CONGESTION MANAGEMENT PROCESS (CMP) REPORT

Final Report

2015

Prepared for:

Northwest Arkansas Regional Planning Commission
1311 Clayton Street
Springdale, AR 72632

Highway 265 Access Management Plan – AHTD, NWARPC, and the City of Fayetteville

Prepared by:

Co-PLAN
5508 Sandalwood Drive
McKinney, Texas 75070

In Association with:

Texas A&M Transportation Institute

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Northwest Arkansas Regional Planning Commission

Agency	Representative
Avoca	Jordan W. Sullivan
Beaver Water District	Alan Fortenberry
Bella Vista	Peter Christie
Benton County	Bob Clinard
Benton County	John Sudduth
Bentonville	Bob McCaslin
Bentonville	Shelli Kerr
Bentonville	Troy Galloway
Bethel Heights	Cynthia J. Black
Cave Springs	Travis Lee
Centerton	Bill Edwards
Decatur	Bob Tharp
Elkins	Bruce Ledford
Elm Springs	Harold D. Douthit
Farmington	Ernie Penn
Fayetteville	Lioneld Jordan
Fayetteville	Matthew Petty
Fayetteville	Jeremy Pate
Garfield	Gary L. Blackburn
Gateway	Frank Hackler
Gentry	Kevin Johnston
Goshen	Joe Benson
Gravette	Kurt Maddox
Greenland	Bill Groom
Highfill	Cassie Elliott
Hindsville	X Dotson
Huntsville	Kevin Hatfield
Johnson	Chris Keeney
Lincoln	Rob Hulse
Little Flock	Buddy Blue
Lowell	Eldon Long
Pea Ridge	Jackie Crabtree
Prairie Grove	Sonny Hudson
Rogers	Greg Hines
Rogers	Bob Crafton
Rogers	Steve Glass
Siloam Springs	John Turner
Siloam Springs	Ben Rhoads
Springdale	Doug Sprouse
Springdale	Patsy Christie
Springdale	Jim Ulmer
Springtown	Preston Barrett
Sulphur Springs	Greg Barber
Tontitown	Paul Colvin, Jr.
Washington County	Marilyn Edwards
Washington County	Juliet Richey
Washington County	Dan Short
West Fork	Charlie Rossetti
Razorback Transit	Gary Smith
Ozark Regional Transit	ORT Board Chair
University of Arkansas	Mike Johnson
AHTD – Districts	Chad Adams
AHTD – Planning	Jessie Jones
MODOT	Laurel McKean
McDonald County, MO	Keith Lindquist
Pineville, MO	Greg Sweeten

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EXECUTIVE SUMMARY

Congestion management is the use of strategies to optimize operations of a transportation system through management of the existing system. As such, a congestion management process (CMP) is a systematic approach coordinated regionally that provides current performance measures detailing the system performance and evaluates strategies that meet the local objectives.

The CMP, as defined in the federal register, is intended to serve as a systematic process that provides for safe and effective integrated management and operation of the multimodal transportation system. The process includes:

- ***Development of congestion management objectives***
- ***Establishment of measures of multimodal transportation system performance***
- ***Collection of data and system performance monitoring to define the extent and duration of congestion and determine the causes of congestion***
- ***Identification of congestion management strategies***

By definition, the CMP is not to be a stand-alone study and is to be an integral component of the metropolitan transportation planning process. Once an MPO exceeds a population of 200,000, the Moving Ahead for Progress in the 21st Century Act (Map-21) requires a CMP, while not strictly stating the methodology or approach that is to be followed.

The flexibility is intentional within the regulations to allow the MPO to develop a living methodology that evolves with the local objectives and needs.

NWARPC is the designated Metropolitan Planning Organization (MPO) for the region. In 2012, the region was designated as a Transportation Management Area (TMA) based on the 2010 U.S. Census urbanized area exceeding 200,000 in population. The NWARPC Metropolitan Planning Area (MPA) includes all of Washington and Benton County in Arkansas and a portion of McDonald County/City of Pineville in Missouri. The Current MPA boundary is shown in **Figure E-1 (Page 4)**.

By responding to congestion through a process that involves developing congestion management objectives, developing performance measures to support these objectives, collecting data, analyzing problems, identifying solutions, and evaluating the effectiveness of implemented strategies, the CMP provides a structure for responding to congestion in a consistent, coordinated fashion.

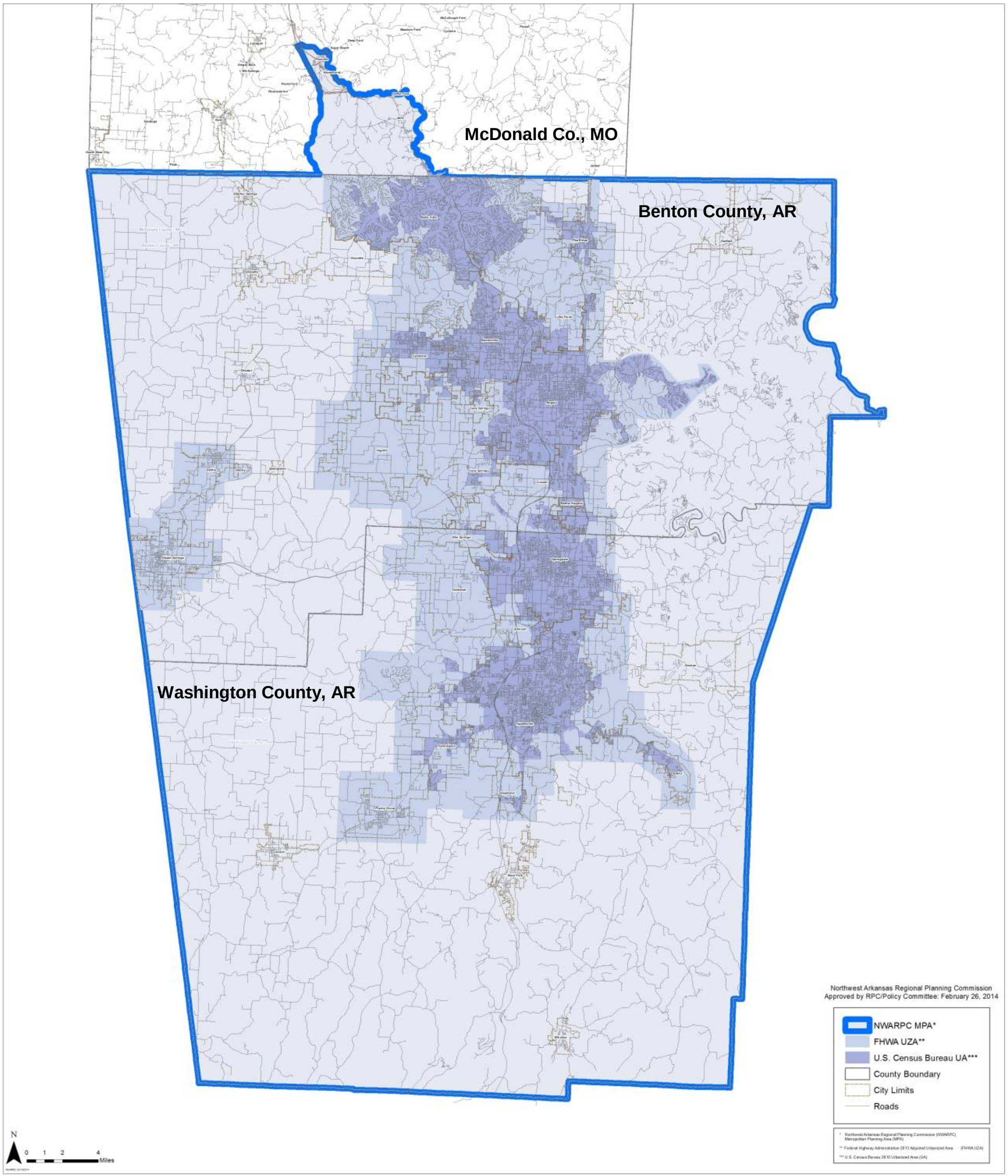


Figure E-1 – NWARPC Metropolitan Planning Area (MPA)

The Northwest Arkansas Regional Planning Commission (NWARPC) is developing its' inaugural congestion management process (CMP) to monitor the transportation network in the Metropolitan Planning Area. The study area includes Benton and Washington Counties in Arkansas and a portion of McDonald County/City of Pineville in Missouri.

The goal of the monitoring system is to ensure optimal performance of the transportation system by identifying congested areas and related transportation deficiencies.

The primary purpose of the 2015 Congestion Management Process is to evaluate the transportation system and prepare a report as part of the Congestion Management Process (CMP) in compliance with the MAP-21, the Moving Ahead for Progress in the 21st Century Act. The secondary purpose of the study was to identify trends in congestion and travel time in order to identify problem locations for possible improvements.

Being the inaugural study, the MPO is establishing the baseline of existing congestion for comparison in future years. To help establish the CMP network, the MPO staff invited representatives of local agencies and units of government to a kick-off meeting in June 12, 2014. The primary goal of the meeting was to have a CMP workshop to provide an overview of the CMP objectives. This discussion was very helpful to those in attendance to help guide the local approach for the inaugural CMP. The study network includes 224.5 centerline miles of roadway spread over 13 different roadways divided into 234 directional links bound by a traffic signal, stop sign, or major cross street. For added functionality, each segment was assigned a jurisdiction (City / County) depending on its location within the MPA boundaries. This attribute will allow the MPO and its members to query data within the database for each respective jurisdiction.

The CMP is intended to use an objectives-driven, performance-based approach to planning for the management of congestion. Through the use of congestion management objectives and performance measures, the CMP provides a mechanism for ensuring that investment decisions are made with a clear focus on desired outcomes. The purpose of this study was to identify and quantify problem areas using private sector data. The results of this study are used as factors in prioritizing needed improvements. Through the use of private sector travel speed data, various performance measures are calculated. This data provides the needed reference material to prepare recommendations that are focused on the true cause of the congestion.

Private sector travel speed data was procured for the region which covered the vast majority of the identified network. The CMP network roadways included arterials and freeways. Segment delay for vehicles was recorded within the defined segmentation and compared with criteria in the Highway Capacity Manual (HCM). In order to differentiate between congested roadways and roadways with low speed limits, various performance measures for illustrating the data were introduced. The preferred performance measure as determined by the CMP Committee, made of member of the Technical Advisory Committee (TAC) is composed of two parts. The first element is delay as compared to the posted speed limit. The second element begins with the link daily volumes as provided by AHTD. By applying the vehicle volumes to the measured delays on the links, the volume delay was determined. The CMP segments vary in length across the board between those on arterials and freeways. In order to standardize the results and allow direct comparison across the network, the volume-delay results were divided by the length. This provides a result with the units, vehicle-hours of delay per road mile, thus allowing a more direct comparison among segments. As a result, the preferred performance measure was determined and used to identify the operating results of each link of the CMP network.

Of the 242 directional miles studied in the morning peak and afternoon peak periods, it was determined to classify the top 15% of the segments as congested including both the results of the AM and PM periods. In discussions with the Committee, the AM period was defined as 7-9 AM. while the PM. period was described as 4:30-6:30 PM. **Table E-1** and **Figure E-2** below shows the Top 20 congested segments in this study based on the volume-delay per mile performance measure for both the AM and PM peak period. This results in some segments being classified as “congested” for both periods.

One of the biggest benefits of the CMP is a structured, transparent process for effective allocation of limited transportation funding among operations and capital projects and programs. It also highlights travel demand management and operations strategies that historically may not have been a focus of metropolitan transportation planning. Through an integrated congestion monitoring system, decision-makers are provided with system performance and the effectiveness of potential solutions as well as the results of implemented strategies.

Table E-1-Top 20 Congested Segments

Top 20 Rank (Art/Fwy)	SegmentId	Route	Segment Name	Time Period	Func Class	City	Length (mi)	Weighted Avg Speed Limit	Congestion Index	Volume Delay per Mile
1	9E	Hwy 71 - SB	Mercy Way to Riorden Rd	AM	Art	Bella Vista	1.61	45.0	0.51	194.2
2	9C	Hwy 71 - SB	Peach Orchard Rd to Mercy Way	AM	Art	Bella Vista	1.34	45.0	0.49	168.1
3	2E	North St - EB	Oakland Ave to Hwy 45	PM	Art	Fayetteville	1.37	26.4	0.38	155.0
4	5389030	I-49 - SB	South of Fullbright	PM	Fwy	Fayetteville	0.27	60.0	0.68	123.3
5	2E	North St - EB	Oakland Ave to Hwy 45	AM	Art	Fayetteville	1.37	26.4	0.45	106.4
6	5369443	I-49 SB	Short segment at on-ramp from Walnut	PM	Fwy	Rogers	0.21	70.0	0.44	103.4
7	10M	Hwy 71B - EB	I-49 to Rainbow Rd	PM	Art	Bentonville	1.34	45.0	0.46	79.2
8	5369443	I-49 SB	Short segment at on-ramp from Walnut	AM	Fwy	Rogers	0.21	70.0	0.48	73.1
9	2C	Hwy 16 - EB	Rupple Rd to Futtrall	PM	Art	Fayetteville	1.07	43.9	0.48	70.1
10	2C	Hwy 16 - WB	Rupple Rd to Futtrall	PM	Art	Fayetteville	1.07	43.9	0.48	69.7
11	5389031	I-49 - SB	West of Hwy 112	PM	Fwy	Fayetteville	0.25	60.0	0.65	67.2
12	5369409	I-49 - NB	South of Walton on-ramp	PM	Fwy	Bentonville	0.34	54.4	0.47	66.6
13	10M	Hwy 71B - Walton Blvd - WB	I-49 to Rainbow Rd	PM	Art	Bentonville	1.34	45.0	0.50	65.7
14	9C	Hwy 71 - NB	Peach Orchard Rd to Mercy Way	PM	Art	Bella Vista	1.34	45.0	0.71	60.9
15	5402368	Hwy 71 - SB	North CMP limits	PM	Art	Missouri	0.06	45.0	0.40	58.5
16	10F	Hwy 71B - NB	Shiloh to Tyson Pkwy	PM	Art	Springdale	1.70	43.3	0.55	55.4
17	5389276	I-49 - NB	North of Hwy 412	AM	Fwy	Springdale	0.54	70.0	0.67	53.6
18	5402369	Hwy 71 - NB	North CMP limits	PM	Art	Missouri	0.06	45.0	0.42	52.7
19	5389139	Fullbright - WB	Within I-49 interchange	PM	Fwy	Fayetteville	0.61	60.0	0.71	51.6
20	5389081	I-49 - NB	South of Fullbright interchange	AM	Fwy	Fayetteville	0.43	63.5	0.73	51.0

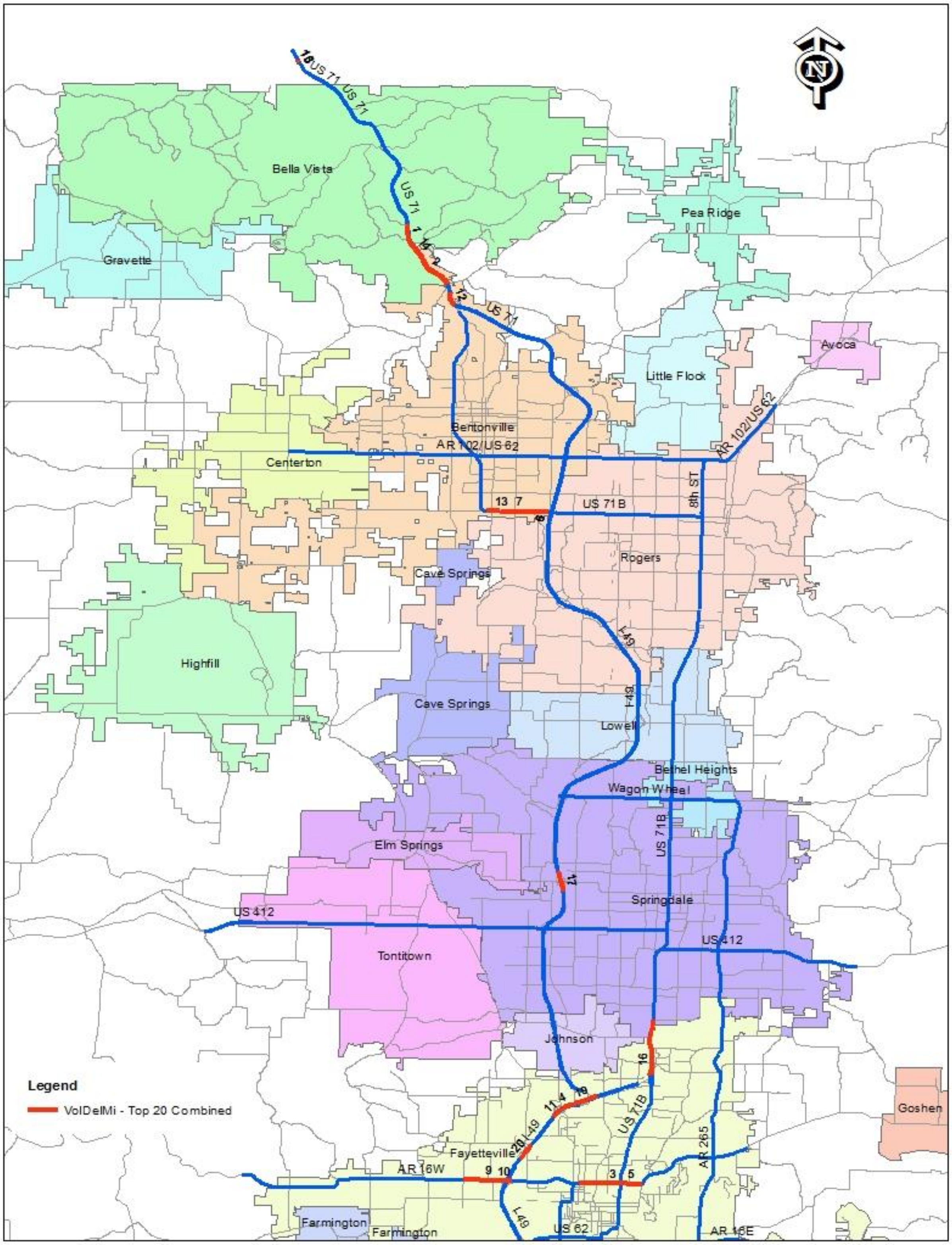


Figure E-2 – Top 20 Congested Segments

Managing demand and implementing operations strategies are more cost-effective in the short-term than larger capacity adding projects. At a minimum, operations should not be forgotten when performing capacity projects in order to enhance their effectiveness. History has shown, that widening a corridor without attention to optimizing the signal system leads to little reduction in delays. Other MPOs have created funding set-asides to be used to address smaller scale projects that can be quickly addressed without the need for lengthy ROW or environmental process.

In the NWA region, many corridors could benefit from the application of access management techniques (See Figure E-3) to its developed and currently undeveloped corridors. The Federal Highway Administration defines access management as “the process that provides access to land development while simultaneously preserving the flow of traffic on the surrounding system in terms of safety, capacity, and speed.” It is accomplished by controlling the design of access points, the location of access points, and the number of access points allowed within a given distance. Access management provides benefits related to safety, mobility, the environment, and fuel consumption. While it is possible to retrofit already developed corridors for access management, common problems include lack of right-of-way and landowner opposition. It is less expensive to apply access management techniques to undeveloped corridors as they develop. Consideration should be given to developing an access management program that would define land patterns and traffic flow, program goals, policies, implementation and financial strategies.

2013 2015

Figure E-3 - Highway 265 Access Management Plan 3-lane Undivided to 4-lane Divided Median Boulevard, Bike Lanes, and Sidewalks

HISTORY OF THE CONGESTION MANAGEMENT PROCESS

The NWARPC has initiated the Congestion Management Process (CMP) to monitor the transportation network in the region. The goal of the monitoring system is to ensure optimal performance of the transportation system by identifying congested areas and related transportation deficiencies. This information will then be used in the transportation planning process to develop strategic improvement projects that will improve and maintain the performance of roadways at a system level.

The 2013 study was conducted using a full year dataset for 2013. The primary tasks completed as part of this study include:

- Geo-coding the routes included in the CMP network
- Conflation of private sector data to the coded network
- Conflation of the AHTD volumes to the coded network
- Calculations of performance measures
- Congestion mitigation recommendations

WHAT IS THE CONGESTION MANAGEMENT PROCESS?

Guidance provided by FHWA includes eight (8) "actions" that comprise a well-developed CMP. The elements are referred to as actions to indicate that the process is not to be thought of as a linear methodology to step through, but may include variations and at times one may need to revisit previous steps as a result of another. The actions below taken directly from the 2011 FHWA published "*Congestion Management Process: A Guidebook*" were used as the basis for the structure for this report, as well as the MPO's inaugural CMP itself.

1. **Develop Regional Objectives for Congestion Management** – First, it is important to consider,—What is the desired outcome? —What do we want to achieve? It may not be feasible or desirable to try to eliminate all congestion, and so it is important to define objectives for congestion management that achieve the desired outcome.

2. **Define CMP Network** – This action involves answering the question, —What components of the transportation system are the focus…and involves defining both the geographic scope and system elements (e.g., freeways, major arterials, transit routes) that will be analyzed in the CMP.

3. **Develop Multimodal Performance Measures** – The CMP should address, —How do we define and measure congestion? This action involves developing performance measures that will be used to measure congestion on both a regional and local scale. These performance measures should relate to, and support, regional objectives.

4. **Collect Data/Monitor System Performance** – After performance measures are defined, data should be collected and analyzed to determine, —How does the transportation system

perform? Data collection may be on-going and involve a wide range of data sources and partners.

5. **Analyze Congestion Problems and Needs** – Using data and analysis techniques, the CMP should address the questions, —What congestion problems are present in the region, or are anticipated? —What are the sources of unacceptable congestion?

6. **Identify and Assess Strategies** – Working together with partners, the CMP should address the question, —What strategies are appropriate to mitigate congestion? This action involves both identifying and assessing potential strategies, and may include efforts conducted as part of the MTP, corridor studies, or project studies.

7. **Program and Implement Strategies** – This action involves answering the question…How and when will solutions be implemented? It typically involves including strategies in the MTP, determining funding sources, prioritizing strategies, allocating funding in the TIP, and ultimately, implementing these strategies.

8. **Evaluate Strategy Effectiveness** - Finally, efforts should be undertaken to assess, —What have we learned about implemented strategies? This action may be tied closely to monitoring system performance under Action 4, and is designed to inform future decision making about the effectiveness of transportation strategies.

1.0 Action 1 – Develop Regional Objective for Congestion Management

The starting point for the CMP is to develop regional objectives for congestion management. These objectives draw from the regional vision and goals that are articulated in the MTP. The goal of the CMP is not to eliminate congestion, but rather to manage this congestion while balancing community livability, access, and pedestrian safety.

Objective One: Develop procedures for evaluating the relative congestion of facilities. *NWARPC utilized 2013 Inrix XD Speed Data and 2013 AHTD AADT and conflated the CMP Network for Congestion Analysis*;

Objective Two: Develop procedures to determine if congestion mitigation strategies should be implemented for a particular facility. *Performance measures were calculated to determine congested corridors within the region along with a "tool box" of potential mitigation strategies*;

Objective Three: Develop a procedure or procedures for evaluating the effectiveness of congestion mitigation strategies implemented. *NWARPC intends to evaluate the deployed access management strategies, intersection/interchange improvements, roadway widening, safety* *improvements, and signal timing projects in the next phase of the CMP.*

Therefore, the objective is to manage congestion and identify those roadway segments with “unacceptable” congestion and establish objectives for congestion management in line with regional goals. The MPO will work to promote projects and policies that support the stated vison, goals, and objectives as part of the metropolitan planning process.

Stakeholders and participants in this study were part of the Technical Advisory Committee. The CMP Committee included representatives of the following governments units or agencies:

- Lowell
- Bentonville
- Fayetteville
- Rogers
- Springdale
- AHTD

2.0 Action 2 – Define CMP Network

To help establish the CMP network, the MPO staff invited representatives of local agencies and units of government to a kick-off meeting in June 2014. The primary goal of the meeting was to provide an overview of the CMP objectives.

The 2015 CMP network included a large portion of the roadway network functionally classified as arterial and freeway. This will allow a baseline to be established of the existing delay for the MPO to compare with future updates.

The study network included 224.5 centerline miles of roadway over 13 different roadways divided into 234 directional links bound by a traffic signal, stop sign, or major cross street. **Figure 1** shows the city limits and CMP network, while a few of the roadways extend outside the city limits and state. **Figure 2** reflects the CMP Segments whereby the performance measures are summarized within. The Interstate 49 segments are not labeled individually due to length of the segments. The individual segments are delineated on the map and described in **Table 1** (Page 29) and in **Appendices B and C**.

All of the CMP network roadways were evaluated during the AM and PM peak periods between the hours of 7:00 AM-9:00 AM and 4:30 PM-6:30 PM (Monday through Friday) respectively. The total directional and centerline miles during each study period are shown in **Table 1**.

The CMP Committee identified a subset of roadway segments as “preserved” or sometimes referred to as “multimodal corridors”. By associating this identification with the segments, the Committee wants to maintain the character and speeds of the corridor for various reasons and is not interested in reducing congestion, delays or increasing speeds. This applies to areas with high density of pedestrians, on-street parking, minimum ROW, etc. These segments, as highlighted in **Figure 3 (Page 13)**, were evaluated, but will not be included in the congestion analysis or mitigation considerations.

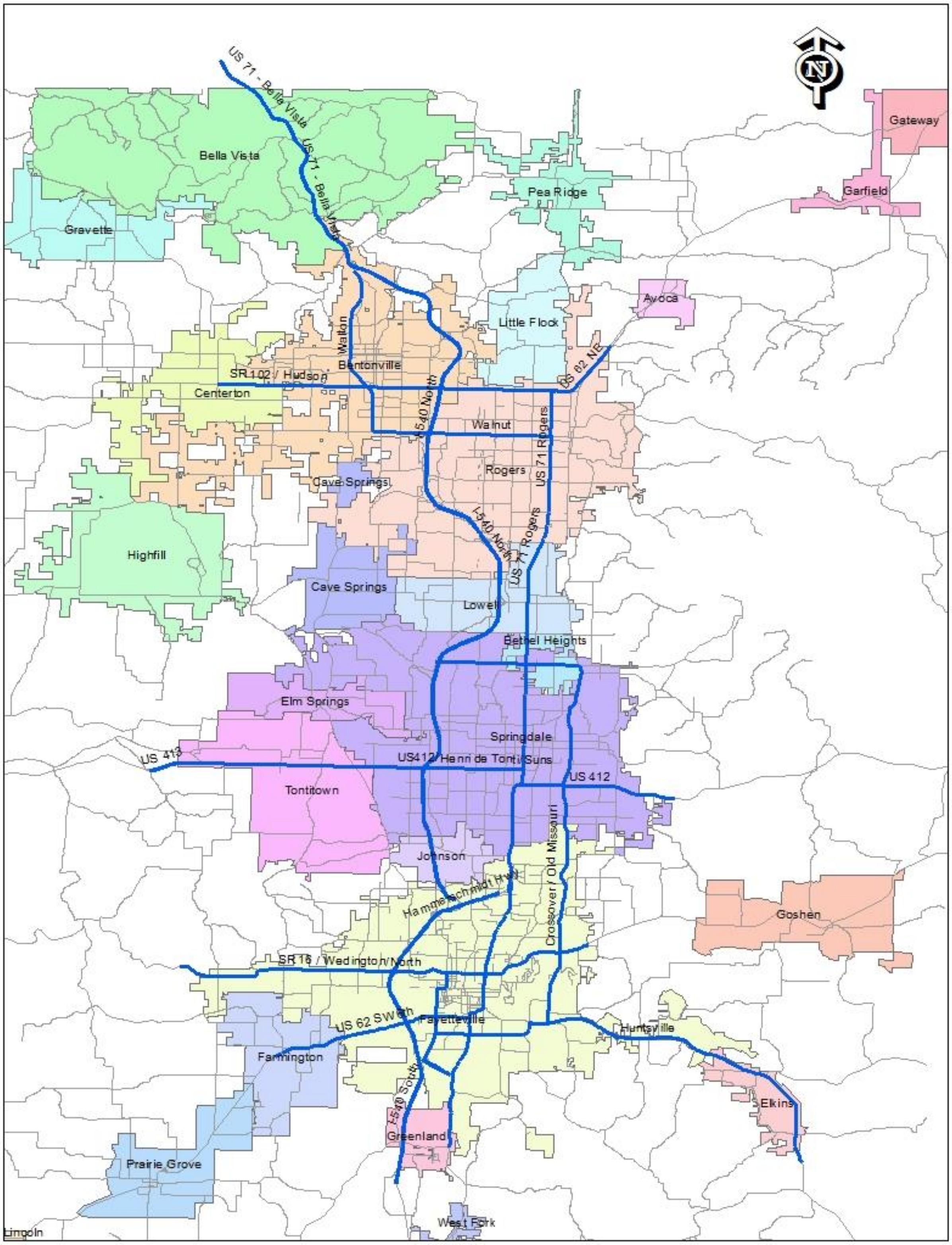


Figure 1 – 2015 CMP Network

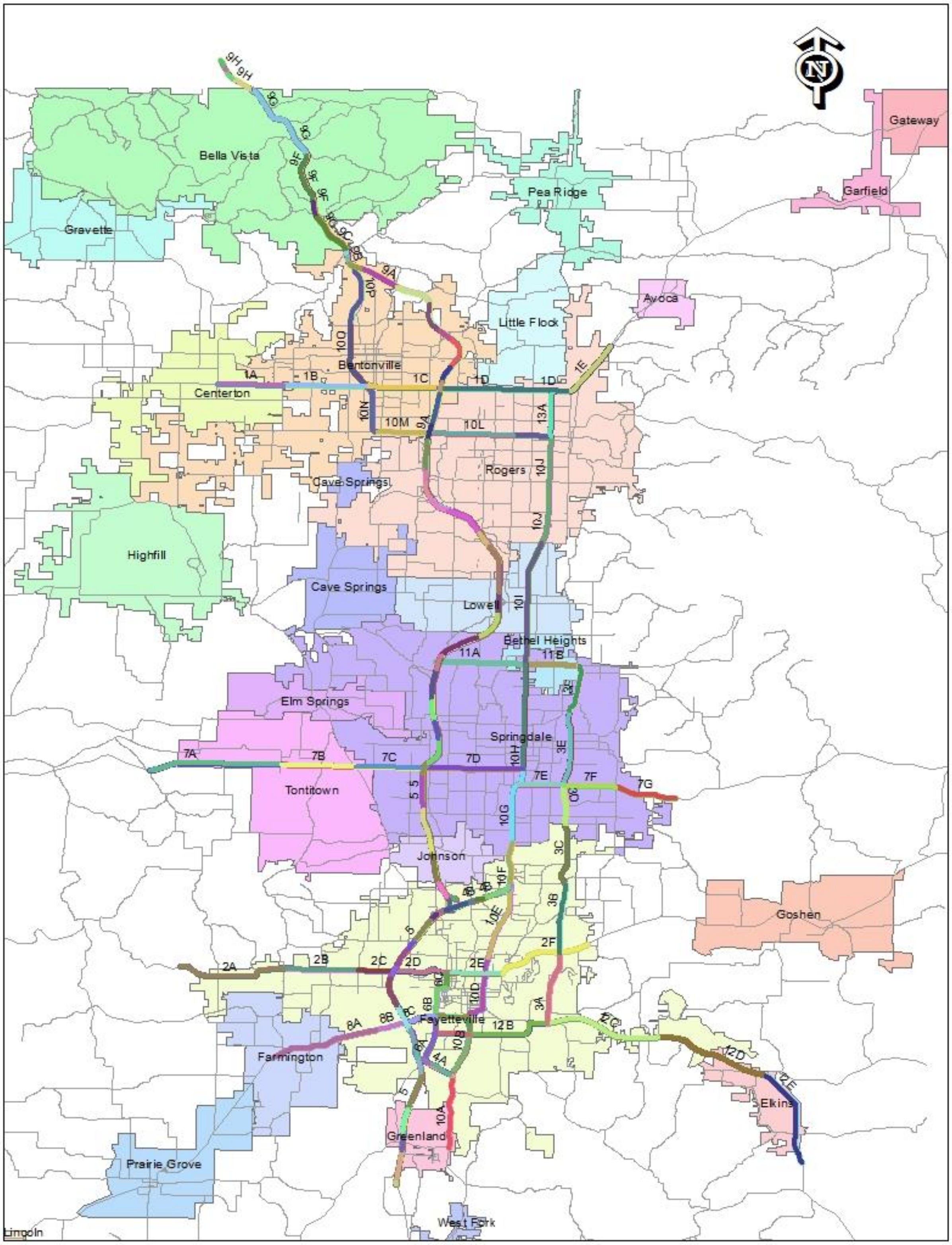


Figure 2 – 2015 CMP Segments

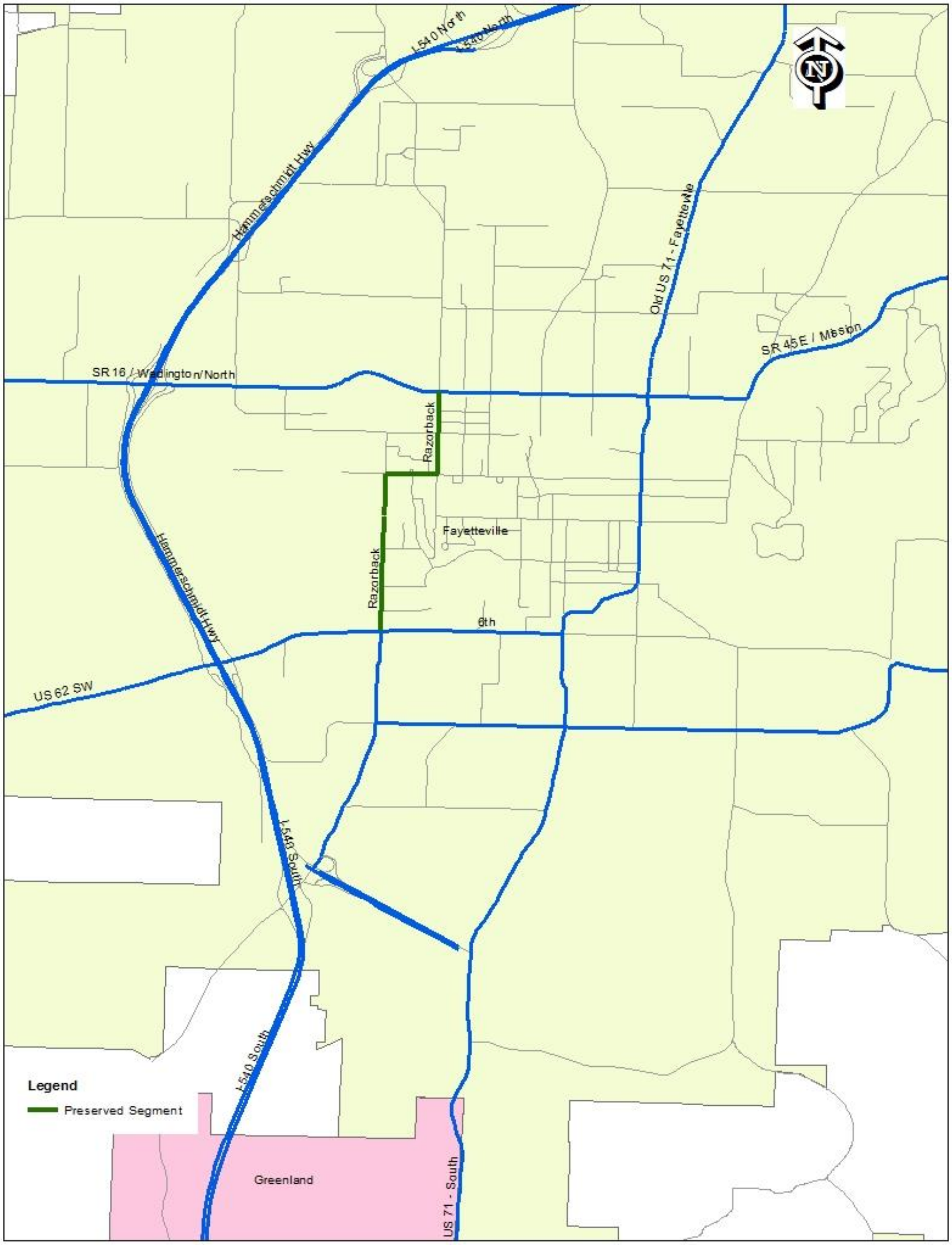


Figure 3 – Preserved Segments

3.0 Action 3 – Develop Multimodal Performance Measures

Performance measures are a critical component of the CMP. According to Federal regulation, the CMP must include *"appropriate performance measures to assess the extent of congestion and support the evaluation of the effectiveness of congestion reduction and mobility enhancement strategies for the movement of people and goods. Since levels of acceptable system performance may vary among local communities, performance measures should be tailored to the specific needs of the area and established cooperatively by the State(s), affected MPO(s), and local officials in consultation with the operators of major modes of transportation in the coverage area* (23 CFR 450.320 (c) 2).

3.1 Traffic Flow

The Highway Capacity Manual 2010 defines capacity as "…the maximum hourly rate at which persons or vehicles reasonably can be expected to traverse a point or a uniform section of a lane or roadway during a given time period under prevailing roadway, traffic, and control conditions."

The capacity of a roadway, and its operational characteristics, is a function of a number of elements including: the number of lanes and lane widths, shoulder widths, roadway alignment, access, traffic signals, grades, and vehicle mix. Generally, roadways with wider travel lanes, fewer traffic control devices, straight alignments, etc. allow faster travel speeds.

3.2 Congestion Index (CI) and Volume Delay per Mile

Federal guidance recommends that CMPs include performance measures that are clearly understood and relatable to the public, decision makers, and technical practitioners. The MPO has introduced the use of congestion index (CI) as one element of performance in the CMP. This performance measure allows easy comparison of the efficiency of roadways as a ratio of average travel speed to the posted speed limit. The second measure is volume delay per mile. This performance measure calculates the delay or amount of time drivers wait as compared to traveling at the posted speed. Also, by multiplying it by the link volume, the overall impact of the delay can be measured. CI is purely a measure of delay time, but does not relate the number of cars in the delay. In many cases the minor or secondary roads are high on the CI ranking but rank lower on the volume delay because fewer vehicles and people are affected on these secondary roads. The CMP segments vary in length across the board between those on arterials and freeways. In order to standardize the results and allow direct comparison across the network, the volume-delay results were divided by the length. This provides a result with the units of vehicle hours of delay per mile, thus allowing a more direct comparison between segments. As a result, the preferred performance measure was determined and used to identify the operating results of each link of the CMP network.

- CI = Actual Average Speed / Weighted Average Posted Speed Limit

  CI = Congestion Index
  Actual Average Speed = Average speed of all INRIX data on the segment
  Weighted Average Posted Speed Limit = Average of all posted speed limits on the segment weighted by length

- Volume Delay (VD/mile) = (Delay X Segment Volume from Travel Demand Model) / Segment Length

Based on the local conditions in the region, attention was focused on the peak periods. The duration of congestion and other performance measures were not as much of a concern with the short peaking of congestion within the region. This also is applicable in most areas of the region to performance measures based on volume. There are a few areas within the region where capacity is an issue, but most delay occurs at the node level and is not a link problem. Because volume is measured mid-block and does not consider the operations of the nodes (intersections), attention is being focused at the location where the MPO can get the most benefit.

The MPO's primary performance measure, as selected by the CMP Committee, is volume delay per mile. The MPO CMP Committee evaluated thresholds to define what would be used as "unacceptable" congestion. In order to narrow the focus on those roadway segments that need attention and commonly have recurring delay, the results were tabulated and the highest 15% of the network was categorized as congested. Over time, with future updates, the committee will be able to revisit these thresholds and adjust as desired. FHWA encourages the MPO to be flexible with the process and customize the methodology and performance measures to respond to the local and regional objectives.

The MPO can also consider adding other performance measures in future updates that are multi-modal based that reflect the accessibility of transit, bike, and pedestrian facilities. This can be as direct on the regional level as the % of jobs or households within ¼ mile of transit. This will serve as an indicator of the accessibility to transit and should have some correlation to the ridership.

4.0 Action 4 – Collect Data / Monitor System Performance

It is necessary for MPO to maintain an accurate, up to date regional transportation model in order to conform to State and Federal regulations for transportation planning. The MPO maintains the regional model using current information on the roadway network, area development, and other relevant characteristics. The MPO will collect data as necessary to support the CMP and planning process.

For this 2015 study, the base conditions of the selected corridors were collected including: roadway characteristics, travel time, and travel speed data. The primary purpose of this year's 2015 CMP is to establish the MPO's initial CMP base.

Mapping of the roadway attributes and collection of travel speeds were collected for arterials and freeways included in the CMP Network. The routes that were studied in 2013 are shown in **Figure 1 (Page 29)**. In future years, the MPO may consider a more detailed analysis of a subset of the overall network based on the results of this year's baseline analysis. That way, the MPO can maximize the detail collected on a smaller roadway set, while not collecting data just for the sake of treating the entire network the same. FHWA favors using professional judgment on defining the network with consideration given for a systematic data collection plan that may include cyclical analysis of certain roadways based on historic results or known changes since the last update.

INRIX is one of the leading providers of real-time, historical and predictive traffic information. As illustrated in **Figure 4**, it works by combining anonymous, real-time GPS probe data from more than 1,000,000 commercial fleet, delivery, taxi vehicles, and smart phone users across the U.S. with market-specific criteria that affect traffic such as construction and road closures, real-time incidents, sporting and entertainment events, weather forecasts and school schedules.

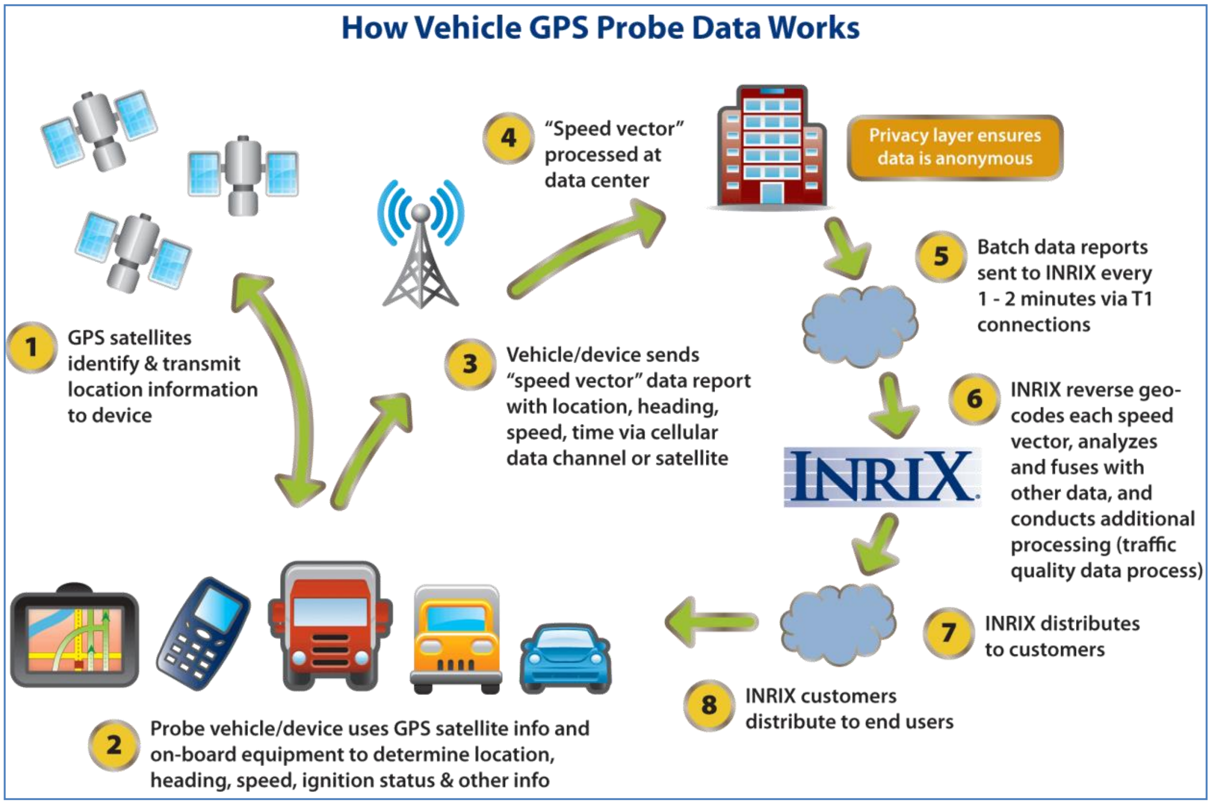


Figure 4 - INRIX Data Collection Process

INRIX also recently introduced the INRIX Total Fusion service that combines real-time predictive and historical traffic information for over 800,000 miles of roadways across the U.S. The segmentation of INRIX data is based on Traffic Messaging Channel (TMC) background and TeleAtlas map network. TMC location codes were established as a standardized way (independent of map vendor) to report traffic incidents on major roadways. TMC codes were originally conceived of as points on the road network, typically assigned at significant decision points, interchanges or intersections, for the purpose of describing locations of traffic incidents (accidents, construction, traffic slowdowns, etc.) in an unambiguous, vendor independent format. It is possible to report traffic flow data – as INRIX does – by considering the road segments implied by the distance between consecutive TMC codes. These road segments are also referred to as "TMC Paths". In North America, a consortium of Tele Atlas and NAVTEQ, the nation's leading suppliers of commercial map databases, created and maintain a U.S./Canada TMC location code table that adheres to the international standard on location referencing (ISO 14819-3:2004). Initially published in fall 2003, the North American Location Code Alliance owns, maintains and expands the location tables. The version that is currently utilized by INRIX contains in excess of 218,000 location codes spanning the U.S. and Canada, and allowing TMC paths to be created for roughly 400,000 centerline miles of roads. Updated versions of the location tables that further sub-divide the TMC network, referred to as the XD network, were released in 2013 in order to expand road coverage. Note that the TMC standard mandates that the tables remain backwards compatible as new versions are introduced. Although coverage area and granularity will change, older codes will continue to map to the correct spatial location.

INRIX historical data product provides historical traffic flow information in major metro areas in U.S. by deriving historic flow from traffic sensors, probe vehicles and Smart Dust Network which combines data from various sources with a patented inference engine. The inference engine calculates the speed of each road segment to a measured degree of accuracy. The historical traffic flow data is provided for all major roads and most local arterials in the U.S., with arterials being a more recent addition to the product. The depth of historic information is greater on freeways compared to arterials.

The reported statistics for each segment include:

- The link identifier like LinkID or TMC Code
- Calculated average speed for each time interval
- Percentage of time spent under speeds of 30 mph, 50 mph and 60 mph
- Percentile speeds for each time interval like 10th percentile, 15th percentile, 25th, 50th, and 85th percentile if sufficient data is available to make this calculation.

While the dominant source of data is obtained from fleet systems that use GPS to monitor vehicle location, speed, and trajectory, other data sources such as sensors may also be used. The INRIX system fuses data from various sources to present a comprehensive picture of traffic flow. This is being considered as an innovative data source for both highway performance monitoring and regional planning. The archived data is a valuable source for congestion monitoring and evaluation for the Congestion Management Process (CMP), as well as for validation of the regional travel forecasting model.

Traffic speeds and volumes are the two basic building blocks for most congestion measures. It was decided by the CMP Committee to use a 2013 annual dataset after taking into account the initiation of the vast majority of construction along I-49. This allowed the analysis to reflect the "before" conditions and not be influenced by the on-going construction and possible diversion of traffic to alternative routes due to construction activities. In this effort, the 2013 traffic speed data licensed from INRIX was referenced to different roadway segments than the segments for which Arkansas State Highway and Transportation Department (AHTD) reports traffic volumes. Additionally, NWARPC defined CMP-specific segments that did not match exactly either the INRIX XD speed segments or the AHTD traffic volume segments. Therefore, the project team had to conflate (or combine) the INRIX XD speed segments and the AHTD traffic volume segments to the NWARPC-defined CMP segments. The sole sources of performance data for this inaugural study include the INRIX XD data and AHTD volumes. The saturation and coverage of data from INRIX continues to grow dramatically each year. As shown in **Figure 5 (Page 19)**, the 2013 dataset used for this CMP did not have coverage along Wagon Wheel (Corridor 11A and 11B); therefore, no results will be reported along that

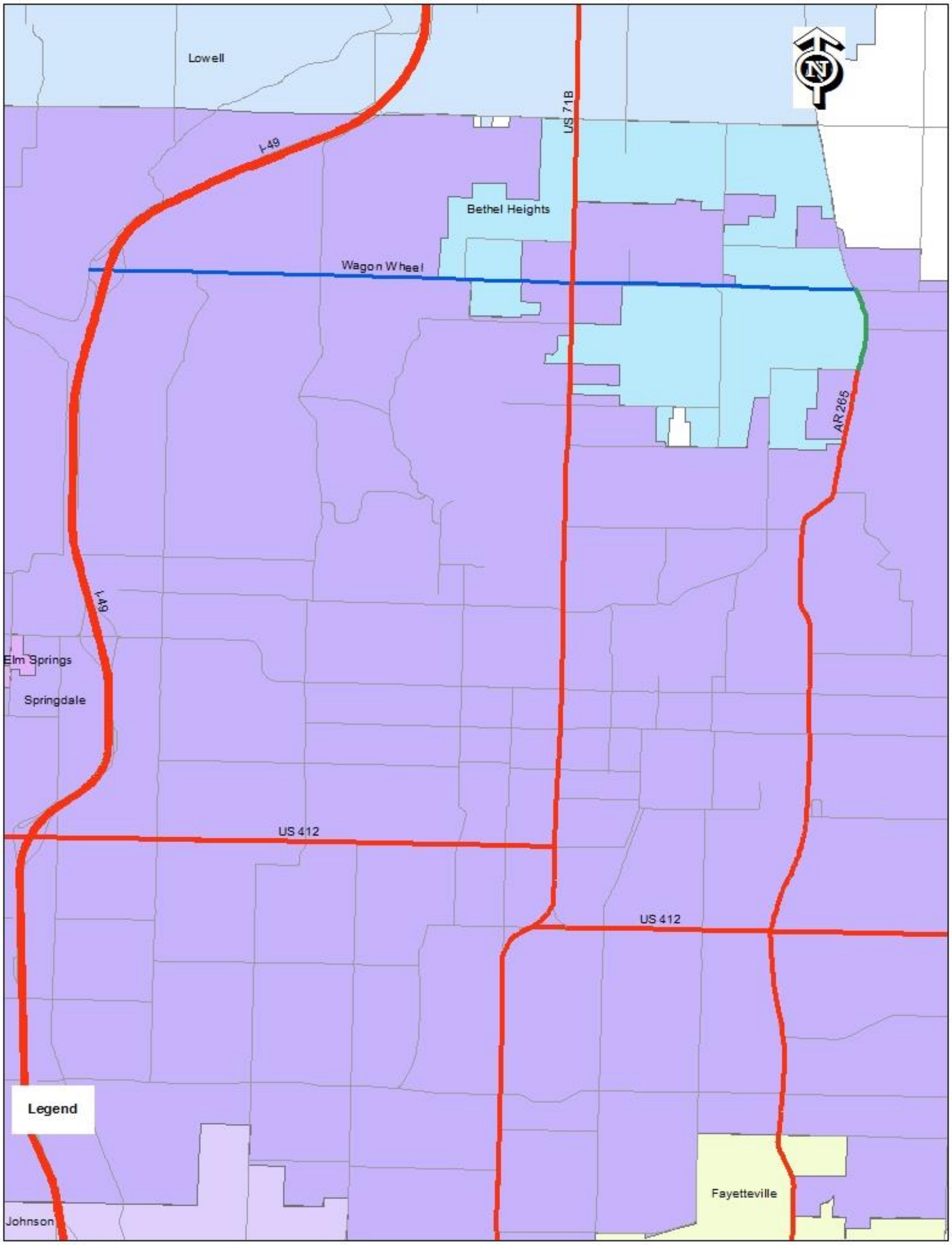


Figure 5 – Subset of 2013 INRIX XD Dataset Coverage

route within this report. Alternative data sources will need to be used in the future if it is desired to include this route with future updates to the CMP.

The project team obtained AHTD's traffic volume network as part of the defined GIS network provided in the previous step. The GIS file contained multiple years of traffic data, and we used traffic volumes for the most recent year available, which was 2013. The project team performed the conflation process within the ESRI ArcView GIS software, using a mostly automated process that has been described in **Appendix A**. The automated network conflation results were reviewed and manual corrections/adjustments were made by a GIS analyst.

Through the integrated datasets assembled in GIS and the additional data assembled below, the data collected in this study has a variety of additional uses outside the CMP. Because the information is all housed in a GIS, queries can group data by area for use in individual planning processes. Within the GIS, the MPO will have access to the following datasets:

- CMP Routes
- Speed Limits (**Figure 6**)
- School Zones (**Figure 7**)
- Intersection Control (**Figure 8**)
- Jurisdiction
- Average Speed
- Congestion Index (% posted speed)
- Peak Period Travel Time
- Segment Delay
- Segment Volume
- Volume Delay per Mile

North Street, Fayetteville

Studies like a CMP are data intensive and typically require a large amount of resources and time to assemble. Other data sources may include transit operations, ridership, and incidents.

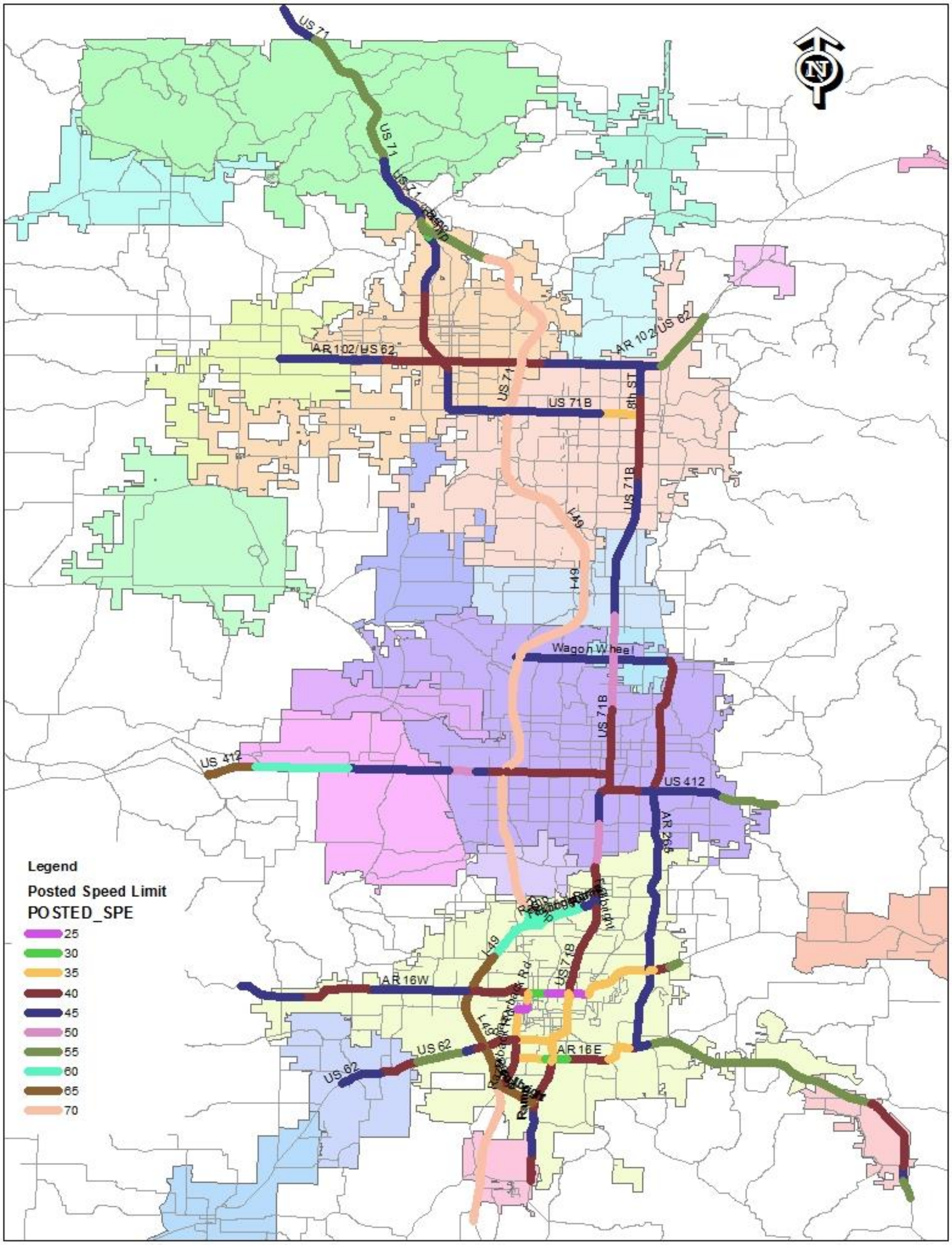


Figure 6 – Speed Limits

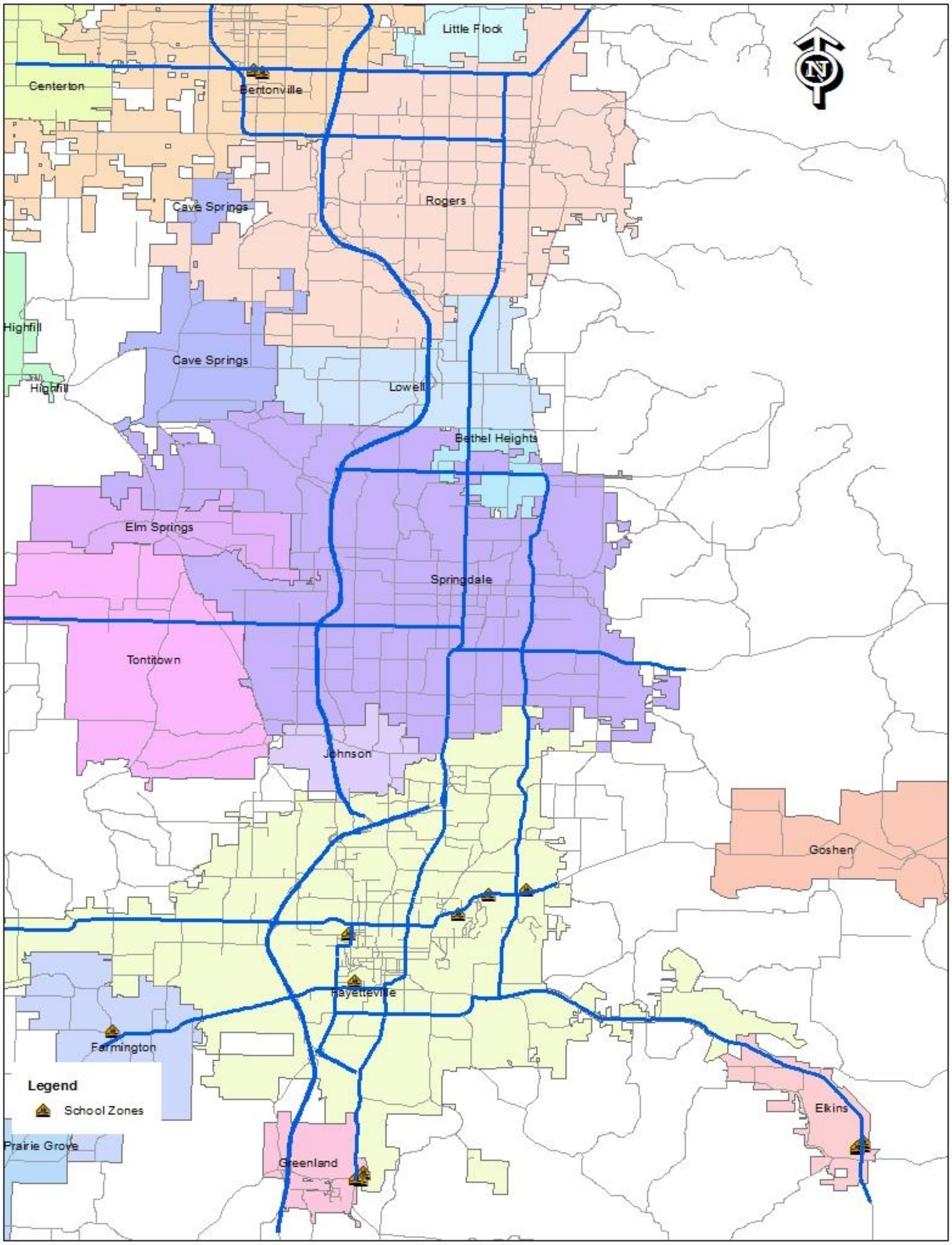


Figure 7 – School Zones

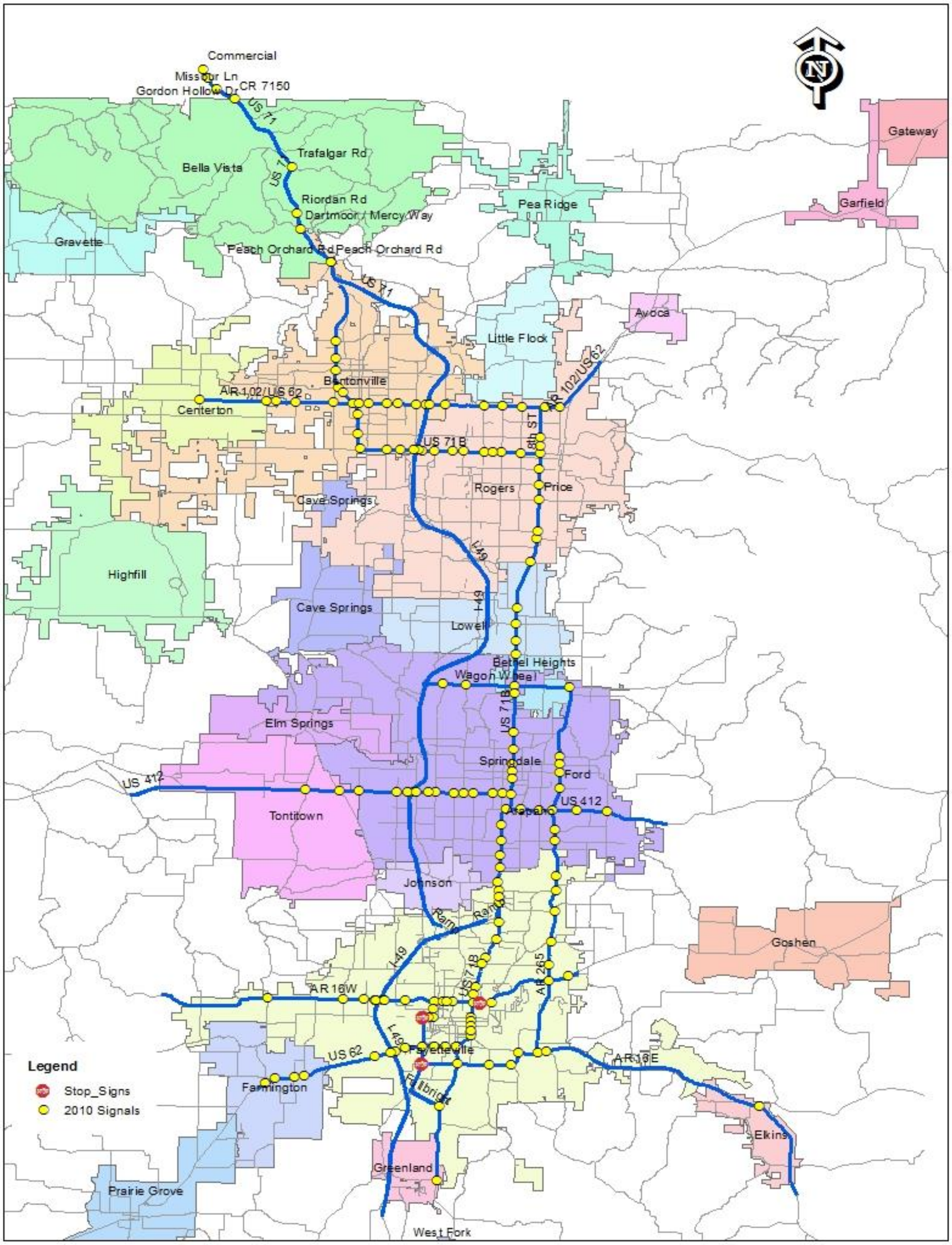


Figure 8 – Intersection Control

5.0 Action 5 – Analyze Congestion Problems and Needs

Given the data collected and dataset assembled, the primary performance measure for the CMP is volume-delay per mile. This performance measure calculates the delay or amount of time drivers wait as compared to traveling at the posted speed. Also, by multiplying it by the link volume, the overall impact of the delay can be measured. The CMP segments vary in length across the board between those on arterials and freeways. In order to standardize the results and allow direct comparison across the network, the volume-delay results were divided by the length. This provides a result with the units in vehicle hours of delay per mile, thus allowing a more direct comparison between segments. As a result, the preferred performance measure was determined and used to identify the operating results of each link of the CMP network.

According to the MPO thresholds developed by the CMP Committee, the top 15% of the performance measure were identified as being congested.

5.1 Roadway Segment Definition

Utilizing the roadway attributes, the CMP corridors were divided into segments with the endpoint or nodes being represented by controlled intersections or major cross-streets.

The roadway segment endpoints are defined at each traffic signal or stop sign. This allowed the segments to be evaluated on a detailed level and then combined, as appropriate, to make corridor recommendations. In addition, for the approximately 224.5 miles of roadways including 13 different roads, the network was further divided into 234 directional links for detailed evaluation. These segments either had a traffic signal, stop sign, or a major cross street in rural areas with limited controlled intersections, as the end points.

5.2 Data Reduction

The method of recording roadway information and the use of an annual private sector dataset create large amounts of data that require manipulation into a useable format. City limits were added directly into the database using the most current boundary files in the MPO's system. Each roadway was defined as a "route" in both directions and beginning and ending points were determined in order to calculate travel time and average speed for the segment.

5.3 Data Formatting

The travel time information and associated performance measures were formatted into tables, graphs, and in ArcGIS. ArcGIS is a geographic information system (GIS) software that allows the user a quick, easy-to-understand graphical reference. ArcGIS reads the study data files, stored in geo-databases, and presents the information graphically. ArcGIS allows the user to group and summarize data for specific purposes.

When congestion occurs during only one time period, the user can study the detailed information to determine the cause of the delay. Thus, improvements can be better focused to ensure the most appropriate use of funds.

ArcGIS can be used to view the information provided in this study for reference and for future projects. Maps and figures can be made for presentations. Information such as speed limits along specific roadways, location and number of traffic signals, the location and number of stop signs, and the location and length of school zones can be summarized and viewed. The information can be summarized for the entire region or broken down and summarized by city, and can be used to identify future improvements.

Figure 9 (Page 26) illustrates the congested segments (lowest performing 15% segments) based on volume delay per mile results for the CMP network. **Figure 10** (Page 29) further differentiates between the congested segments by functional class. More detailed results can be seen within the tabular summaries included in the Appendix.

5.4 Multimodal Analysis

This year's network also reflects the existence of the transit network. Specific details on the transit operations are not currently included in the analysis, but the MPO will need to continue building on the system created so the CMP can truly be multi-modal not only with transit but bike and pedestrian accessibility also. The CMP can and should reflect various performance measures to evaluate the components of an integrated multimodal transportation system.

Several "preserved" or "multimodal corridors" were designated in this initial effort as locations where lower speeds and higher levels of auto congestion would be accepted to aid in encouraging alternative transportation (transit, biking, and walking).

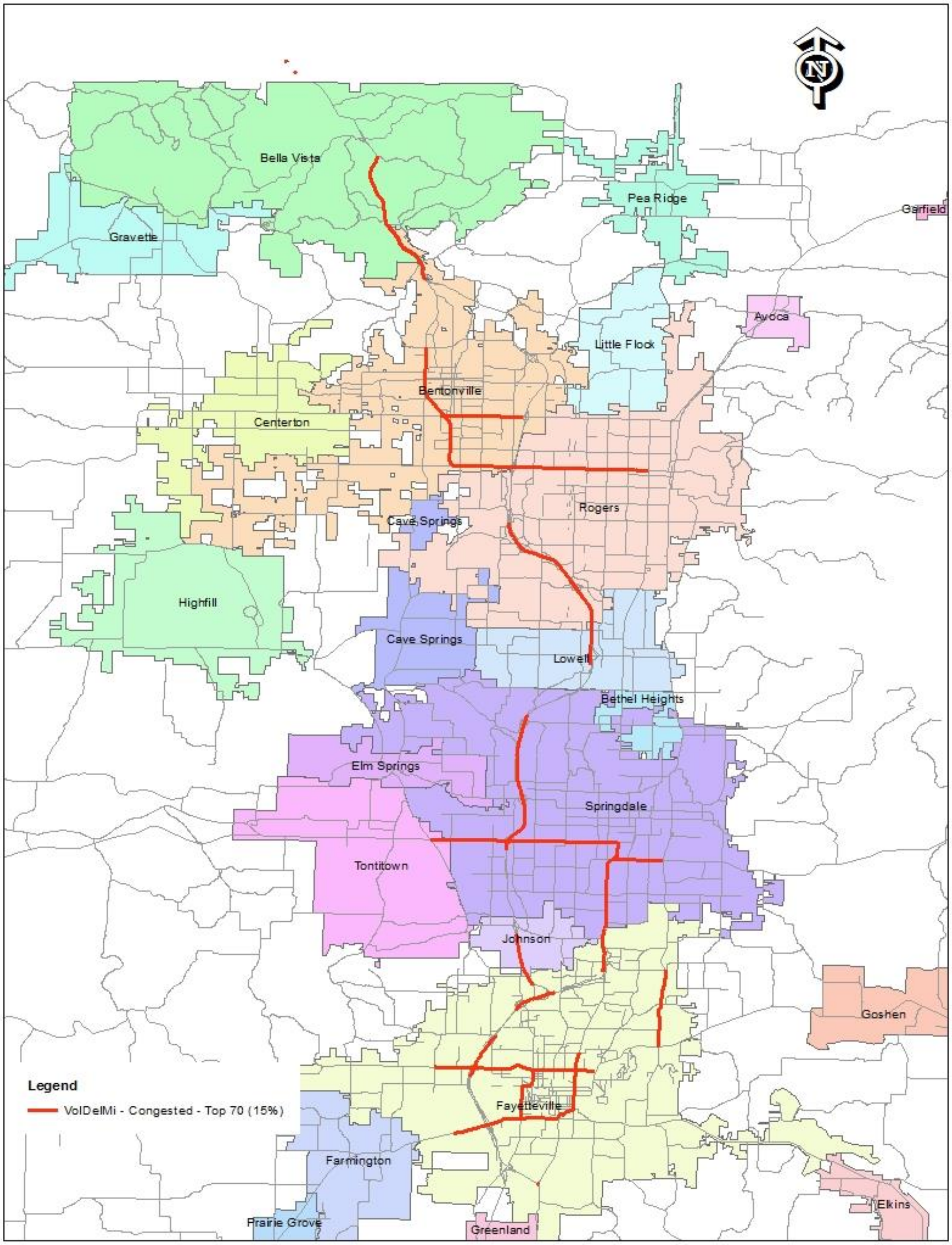


Figure 9 – Peak Period Congestion Results

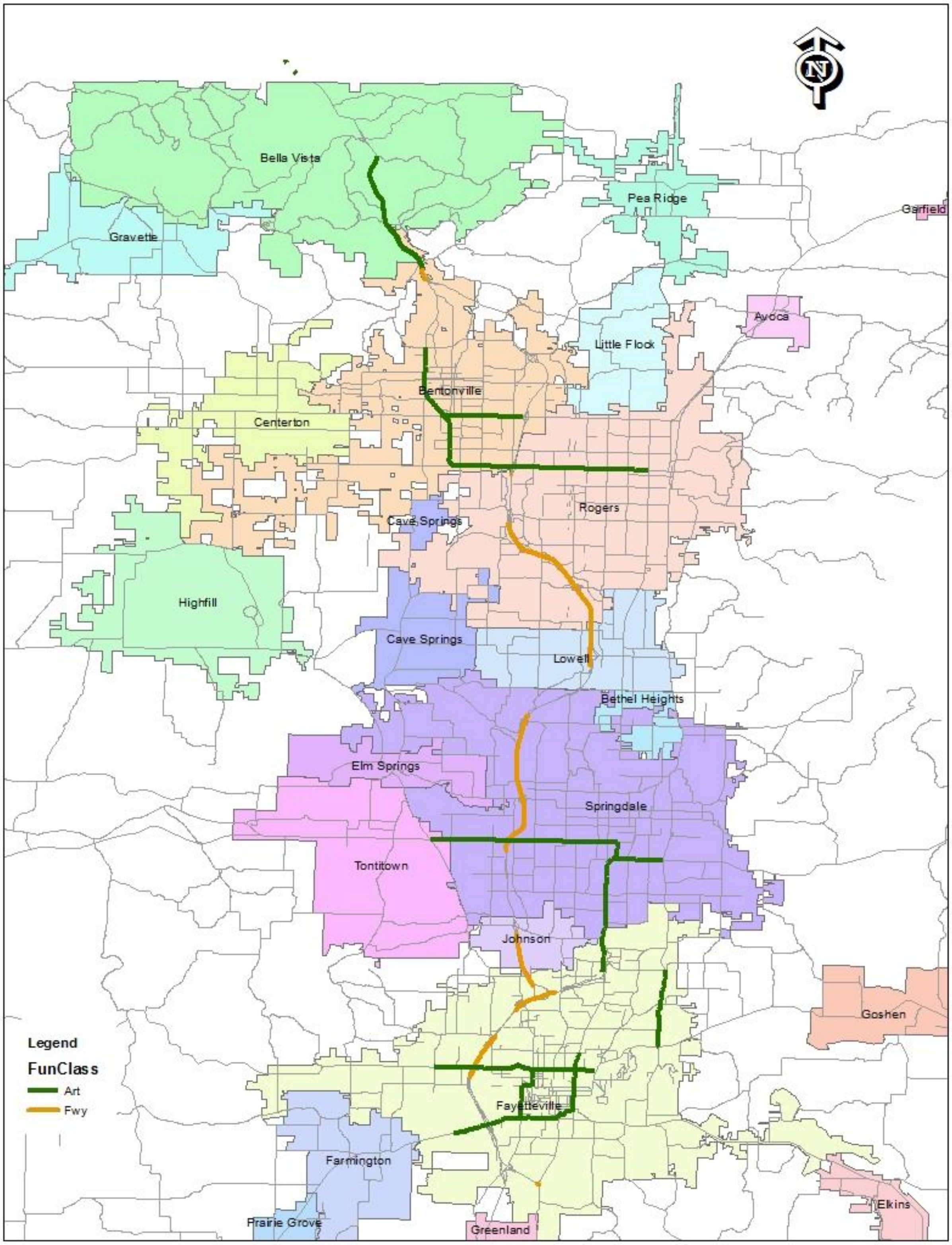


Figure 10 – Congested Segments by Functional Class

6.0 Action 6 – Identify and Assess CMP Strategies

6.1 Congestion Results

Congested Segments. The travel speeds on congested segments are slower than drivers typically want to drive, and there may be less opportunity for lane changing and maneuvering.

Stable Flow Segments. Stable-flow sections are accommodating volumes less than capacity. Travel speeds are somewhat slower than the speed limit, but generally acceptable to drivers. Lane changing and maneuvering is less difficult than in congested segments.

Free Flow Segments. Free-flow sections are operating well below capacity. Travel speeds equal or exceed the speed limit and traffic can maneuver without interference.

Appendix B lists each roadway segment and the performance measure results for the travel time runs. Of the directional miles studied in AM and PM, the CMP Committee determined to classify the top 15% of the segments as congested including both the results of the AM and PM periods.

The 20 most congested segments based on the Volume-Delay per Mile are summarized in **Table 1** and illustrated in **Figure 11**. This table was developed by ranking segments by volume delay per mile. For the Top 20, the average CI, was found to be 0.53 or an average of 53% of the posted speed limit. For further study and analysis, **Appendix C** includes those segments found to be congested ranked by functional class.

Table 1 – Top 20 Congested Segments

Top 20 Rank (Art/Fwy)	SegmentId	Route	Segment Name	Time Period	Func Class	City	Length (mi)	Weighted Avg Speed Limit	Congestion Index	Volume Delay per Mile
1	9E	Hwy 71 - SB	Mercy Way to Riorden Rd	AM	Art	Bella Vista	1.61	45.0	0.51	194.2
2	9C	Hwy 71 - SB	Peach Orchard Rd to Mercy Way	AM	Art	Bella Vista	1.34	45.0	0.49	168.1
3	2E	North St - EB	Oakland Ave to Hwy 45	PM	Art	Fayetteville	1.37	26.4	0.38	155.0
4	5389030	I-49 - SB	South of Fullbright	PM	Fwy	Fayetteville	0.27	60.0	0.68	123.3
5	2E	North St - EB	Oakland Ave to Hwy 45	AM	Art	Fayetteville	1.37	26.4	0.45	106.4
6	5369443	I-49 SB	Short segment at on-ramp from Walnut	PM	Fwy	Rogers	0.21	70.0	0.44	103.4
7	10M	Hwy 71B - EB	I-49 to Rainbow Rd	PM	Art	Bentonville	1.34	45.0	0.46	79.2
8	5369443	I-49 SB	Short segment at on-ramp from Walnut	AM	Fwy	Rogers	0.21	70.0	0.48	73.1
9	2C	Hwy 16 - EB	Rupple Rd to Futtrall	PM	Art	Fayetteville	1.07	43.9	0.48	70.1
10	2C	Hwy 16 - WB	Rupple Rd to Futtrall	PM	Art	Fayetteville	1.07	43.9	0.48	69.7
11	5389031	I-49 - SB	West of Hwy 112	PM	Fwy	Fayetteville	0.25	60.0	0.65	67.2
12	5369409	I-49 - NB	South of Walton on-ramp	PM	Fwy	Bentonville	0.34	54.4	0.47	66.6
13	10M	Hwy 71B - Walton Blvd - WB	I-49 to Rainbow Rd	PM	Art	Bentonville	1.34	45.0	0.50	65.7
14	9C	Hwy 71 - NB	Peach Orchard Rd to Mercy Way	PM	Art	Bella Vista	1.34	45.0	0.71	60.9
15	5402368	Hwy 71 - SB	North CMP limits	PM	Art	Missouri	0.06	45.0	0.40	58.5
16	10F	Hwy 71B - NB	Shiloh to Tyson Pkwy	PM	Art	Springdale	1.70	43.3	0.55	55.4
17	5389276	I-49 - NB	North of Hwy 412	AM	Fwy	Springdale	0.54	70.0	0.67	53.6
18	5402369	Hwy 71 - NB	North CMP limits	PM	Art	Missouri	0.06	45.0	0.42	52.7
19	5389139	Fullbright - WB	Within I-49 interchange	PM	Fwy	Fayetteville	0.61	60.0	0.71	51.6
20	5389081	I-49 - NB	South of Fullbright interchange	AM	Fwy	Fayetteville	0.43	63.5	0.73	51.0

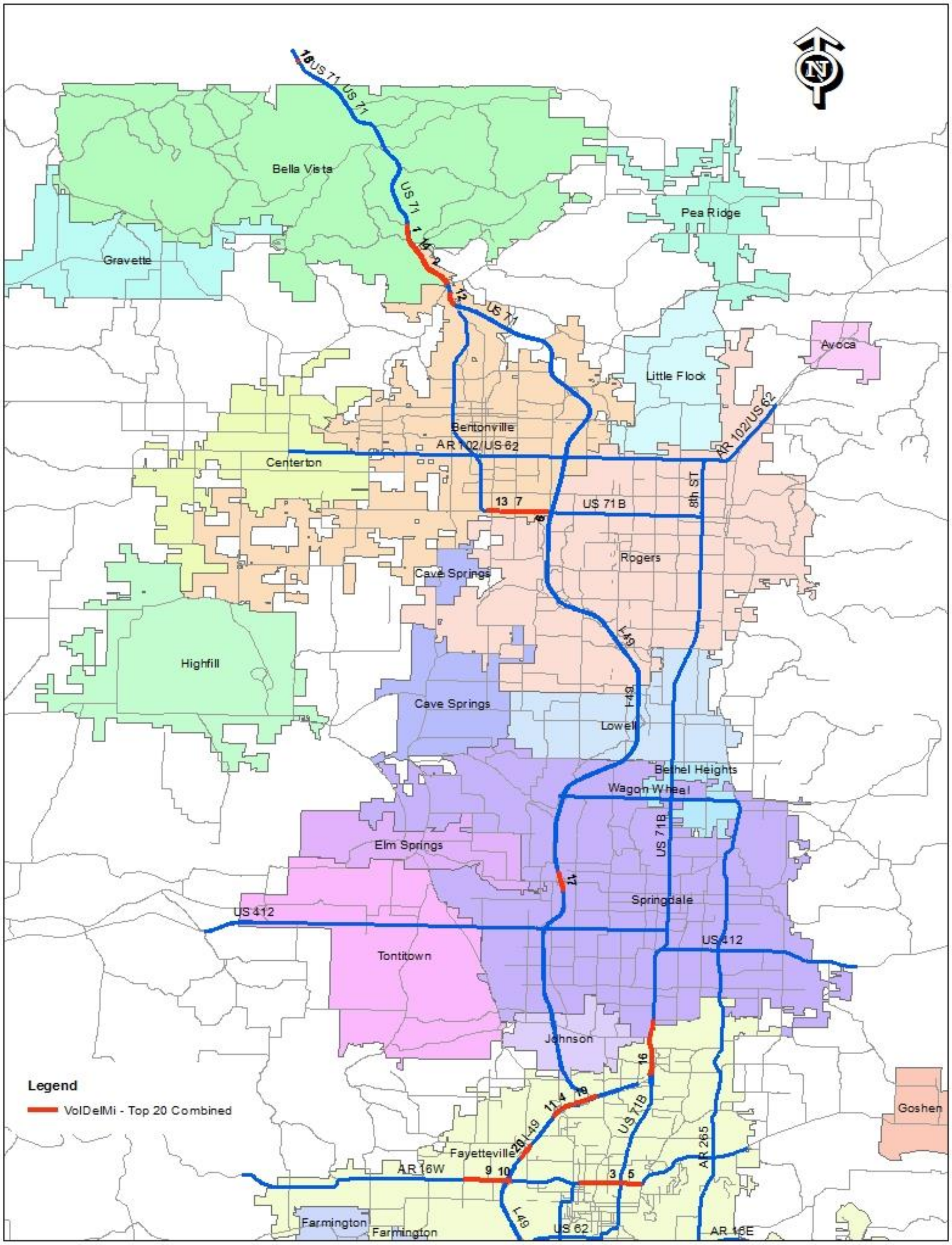


Figure 11 – Top 20 Congested Segments

6.2 Recommendations

Private sector data as used in this study bring with it many advantages, but also a few disadvantages. The primary advantage includes a large dataset that opens the door to various performance measures and applications from 5 minute results for any day of the week to annualized results for a full year at a reasonable cost. The downside of such link based datasets is the limitation in evaluating detailed intersection level results.

Within the context of the CMP, link level results limit the details available to determine appropriate mitigation for those segments identified as being congested; therefore, specific segment or link recommendations to address congestion on CMP segments are not possible given the dataset used for the CMP. The recommendations will be limited to a "tool box" of recommendations that are typically seen with other CMPs. To address this issue, it is recommended that the MPO consider taking a "hybrid" approach for the next CMP update. That would include the use of a private sector dataset initially as a regional review of the network. The analysis would then continue for those found to be congested with more detailed data collection either using local sources, such as traffic counts or data from traffic controllers (available), or collection of travel time runs on a limited level to evaluate the performance of the corridor. These datasets would assist in better pinpointing the location of delays within a segment, rather than just knowing the average speed within a segment was low between the start and end nodes.

This is a very timely research topic within the industry given the growing use of private sector data in regional operational assessments and CMP. Purdue University is actively performing research on limitations and supplemental sources of data of large datasets, including private sector data.

Typically, an arterial network plays a large role in circulation of traffic within a region. Over the years, approximately 70% of signalized corridors show signs of poor signal coordination, thus creating avoidable delays on the surface streets. This leads to not only delays, but increased emissions and incidents. The following tools should be considered on a regional level to address delays along local corridors and those that are more regionally significant. Improvements include signal timing optimization / traffic signal progression, access management, incident management, additional capacity, and adding signals in place of stop signs. Benefits of these improvements are described below. Additionally, the use of alternative modes such as public transit, bicycling, and walking to the extent possible should be encouraged.

Signal Timing

Typically, many of the recommendations include signal timing improvements. Signal timing improvements are a relatively inexpensive way to make significant improvements on a transportation network. Improved signal timing can decrease delay by appropriately allocating green time among competing phases. This allows more traffic to pass through the signal with less delay. By adjusting cycle lengths and offsets, drivers can travel longer distances along a corridor before having to stop for a red light. This decreases travel time and improves air quality. Both signal timing optimization and traffic signal progression are low cost improvements to make the best use of existing capacity and optimize allocation of funding. The cost for a signal timing improvement project varies depending on the number of traffic signals, the controller capabilities, the location of the traffic signals and adjacent signals, the number of timing plans required, and implementation and fine-tuning needs. Adaptive signal control as has been implemented along US 71B in Springdale and Rogers and US 62 in Rogers, will be much more expensive per intersection than just occasional signal optimization, but depending on the application, may be cost effective in the long run.

The U.S. Department of Transportation's Federal Highway Administration (FHWA) has produced a video showing that retiming traffic signals is one of the more cost-effective techniques available to state and local agencies in their efforts to manage congestion and growing travel demand. The video, "It's About Time, Traffic Signal Management: Cost-Effective Street Capacity and Safety," demonstrates how signal timing on roads can improve air quality while reducing fuel consumption, decreasing traffic congestion, and saving time for commercial and emergency vehicles. Two-thirds of all highway miles in the United States are roads with traffic signals. According to the Institute of Transportation Engineers, the United States has about 300,000 traffic signals. The performance of about 75 percent of them could be improved easily and inexpensively by updating equipment or by simply adjusting the timing.

Signal timing is an area that deserves attention within the region to allow maximum efficiency of the existing system before costly widening to add capacity. The results will be very evident as has been demonstrated previously with localized projects. A regional perspective would produce consistent travel time runs even when crossing from one city/agency to another.

As transportation funding continues to be limited, operations are being highlighted by many MPOs across the country. It has been clearly proven locally and nationally that operational improvements provide the highest benefit/cost ratio and on a regional scale as compared to local capacity projects that benefit a smaller portion of the area.

Data collection, development of a model for each desired timing plan, signal timing optimization, and implementation can be accomplished along a corridor for around $3,000 per intersection (not including any necessary hardware in the signal cabinet).

The methods will vary as to how to accomplish the desired results depending on the signal hardware currently in place and the expansion capabilities. It can be as simple as installing a GPS clock at each intersection ($500) to synchronize the controller clocks to more advanced systems where each intersection needs vehicle detection ($15,000) and wireless communications ($2,500) between signals. Either way, the benefit/cost ratio of this type of work is unmatched in today's funding environment.

Until a time when the system is fine-tuned to operate efficiently within the existing roadway cross-section, it is difficult to identify those areas that may need more attention including local geometric improvements, access management, or finally added capacity.

Access Management

The Federal Highway Administration defines access management as "the process that provides access to land development while simultaneously preserving the flow of traffic on the surrounding system in terms of safety, capacity, and speed."

Access management is accomplished in a variety of ways such as managing the design of access points, the location of access points, the number of access points allowed within a given distance (access density), and the roadway median treatment. Generally, the number of access points is minimized and regularly spaced from each other so that conflict points are separated.

Access management can provide a number of benefits to the public agency and to the traveling public. Capacity is preserved and safety (motorized and non-motorized) is improved by minimizing conflict points and minimizing speed differentials between through traffic and slow moving turning traffic. Safety for turning movements is also improved by providing adequate turning (auxiliary) lanes or by prohibiting turns in key locations using a raised median. In addition to safety and efficiency improvements, access management also provides environmental and financial benefits with reduced vehicle emissions and improved fuel economy by maintaining the flow of traffic.

On new roadways, or on undeveloped corridors, access management can be used to minimize operational traffic problems, due to unmanaged development, before they occur. In these cases, it is inexpensive and fairly easy to accomplish. The traveling public benefits from a safe and efficient corridor. Property owners benefit from safe access. The agency benefits from a low cost management plan from the onset rather than costly highway improvement projects once problems occur. Once corridors are developed, it is more difficult, expensive, and time consuming to retrofit managed access. Whenever possible, access management should be given high priority on undeveloped corridors.

Access management can be very challenging on existing 'built-up' urban roadways. Common issues include limited right-of-way and opposition by land owners. Still, retrofitting a corridor with access management can provide benefits. Possible retrofitting improvements include: consolidating and closing driveways, constructing raised medians, constructing auxiliary lanes, providing regularly spaced traffic signals to encourage use of a major cross-street or driveway, and providing alternative routes such as internal access roads.

Intersection Control

Adding signals or roundabounts, when warranted, may be an improvement at all-way stop intersections or intersections with heavy major-street and cross-street traffic. This reduces delay for previously stop-controlled movements but may increase delay for movements that were not controlled. As traffic volumes increase, traffic signals or other types of intersection design such as roundabouts or continuous flow intersections should be considered to efficiently move traffic. Local intersection improvements also can result in big reductions in delays through bottleneck mitigation. Local improvements include geometric changes related to increased queue storage to channelized right turns and overlapping signal phases.

2010 2015

Fulbright Expy - Northhills Blvd - Futrall Dr. Roundabout

2010 2015

Fayetteville Flyover/Fulbright Expressway

Incident Management

Incident management plays a large roll in reducing delays and secondary incidents. By identifying incidents early and having quick responses from tow trucks available in close proximity that may be stationed or roving, clearing of incidents helps traffic return to normal operations as quick as possible.

Safety Projects (Roadway Departures, Bicycle and Pedestrian Crossings)

Safety projects reduce crash rates and the severity of crashes. Non-reoccurring congestion based on traffic incidents (crashes) can account for up to 25% as the source of congestion. The region should continue to deploy rumble strips as needed, cable median barriers, enhanced signing at curves and high friction pavements to reduce crash rates on the CMP network.

2010 2015

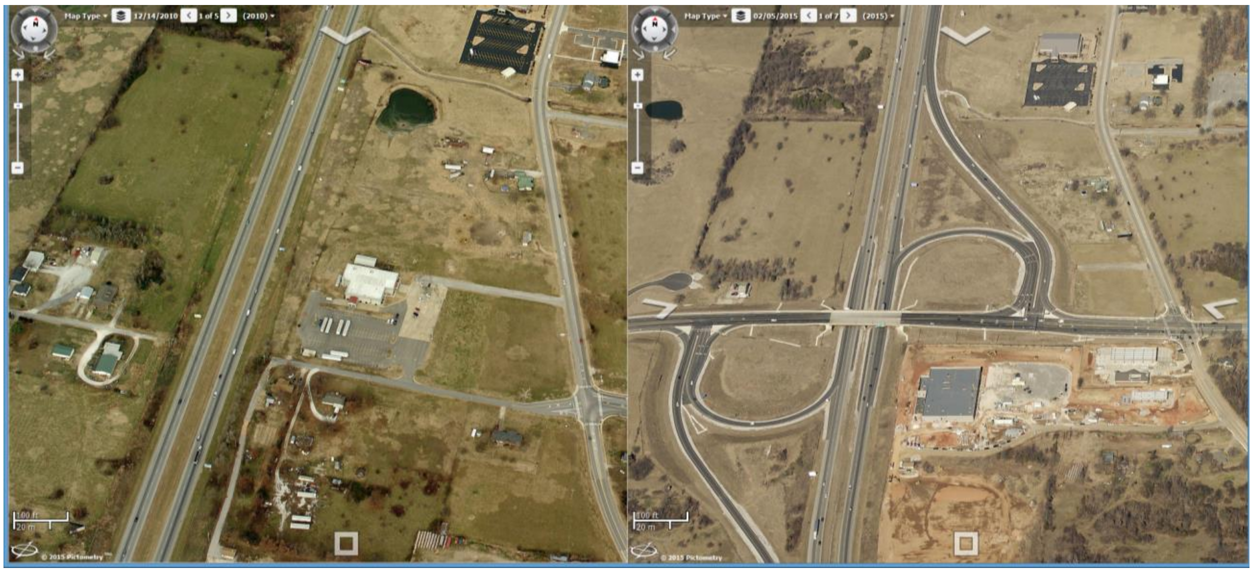
I-49 Cable Median Barrier Project, Springdale, AR

2010 2015

MLK Blvd - Razorback Regional Greenway Pedestrian and Bicycle Underpass

Added Capacity

Roadway widening is necessary where traffic signal timing and access management are unable to provide enough capacity for heavy traffic volumes. Some segments may improve in the short term with optimized signal timing, but may ultimately warrant additional capacity through widening. Widening could include adding a through lane for a long section of road, or providing turn lanes at intersections. Adding capacity through roadway widening is generally expensive.



2010 2015
Don Tyson Parkway Interchange/I-49

7.0 Action 7 – Program and Implement CMP Strategies

A fully integrated CMP not only evaluates the current congestion conditions and recommends mitigation, but prioritizes the improvements and incorporates them into the planning process. Those improvements can be viewed as local improvements, corridor strategies, or regional programs/initiatives.

Regions are expected to manage their system to get as much capacity out of the existing system prior to capital projects to widen the roadways. Ideally, every effort should be exhausted and documented before getting to the end of the line and adding capacity.

This study serves as the initial element of the CMP and should not be viewed as a complete CMP. The CMP is a living process that is part of the planning process. This initial study is documenting the current conditions, ranking the magnitude of observed congestion, recommending possible mitigation, and prioritizing those improvements. The MPO will apply these findings and integrate them into the planning process.

One option that many MPOs have used is in the form of a “set aside” funding category for localized bottleneck and operational projects. These projects are “quick fixes” and do not need the sometime lengthy process required for capital projects. Also, the prioritization of operational projects compared to the larger capital projects at times is tough to compare. By having a separate category for operational projects makes the time to market much shorter and the community can benefit much sooner.

8.0 Action 8 – Evaluate Strategy Effectiveness

This 2015 CMP is the first effort toward development of a full CMP. Therefore, the MPO is not able to evaluate the benefits of implemented strategy this time around; however, in the future the MPO’s CMP will go full circle to identify the conditions, recommend mitigation, prioritize the improvements, plan the schedule and funding, and evaluate the benefits.

MPO member agencies have implemented various projects over the last few years. In the future, projects like those shown below will be evaluated using before/after datasets. The assessments of historic projects are not only intended to validate the benefits of specific projects, but to evaluate general strategies effectiveness.

Recent projects include:

Adaptive Signal Control

City of Rogers**:**

- Highway 71B/Walnut Street – From I-49 to Highway 71B (Walnut) – Completed December 2011

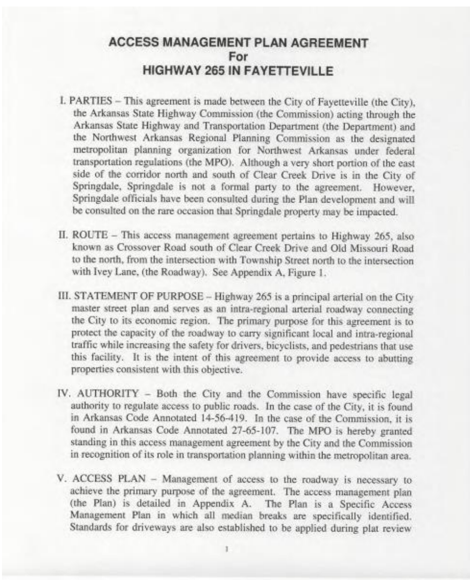
- Highway 71B/South 8th Street – From Olive Street to New Hope Road – Completed December 2011
- I-49 / New Hope Road – interchange signals

City of Springdale**:**

- Highway 71B/Thompson – From Don Tyson Blvd. to Randall Wobbe – Completed April 2010

<u>Highway 265 Access Management Plan</u>

- This plan was part of an agreement between the city of Fayetteville, the Arkansas State Highway and Transportation Department and the Northwest Arkansas Regional Planning Commission to protect the capacity of the roadway, improve safety for drivers, bicyclists and pedestrians. The agreement was executed in 2009.



ACCESS MANAGEMENT PLAN AGREEMENT
For
HIGHWAY 265 IN FAYETTEVILLE

I. PARTIES – This agreement is made between the City of Fayetteville (the City), the Arkansas State Highway Commission (the Commission) acting through the Arkansas State Highway and Transportation Department (the Department) and the Northwest Arkansas Regional Planning Commission as the designated metropolitan planning organization for Northwest Arkansas under federal transportation regulations (the MPO). Although a very short portion of the east side of the corridor north and south of Clear Creek Drive is in the City of Springdale, Springdale is not a formal party to the agreement. However, Springdale officials have been consulted during the Plan development and will be consulted on the rare occasion that Springdale property may be impacted.

II. ROUTE – This access management agreement pertains to Highway 265, also known as Crossover Road south of Clear Creek Drive and Old Missouri Road to the north, from the intersection with Township Street north to the intersection with Ivey Lane, (the Roadway). See Appendix A, Figure 1.

III. STATEMENT OF PURPOSE – Highway 265 is a principal arterial on the City master street plan and serves as an intra-regional arterial roadway connecting the City to its economic region. The primary purpose for this agreement is to protect the capacity of the roadway to carry significant local and intra-regional traffic while increasing the safety for drivers, bicyclists, and pedestrians that use this facility. It is the intent of this agreement to provide access to abutting properties consistent with this objective.

IV. AUTHORITY – Both the City and the Commission have specific legal authority to regulate access to public roads. In the case of the City, it is found in Arkansas Code Annotated 14-56-419. In the case of the Commission, it is found in Arkansas Code Annotated 27-65-107. The MPO is hereby granted standing in this access management agreement by the City and the Commission in recognition of its role in transportation planning within the metropolitan area.

V. ACCESS PLAN – Management of access to the roadway is necessary to achieve the primary purpose of the agreement. The access management plan (the Plan) is detailed in Appendix A. The Plan is a Specific Access Management Plan in which all median breaks are specifically identified. Standards for driveways are also established to be applied during plat review

1

<u>Congestion Analysis and Performance Measures for Northwest Arkansas</u>

The Interstate 49 Improvements Study prepared by Parsons Transportation Group in 2006 considered the needed Interstate widening and focused on an analysis of nineteen interchanges in order to recommend short-term, interim and long-term improvements. The study developed the following:

- 2024 travel demand forecast for I-49
- Identified congestion segments
- Calculated 2006 and 2024 Level of Service
- Recommended interstate widening
- Analyzed nineteen interchanges on I-49

The Northwest Arkansas Eastern North-South Corridor Study

Completed in 2011, the project analyzed the need for improvements to an eastern north-south corridor in order to alleviate the traffic congestion on the existing north-south routes, especially Highway 71B. The study extended from Highway 16 East in Fayetteville to Highway 62 in Rogers, with a potential extension to Bentonville.

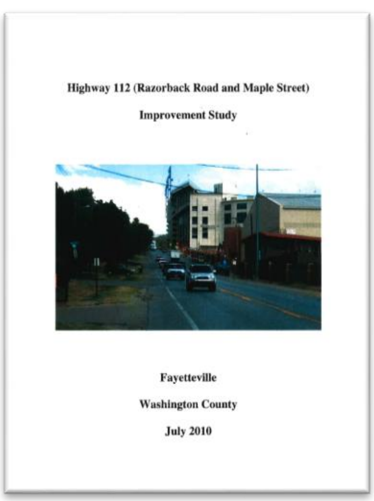
Highway 112 (Razorback Road and Maple Street) Improvement Study

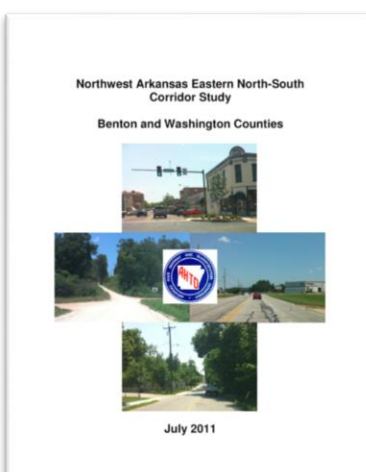
Completed in 2010 by the Arkansas State Highway and Transportation Department, the study was conducted to determine the appropriate cross-section for improvements to Highway 112 along Razorback Road and Maple Street between Highway 180 (Martin Luther King Blvd.) and Garland Ave. through the University of Arkansas campus in Fayetteville.

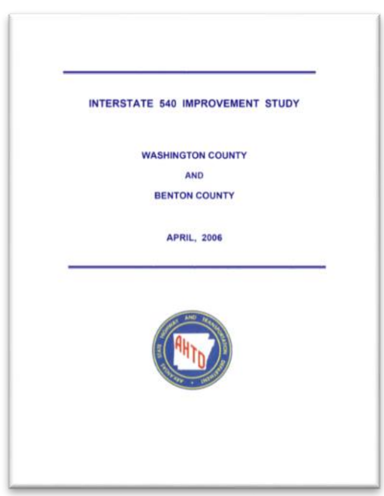
CONCLUSION

The Congestion Management Process (CMP) plays an essential role within the transportation planning and programming process by providing decision-makers at MPOs, local governments, and state agencies a clear analytical understanding of congestion in the region. The CMP must be an integral element in a well-organized, objectives-driven, performance-based planning approach.

The flexibility of the regulations and guidelines has allowed the MPO to customize the CMP in various ways to reflect both regional needs and priorities. MPOs around the country have developed unique methods of implementing the CMP. The NWARPC looks forward to continue working with the members of the CMP Committee to build on the momentum begun through the development of this component of the overall CMP by using the performance measures identified here within, by aligning the CMP closely with the Metropolitan Transportation Plan and Transportation Improvement Program, and using the CMP performance measures to directly influence project prioritization and funding.







Appendix A

Detailed Conflation and Traffic Volume Estimation Procedures

Detailed Conflation and Traffic Volume Estimation Procedures

The following steps were used to conflate the traffic speed and traffic volume networks, which are then used to calculate the congestion performance measures for each CMP-defined road segment.

1. Identify/obtain AHTD traffic volume data by road section
2. Match the AHTD road network sections with the traffic speed dataset road sections
3. Estimate traffic volumes for each 15-minute time interval from the daily volume data
4. Calculate congestion measures based on integrated 15-minute speeds and volumes

Step 1. Identify/Obtain Traffic Volume Data

An AHTD dataset provided the source for traffic volume data, although the geographic segmentation in the AHTD dataset are not identical to the private sector speed data. The daily traffic volume data must be divided into the same time interval as the traffic speed data (hour intervals). While there are some detailed traffic counts on major roads, the most widespread and consistent traffic counts available are average daily traffic (ADT) counts. The hourly traffic volumes for each section; therefore, were estimated from these ADT counts using typical time-of-day traffic volume profiles developed from continuous count locations or other data sources. The section “Estimation of Hourly Traffic Volumes” shows the average hourly volume profiles used in the measure calculations.

Volume estimates for each day of the week (to match the speed database) were created from the average volume data using the factors in Exhibit A-1. Automated traffic recorders from around the country were reviewed and the factors in Exhibit A-1 are a “best-fit” average for both freeways and major streets. Creating an hourly volume to be used with the traffic speed values, then, is a process of multiplying the annual average by the daily factor and by the hourly factor.

Exhibit A-1. Day of Week Volume Conversion Factors

Day of Week	Adjustment Factor (to convert average annual volume into day of week volume)
Monday to Thursday	+5%
Friday	+10%
Saturday	-10%
Sunday	-20%

Step 2. Combine the Road Networks for Traffic Volume and Speed Data

The second step was to combine the road networks for the traffic volume and speed data sources, such that an estimate of traffic speed and traffic volume was available for each roadway segment in each urban area. The combination (also known as conflation) of the traffic volume and traffic speed networks was accomplished using Geographic Information Systems (GIS) tools. The INRIX speed network was combined with an ADT count from the AHTD volume network, and then integrated onto the CMP-defined roadway segments. The traffic count and speed data for each roadway segment were then used to calculate congestion measures.

Step 3. Estimate Traffic Volumes for Shorter Time Intervals

The third step was to estimate traffic volumes for one-hour time intervals for each day of the week.

Typical time-of-day traffic distribution profiles are needed to estimate hourly traffic flows from average daily traffic volumes. Previous analytical efforts[1,2] have developed typical traffic profiles at the hourly level (the roadway traffic and inventory databases are used for a variety of traffic and economic studies). These traffic distribution profiles were developed for the following different scenarios (resulting in 16 unique profiles):

- Functional class: freeway and non-freeway
- Day type: weekday and weekend
- Traffic congestion level: percentage reduction in speed from free-flow (varies for freeways and streets)
- Directionality: peak traffic in the morning (AM), peak traffic in the evening (PM), approximately equal traffic in each peak

The 16 traffic distribution profiles shown in Exhibits A-2 through A-6 are considered to be very comprehensive, as they were developed based upon 713 continuous traffic monitoring locations in urban areas of 37 states.

[1] *Roadway Usage Patterns: Urban Case Studies*. Prepared for Volpe National Transportation Systems Center and Federal Highway Administration, July 22, 1994.

[2] *Development of Diurnal Traffic Distribution and Daily, Peak and Off-peak Vehicle Speed Estimation Procedures for Air Quality Planning*. Final Report, Work Order B-94-06, Prepared for Federal Highway Administration, April 1996.

Exhibit A-2. Weekday Traffic Distribution Profile for No to Low Congestion

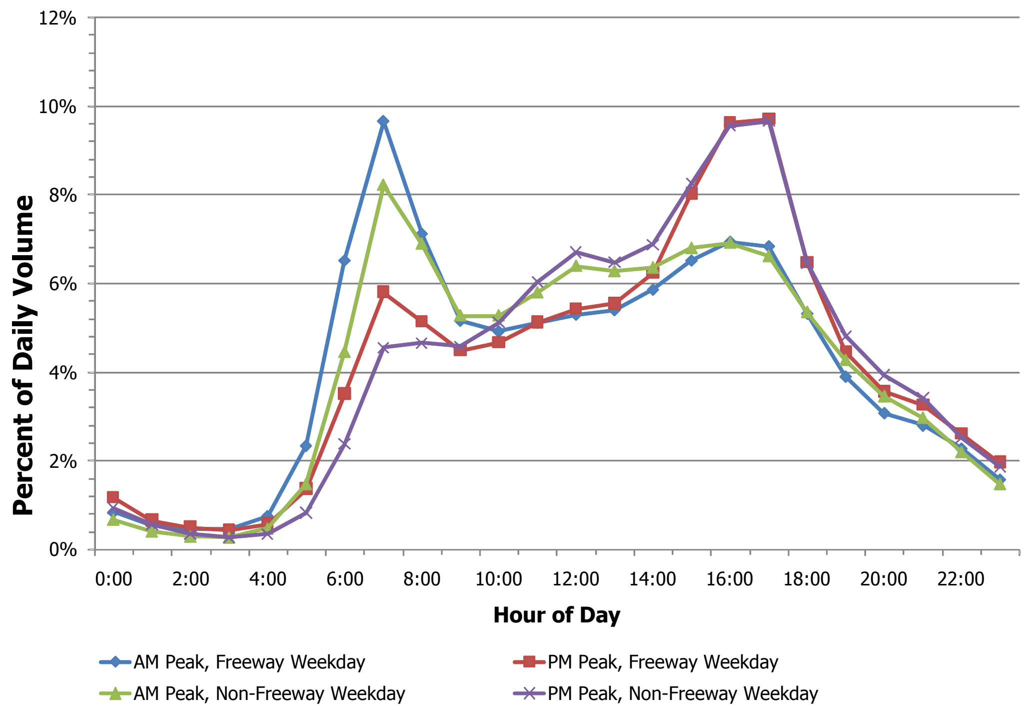


Exhibit A-3. Weekday Traffic Distribution Profile for Moderate Congestion

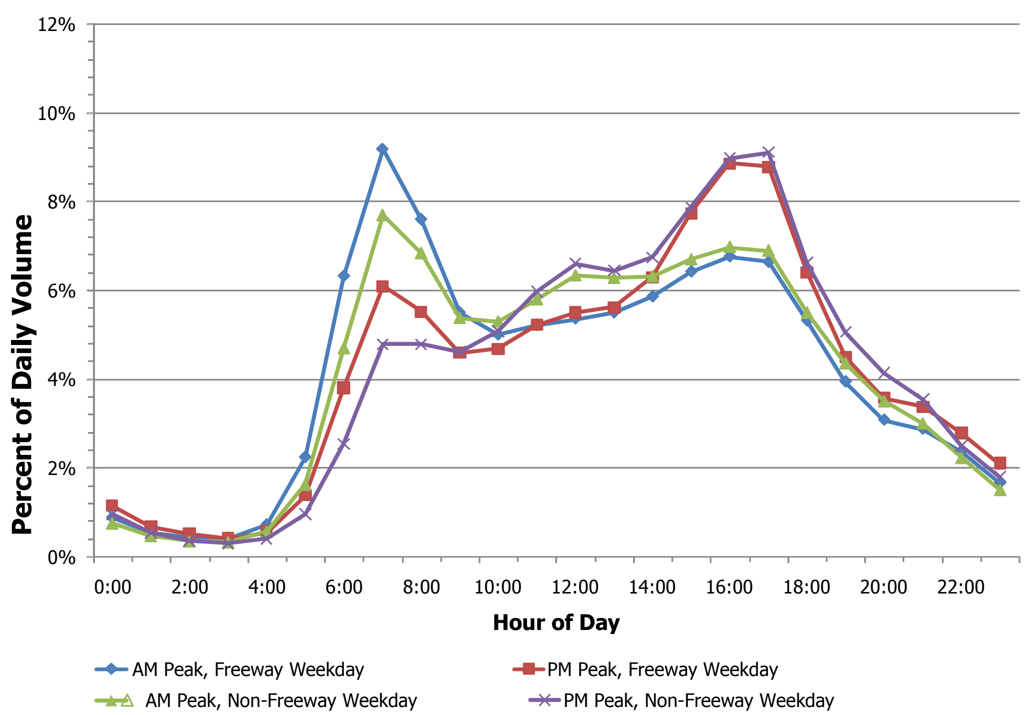


Exhibit A-4. Weekday Traffic Distribution Profile for Severe Congestion

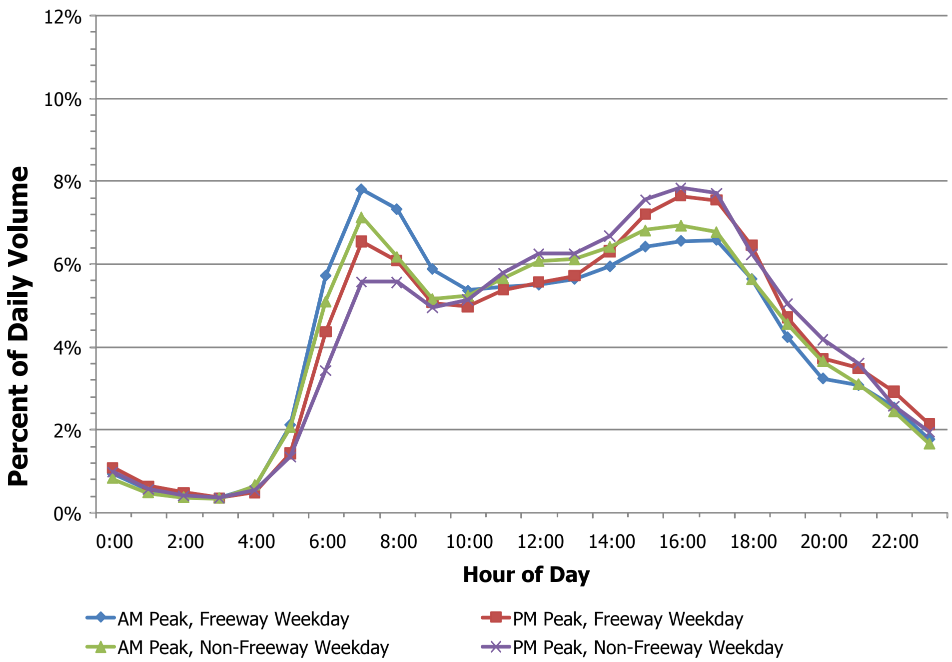


Exhibit A-5. Weekend Traffic Distribution Profile

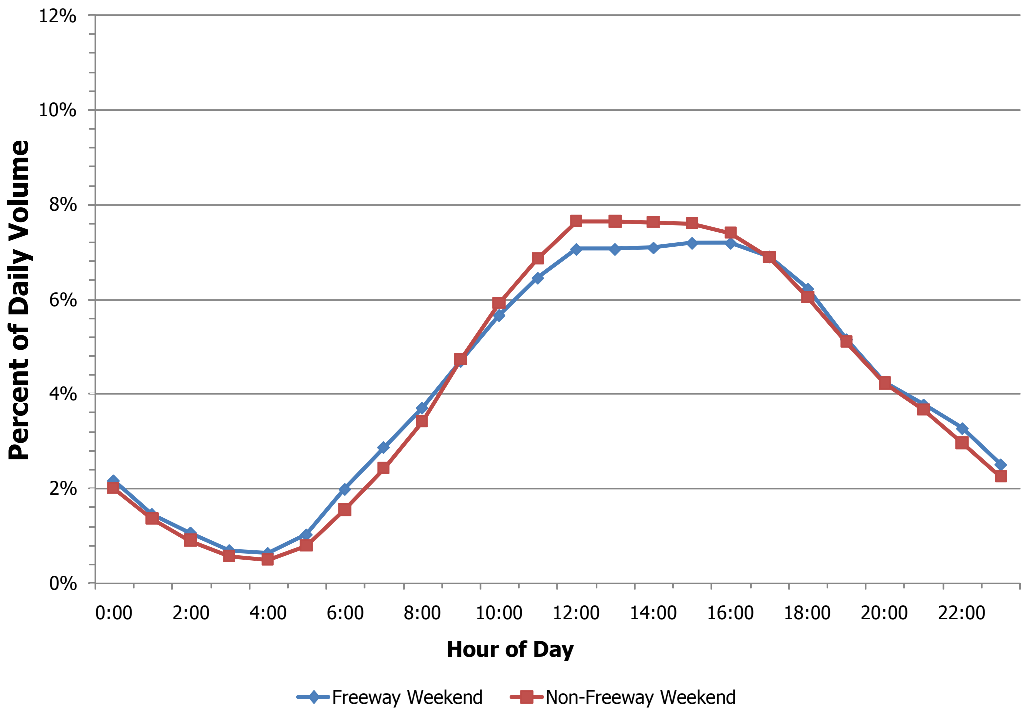
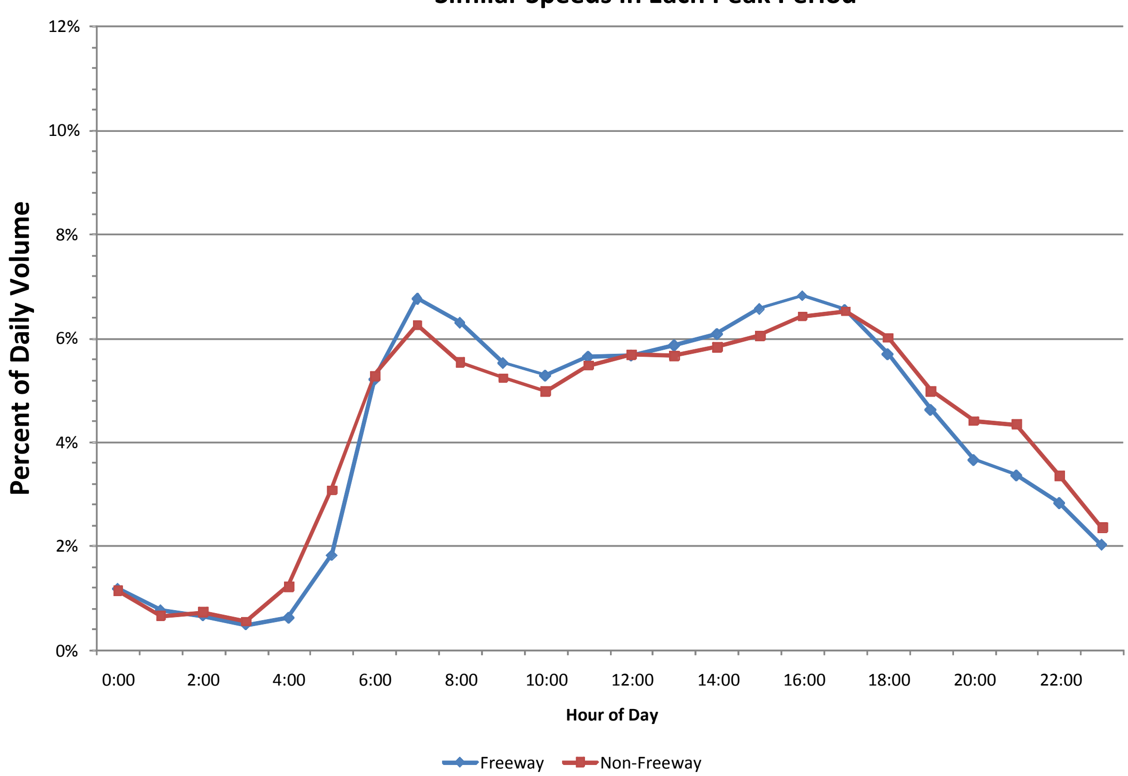


Exhibit A-6. Weekday Traffic Distribution Profile for Severe Congestion and Similar Speeds in Each Peak Period



The next step in the traffic flow assignment process is to determine which of the 16 traffic distribution profiles should be assigned to each Traffic Message Channel (TMC) path (the "geography" used by the private sector data providers), such that the hourly traffic flows can be calculated from traffic count data supplied by AHTD. The assignment should be as follows:

- Functional class: assign based on AHTD functional road class
  - Freeway – access-controlled highways
  - Non-freeway – all other major roads and streets

- Day type: assign volume profile based on each day
  - Weekday (Monday through Friday)
  - Weekend (Saturday and Sunday)

- Traffic congestion level: assign based on the peak period speed reduction percentage calculated from the private sector speed data. The peak period speed reduction is calculated as follows:
  1) Calculate a simple average peak period speed (add up all the morning and evening peak period speeds and divide the total by the 8 periods in the eight peak hours) for each TMC path using speed data from 7 a.m. to 9 a.m. (morning peak period) and 4:30 p.m. to 6:30 p.m. (evening peak period).
  2) Calculate a free-flow speed during the light traffic hours (e.g., 10 p.m. to 5 a.m.) to be used as the baseline for congestion calculations.
  3) Calculate the peak period speed reduction by dividing the average combined peak period speed by the free-flow speed.

$$\begin{matrix}\text{Speed}\\ \text{Reduction Factor}\end{matrix} = \frac{\begin{matrix}\text{Average Peak}\\ \text{Period Speed}\end{matrix}}{\begin{matrix}\text{Free-Flow Speed}\\ (10\text{ p.m. to }5\text{ a.m.})\end{matrix}} \qquad \text{(Eq. A-1)}$$

For Freeways:
  - speed reduction factor ranging from 90% to 100% (no to low congestion)
  - speed reduction factor ranging from 75% to 90% (moderate congestion)
  - speed reduction factor less than 75% (severe congestion)

  For Non-Freeways:
  - speed reduction factor ranging from 80% to 100% (no to low congestion)
  - speed reduction factor ranging from 65% to 80% (moderate congestion)
  - speed reduction factor less than 65% (severe congestion)
- Directionality: Assign this factor based on peak period speed differentials in the private sector speed dataset. The peak period speed differential is calculated as follows:
  1) Calculate the average morning peak period speed (7 a.m. to 9 a.m.) and the average evening peak period speed (4:30 p.m. to 6:30 p.m.)
  2) Assign the peak period volume curve based on the speed differential. The lowest speed determines the peak direction. Any section where the difference in the morning

and evening peak period speeds is 6 mph or less will be assigned the even volume distribution.

Step 4. Calculate Congestion Performance Measures

At this point in the process, we now have a traffic speed value and traffic volume estimate for every 15 minutes of an average weekday for each of the CMP-defined roadway segments. The total size of this integrated volume and speed database is 143,136 rows/records, which can be imported into an Excel spreadsheet or Access database table for specific congestion measure calculations. In this effort, the project team used Microsoft Excel for final performance measure calculations.

Appendix B

2013 Intersection Segment Results

Appendix C

Congested Segments Ranked by Functional Class