○○○	Short	10

Source: Crawford, J.A., et.al., *A Michigan Toolbox for Mitigating Traffic Congestion,* prepared for the Michigan Department of Transportation, prepared by the Texas Transportation Institute, September 30, 2011.

APPENDIX D

2011 MAG Non-Recurring Congestion Study Countermeasures

Table 4.3 – Summary of NRC Countermeasures for Freeway Application

NRC Countermeasures	NRC Countermeasure Focus		Incident Element Focus					Applicability to MAG Region		Possible Next Steps
	Construction	Incidents	Public Awareness	Reducing # Incidents	Faster Detection	Faster Response	Faster Clearance	Currently in Use	Future Considerations →	
511 Traveler Info Dissemination	✓	✓	✓					✓	✓	Enhance
CCTV Camera Surveillance	✓	✓			✓			✓	✓	Enahnce
Highway Advisory Radio (HAR)	✓	✓	✓					X	✓	Test Variant
Info Dissemination via Permanent DMS	✓	✓	✓					✓	✓	Improve
Monitor Conditions per Real-Time Traffic Prediction	✓	✓			✓	✓		X	✓	Test
Restricted Work Zone Hours	✓							✓	✓	Enhance
Use of Dynamic Lane Merge Control	✓							X	✓	Consider
Use of Full or Dynamic Ramp Closures	✓	✓					✓	X	✓	Consider
Use of Smart Work Zones	✓							X	✓	Consider
Use of Variable Speed Limits	✓	✓		✓				X	✓	Test
Availability of Site Management/ Response Teams		✓				✓		✓	✓	Enhance
Broadcast Dynamic Route Diversion		✓	✓					X	✓	Consider
Enforce Quick Clearance Program/Law		✓	✓				✓	✓	✓	Improve
Install More/More Advanced Vehicle Detectors		✓			✓			✓	✓	Enhance
Permit Shoulder Running		✓				✓	✓	X	✓	Consider
Required Vehicle Safety Inspections		✓		✓				X	X	none
Use of Dynamic Lane Assignment		✓		✓			✓	X	✓	Test
Use of Advanced Ramp Metering System		✓		✓				✓	✓	Pending
Use of Service Patrols		✓		✓	✓	✓		✓	✓	Enahnce
Vehicles Equipped w/ Push Bumpers		✓					✓	✓	X	none

Source: *MAG Non-Recurring Congestion Study,* Maricopa Association of Governments, prepared by Lee Engineering, with the Texas Transportation Institute, Final Report, October 2011.

Table 4.4 – Summary of NRC Countermeasures for Arterial Application

NRC Countermeasures	NRC Countermeasure Focus		Incident Element Focus					Applicability to MAG Region		Possible Next Steps
	Construction	Incidents	Public Awareness	Reducing # Incidents	Faster Detection	Faster Response	Faster Clearance	Currently in Use	Future Considerations →	
511 Traveler Info Dissemination	✓	✓	✓					✓	✓	Enhance
CCTV Camera Surveillance	✓	✓			✓			✓	✓	Enahnce
Dynamic Signal Timing to Adjust to NRC Events	✓	✓		✓				X	✓	Pending
Info Dissemination via Permanent DMS	✓	✓	✓					✓	✓	Improve
Info Dissemination via Portable DMS	✓	✓	✓					✓	✓	Test
Restricted Work Zone Hours	✓							✓	✓	Enhance
Availability of Site Management/ Response Teams		✓				✓		✓	✓	Enhance
Broadcast Dynamic Route Diversion		✓	✓					X	✓	Consider
Required Vehicle Safety Inspections		✓		✓				X	X	none
Use of Service Patrols		✓		✓				✓	✓	Enahnce
Vehicles Equipped w/ Push Bumpers		✓					✓	✓	X	none

Source: *MAG Non-Recurring Congestion Study,* Maricopa Association of Governments, prepared by Lee Engineering, with the Texas Transportation Institute, Final Report, October 2011.

APPENDIX E

2016 PAG CMP Addendum Performance Measures

(Note that Performance Measures Indicated with an * in the Performance Measure Appendix Sheets Table of Contents are considered to be Congestion Management Process Related)

PERFORMANCE MEASURE APPENDIX SHEETS

RMAP System Goals	PAG Item #	PM Category	Performance Measure	Page
Environmental Stewardship	ES-1	Air Quality	Annual On-Road Greenhouse Gas (GHG) Emissions per Capita	Page A.1
	ES-2.1	Air Quality	Annual Weekday Concentrations of NOX, VOC, CO, PM2.5, and PM10 per Capita	Page A.2
Freight and Economic Growth	FEG-1	Freight Delay*	80th percentile travel time of commercial vehicles on the interstate system	Page A.3
	FEG-2.1	Freight Delay*	Commercial vehicle delay on the interstate system	Page A.4
	FEG-2.2	Freight Share	Share of commercial vehicles on the interstate (both peak hours and off-peak hours)	Page A.5
Land Use and Transportation	LUT-1	Job Access by Auto	Percent of regional jobs the average employee can reach in 30 minutes by automobile	Page A.6
	LUT-2.1	Job Access by Transit	Percent of regional jobs the average employee can reach in 45 minutes by transit	Page A.7
	LUT-2.2	Access to Transit*	Percent of residents living within ¼ mile of a transit stop	Page A.8
	LUT-2.3	Transit to Work Access*	Percent of jobs within ¼ mile of a transit stop	Page A.9
	LUT-2.4	Accessibility Index*	Accessibility Index for all modes	Page A.10
Multi-Modal Choices	MMC-1	Five Year Average Walk, Bike or Transit to Work*	Modal split as a percentage of commuting population	Page A.11
	MMC-2.1	Mode Split*	Walk, bike, and transit mode share for all trips (modeled values)	Page A.12
	MMC-2.2	Average Transit Speed*	Average transit speed for express, local, and selected corridors	Page A.13
	MMC-2.3	Average Transit Time*	Average travel time by transit (selected routes, door-to-door, For all trips, door-to-door)	Page A.14
	MMC-2.4	Pedestrian Accessibility Ratio*	Ratio of accessible to inaccessible sidewalks on major roadways in urban areas	Page A.15
	MMC-2.5	Miles of Pedestrian Facilities*	Total miles of complete and accessible pedestrian facilities on major roadways	Page A.16
	MMC-2.6	Bicycle Facility Miles Ratio*	Total bicycle facility miles per 100,000 residents	Page A.17
	MMC-2.7	Bicycle Facility Miles*	Total miles of bike facilities by type	Page A.18
	MMC-2.8	Transit Trips	Annual unlinked passenger trips	Page A.19
	MMC-3.3	Transit Travel Time to Auto Travel Time Differential	Transit to auto differential during peak travel times, along specified corridors	Page A.20
	MMC-3.6	Person Miles by Mode	Person miles traveled by mode	Page A.21
Transportation Safety	S-1	Crash Severity*	Total vehicular, pedestrian, and bicyclist fatalities on all roadways, five year moving average	Page A.22
	S-2.1	Crash Severity*	Fatality rate by VMT (per hundred million VMT), five year moving average	Page A.23

Transportation Safety	S-2.2	Crash Severity*	Total serious injuries (vehicular, pedestrian, and bicyclist) on all roadways, five year moving average	Page A.24
	S-2.3	Crash Severity*	Serious injury rate by VMT (per hundred million VMT), five year moving average	Page A.25
	S-2.4	Pedestrian Safety	Total 5-year average of pedestrian incapacitating injuries	Page A.26
	S-2.5	Pedestrian Safety	Rate of 5-year average incapacitating pedestrian injuries per 10,000 (walk to work rate)	Page A.27
	S-2.6	Pedestrian Safety	Total 5-year average of pedestrian fatalities	Page A.28
	S-2.7	Pedestrian Safety	Rate of 5-year average pedestrian fatalities per 10,000 (walk to work rate)	Page A.29
	S-2.8	Bicyclist Safety	Total 5-year average bicycle incapacitating injuries	Page A.30
	S-2.9	Bicyclist Safety	Rate of 5-year average incapacitating bicycle injuries per 10,000 (bike to work rate)	Page A.31
	S-2.10	Bicyclist Safety	Total 5-year average of bicycle fatalities	Page A.32
	S-2.11	Bicyclist Safety	Rate of 5-year average bicycle fatalities per 10,000 (bike to work rate)	Page A.33
	S-2.12	Transit Safety*	Total transit vehicle crashes per 100,000 miles, five-year moving average	Page A.34
	S-2.13	Vulnerable Users*	Serious injuries and fatalities of vulnerable users, five year moving average	Page A.35
System Maintenance	SM-1	Pavement Condition: Federal-Aid Roadways	Percentage of federal-aid roadways rated in "poor" condition (IRI)	Page A.36
	SM-2.1	Pavement Condition: Interstate	Percentage of interstate roadways rated in "poor" condition (IRI)	Page A.37
	SM-2.2	Pavement Condition: Non-Interstate	Percentage of non-interstate roadways (NHS) rated in "poor" condition (IRI)	Page A.38
	SM-2.3	Bridge Condition	Percentage of total bridge deck area determined to be structurally deficient (NHS)	Page A.39
	SM-2.4	Transit State of Good Repair	Average age of transit assets as a percent of useful life	Page A.40
System Performance	SP-1	Congestion Extent: Vehicle Measures*	Percent of peak hour VMT travelled under LOS E or F	Page A.41
	SP-2.1	Daily Vehicle Hours of Travel Per Capita*	Hours of Vehicle Travel in Relation to Population	Page A.42
	SP-2.2	Daily Vehicle Miles Traveled (VMT)*	Vehicle Miles Traveled per Capita	Page A.43
	SP-2.3	Reliability*	Planning Time Index (PTI)	Page A.44
	SP-2.4	Variability*	Travel Time Index (TTI)	Page A.45
	SP-3.6	Freeway Performance*	Commuter travel time by auto on selected freeway routes	Page A.46
	SP-3.7	Non-Freeway Performance*	Commuter travel time by auto on selected non-freeway routes	Page A.47

AIR QUALITY

Performance Measure	**Annual On-Road Greenhouse Gas (GHG) Emissions per Capita**	
Overview	On-road GHG emissions from on road vehicles and currently account for about one-third of eastern Pima County's total GHG emissions and are one of the performance measures tracked as a Federal requirement performance measures. The following GHG emissions: carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) are tracked and reported as carbon dioxide equivalents (CO2e) based on their relative global warming potentials. The purpose of monitoring GHG is to evaluate the impact of any future climate mitigation efforts. Future year GHG emission reduction targets should be established as a percentage reduction from a set base year. (Source: USDOT, Transportation's Role in Reducing U.S. Greenhouse Gas Emission).	
Documentation & Support	Federal Requirement?	Yes*
	Included in 2010 CMP?	No
	Included in 2045 RMAP?	Yes
Benchmarking and Future Targets	In 2015	3.63 US tons per capita (Pima County, 2015)
	By 2020	Reduce by 5% below 2015 per capita emissions
	By 2045	Reduce by more than 30% below 2015 per capita emissions
Data & Sources	Data Source	MOVES2014 model
	Data Update Schedule	Data updates annually, MOVES model updates as needed
	Link to Data Updates	N/A
Process Detail	A GHG emissions rate is established for each vehicle type using vehicle age distribution, speed, road type, local meteorology, applicable federal vehicle emission standards and other factors and expressed in grams per mile. The total on-road GHG emissions are reported in US tons per capita for a given year. The total shown above (3.63 US tons/capita) represents emissions from all vehicle types in the community for 2015.	

*The final system performance rule contains a Green House gas PM that will be required of all MPO's. The exact methodology of PAG's current green house gas PM may have to be modified or amended to meet the new requirement at a later date. The required GHG PM uses tailpipe CO2 emission on the NHS per year. The target would also be re-evaluated with any changes.

AIR QUALITY

Performance Measure	**Average Daily Weekday Emissions of NO_X, VOC, $PM_{2.5}$ and PM_{10}**	
Overview	This performance measure tracks the average daily weekday emissions of oxides of nitrogen (NO_X), volatile organic compounds (VOC), carbon monoxide (CO), particulate matter ($PM_{2.5}$ and PM_{10}). These pollutants are monitored to insure the region meets the EPA's health standards (National Ambient Air Quality Standards). This performance measure is reported on an annual basis, and represents the daily weekday emissions for each pollutant. is the average concentration of the pollutants on a weekday. Pima County is in attainment for all EPA air quality standards. In the late 1970's and early 1980's, Pima County did not meet the CO standards. In 2000, Pima County was designated in attainment for CO and remains a CO maintenance area.	
Documentation & Support	Federal Requirement?	Yes (CO transportation conformity determination is conducted for all PAG transportation plans)
	Included in 2010 CMP?	No
	Included in 2045 RMAP?	Yes
Benchmarking and Future Targets	In 2015	NO_X: 22.8 metric tons VOC:18.3 metric tons CO: 164 metric tons $PM_{2.5}$: 0.5 metric tons PM_{10}: 1.3 metric tons
	By 2020	NO_X: Reduce by 13% from 2015 emissions VOC: Reduce by 12% from 2015 emissions CO: Reduce by 12% from 2015 emissions $PM_{2.5}$ & PM_{10}: Maintain 2015 levels
	By 2045	NO_X: Reduce by 80% from 2015 emissions VOC: Reduce by 75% from 2015 emissions CO: Reduce by 70% from 2015 emissions $PM_{2.5}$ & PM_{10}: Maintain 2015 levels
Data & Sources	Data Source	MOVES2014 model run
	Data Update Schedule	CO annually
	Link to Data Updates	N/A
Process Detail	The modeled emissions are for an average weekday when emissions are expected to be the highest. For CO, data represents an average January weekday; for VOC, NOx, PM2.5 and PM10 emissions represent an average July weekday.	

FREIGHT DELAY

Performance Measure	**Truck Travel Time Reliability (TTTR) Index**	
Overview	This PM assesses freight movement on the Interstate System and will inform FHWA's National Highway Freight Program (NHFP). Travel time data is used to create a reliability index by dividing the 95 percentile travel time by the 50th percentile or nominal truck travel time. This process is done on defined segments of mainline traffic for five time periods (AM peak, Mid day, PM peak, overnight and weekend).	
Documentation & Support	Federal Requirement? *	Yes
	Included in 2010 CMP?	No
	Included in 2045 RMAP?	Yes
Benchmarking and Future Targets	In 2016	Under development
	By 2020	Under development
	By 2045	Under development
Data & Sources	Data Source	NMPRDS
	Data Update Schedule	Monthly
	Link to Data Updates	ADOT Arizona Annual System Performance Measures: https://apps.azdot.gov/AASPM_Launch/?viewer=AASPM&layerTheme=2
Process Detail	First step would be identifying the reporting segments. usually, the reporting segments in urbanized areas would have a maximum length of ½ mile, while the maximum length in non-urbanized areas will be 10 miles, unless an individual travel time segment is longer. The second step would be identifying the normal (50th percentile) and 95th percentile truck travel time for each reporting segment of the Interstate System using a full calendar year of data from the truck travel time dataset for each time period. Truck Travel Time Reliability would be then calculated to the nearest hundredth by taking the ratio of 95th percentile truck travel time to 50th percentile truck travel time.	

*Note: Documentation for the federal proposed rulemaking: Federal Register, April 22, 2016. National Performance Management Measures; Assessing Performance of the National Highway System, Freight Movement on the Interstate System, and Congestion Mitigation and Air Quality Improvement Program, Proposed Rule.

FREIGHT DELAY

Performance Measure	**Commercial vehicle delay on the interstate system**	
Overview	Commercial vehicle delay is an indicator of interstate level-of-service and congestion. Commercial vehicle delay has significant impacts on economic efficiency, freight movement, and air quality, and is caused by non-commercial vehicle congestion, roadway restrictions and closures, and can also be caused by inclement weather.	
Documentation & Support	Federal Requirement?	No
	Included in 2010 CMP?	No
	Included in 2045 RMAP?	Yes
Benchmarking and Future Targets	In 2016	0.84 hours
	By 2020	None
	By 2045	Not established at this time
Data & Sources	Data Source	NPMRDS
	Data Update Schedule	Monthly
	Link to Data Updates	ADOT Arizona Annual System Performance Measures: https://apps.azdot.gov/AASPM_Launch/?viewer=AASPM&layerTheme=3
Process Detail		

FREIGHT SHARE

Performance Measure	**Share of commercial vehicles on the interstate (both peak hours and off-peak hours)**	
Overview	In Arizona, commercial vehicles consist of freight trucks, buses, and light duty vehicles (passenger cars, pickup trucks, and vans used for commercial purposes). The share of commercial vehicles, in relation to personal vehicles, is useful in determining primary roadway uses and to identify sections of the interstate with high commercial vehicle use.	
Documentation & Support	Federal Requirement?	No
	Included in 2010 CMP?	No
	Included in 2045 RMAP?	Yes
Benchmarking and Future Targets	In 2016	10 percent
	By 2020	None
	By 2045	None (Not Needed)
Data & Sources	Data Source	ADOT vehicle count program published on MS2
	Data Update Schedule	Continuous count locations
	Link to Data Updates	http://www.azdot.gov/planning/DataandAnalysis/average-annual-daily-traffic and http://adot.ms2soft.com/
Process Detail	The share of commercial vehicles and personal vehicles is measured using vehicle classification counts at various locations within the interstate system. The percentage of trucks or commercial vehicles divided by the total volume.	

JOB ACCESS BY AUTO

Performance Measure	**Percent of regional jobs the average employee can reach in 30 minutes by automobile**	
Overview	The percent of regional jobs that the average employee can reach in 30 minutes by automobile is a measure of accessibility. Interstate access, arterial congestion, and interstate congestion are factors that affect the range the average employee can reach within the set time frame. This performance measure estimates the accessibility of employment within a reasonable commuting time period.	
Documentation & Support	Federal Requirement?	No
	Included in 2010 CMP?	No
	Included in 2045 RMAP?	Yes
Benchmarking and Future Targets	In 2016	232,112 jobs
	By 2021	Increase by 7% above 2016 estimates
	By 2045	Increase by 45% above 2016 estimates
Data & Sources	Data Source	PAG Travel Demand Model
	Data Update Schedule	Annual
	Link to Data Updates	None
Process Detail	This performance measure is modeled annually using spatial population and employment data.	

JOB ACCESS BY TRANSIT

Performance Measure	**Percent of regional jobs the average employee can reach in 45 minutes by transit**	
Overview	The percent of regional jobs that the average employee can reach in 45 minutes by transit is a measure of accessibility. Along with interstate access, arterial congestion, and interstate congestion, this performance measure is impacted by the accessibility to transit, transfer connections, number of transit stops, and location of transit stops. This performance measure estimates the accessibility of employment within a reasonable transit commuting time period.	
Documentation & Support	Federal Requirement?	No
	Included in 2010 CMP?	No
	Included in 2045 RMAP?	Yes
Benchmarking and Future Targets	In 2016	26,332 jobs
	By 2020	Increase by 10%
	By 2045	Increase by 50%
Data & Sources	Data Source	PAG Travel Demand Model
	Data Update Schedule	Annual
	Link to Data Updates	None
Process Detail	This performance measure is modeled using spatial population, employment, and transit network data.	

ACCESS TO TRANSIT

Performance Measure	**Percent of residents living within ¼ mile of a transit stop**	
Overview	A 1/4-mile walk is approximately equivalent to a 5-minute walk. People who live within a 1/4 mile radius of a transit stop are more likely to use transit than others who live farther, as others may require a second mode of transportation to reach the transit stop (vehicle, bicycle). This performance measure tracks the percentage of residents within the 1/4 mile transit stops buffer to quantify the population that is most likely to use transit. This measure is useful to track alongside total ridership, as fluctuations with total ridership over time may correlate with resident population within the 1/4 mile transit buffer.	
Documentation & Support	Federal Requirement?	No
	Included in 2010 CMP?	No
	Included in 2045 RMAP?	Yes
Benchmarking and Future Targets	In 2016	42.6 % of residents
	By 2020	43 % of residents
	By 2045	More than 45 % of residents
Data & Sources	Data Source	PAG Travel Demand Model
	Data Update Schedule	Annual
	Link to Data Updates	ACS website (Block Group): https://goo.gl/HQ16ER
Process Detail	This performance measure is modeled using population data and transit stop information. The SunTran bus stops are buffered to 1/4 mile, and the census geography data is overlaid to create the model.	

TRANSIT TO WORK ACCESS

Performance Measure	**Percent of jobs within ¼ mile of a transit stop**	
Overview	A 1/4-mile walk is approximately equivalent to a 5-minute walk. People who work within a 1/4-mile radius of a transit stop are more likely to use transit than others who work farther, as others may require a second mode of transportation to reach the employment location (vehicle, bicycle). This performance measure tracks the percentage of jobs within the 1/4 mile transit stops buffer to determine the areas which will attract the greatest transit ridership.	
Documentation & Support	Federal Requirement?	No
	Included in 2010 CMP?	No
	Included in 2045 RMAP?	Yes
Benchmarking and Future Targets	In 2016	58.9 % of jobs
	By 2020	59 % of jobs
	By 2045	60 % of jobs
Data & Sources	Data Source	PAG Travel Demand Model
	Data Update Schedule	Annual
	Link to Data Updates	N/A
Process Detail	This performance measure can be modeled using employment data and transit stop information. The SunTran bus stops are buffered to 1/4 mile, and the census, geography, and employment data is overlaid to create the model.	

ACCESSIBILITY INDEX

Performance Measure	**Accessibility Index for all modes**	
Overview	The Accessibility Index is a way of quantifying, for the purpose of comparison, how easily residents can get to their employment. The area with higher Accessibility Index Value, the more employments, a resident can reach in a shorter amount of time by both automobile or transit.	
Documentation & Support	Federal Requirement?	No
	Included in 2010 CMP?	No
	Included in 2045 RMAP?	Yes
Benchmarking and Future Targets	In 2016	53,595
	By 2020	Increase by 3%
	By 2045	Increase by 15%
Data & Sources	Data Source	PAG Travel Demand Model
	Data Update Schedule	Annual
	Link to Data Updates	N/A
Process Detail	The accessibility index is a ratio of employment opportunity and transportation barriers. For the transportation barriers, or impedance, the travel times between transportation analysis zones (TAZs) are used. Employment in nearby TAZs has less impedance and results in higher accessibility values. Employment opportunities in distant TAZs have large travel times which reduce the accessibility values. Each origin TAZ has a ratio to all of the TAZs in the region, with the number of jobs as the numerator and the impedance of network travel time as the denominator. This process is run for every TAZ as an origin then averaged, as weighted by its population ratio, so that a TAZ with more population has better regional employment opportunities. This process is for both passenger vehicles and transit passengers during peak and off-peak travel times.	

5-YEAR AVERAGE WALK, BIKE OR TRANSIT TO WORK

Performance Measure	**Modal split as a percentage of commuting population**	
Overview	This performance measure determines the modal split of those walking, biking, or using transit to get to work. Pedestrian and bicycle facility infrastructure improvements, expanded access to transit, bicycle sharing programs, and employer trip reduction programs are examples of efforts to increase the modal split of commuters using these alternative modes to get to work. Increases in walking, biking, and transit over time indicates the effectiveness of these improvement initiatives.	
Documentation & Support	Federal Requirement?	No
	Included in 2010 CMP?	No
	Included in 2045 RMAP?	Yes
Benchmarking and Future Targets	In 2016	6.7 % of commuters
	By 2020	7.25 % of commuters
	By 2045	More than 10 % of commuters
Data & Sources	Data Source	ACS data, five year average
	Data Update Schedule	Annually, data update occurs in the 4th quarter
	Link to Data Updates	ACS website (Block Group): https://goo.gl/io48ct
Process Detail	Commuter data from the American Community Survey (ACS) is used to determine the modal split of the commuting population. A five-year moving average is used in order to analyze a larger sample size relative to using only one year of data, reducing margins of error of estimates for small subpopulations.	

MODE SPLIT

Performance Measure	**Walk, bike, and transit mode share for all trips (modeled values)**	
Overview	This performance measure determines the modal share of those walking, biking, or using transit. This is based on PAG Travel Demand Model output and includes all trips using these three models. Pedestrian and bicycle facility infrastructure improvements, expands access to transit and bicycle sharing programs are examples of efforts to improve the modal split and encourage using alternate modes of transportation. Increases in walking, biking, and using transit over time can indicate the effectiveness of these improvement initiatives.	
Documentation & Support	Federal Requirement?	No
	Included in 2010 CMP?	No
	Included in 2045 RMAP?	Yes
Benchmarking and Future Targets	In 2016	16.4 % of trips
	By 2020	17 % of trips
	By 2045	More than 20 % of trips
Data & Sources	Data Source	PAG Travel Demand Model
	Data Update Schedule	Annual
	Link to Data Updates	http://nhts.ornl.gov/download.shtml
Process Detail	This is a product of PAG's Travel Demand Model, which is calibrated using data sources such as the National Household Travel Survey.	

AVERAGE TRANSIT SPEED

Performance Measure	**Average transit speed for express, local and selected corridors**	
Overview	Average transit speed is an indicator of route congestion and transit operation and efficiency and is determined by the miles traveled during operating hours. This measure includes time elapsed during transit stops for all transit services with the exception of SunShuttle Dial-a-Ride. (SunTran Local and Express, Sunlink, SunShuttle(4XX), and CatTran).	
Documentation & Support	Federal Requirement?	No
	Included in 2010 CMP?	Yes
	Included in 2045 RMAP?	Yes
Benchmarking and Future Targets	In 2016	13.25 mph
	By 2020	13.75 mph
	By 2045	Over 15 mph
Data & Sources	Data Source	PAG Travel Demand Model
	Data Update Schedule	Annual
	Link to Data Updates	N/A
Process Detail	The average transit speed is determined by dividing the operating hours by the miles traveled during operation.	

AVERAGE TRANSIT TIME

Performance Measure	**Average travel time by transit (selected routes, door-to-door, For all trips, door-to-door)**	
Overview	The average travel time by transit accounts for all components of the trip, from the origin to the destination. For example, a home to work trip includes the time from home to the transit stop (walking, biking, vehicle), the time spent waiting for transit, the time riding transit, and the time spent from the transit stop to work (walking, biking, vehicle). The PAG transit system includes Sun Link Streetcar, Sun Shuttle, Sun Van, Cat Tran, and Ajo Community Circulator Service.	
Documentation & Support	Federal Requirement?	No
	Included in 2010 CMP?	Yes
	Included in 2045 RMAP?	Yes
Benchmarking and Future Targets	In 2016	50.81 minutes
	By 2020	50.5 minutes
	By 2045	Below 50 minutes
Data & Sources	Data Source	PAG Travel Demand Model
	Data Update Schedule	Annual
	Link to Data Updates	N/A
Process Detail	PAG Travel Demand Model Output.	

PEDESTRIAN ACCESSIBILITY RATIO

Performance Measure	**Ratio of accessible to inaccessible sidewalks on major roadways in urban areas**	
Overview	The pedestrian accessibility ratio is a measure of the percentage of sidewalks that are accessible in urban areas. Sidewalks are considered to be accessible when the criteria for sidewalk width, grade, cross slope, clearance from obstructions, and curb ramps are met, according to the 2010 ADA Standards for Accessible Design. This performance measure is an indicator of accessibility and safety for all pedestrians, but specifically impacts pedestrians with disabilities. The United States Access Board has drafted Public Rights-of-Way Accessibility Guidelines (PROWAG), which if adopted, will update accessibility criteria.	
Documentation & Support	Federal Requirement?	No
	Included in 2010 CMP?	No
	Included in 2045 RMAP?	Yes
Benchmarking and Future Targets	In 2016	33 % of major roadways in urban area
	By 2020	40 % of major roadways in urban area
	By 2045	80 % of major roadways in the urban area
Data & Sources	Data Source	Special Collection
	Data Update Schedule	Once every 5 years (or less frequently)
	Link to Data Updates	2010 ADA Standards for Accessible Design: goo.gl/bSNm8w; US Access Board PROWAG: goo.gl/jo0EJM
Process Detail	Sidewalk condition and ADA accessibility inventory data are conducted by special collection only. Due to the extensive sidewalk network within the PAG region and the need for visual inspection, an annual inventory is not feasible nor necessary. The sidewalk inventory is conducted approximately once every five years by visual inspection.	

MILES OF PEDESTRIAN FACILITIES

Performance Measure	**Total miles of complete and accessible pedestrian facilities on major roa**	
Overview	The total miles of complete and accessible pedestrian facilities is an indicator of accessibility and safety for all pedestrians but can specifically impact pedestrians with disabilities. Sidewalks are considered to be accessible when the criteria for sidewalk width, grade, cross slope, clearance from obstructions, and curb ramps are met.	
Documentation & Support	Federal Requirement?	No
	Included in 2010 CMP?	Yes
	Included in 2045 RMAP?	Yes
Benchmarking and Future Targets	In 2016	442 miles
	By 2020	560 miles
	By 2045	1200 miles
Data & Sources	Data Source	Special Collection
	Data Update Schedule	Once every 5 years (or less frequently)
	Link to Data Updates	N/A
Process Detail	Sidewalk condition and ADA accessibility inventory data are conducted by special collection only. Due to the extensive sidewalk network within the PAG region and the need for visual inspection, an annual inventory is not feasible nor necessary. The sidewalk inventory is conducted approximately once every five years by visual inspection.	

BICYCLE FACILITY MILES RATIO

Performance Measure	**Total bicycle facility miles per 100,000 residents**	
Overview	This performance measure relates the total bicycle facility miles to population density. It is a representative value of bicycle facility supply/availability to potential users.	
Documentation & Support	Federal Requirement?	No
	Included in 2010 CMP?	Yes
	Included in 2045 RMAP?	Yes
Benchmarking and Future Targets	In 2016	1 mile per 100,000 population
	By 2020	1.05 miles per 100,000 population
	By 2045	1.2 miles per 100,000 population
Data & Sources	Data Source	PAG Technical Services Department
	Data Update Schedule	Annually
	Link to Data Updates	N/A
Process Detail	This performance measure is tracked using the regional bicycle facilities map "PAG Bikeways Map" and Census Bureau population data. The Bikeways Map is updated annually.	

BICYCLE FACILITY MILES

Performance Measure	**Total miles of bike facilities by type**	
Overview	The total miles of bicycle facility provides a measure of the overall investment made to enhance the bicycle network. The total miles includes shared-use paths, bike boulevards, separated bike lanes, enhanced bike routes, and bike lanes.	
Documentation & Support	Federal Requirement?	No
	Included in 2010 CMP?	No
	Included in 2045 RMAP?	Yes
Benchmarking and Future Targets	In 2016	707 miles
	By 2020	760 miles
	By 2045	1000 miles
Data & Sources	Data Source	PAG Technical Services Department
	Data Update Schedule	Annually
	Link to Data Updates	N/A
Process Detail	This performance measure is tracked using the regional bicycle facilities map "PAG Bikeways Map," which is updated annually.	

TRANSIT TRIPS

Performance Measure	**Annual unlinked passenger trips**	
Overview	The American Public Transportation Association defines unlinked passenger trips as the number of passengers who board public transportation vehicles. Passengers are counted each time they a board vehicle, no matter how many vehicles they use to travel from their origin to their destination. It can be difficult to determine the true number of passengers using transit (and ensure riders are only being counted once), therefore the annual unlinked passenger trips provides a standard system for counting total boardings.	
Documentation & Support	Federal Requirement?	No
	Included in 2010 CMP?	No
	Included in 2045 RMAP?	Yes
Benchmarking and Future Targets	In 2016	19,700,000 trips per year
	By 2020	22,000,000 trips
	By 2045	Increase by 75%
Data & Sources	Data Source	SunTran Ridership Statistics
	Data Update Schedule	Annually
	Link to Data Updates	N/A
Process Detail	Each time a passenger is permitted entry on a SunTran transit vehicle, riders must present a valid transit pass or exact change. These boarding statistics are recorded by SunTran.	

TRANSIT TRAVEL TIME TO AUTO TRAVEL TIME DIFFERENTIAL

Performance Measure	**Transit to auto differential during peak travel times, along specified corridors**	
Overview	The transit to auto travel time differential refers to the difference in travel time between transit vehicles and personal vehicles during peak travel times. The goal of this performance measure is to reduce the travel time differential between transit trips and personal vehicle trips.	
Documentation & Support	Federal Requirement?	No
	Included in 2010 CMP?	No
	Included in 2045 RMAP?	No
Benchmarking and Future Targets	In 2016	None
	By 2020	None
	By 2045	Decrease
Data & Sources	Data Source	PAG Travel Demand Model
	Data Update Schedule	Annual
	Link to Data Updates	N/A
Process Detail	This performance measure can be tracked using travel time model data for personal vehicle and transit modes.	

PERSON MILES BY MODE

Performance Measure	**Person miles traveled by mode**	
Overview	Person miles traveled by mode measures the amount that the average person either 1) walks, 2) bicycles, or 3) drives in a year in a private vehicle (including cars, vans, SUVs, pickup trucks, taxicabs, recreational vehicles, motorcycles, and light electric vehicles such as golf carts).	
Documentation & Support	Federal Requirement?	No
	Included in 2010 CMP?	No
	Included in 2045 RMAP?	No
Benchmarking and Future Targets	In 2016	None
	By 2020	None
	By 2045	None
Data & Sources	Data Source	PAG Travel Demand Model
	Data Update Schedule	Annually
	Link to Data Updates	None
Process Detail	This performance measure can be tracked using model output for person miles.	

CRASH SEVERITY

Performance Measure	**Total fatalities on all public roads, 5-year moving average**	
Overview	The total number of fatalities is an indicator of transportation safety. The 2014 comprehensive cost of a fatal injury crash is $9.3 million. A 5-year moving average is used to account for annual variation and to better understand multiyear trends. ("Guidance of Treatment of the Economic Value of a Statistical Life (VSL)" USDOT.)	
Documentation & Support	Federal Requirement?	Yes
	Included in 2010 CMP?	Yes
	Included in 2045 RMAP?	Yes
Benchmarking and Future Targets	In 2016	100 fatalities
	By 2020	95 fatalities
	By 2045	Decrease by 25%
Data & Sources	Data Source	FARS and ALISS Databases
	Data Update Schedule	FARS (December) and ALISS (June) updated annu
	Link to Data Updates	ftp://ftp.nhtsa.dot.gov/fars/ https://goo.gl/Nnooqn
Process Detail	Crash data is collected from the ADOT ALISS database or the NHTSA FARS database. ALISS crash data of a particular year is available the following June, and the FARS data of a particular year is available the following December. FARS data has a processing time of approximately two years. ALISS data or Interim FARS is used, when available, to fill in the missing year's data until final FARS values are available. When analyzing the crash data, a five-year moving average is used to help control for annual data variability.	

CRASH SEVERITY

Performance Measure	**Fatality rate by VMT (per hundred million VMT), five year moving average**	
Overview	The fatality rate by vehicle miles traveled (VMT) standardizes the crash frequency based on miles traveled within the PAG region. Over time, this performance measure can indicate if variation in the total number of fatalities is attributed to the total VMT, or if there are other factors influencing the fatality rate. VMT is based on traffic data counts collected through permanent automatic traffic recorders on public roadways.	
Documentation & Support	Federal Requirement?	Yes, Final Rule
	Included in 2010 CMP?	Yes
	Included in 2045 RMAP?	Yes
Benchmarking and Future Targets	In 2016	1.2 fatalities per 100 million VMT
	By 2020	1.11 fatalities per 100 million VMT
	By 2045	Reduce by 45%
Data & Sources	Data Source	FARS, ALISS, and HPMS Databases
	Data Update Schedule	FARS (December), ALISS (June), and HPMS (Augu
	Link to Data Updates	ftp://ftp.nhtsa.dot.gov/fars/ https://www.fhwa.dot.gov/policyinformation/hpms/shapefiles.cfm
Process Detail	Crash data is collected from the ADOT ALISS database or the NHTSA FARS database. ALISS crash data of a particular year is available the following June, and the FARS data of a particular year is available the following December. FARS data has a processing time of approximately two years. ALISS data or Interim FARS is used, when available, to fill in the missing year's data until final FARS values are available. When analyzing the crash data, a five-year moving average is used to help control for annual data variability.	

CRASH SEVERITY

Performance Measure	**Total serious injuries on all public roads, 5-year moving average**	
Overview	The total number of serious injuries is an indicator of transportation safety. The 2014 comprehensive cost of a serious injury crash is $987,000. This data can be used for transportation safety analyses and benefit-cost ratio calculation. ("Guidance of Treatment of the Economic Value of a Statistical Life (VSL)" USDOT.)	
Documentation & Support	Federal Requirement?	Yes, Final Rule
	Included in 2010 CMP?	Yes
	Included in 2045 RMAP?	Yes
Benchmarking and Future Targets	In 2016	675 injuries
	By 2020	640 injuries
	By 2045	Decrease by 25%
Data & Sources	Data Source	ALISS Databases
	Data Update Schedule	ALISS (June) updated annually
	Link to Data Updates	N/A
Process Detail	Crash data is collected from the ADOT ALISS database. ALISS crash data of a particular year is available the following June. When analyzing the crash data, a 5-year moving average is used to help control for annual data variability.	

CRASH SEVERITY

Performance Measure	**Serious injury rate by VMT (per hundred million VMT), five year moving average**	
Overview	The serious injury rate by vehicle miles traveled (VMT) standardizes the crash frequency based on miles traveled within the PAG region. Over time, this performance measure can indicate if variation in the total number of serious injury crashes is attributed to the total VMT, or if there are other factors influencing the crash rate. VMT is based on traffic data counts collected through permanent automatic traffic recorders on public roadways.	
Documentation & Support	Federal Requirement?	Yes, Final Rule
	Included in 2010 CMP?	Yes
	Included in 2045 RMAP?	Yes
Benchmarking and Future Targets	In 2016	8.09 injuries per 100 million VMT
	By 2020	7.75 injuries per 100 million VMT
	By 2045	Reduce by 45%
Data & Sources	Data Source	ALISS, and HPMS Databases
	Data Update Schedule	ALISS (June) and HPMS (August) updated annually
	Link to Data Updates	N/A
Process Detail	Crash data is collected from the ADOT ALISS database. ALISS crash data of a particular year is available the following June. When analyzing the crash data, a 5-year moving average is used to help control for annual data variability.	

PEDESTRIAN SAFETY

Performance Measure	**Total 5-year average of pedestrian incapacitating injuries**	
Overview	This performance measure is an indicator of overall pedestrian safety related to motor vehicle crashes.	
Documentation & Support	Federal Requirement?	No
	Included in 2010 CMP?	No
	Included in 2045 RMAP?	Yes
Benchmarking and Future Targets	In 2016	59.6 pedestrian injuries
	By 2020	56 pedestrian injuries
	By 2045	Decrease by 33%
Data & Sources	Data Source	ALISS
	Data Update Schedule	Annually (June)
	Link to Data Updates	N/A
Process Detail	Crash data is collected from the ADOT ALISS database. The crash data of a particular year is available the following June. When analyzing the crash data, a five-year moving average is used to help control for annual data variability.	

PEDESTRIAN SAFETY

Performance Measure	**Rate of 5-year average incapacitating pedestrian injuries per 10,000 (walk to work rate)**	
Overview	This performance measure relates the total number of pedestrian incapacitating injury crashes to the population of pedestrian commuters, as a measure of pedestrian exposure. The average rate is calculated over a 5-year moving average.	
Documentation & Support	Federal Requirement?	No
	Included in 2010 CMP?	No
	Included in 2045 RMAP?	Yes
Benchmarking and Future Targets	In 2016	57.12 pedestrian injuries per 10,000 walk commuters
	By 2020	51 pedestrian injuries per 10,000 walk commuters
	By 2045	Decrease by 70%
Data & Sources	Data Source	ALISS, ACS
	Data Update Schedule	ALISS updated annually (June)
	Link to Data Updates	N/A
Process Detail	Crash data is collected from the ADOT ALISS database and the population of pedestrian commuters is collected from the American Community Survey database. When analyzing the crash data, a five-year moving average is used to help control for annual data variability.	

PEDESTRIAN SAFETY

Performance Measure	**Total 5-year moving average of pedestrian fatalities**	
Overview	This performance measure is an indicator of overall pedestrian safety related to motor vehicle crashes.	
Documentation & Support	Federal Requirement?	No
	Included in 2010 CMP?	No
	Included in 2045 RMAP?	Yes
Benchmarking and Future Targets	In 2016	22 pedestrian fatalities
	By 2020	20 pedestrian fatalities
	By 2045	Decrease by 33%
Data & Sources	Data Source	ALISS
	Data Update Schedule	Annually (June)
	Link to Data Updates	N/A
Process Detail	Crash data is collected from the ADOT ALISS database. The crash data of a particular year is available the following June. When analyzing the crash data, a five-year moving average is used to help control for annual data variability.	

PEDESTRIAN SAFETY

Performance Measure	**Rate of 5-year average pedestrian fatalities per 10,000 (walk to work rate)**	
Overview	This performance measure is an indicator of pedestrian exposure. This performance measure relates the total number of fatal motor vehicle crashes involving a pedestrian to the population of pedestrian commuters. The average rate is calculated over a 5-year moving average.	
Documentation & Support	Federal Requirement?	No
	Included in 2010 CMP?	No
	Included in 2045 RMAP?	Yes
Benchmarking and Future Targets	In 2016	21.08 pedestrian fatalities per 10,000 walk commuters
	By 2020	18.5 pedestrian fatalities per 10,000 walk commut
	By 2045	Decrease by 70%
Data & Sources	Data Source	ALISS, ACS
	Data Update Schedule	ALISS updated annually (June)
	Link to Data Updates	N/A
Process Detail	Crash data is collected from the ADOT ALISS database and the population of pedestrian commuters is collected from the American Community Survey database. When analyzing the crash data, a five-year moving average is used to help control for annual data variability.	

BICYCLIST SAFETY

Performance Measure	**Total 5-year average bicycle incapacitating injuries**	
Overview	This performance measure is an indicator of overall bicyclist safety related to motor vehicle crashes.	
Documentation & Support	Federal Requirement?	No
	Included in 2010 CMP?	No
	Included in 2045 RMAP?	Yes
Benchmarking and Future Targets	In 2016	39.2 bicyclist injuries
	By 2020	37 bicyclist injuries
	By 2045	Decrease by 33%
Data & Sources	Data Source	ALISS
	Data Update Schedule	Annually (June)
	Link to Data Updates	N/A
Process Detail	Crash data is collected from the ADOT ALISS database. The crash data of a particular year is available the following year in June. When analyzing the crash data, a five-year moving average is used to help control for annual data variability.	

BICYCLIST SAFETY

Performance Measure	**Rate of 5-year average incapacitating bicycle injuries per 10,000 (bike to work rate)**	
Overview	This performance measure relates the total number of incapacitating injury motor vehicle crashes related to bicyclists to the population of bicyclist commuters, as a measure of bicyclist exposure. The average rate is calculated over a 5-year moving average.	
Documentation & Support	Federal Requirement?	No
	Included in 2010 CMP?	No
	Included in 2045 RMAP?	Yes
Benchmarking and Future Targets	In 2016	57.67 bicyclist injuries per 10,000 bike commuters
	By 2020	51 bicyclist injuries per 10,000 bike commuters
	By 2045	Decrease by 70%
Data & Sources	Data Source	ALISS, ACS
	Data Update Schedule	ALISS updated annually (June)
	Link to Data Updates	N/A
Process Detail	Crash data is collected from the ADOT ALISS database and the population of bicyclist commuters is collected from the American Community Survey database. When analyzing the crash data, a five-year moving average is used to help control for annual data variability.	

BICYCLIST SAFETY

Performance Measure	**Total 5-year average of bicycle fatalities**	
Overview	This performance measure is an indicator of overall bicyclist safety related to motor vehicle crashes.	
Documentation & Support	Federal Requirement?	No
	Included in 2010 CMP?	No
	Included in 2045 RMAP?	Yes
Benchmarking and Future Targets	In 2016	2.8 bicyclist fatalities
	By 2020	2.6 bicyclist fatalities
	By 2045	Decrease by 33%
Data & Sources	Data Source	ALISS
	Data Update Schedule	Annually (June)
	Link to Data Updates	N/A
Process Detail	Crash data is collected from the ADOT ALISS database. The crash data of a particular year is available the following year in June. When analyzing the crash data, a five-year moving average is used to help control for annual data variability.	

BICYCLIST SAFETY

Performance Measure	**Rate of 5-year average bicycle fatalities per 10,000 (bike to work rate)**	
Overview	This performance measure relates the total number of fatal motor vehicle crashes related to bicyclists to the population of bicyclist commuters, as a measure of bicyclist exposure. The average rate is calculated over a 5-year moving average.	
Documentation & Support	Federal Requirement?	No
	Included in 2010 CMP?	No
	Included in 2045 RMAP?	Yes
Benchmarking and Future Targets	In 2016	4.12 bicyclist fatalities per 10,000 bike commuters
	By 2020	3.65 bicyclist fatalities per 10,000 bike commuters
	By 2045	Decrease by 70%
Data & Sources	Data Source	ALISS, ACS
	Data Update Schedule	ALISS updated annually (June)
	Link to Data Updates	N/A
Process Detail	Crash data is collected from the ADOT ALISS database and the population of bicyclist commuters is collected from the American Community Survey database. When analyzing the crash data, a five-year moving average is used to help control for annual data variability.	

TRANSIT SAFETY

Performance Measure	**Total transit vehicle crashes per 100,000 miles, five-year moving average**	
Overview	The frequency and rate of transit-related crashes can be used to prioritize roadway improvements along various corridors and/or intersections and potentially to prioritize transit operation and safety improvements. This performance measure can help identify changes in transit operations safety year-to-year.	
Documentation & Support	Federal Requirement?	No
	Included in 2010 CMP?	No
	Included in 2045 RMAP?	Yes
Benchmarking and Future Targets	In 2016	1.7 transit vehicle crashes per 100,000 miles
	By 2020	1.5 transit vehicle crashes per 100,000 miles
	By 2045	Decrease by 10% from 2015
Data & Sources	Data Source	SunTran
	Data Update Schedule	Annually
	Link to Data Updates	N/A
Process Detail	This performance measure analyzes the total volume of crashes that involve a transit vehicle (i.e., bus, trolley, light rail) and normalize it by the number of roadway miles in the roadway network. The PAG transit system includes Sun Link Streetcar, Sun Shuttle, Sun Van, Cat Tran, and Ajo Community Circulator Service. Five years of crash data is used for analysis and is presented as a 5-year moving average.	

VULNERABLE USERS

Performance Measure	**Serious injuries and fatalities of vulnerable users, 5-year moving average**	
Overview	Vulnerable Road Users (VRUs) are defined as road users who are the most at risk for serious injury or death when they are involved in a motor vehicle-related collision. Vulnerable road users include pedestrians (of all ages, types, and abilities, particularly older pedestrians and people with disabilities) and bicyclists. This performance measure is an indicator of vulnerable user safety.	
Documentation & Support	Federal Requirement?	Yes, Final Rule
	Included in 2010 CMP?	No
	Included in 2045 RMAP?	No
Benchmarking and Future Targets	In 2014	115 total serious injuries and fatalities
	By 2019	103.5 total serious injuries and fatalities
	By 2045	Reduce number of fatalities and serious injuries by 33% below 2014 estimates Reduce fatality and serious injury rates by 70% below 2014 estimates
Data & Sources	Data Source	FARS and ALISS Databases
	Data Update Schedule	FARS (December) and ALISS (June) updated annu
	Link to Data Updates	N/A
Process Detail	Crash data is collected from the ADOT ALISS database or the NHTSA FARS database. ALISS crash data of a particular year is available the following June, and the FARS data of a particular year is available the following December. FARS data has a processing time of approximately two years. ALISS data or Interim FARS is used, when available, to fill in the missing year's data until final FARS values are available. When analyzing the crash data, a five-year moving average is used to help control for annual data variability.	

PAVEMENT CONDITION: FEDERAL-AID ROADWAYS

Performance Measure	**Percentage of federal-aid roadways rated in "poor" condition (IRI based)**	
Overview	The International Roughness Index (IRI) is closely associated with pavement condition and can be used to track pavement deterioration over time and plan maintenance and rehabilitation efforts. An IRI rating greater than 170 is considered poor condition.	
Documentation & Support	Federal Requirement?	No
	Included in 2010 CMP?	No
	Included in 2045 RMAP?	Yes
Benchmarking and Future Targets	In 2016	37 % in poor condition
	By 2020	Below 30% in poor condition
	By 2045	Below 20% in poor condition
Data & Sources	Data Source	ARAN Van Data
	Data Update Schedule	Once every 1-2 years
	Link to Data Updates	N/A
Process Detail	A pavement's IRI is measured using a profilometer, which is a vehicle equipped with longitudinal profile sensors. The measurement is provided in terms of average slope, or the ratio of the suspension motion of the vehicle to the distance traveled by the vehicle during the test (in/mile). Even though this is not a federal PM, FHWA's thresholds for all Pavement PMs are used to calculate it. Additional development on this PM is forthcoming. For pavement this includes the addition of percent cracking and rutting to the pavement condition values.	

PAVEMENT CONDITION: INTERSTATE

Performance Measure	**Percentage of interstate roadways rated in "poor" condition (IRI based)**	
Overview	The International Roughness Index (IRI) is closely associated with pavement condition and can be used to track pavement deterioration over time and plan maintenance and rehabilitation efforts. An IRI rating greater than 170 is considered poor condition.	
Documentation & Support	Federal Requirement?	Yes
	Included in 2010 CMP?	No
	Included in 2045 RMAP?	Yes
Benchmarking and Future Targets	In 2016	Unknown
	By 2020	Unknown
	By 2045	Below 20% in poor condition
Data & Sources	Data Source	HPMS
	Data Update Schedule	Annually (June)
	Link to Data Updates	N/A
Process Detail	A pavement's IRI is measured using a profilometer, which is a vehicle equipped with longitudinal profile sensors. The measurement is provided in terms of average slope, or the ratio of the suspension motion of the vehicle to the distance traveled by the vehicle during the test (in/mile). Even though this is not a federal PM, FHWA's thresholds for all Pavement PMs are used to calculate it. Additional development on this PM is forthcoming. For pavement this includes the addition of percent cracking and rutting to the pavement condition values.	

PAVEMENT CONDITION: NON-INTERSTATE

Performance Measure	**Percentage of non-interstate roadways (NHS) rated in "poor" condition (IRI)**	
Overview	The International Roughness Index (IRI) is closely associated with pavement condition and can be used to track pavement deterioration over time and plan maintenance and rehabilitation efforts. An IRI rating greater than 170 is considered poor condition.	
Documentation & Support	Federal Requirement?	Yes
	Included in 2010 CMP?	No
	Included in 2045 RMAP?	Yes
Benchmarking and Future Targets	In 2016	Unknown
	By 2020	Unknown
	By 2045	Below 20% in poor condition
Data & Sources	Data Source	HPMS
	Data Update Schedule	Annually (June)
	Link to Data Updates	N/A
Process Detail	A pavement's IRI is measured using a profilometer, which is a vehicle equipped with longitudinal profile sensors. The measurement is provided in terms of average slope, or the ratio of the suspension motion of the vehicle to the distance traveled by the vehicle during the test (in/mile). Even though this is not a federal PM, FHWA's thresholds for all Pavement PMs are used to calculate it. Additional development on this PM is forthcoming. For pavement this includes the addition of percent cracking and rutting to the pavement condition values.	

BRIDGE CONDITION

Performance Measure	**Percentage of total bridge deck area determined to be structurally deficient condition (on NHS)**	
Overview	Structural deficiency refers to a bridge that has one or more structural defects that require attention. This measure does not indicate the severity of the defect, but rather that a defect is present. This performance measure helps to quantify the extent of the deficiency by determining the percentage of total bridge deck area that is structurally deficient.	
Documentation & Support	Federal Requirement?	Yes, Notice of Proposed Rulemaking (NPRM)
	Included in 2010 CMP?	No
	Included in 2045 RMAP?	Yes
Benchmarking and Future Targets	In 2016	8%
	By 2020	8%
	By 2045	Maintain levels below 10% in poor condition
Data & Sources	Data Source	NBI
	Data Update Schedule	Annually
	Link to Data Updates	N/A
Process Detail	Each bridge is given a condition rating for its deck, superstructure and substructure. If any of these three are rated a 4 or below (on a scale of 0-9) the bridge is considered to be in poor condition. If all conditions are rated 7 or above, the bridge is considered to be in good condition. The condition of each bridge is weighted by the bridge deck area (length multiplied by width).	

TRANSIT STATE OF GOOD REPAIR

Performance Measure	**Average age of transit assets as a percent of useful life**	
Overview	The average age of transit assets as a percent of useful life is a measure that reflects overall asset conditions and goals to achieve state of good repair. The average age of transit assets refers to the length of time that transit vehicles and infrastructure are in use, before they need to be replaced. In some cases, transit assets may still be in use beyond their "useful life." This indicates a maintenance need and can impact system reliability and readiness.	
Documentation & Support	Federal Requirement?	No
	Included in 2010 CMP?	No
	Included in 2045 RMAP?	Yes
Benchmarking and Future Targets	In 2016	6.5 years
	By 2020	6.5 years
	By 2045	Maintain or remain below 7 years
Data & Sources	Data Source	SunTran
	Data Update Schedule	Annually
	Link to Data Updates	N/A
Process Detail	This performance measure is tracked by maintaining records on the date and maintenance schedule of transit vehicles and other transit infrastructure features.	

CONGESTION EXTENT: VEHICLE MEASURES

Performance Measure	**Percentage of peak hour VMT travelled under LOS E or F**	
Overview	The percentage of vehicle miles traveled at or below LOS E during the peak hour is an indicator of operational measures of effectiveness. Low levels of service indicate vehicle delay, queues, and overall congestion. According to ADOT standards, LOS A - LOS D are acceptable, while LOS E and LOS F may require efforts to improve operational effectiveness.	
Documentation & Support	Federal Requirement?	No
	Included in 2010 CMP?	Yes
	Included in 2045 RMAP?	Yes
Benchmarking and Future Targets	In 2016	1.15% of VMT
	By 2020	1.2% of VMT
	By 2045	At or below 1.8% of VMT
Data & Sources	Data Source	PAG Travel Demand Model
	Data Update Schedule	Annual
	Link to Data Updates	N/A
Process Detail	This performance measure is modeled on an annual basis using traffic volume, delay, and VMT data.	

DAILY VEHICLE HOURS OF TRAVEL PER CAPITA

Performance Measure	**Hours of Vehicle Travel in Relation to Population**	
Overview	This performance measure tracks the total hours of vehicle travel time within the region in relation to the population. Examples of factors influencing this performance measure include the use of alternative modes, employment, and overall economic health.	
Documentation & Support	Federal Requirement?	No
	Included in 2010 CMP?	Yes
	Included in 2045 RMAP?	Yes
Benchmarking and Future Targets	In 2016	0.54 hours
	By 2020	0.54 hours (no change)
	By 2045	Reduce by 5%
Data & Sources	Data Source	PAG Travel Demand Model
	Data Update Schedule	Annual
	Link to Data Updates	N/A
Process Detail	This performance measure is modeled annually using traffic volume data and population statistics.	

DAILY VEHICLE MILES TRAVELED (VMT)

Performance Measure	**Vehicle Miles Traveled per Capita**	
Overview	This performance measure indicates the average distance traveled per person, using the total vehicle miles traveled compared to the total regional population.	
Documentation & Support	Federal Requirement?	No
	Included in 2010 CMP?	No
	Included in 2045 RMAP?	Yes
Benchmarking and Future Targets	In 2016	20.6 VMT per capita
	By 2020	20.6 VMT per Capita (no change)
	By 2045	Reduce by 10%
Data & Sources	Data Source	PAG Travel Demand Model.
	Data Update Schedule	Annual
	Link to Data Updates	N/A
Process Detail	The vehicle miles traveled per capita is modeled annually using VMT data and population statistics.	

RELIABILITY

Performance Measure	**Planning Time Index (PTI)**	
Overview	The Planning Time Index (PTI) is the ratio of the 95th percentile travel time as compared to the free-flow travel time. This measure is computed for the AM peak period (6:00 a.m. to 9:00 a.m.) and the PM peak period (4:00 p.m. to 7:00 p.m.) on weekdays. For example, a PTI of 1.6 means that, for a 15-minute trip in light traffic, the total time that should be planned for that trip is 24 minutes to ensure on-time arrival for 95% of trips.	
Documentation & Support	Federal Requirement?	No
	Included in 2010 CMP?	Yes
	Included in 2045 RMAP?	No
Benchmarking and Future Targets	In 2016	Unknown
	By 2020	Unknown
	By 2045	Maintain or reduce levels (proportional with population growth)
Data & Sources	Data Source	Potential data needs: National Performance Measure Research Data Set (NPMRDS) aggregated bi-weekly or by month on NHS; HPMS, Third party data
	Data Update Schedule	Monthly
	Link to Data Updates	N/A
Process Detail	The Planning Time Index is calculated as the 95th percentile travel time divided by free flow travel time and is computed during the morning and afternoon peak periods. The PAG regional PTI score is calculated using weighted averages across road sections, time periods, and by VMT.	

VARIABILITY

Performance Measure	**Travel Time Index (TTI)**	
Overview	The Travel Time Index (TTI) is the ratio of the peak-period travel time as compared to the free-flow travel time. This measure is computed for the AM peak period (6:00 a.m. to 9:00 a.m.) and the PM peak period (4:00 p.m. to 7:00 p.m.) on weekdays. For example, a TTI of 1.25 means that for a 16-minute trip taken during free flow conditions, the same trip takes 20 minutes during the peak-period travel time.	
Documentation & Support	Federal Requirement?	No
	Included in 2010 CMP?	Yes
	Included in 2045 RMAP?	Yes
Benchmarking and Future Targets	In 2016	1.44
	By 2020	1.48
	By 2045	Minimize increase to below 10%
Data & Sources	Data Source	There are two TTI data sources: One is NPMRDS, which only covers the NHS as set by MAP-21. The other is a PAG Travel Demand Model output, which includes all major roads.
	Data Update Schedule	Annual
	Link to Data Updates	N/A
Process Detail	The Travel Time Index is calculated as the peak-period travel time divided by free flow travel time. The PTI is computed during the morning and afternoon peak periods. The PAG regional TTI score is calculated using weighted averages across road sections, time periods, and by VMT.	

MODEL NETWORK PERFORMANCE

Performance Measure	**Commuter travel time by auto on all the travel demand model network**	
Overview	The commuter travel time by vehicle on freeway routes is a measure of operational efficiency, delay, and congestion. This performance measure is the average daily commuter time by personal vehicles.	
Documentation & Support	Federal Requirement?	No
	Included in 2010 CMP?	Yes
	Included in 2045 RMAP?	No
Benchmarking and Future Targets	In 2016	Unknown
	By 2020	Unknown
	By 2045	Maintain or reduce levels (proportional with popu
Data & Sources	Data Source	ACS data by mode, FMS data by corridor, and NPMRDS
	Data Update Schedule	Modeled Annually
	Link to Data Updates	N/A
Process Detail	This performance measure is modeled annually and uses commuter survey data from the American Community Survey (ACS), freeway travel time data, and NPMRDS.	

NON-FREEWAY PERFORMANCE

Performance Measure	**Commute Time by Mode - active transportation modes (transit, Walk, Bike)**	
Overview	The commuter travel time by active transportation mode on non-freeway routes is a measure of operational efficiency, delay, and congestion. This performance measure is the average daily commuter time by active transportation.	
Documentation & Support	Federal Requirement?	No
	Included in 2010 CMP?	No
	Included in 2045 RMAP?	No
Benchmarking and Future Targets	In 2016	Unknown
	By 2020	Unknown
	By 2045	Maintain or reduce levels (proportional with population growth)
Data & Sources	Data Source	PAG Travel Demand Model
	Data Update Schedule	Modeled Annually
	Link to Data Updates	N/A
Process Detail	This performance measure is modeled annually and uses commuter survey data from the American Community Survey (ACS) as well as non-freeway travel time data.	