14 • Transportation Systems Management & Operations

Introduction

Transportation Systems Management and Operations (TSMO) encompasses a range of practices and technologies used to maximize the safety, reliability, and efficiency of existing transportation systems. Used alone or in conjunction with travel demand management (TDM) strategies, these methods can reduce congestion and improve travel time reliability. The need for TSMO should be considered at any location that experiences either recurring or non-recurring congestion or both. Typical causes of congestion can include:

- Poor highway geometrics
- Inefficient traffic coordination or use of system capacity
- Inefficient merging of vehicles entering a busy highway
- Traffic incidents such as high crash locations
- Drivers with poor skills

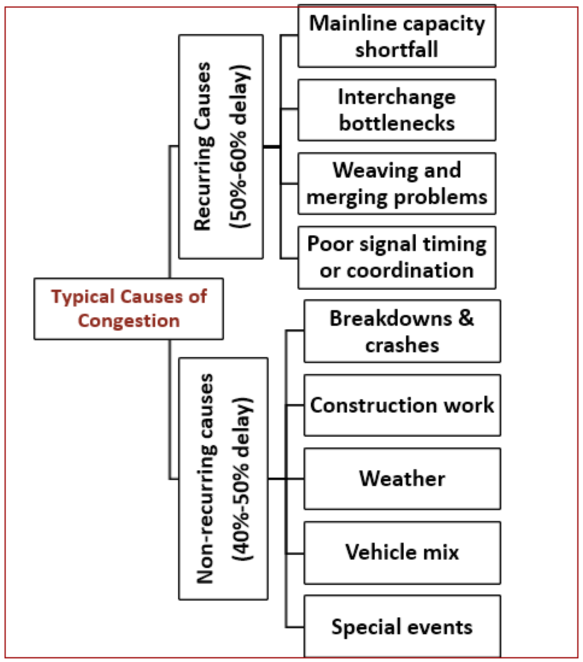
WHAT IS TSMO?

TSMO means integrated strategies to optimize the performance of existing infrastructure through the implementation of cross-jurisdictional multimodal and intermodal systems, services, and projects designed to preserve capacity and improve security, safety, and reliability of transportation systems.

23 U.S Code $101(a)(30)

Figure 14-1 summarizes the typical causes of congestion or traffic delay and what share is typically due to recurring causes and non-recurring causes. In some cases, TSMO improvements can serve as an alternative to adding capacity by increasing the mobility and reliability of the existing system enough to meet current and projected traffic needs and do so more quickly. Other times TSMO may improve conditions enough to delay the need for a road expansion project, enabling an agency to stretch their limited funding to more areas.

Figure 14-1: Typical Causes of Congestion



Source: FHWA Office of Operations

The main objective of TSMO strategies is to improve safety and mobility outcomes by actively managing the transportation network. This includes:

- Optimizing the performance of existing facilities, thereby maximizing the performance of the system;
- Using targeted solutions to address causes of congestion; and
- Complementing capacity projects with services.

Common TSMO tools can include lower cost construction improvements such as addition of auxiliary lanes, coordination of traffic signals, variable message signs advising motorists of delays or detours, telephone or internet-based resources with information on real-time traffic and roadway conditions, or the use of managed lanes. These strategies are often supported and enabled by Intelligent Transportation System (ITS) technologies that provide the sensor, communication, data management, and artificial intelligence technology that drives these systems.

MnDOT has been the primary agency leading the implementation of many TSMO and ITS tools and strategies across the Rochester area. This work began in the mid-2000's as part of the construction management plan for reconstruction of TH 52, with investments in a regional Traffic Operations Center, variable message boards, traffic surveillance cameras, and communication equipment. The City of Rochester plays an important role in one of the primary TSMO strategies deployed in the Rochester—traffic signal coordination—partnering with MnDOT and Olmsted County to equip and manage signal coordination on high volume arterials throughout the community.

Key elements of the ongoing TSMO work of the local road authorities include

- Periodic signal retiming and coordination projects

- Ongoing installation of advanced communications infrastructure to permit a higher level of control over traffic systems
- Signal pre-emption capabilities for both emergency service responders and transit vehicles
- Monitoring technologies including advanced vehicle detection sensors and closed-circuit television to monitor traffic flow on major highways
- Deployment of automatic vehicle location technology to provide for real time bus location information
- Enhancements such as mobile data terminals for law enforcement officers

Other key efforts to improve system performance include the adoption and application of access management and level of service policies to guide planning and project design efforts.

MnDOT adopted a Statewide Strategic TSMO plan in 2018 to complement its Statewide ITS Architecture Plan and provide both guidance to TSMO efforts and investment in technology to advance these efforts. The ITS plans have been updated periodically to remain in conformance with the National ITS Architecture and Standards. ROCOG recognizes the Minnesota Statewide Regional ITS Architecture as the regional architecture that will govern ITS improvements within the metropolitan transportation planning area.

Understanding the Factors That Contribute to Poor Operations

Figure 14-1 summarizes the typical causes of congestion, based on research conducted by FHWA. The basic problem is turbulence; even a little disrupts the smooth, linear flow of traffic when congestion is heavy. This dramatically reduces travel speeds and encourages driver behavior that increases the chance of crashes, further reducing speeds and travel time reliability. TSMO address poor operations by targeting the following main sources of turbulence.

- **Poor highway geometrics:** This can mean turns that are too tight, bottlenecks due to lane drops, or lanes that are too narrow. Fixes are primarily engineering ones, not in terms of lanes added but roadway reconfiguration to reduce or eliminate the source of turbulence.
- **Inefficient coordination or use of system capacity:** Poor signal timing is the best example of this. If traffic flow involves excessive stop and go movement, capacity drops. Optimizing signal timing can improve flow.
- **Inefficient merging of vehicles entering or exiting a busy highway:** Typically seen at on-ramps, the main strategy involves smoothing the entry of vehicles through improvement in highway geometry by adjusting merge or lane design. This

also happens on arterials, where the problem can occur at uncontrolled intersection or driveways as a result of the speed differentials that occur when vehicles turn on or off the road under higher volume conditions. Greater attention to access management can aid in addressing this issue.

- **No or limited information about congestion and alternatives:** If drivers can be alerted to traffic problems before they're part of them, they can take steps to avoid them. Solutions such as sensors and video cameras installed along highways permit traffic managers to monitor highways in real time. Various types of information services can tap into this information to inform drivers about highway conditions.
- **Too many cars on the highway at the same time:** An efficiently designed system used by well-informed drivers can still get overly congested at peak periods. Measures aimed at spreading demand over time such as flexible or staggered work start times, shifting to more space-efficient travel modes such as transit, though services such as commuter bus, park & ride lots, and financial benefits such as subsidized bus passes can help ease congestion. These policies are especially valuable during the morning commute when commuters are more time-constrained and on days with bad weather, major traffic incidents, or special events.
- **Traffic incidents:** Research has found that crashes and disabled vehicles can contribute to as much as 60 percent of time lost to congestion. Timely response to incidents, which typically requires response by multiple agencies, can minimize the impact and provide significant benefits on highly congested corridors.
- **Poor Drivers:** Certain driving behaviors such as speeding, weaving in and out of traffic, and tailgating disturb smooth traffic flow. TSMO measures such as more sophisticated or automated law enforcement, more information such speed monitoring signs, or targeted public campaigns such as saturation events targeting speeding, can help remind drivers to improve their driving habits.

Examples of TSMO Tools and Their Benefits

Figure 14-2 provides examples of TSMO strategies applicable in both urban and rural environments. Many TSMO strategies make economic sense but require a different way of thinking about benefit; think of them as analogous to the strategies private business owners use to "drive costs out of the system". But communicating and realizing the benefits may require some education to get decision makers to think in terms of full costs rather than the just the direct costs of implementation.

The reason for this is that trips vary in their value. Improving efficiency is about more than simply freeing up more capacity for more drivers to make more trips. For example, when a fender bender occurs on a congested road, the time disruption to many other travelers is expensive from an economic perspective given the lost time experienced by those impacted, yet these indirect costs are often not given consideration when deciding to deploy TSMO strategies. Table 14-2 reports on typical TSMO strategies and the assesses the economic and other benefits that can accrue from wider use of these strategies.

Existing/Future Congestion & Crash Concerns

Figures 14-3 through 14-6 identify potential areas where traffic and safety conditions may present opportunities for considering the use of TSMO strategies to address travel time reliability, safety or accessibility concerns. These graphics are based on recent work conducted for Rochester's 2018 comprehensive plan update (P2S 2040), the 2018 DMC Integrated Transit Studies, and the ROCOG Plan. In some locations, congestion and safety issues may co-exist, while in other locations only safety issues or congestion are present. This information provides an initial level of screening for identifying current sites or corridors for further study and key areas to monitor for emergence of future problems. It can provide the basis for creating a systematic, multi-year plan of potential improvement needs and strategies.

Congestion Assessment

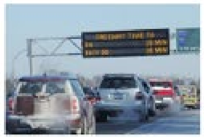
Figures 14-3 and 14-4 were developed as part of P2S 2040 and identify existing areas of congestion (Figure 14-3) and projected future areas of congestion (Figure 14-4). Corridors flagged for congestion are identified based on traffic volumes and road geometry and provide only a high-level screening of areas where future study may be warranted. Table 14-1 provides additional data regarding future conditions for the corridors identified on Figure 14-4, where future volumes exceed the typical capacity of an unmanaged arterial road, but with effective TSMO measures could continue to operate with the current number of lanes under projected 2045 traffic volumes.

Portal Capacity

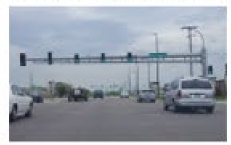
The DMC Integrated Transit Studies identified existing access capacity issues at all west side entry portals into downtown projected access capacity issues at the majority of downtown portals by 2040, as illustrated in Figures 14-5 and 14-6. These portals should be monitored as downtown activity intensifies to ensure timely implementation of measures such as transit system improvements to help moderate or reduce peak period traffic demand.

Figure 14-2: Typical TSMO Strategies and Their Benefit

Example TSMO strategies and benefits

TSMO Strategy	How It Works[1]	Observed Benefits
Traveler Information 	Provides current and anticipated travel and weather conditions, route, and mode options (and other information) via dynamic message signs, 511, web, social media, and text. Supports travelers' optimal choice of trip route, timing, and mode	**National[2]** 511 customer satisfaction of 68–92% Route-specific travel times: 5–13% increase in on-time performance (i.e., reliability)
Traffic Incident Management 	Applies incident detection, verification, response, clearance, crash investigation, medical response, and traffic control Organizes the management and clearance of disruptions and responses to emergencies and ensure incident site safety and restoration of traffic flow	**National[2]** Reduced duration of traffic incidents 30-50% resulting in • Reduced congestion • Improved reliability • Improved safety including reduction in secondary crashes
Safety Service Patrol 	Locates, assists, and removes disabled vehicles, crashes, and debris from freeways; assists State Patrol with crash site traffic control and first aid Reduces congestion, improves safety, and provides a customer-oriented approach to freeway operations	**National[2]** B/C ratio = 5:1 to 25:1 **MnDOT** MnDOT Freeway Incident Response Safety Team or FIRST: B/C ratio = 15:1
Road Weather Management Systems 	Generates advance and current information regarding disruptive weather conditions by combining roadway environmental sensing, weather information, treatment and clearance strategies and weather information dissemination Improves agency capacity to minimize traveler delay and improve agency efficiency of weather-related roadway maintenance	**National[2]** Wet pavement detection and advisory system reduced crashes by 39% B/C ratio = 2:1 to 10:1

Example TSMO strategies and benefits (Continued)

TSMO Strategy	How It Works[1]	Observed Benefits
Work Zone Management Systems 	Provides dynamic, traffic-responsive traffic control (lane use, speeds, warnings) in construction work zones Improves safety to drivers and construction workers and improves traffic flow	**National[2]** B/C ratio = 2:1 to 42:1
Traffic Signal Optimization 	Provides traffic-responsive or traffic adaptive signal operations at intersections for corridor and network optimization and event responsiveness Minimizes delay throughout corridor and network	**National[2]** Reduced traffic delay 15–40% Reduced travel time up to 25% B/C ratios sometimes exceeding 50:1
Adaptive Ramp Metering 	Controls traffic flow (rate and spacing) entering freeway based on actual traffic conditions Minimizes main line traffic disruptions and safety hazards and improves travel time	**National[2]** • Increased freeway throughput 13–26% • Decreased crashes 15–43% **MnDOT** • Increased throughput 14% • Decreased crashes 25% B/C ratio = 15:1

1. AASHTO TSMO Guidance
2. FHWA

Source: MnDOT Transportation Systems Management and Operations Strategic Plan, 2019

Figure 14-3: Corridors Currently Experiencing Periodic Congested Travel

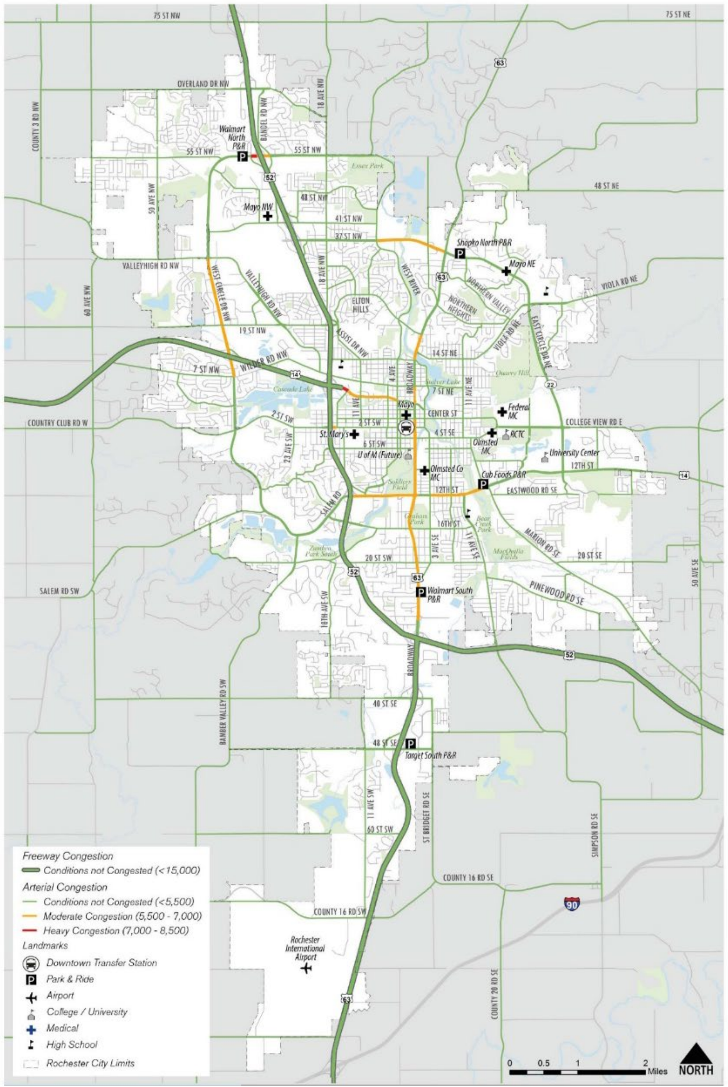


Figure 14-4: Corridors Projected to Experience Congested Travel, 2040 Conditions

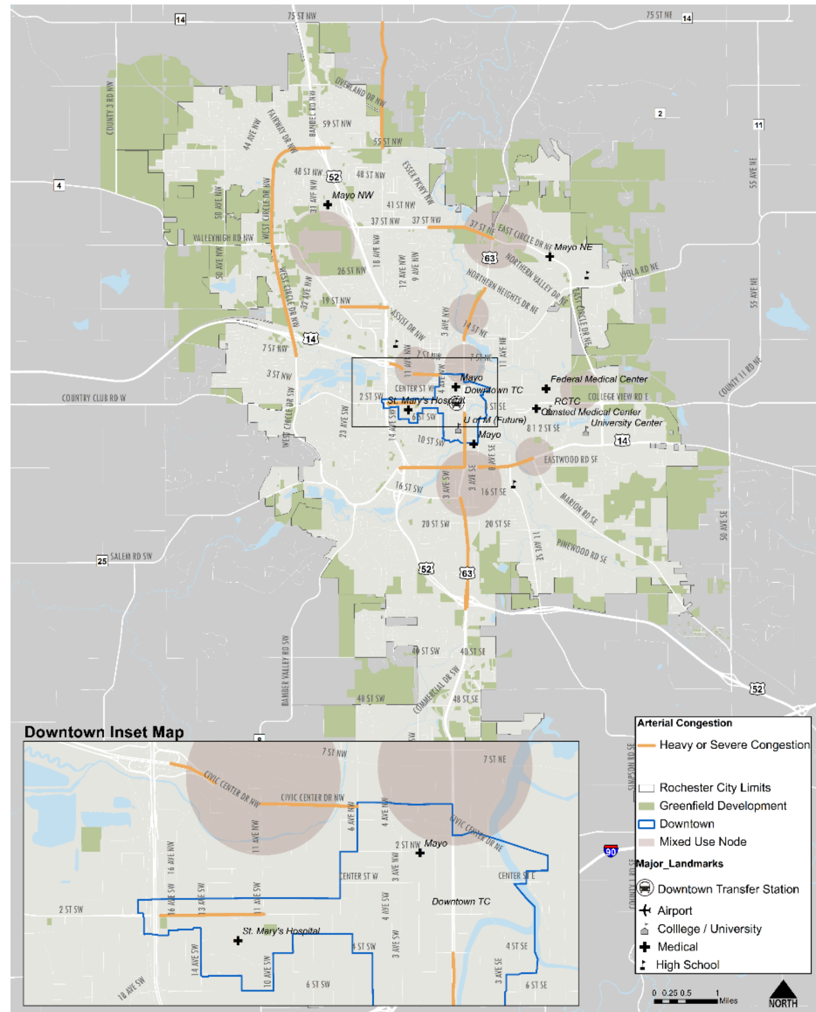


Table 14-1: Characteristics of Congested Corridors in Figures 14-3 and 14-4

Corridor	Traffic Growth Existing & 2045 Traffic Volumes	Transit Infrastructure	High Crash Locations	Signal Coordination Infrastructure
South Broadway HWY 52 to 16th St	26,500 (2016) to 35,000 (South end) 24,300 (2018) to 32,000 (North end) Flagged for Congestion	Primary Transit Network (add BRT infrastructure)	16th St 20th St 25th St	Existing
South Broadway 6th St to 12th St	26,000(2016) to 32,000 Flagged for Congestion	Downtown Rapid Transit Primary Transit Network	6th St 12th St	Existing
12th ST SE Broadway to Marion Rd	23,100 (2018) to 35,000 Flagged for Congestion	No	3rd Ave SE 15th Ave	Existing
12th ST SE Broadway to 52	26,500 (2018) to 30,500 Flagged for Congestion	No	Memorial Parkway 3rd Ave SW	Existing
North Broadway 14th St to Northern Heights	22,000(2018) to 32,000 (South end) 17,500 (2016) to 29,000 (North end) Flagged for Congestion	Primary Transit Network (add BRT infrastructure)	Elton Hills Dr 37th ST NE	Existing
Civic Center Dr Broadway to TH 52	26,000(2018) to 35,000 (East end) 32,500 (2016) to 38,000 (West end) Flagged for Congestion	**Traffic Diversion due to Downtown Rapid Transit	Broadway 6th Ave NW 11th Ave NW	Existing
37th St NW/NE Broadway to West River Road	24,000(2018) to 37,000 Flagged for Congestion	Primary Transit Network (beyond 2040)	Broadway West River Rd	Existing
West Circle Dr TH 52 to 2nd St SW	27,000(2018) to 35,000 (South end) 18,000 (2016) to 32,000 (North end) Flagged for Congestion	Transit Village and West Side Park & Ride impact	19th St 26th St CSAH 4	Existing

Figure 14-5: Existing Downtown Portal Capacity

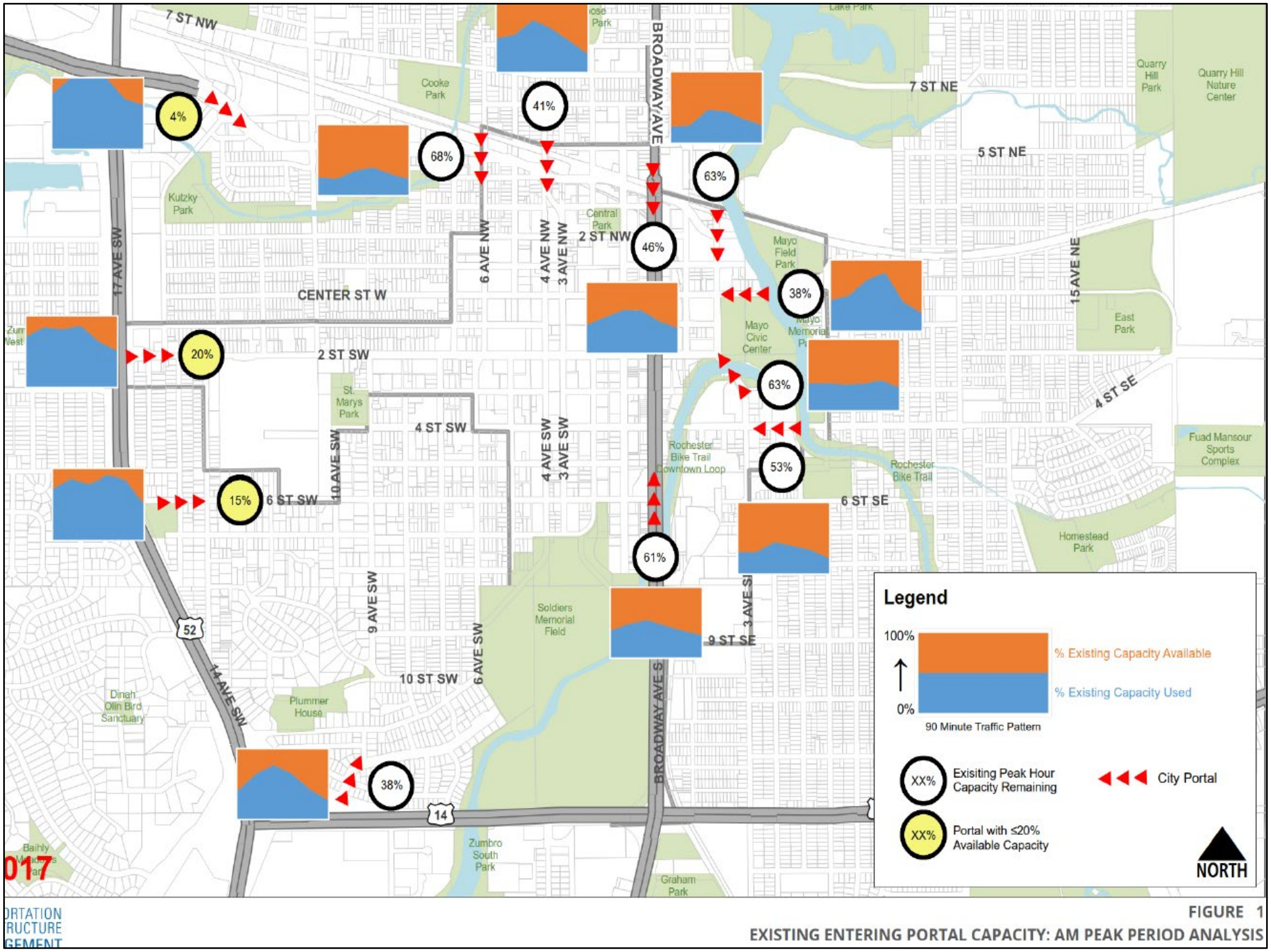
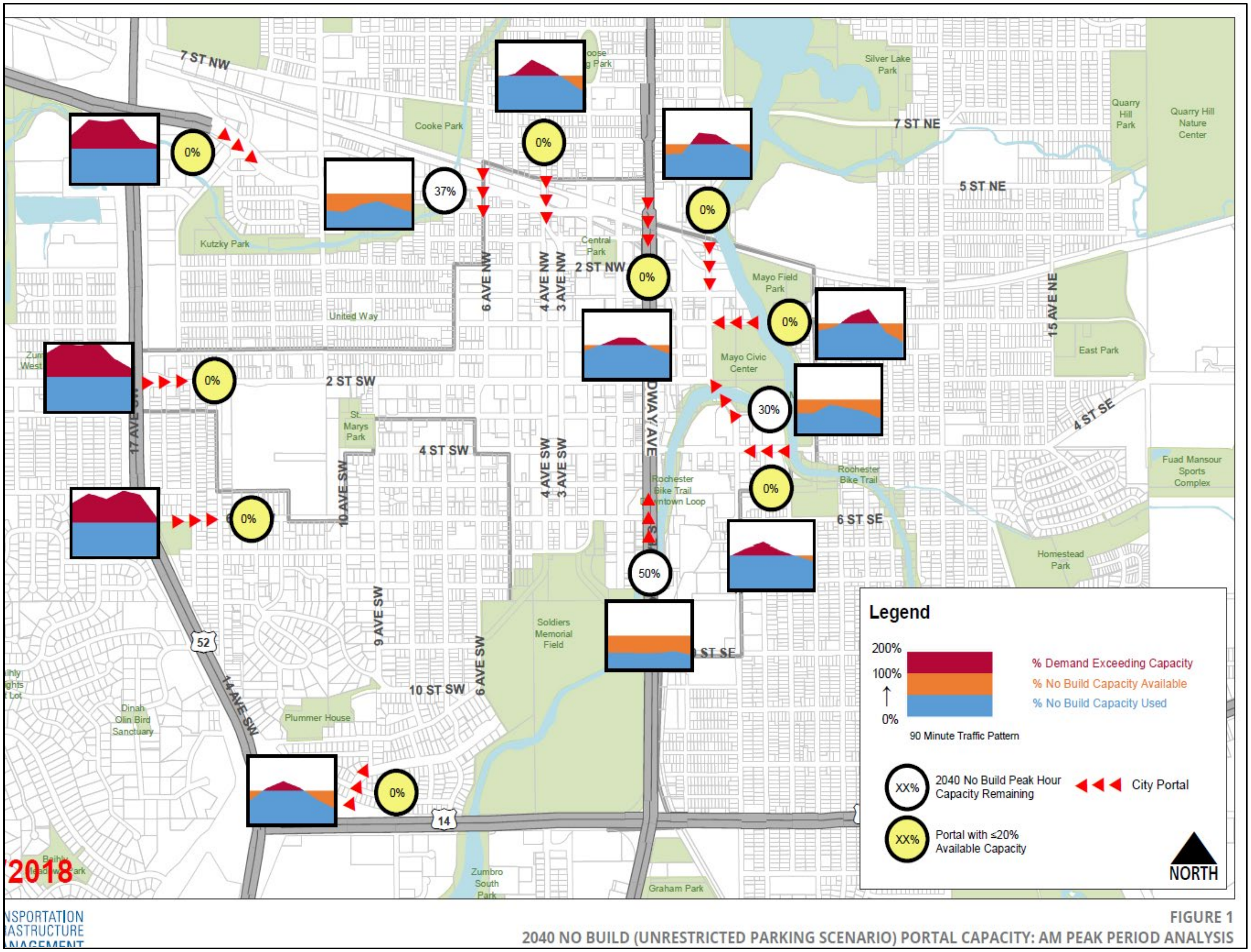


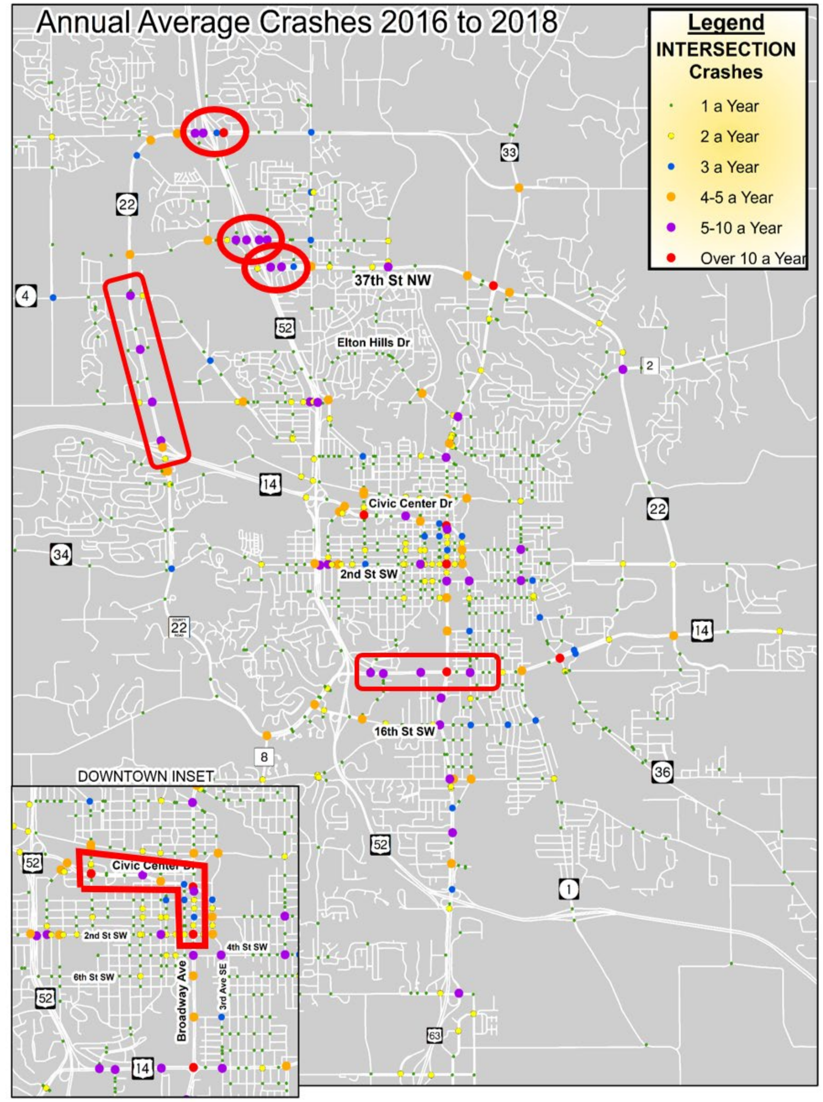
Figure 14-6: Projected 2040 Downtown Portal Capacity



Crash Locations

Figure 14-7 illustrates crash frequency at intersections across the urban area. At selected interchanges and along certain high traffic corridors (coinciding with some of the corridors identified on the congestion map), clusters of high frequency crash locations can be observed in the data. Further study of the crash data is recommended to develop a better understanding of the type and causes of crashes and whether TSMO strategies may be effective in reducing crash numbers.

Figure 14-7: 2016-2018 Annual Average Crashes and High Crash Clusters



Alignment of TSMO Objectives with Goals of the Plan

Moving people and freight while providing benefits to the economy, quality of life, and environment can be enhanced by emphasis on reliable and safe travel that provides desired multi-modal access to its users. The Plan's goals provide broad guidance on the outcomes the community is striving toward; the objectives identify general courses of action meant to guide the selection of strategies and actions within the realm of TSMO that will help to achieve these goals.

Table 14-2 refines the overall goals for the plan described in Chapter 1 to more specifically identify a set of objectives which support the overall goals for TSMO in the Long-Range Plan and illustrate how the goals and objectives align and address the Planning Factors spelled out in federal legislation.

Table 14-2: TSMO Objectives and Alignment with Plan Goals

TSMO Planning Objectives	ROCOG Long Range Transportation Planning Goals
Preserve ITS/traffic signal equipment and infrastructure inventory through monitoring of service life and timely maintenance. **Improve** the reliability and predictability of travel by monitoring the use of the transportation system and through collection of pertinent data.	**Preserve** existing transportation infrastructure through systematic maintenance to sustain a state of good repair.
Maximize use of existing roadway capacity by actively managing traffic and identifying congestion hotspots for operational improvements. **Improve** and implement strategies and technologies that mitigate congestion and improve travel flow and reliability. **Provide** and enhance/optimize traffic signal coordination and corridor performance. **Foster** the application of advanced technologies to the transportation system.	**Mitigate** current and future congestion by considering operational improvements or multi-modal options as well as capacity expansion.
Reduce crash rates and improve safety at signalized intersections for pedestrians, bicycles and vehicles. **Improve** the resiliency of the transportation system to react to and recover from major incidents or events, weather, or disruption.	**Improve** safety through mitigation of high risk/high conflict locations/behaviors.
Provide integrated freeway and major arterial corridor management strategies and support systems. **Reduce** delay and travel on selected corridors for vehicles, transit and bicycle / pedestrian travel with low cost operational improvements.	**Provide** adequate capacity and travel options to serve future 2045 Urban Expansion areas.

TSMO Planning Objectives	ROCOG Long Range Transportation Planning Goals
Improve safety and reliability of bicycle and pedestrian travel by implementing intersection crossing and complete street features.	**Improve** bicycle and pedestrian connections with and through Downtown Rochester.
Improve transit system reliability to keep existing riders and attract new riders.	**Support** implementation of transit system enhancements to increase transit mode share.
Improve service for special visitor or traveler needs through the use of ITS applications and specialized traveler information systems. **Reduce** unexpected delays in day to day travel for downtown commuters.	**Support** implementation of DMC Development Plans.
Provide and/or enhance multi-modal information dissemination and trip planning tools that allow system users to make informed travel choices across all modes.	**Educate**, motivate and reward people through programs and services that make it easier for commuters to travel by bus, carpool, walking or biking.
Support investments that reduce congestion and improve travel time reliability to provide reliable movement of goods and services and improved travel for commuting, shopping or recreation.	**Ensure** commercial passenger and freight traffic is convenient, safe and reliable.

The identified objectives will help to influence and guide decisions in the areas of planning, programming, and project development, as well as inform day to day system operations and maintenance activities.

Given the expense and difficulty of adding capacity on existing arterial corridors, and the demand for future capacity as illustrated in Figures 14-4 and 14-5, it is clear that strategic investment in operational improvements will continue to be important in the future. Looking forward, the important role of additional ITS investments and emerging and future technologies such as connected vehicle technology hold promise and need to be considered as deployable technology emerges.

Existing TSMO Plans and Activities

From 2016-2018 MnDOT undertook an initiative to formalize its work on TSMO matters by completing a multi-step planning process focused on developing a TSMO Strategic Plan, Business Plan, and Implementation Plan. The goal of this effort was to establish an internal agency framework in terms of staffing and resources that would focus on establishing goals and objectives for MnDOT relevant to the realm of TSMO.

Figure 14-8 summarizes the main thrust of each planning product that was produced by this effort. The Strategic Plan identified three primary goals:

- Improve safety, reliability and efficiency
- Increase safety
- Carefully and responsibly manage transportation operations assets

Sixteen objectives aligned with these goals were identified, as illustrated in Figure 14-8. A number of the strategies identified in the plan are relevant to the ROCOG Planning Area.

ROCOG supports the goals and objectives of the MnDOT Strategic Plan (Figure 14-9) and is coordinating with MnDOT to explore joint efforts on a number of the specific strategies that MnDOT in the Implementation Plan, highlighted in Figure 14-10.

Figure 14-8: MnDOT TSMO Program Guidance

Figure 14-9: MnDOT TSMO Objectives

Figure 14-10: Key MnDOT TSMO Strategies

Implementation Plan

Strategies

1. Update Signal Timing and Coordination
2. Increase MnDOT Usage of 3rd Party Data and Sharing (e.g. Google, WAZE, INRIX, HERE)
3. Develop Regional TIM Programs
4. Implement Low-Cost / High-Benefit Capital Improvements
5. Coordinate Work Zones Across Districts and Routes
6. Expand Snow Fence Use through Research and Increased Use
7. Expand the Coverage of Freeway and Expressway Traffic Management Systems
8. Develop TIM Strategies for Work Zones
9. Utilize Intelligent Work Zone Systems Where Appropriate
10. Expand the Use of Ramp Metering
11. Expand Use of Technology at Weigh Stations for Enforcement

Of interest to ROCOG are the following strategies:

- Continued work with District 6 on signal timing and coordination as it relates to the intersection of state and local corridors, particularly in the vicinity of west side interchanges along TH 52 and TH 14 which see the highest traffic volumes in the urban area.
- Obtain access to third-party travel data for system monitoring and to enhance the travel condition data available to the general public.
- Implementation of low cost, high benefit improvements, particularly in regards to addressing safety concerns at interchanges as well as high speed expressways such as TH 14 west of Rochester, and response to heightened levels of intersection conflict in the future, particularly along TH 63 east of TH 52 on the north side of Rochester as traffic volumes grow.
- Coordination of work zones and use of intelligent work zone systems on future work in urban areas. A particular corridor where this will be of importance is the future work anticipated on TH 14 in the Byron area, involving construction of multiple grade separated structures and access closures across the corridor.
- Ramp metering, while not used in the Rochester area currently, may take on added importance in the future at locations such as TH 14/52 and the CSAH 22/TH 14 West interchanges as expected growth in downtown Rochester and in northwest Rochester occurs over the next 10-15 years.

Rochester TSMO Activities

The City of Rochester has implemented a number of TSMO strategies across the Rochester area and has collaborated with MnDOT on other initiatives such as development of communications networks to support MnDOT and Rochester Traffic Management Centers (TMC). Among the most widely implemented and important actions for improving the operation of the highway system in the Rochester area include:

- Arterial corridor signal optimization involving the timing and coordination of signals within a corridor or area to minimize the stop-and-go traffic flow

- Regulation of access to reduce opportunities for conflict and disruption of traffic flow on major streets from entering and exiting vehicles
- Low-cost safety and pavement reallocation to address issues through actions such as re-striping travel lane widths, adjusting intersection approach geometry, and channelization of turn movements
- Transit operation enhancements, such as signal pre-emption and real-time transit tracking information using AVL (Automated Vehicle Location) technology, have been deployed to enhance schedule adherence and provide real time information to riders
- Traveler information services including highway advisory radio; variable message signs and online road reports
- Signal preemption to permit emergency vehicles to utilize communications technology to override intersection controls and facilitate response to incidents
- Data management systems to improve management and response to incidents such as reported accidents, unsafe street conditions, and missing or damaged signage, sidewalks, streetlights, and traffic signals

Secondary TSMO Strategies Employed

Table 14-3 summarizes additional strategies and actions used by Rochester, Olmsted County, and MnDOT District 6 to enhance operation of the street network. Most references in this table related to signal systems refers to the City of Rochester as the City manages and maintains most signals in the urban area under joint agreements with Olmsted County and MnDOT.

Table 14-3: Local TSMO – Related Strategies

Strategy or Program	Description of Strategy
	Collaboration
Interagency Coordination	To facilitate the efficient operation of the roadway system MNDOT, the City of Rochester and Olmsted County meet on a periodic basis to discuss operational issues of common concern. Among key coordination efforts are existing agreements between the state, county and city regarding responsibility for signal system operations, and issues such as coordination of speed limits across jurisdictions.
Community Input	Rochester and MnDOT accept comments regarding traffic operational issues via their websites as well as routinely taking input on issues via phone calls and letters. Issues are addressed as they are submitted, with no formal system in place to monitor or track trends in terms of the geographic location or types of requests. One of the most frequent requests the City of Rochester receives in terms of traffic issues is for speed control on neighborhood collector streets;

Strategy or Program	Description of Strategy
	The city currently programs $50,000 annually to provide for the implementation of traffic calming measures through jointly funded projects with neighborhood property owners. Rochester Web Page for submitting traffic concerns: https://www.rochestermn.gov/departments/police/file-a-non-emergency-report/voice-your-traffic-concern MNDOT Web Page for submitting traffic concerns: http://www.dot.state.mn.us/information/submit.html MnDOT also conducts periodic surveys of area businesses to gather input about freight issues. City staff meet with the Downtown Business Association as to help stay informed and respond to business concerns.
	Data Collection and Monitoring
Data Collection	Crash data is reported through the Department of Public Safety Accident Reporting system, which reflects incidents requiring the filing of accident reports under state law. Access to the information in this system is provided through the Minnesota Crash Mapping Analysis Tool (MnCMAT2), an online database accessible through a GIS interface to allow easy on-line access to crash data AADT (Annual Average Daily Traffic) count data is collected on a regular basis under the State Aid Assistance program, and the City of Rochester archives count data gathered as part of targeted studies in a local database. The city also has the infrastructure in place to collect traffic volume data at signalized intersections through video cameras, though utilization at the current time is limited to gathering data needed for specific projects.
Traffic Monitoring & Performance Measurement	Rochester, Olmsted County, MnDOT and law enforcement meet to review traffic crash data from all incidents involving fatalities and serious injury monthly and meet annually to review locations with 5 or more crashes per year in order to monitor trends at these locations and assess the potential for safety projects to mitigate problems at these locations. With adoption of the Statewide Strategic Highway Safety Plan a framework for monitoring crash experience has been established. Regular annual reporting of shared with regional and local entities is provided and coordination through a district level Towards Zero Death collaboration is provided. With the advent of Performance Planning requirements in federal legislation beginning with the 2005 SAFETEA-LU legislation, annual monitoring of a set of performance is conducted by MnDOT in the areas of Safety, Pavement Condition, Bridge Condition, Transit Assets, Transit Safety, and Travel Reliability for the ROCOG area.

Strategy or Program	Description of Strategy
	Transit
Transit Monitoring and Performance	Management of the transit system relies heavily on monitoring to assess the cost effectiveness of various routes and for targeting of service improvements. Four key measures that are assessed routinely on both a system level and route level include 1) farebox recovery; 2) load factor; 3) running speed, 4) on-time performance/schedule adherence and 5) passengers per vehicle hour.
	Non-Motorized
Pedestrian Accommodations	The City of Rochester has incorporated pedestrian activation of signals at intersections in the downtown area and at other locations in the city where significant pedestrian crossing activity occurs on a regular basis and continues to expand the number of locations that have pedestrian activation installed. To improve pedestrian understanding at particular high-volume locations, countdown signals have been installed, primarily in areas around the Mayo Medical Campus and at crossings of Broadway Avenue in downtown Rochester.
School Travel	The City works closely with MnDOT, Olmsted County, and the Rochester School District to assess school route travel options and identify the need for crosswalks, crossing guards, and other safety devices on primary walking routes to schools.
	Traveler Information Services
Traveler Information	Key elements that has been deployed in terms of traveler information systems in the Rochester area are a series of variable message signs along TH 52, TH 14 and TH 63 to alert motorists to difficult travel conditions or incidents that may be impacting traffic operations. MnDOT also provides for distribution of regional traffic and road condition information via its website, including access to information from 32 traffic cameras sited at various locations in the ROCOG area, as part of its statewide 511 system.
	Incident and Event Management
Work Zone and Temporary Operational Changes	The City of Rochester, Olmsted County and MnDOT work with contractors on all projects to implement work zone traffic operation plans in order to facilitate the safe flow of vehicular and non-motorized travelers during construction. All permit applications for construction within the right of way are reviewed to determine their impact on traffic, and if necessary, measures such as limiting the hours of construction, instituting temporary signal retiming, adjusting transit routes and implementing detour routes are considered as mitigation measures. For major projects information about temporary changes and work zone areas is disseminated through the local newspaper, websites, and PSA's sent to all TV and radio stations serving the area.

Strategy or Program	Description of Strategy
	Parking Management
	At this time fixed or dynamic message signing has been introduced on a limited basis to direct motorists to available parking in downtown Rochester. Limited use is made of parking restrictions by time of day or day of week to facilitate traffic operations.

Key TSMO Tools

There are a number of key TSMO tools that play an important role in management of traffic flow on the major street network across the ROCOG Area. Together with ongoing use of a number of advanced planning strategies, these tools are important to the provision of reliable and efficient travel service. This section summarizes these key infrastructure elements and planning strategies.

Primary TSMO Infrastructure

Traffic signal systems are critical for managing traffic flow affecting general vehicular traffic, transit service, freight delivery and emergency response. Key components of these systems include the communication and signal equipment, signal interconnectivity, and periodic retiming of signals.

Communications

MnDOT, Rochester, Olmsted County, and private partners have invested in communications infrastructure to support TSMO initiatives, including the signal management system. A network of fiber optic cable has been constructed that connects most of the signal infrastructure in the urban area. The scope of the current system is illustrated in Figure 14-11.

Of the 170 signals in the Rochester area network, 131 are currently connected to the City Traffic Management Operations Center, permitting centralized monitoring, timing plan implementation and emergency override. Four signals, such as two at the TH 52/TH 63 South interchange, are set up for local operation given the unique traffic control at that locations, and 35 others currently are not connected to the TMC for various reasons, such as lack of access to fiber optic cable.

Signal Coordination

Figure 14-12 illustrates the arterial corridors in Rochester on which signal coordination has been established. Signal coordination can improve arterial function and discourage speeding on arterials while allowing motorists to make better time.

Figure 14-11: Rochester Area Fiber Optic Cable

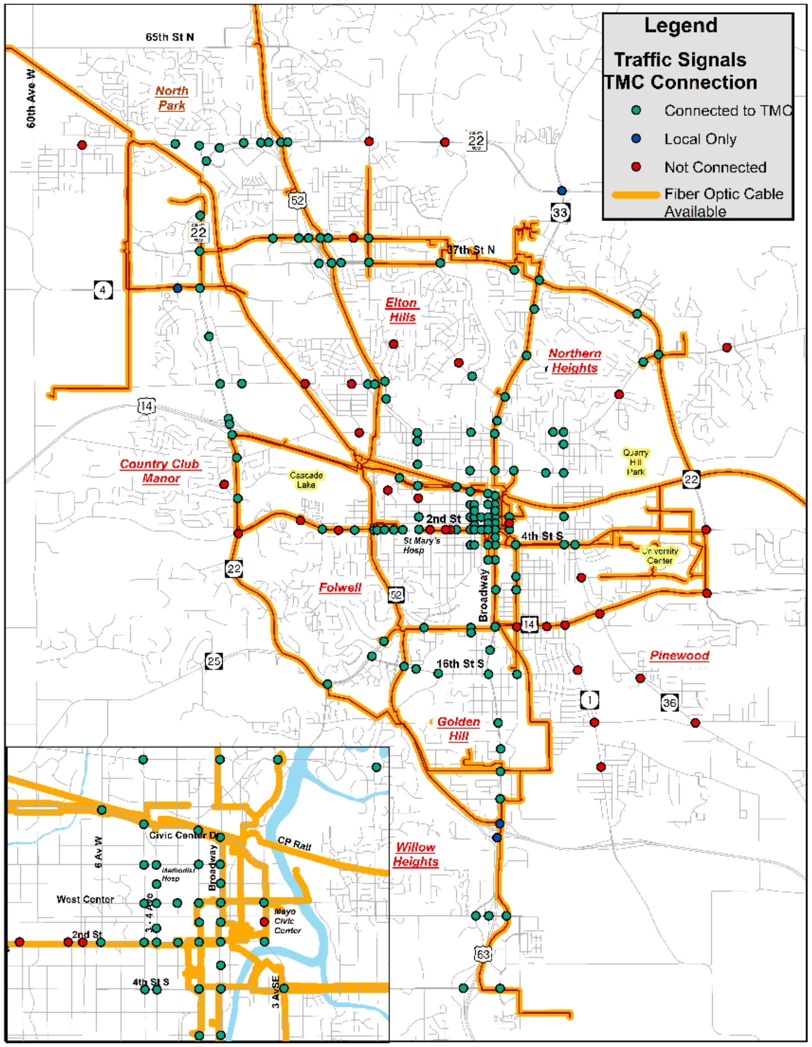
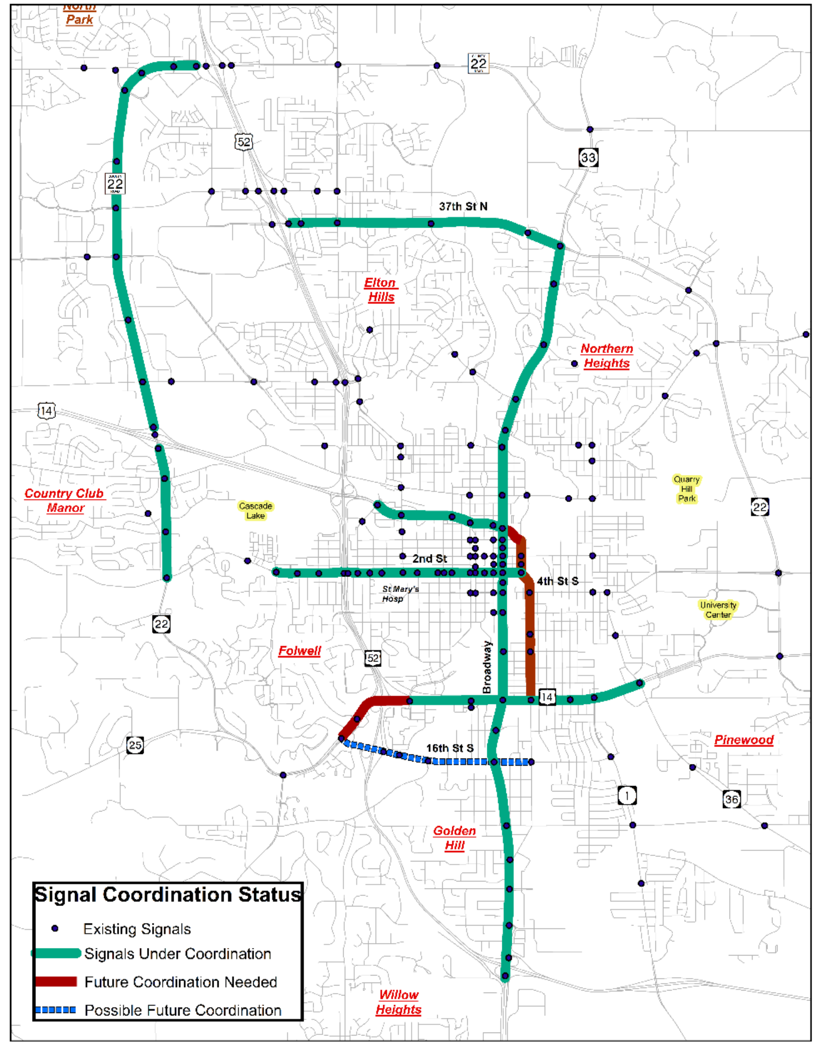


Figure 14-12: Signal Coordination in Rochester



In addition to existing corridors currently operating under coordination, a high-level analysis was completed of other high volumes corridors in the city to identify other corridors that may benefit from future coordination projects. Civic Center Dr /3rd Ave SE on the east side of downtown Rochester as well as extending coordination on 12th St SW to 16th St SW were identified as two future corridor candidates. The analysis also identified 16th St South as a future candidate, although the analysis results were less conclusive as to the benefit of coordination on that corridor under projected 2040 traffic volumes.

Signal Timing

Through cooperative service agreements with MnDOT and Olmsted County, the City of Rochester also manages traffic signals on state and county roadways within the city limits to provide for enhanced coordination of the system. Rochester and Olmsted County budget dollars annually to review and optimize signal timing. The goal of Rochester is to review and retime signals in on an eight-year schedule. Priority is given to the major arterial corridors but differences in priorities between the road authorities (city/county/state) sometimes results in the inability to have the necessary funding in place where joint ownership is involved.

Signal Maintenance

To ensure the operational integrity of the traffic signal network, the Rochester has a signal maintenance program established for

- The replacement of signal hardware installations over 25 years in age, with a goal to replace one system a year
- Installation and upgrading of battery backup power systems for signal installations, with the goal to install four per year
- Replacement of signal LEDs on a ten-year lifecycle
- Signal controller replacement, with the goal to replace one installation a year

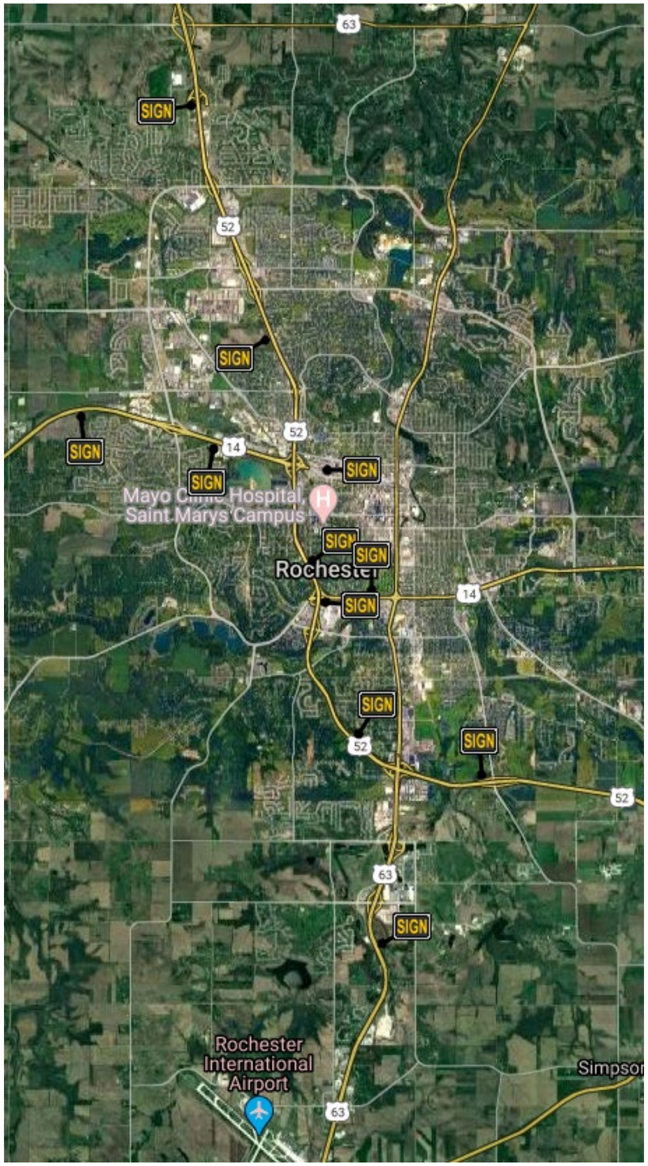
Olmsted County contracts with the City to maintain signal installations in the Rochester area on the County road network at a cost of approximately $160,000 per year, while MnDOT funds an annual set-aside in their District Transportation Improvement Program for signal installation replacement at $450,000 per year within District 6 (an eleven county area).

Supporting TSMO Infrastructure

While traffic signals systems are probably considered to be the main type of TSMO infrastructure, many additional systems or services are in existence which need require communications infrastructure, monitoring and management as well. In the Rochester area, among the important additional systems/services that have been deployed include the following:

- **Transit Signal Priority (TSP)** is an innovation which allows buses to activate signals for extended green time as they approach a signal if they are behind schedule, allowing transit vehicles to provide higher quality service. It should be noted that autos in the same traffic stream with the bus will benefit as well. Because the green phase is typically extended only two or three times per hour, the impact on side streets is minimal. Most of the current fleet is equipped with the necessary hardware and software and signal hardware has been deployed on major corridors and is in the process of being deployed on other on the remainder of bus route corridors.
- **Emergency Vehicle Pre-emption** permits emergency responders to hold existing green or implement all-way red control at signalized intersections to permit emergency vehicles to pass through intersections unhindered. All signals and vehicles have been equipped with this infrastructure.
- **Variable Message Signs** are electronic traffic signs used to give motorists about events or incidents that are impacting travel in the corridor as well as, in limited cases, other information in the public interest. The VMS signs are located as shown in Figure 14-13 and were first installed in 2002 as part of the package of road construction traffic management installed for

Figure 14-13: Variable Message Signs Locations



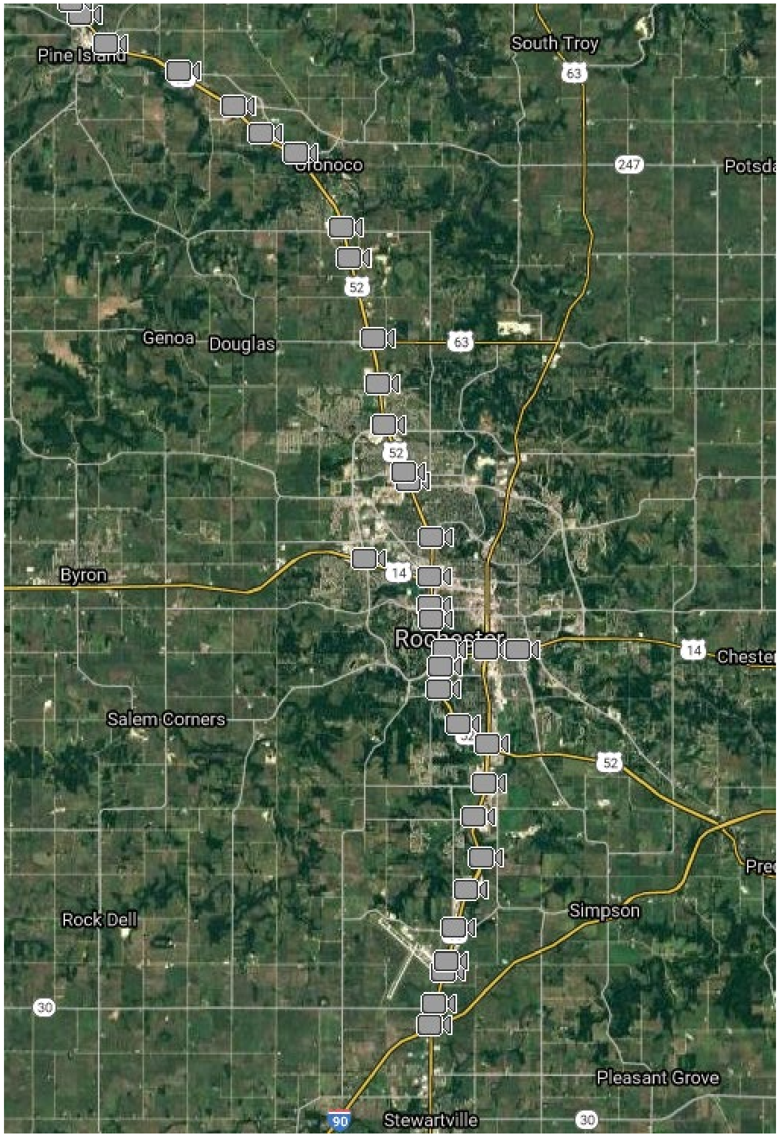
the TH 52 reconstruction project.

- **Traffic Cameras**, as shown in Figure 14-14, are located primarily along TH 52 and provide traffic managers a real time view of conditions on the roadway as well as providing information on current traffic conditions to the public through various media including MnDOT's 511 travel information site.

Primary TSMO Planning Policies

Primary TSMO management policies include access management and traffic control guidelines and regulations adopted as part of plans or through local ordinances. Application of the policies and standards typically occur at the early stages of project development, as part of highway corridor or subarea studies, or during review of private development proposals. Among the actions that can be advanced include establishing parameters to guide decisions such right-of-way preservation needs, establishment of access principles to be applied to lands abutting a corridor, early decisions regarding features such as median openings, and signal locations that will affect future corridor operation. These strategies have been adapted for use by ROCOG in a number of past corridor planning studies to help preserve the future function of major arterial corridors that are critical to the overall operation of the highway network in the Rochester area.

Figure 14-14: Traffic Camera Locations



Access Management Policy

The frequency and location of access connections, along with traffic signal spacing, are key elements for efficiently managing traffic flow and minimizing traffic conflict along highway corridors. They are most beneficial in the management of major urban and regional highways. The justification for control of access is based on several factors, including safety, capacity, economics, and aesthetics. The economic potential of development corridors can be enhanced by a coordinated program of access management.

The functional life of roads can also be extended through higher utilization of the roadway's design capacity, thus permitting funds that might have been spent on road widening to be spent on road maintenance and operations. Studies have found that appropriate control of left and right turns, the impact of unregulated driveways, and the speed of access and egress can improve capacity by 25% over uncontrolled conditions.

Research indicates that access management is just as valuable to pedestrians and bicyclists as to motorists. Every sidewalk or path that crosses a driveway represents multiple potential pedestrian/vehicle conflict points. Reducing the number of driveways per block reduces the number of conflict points proportionally, which makes it easier for both pedestrians and drivers since they have fewer conflicts to concentrate on while passing through a corridor.

The rationale for managing access in rural areas differs from that in urban areas. Roadways in rural areas almost always serve low-density land uses and usually have volumes below capacity thresholds, thus disruptions to through traffic are less significant. However, managing rural access increases safety (by ensuring adequate sight distance, reducing the number of conflict areas, and reducing the severity of crashes when vehicles run off the road) and minimizes ongoing operational and maintenance costs related to snow removal, resurfacing, and drainage repairs.

Establishing rules in advance of development also aids developers by reducing the cost and delay that may occur as a result of needing to negotiate and redesign access. Adopted guidelines assure consistent and equitable treatment of all property owners and business interests.

Right-of-way requirements and access design should always take into consideration the ultimate facility size. The amount of traffic a roadway can handle is dependent upon such factors as the presence of parking, number of driveways and intersections, speed and alignment of the roadway, and anticipated intersection controls. Table 14-4 provides guidance on the approximate volumes that can be accommodated by various non-freeway road types, and how TSMO ("Enhanced Management") can expand the capacity of a roadway.

Table 14-4: Approximate Volumes for Planning Future Roadway Improvements

Road Type	Standard Management	Enhanced Management*
Two-Lane Road	Up to 12,000 VPD	Up to 15,000 VPD
Three-Lane Road	Up to 18,000 VPD	Up to 22,500 VPD
Four-Lane Road	Up to 24,000 VPD	Up to 30,000 VPD
Five-Lane Road	Up to 35,000 VPD	Up to 43,500VPD

VPD – Vehicles per Day

* Enhanced Management Conditions with adequate road design, access control and other capacity enhancing measures

Current Access Management Programs

The main road authorities in the ROCOG Planning Area all have some level of access management policies or ordinances in place to guide the installation of access connections or local streets to major roads.

- Olmsted County adopted an Access Management Ordinance in 2006 that lays out specific permitting and process requirements as well as identifies standards for access. https://www.co.olmsted.mn.us/yourgovernment/ordinancescodes/Documents/Chapter%201300%20Access%20Managment%20Ordinance.pdf
- MnDOT adopted an Access Management Manual in 2008 that establishes guidance on access to state highway facilities which are linked to roadway classification. The Manual also provides guidance on the development and permit review process. Access permitting is handled at the District 6 level
- Rochester has adopted access guidelines as part of its comprehensive Land Development Manual which includes the City's zoning and subdivision regulations. Access design is integrated throughout the City's development review process, so access gets addressed at the earliest stages of a development proposal. Once a development has been approved the final step is application for and issuance of a formal access permit.

Policy Guidance on Access Connections

Table 14-5 provides a set of general policy guidelines that establish benchmarks for the connection of driveways or new public roads (whether as part of a public project or private development) to the major street network in the ROCOG Planning Area. An important principle of connection management is to avoid, if possible, the connection of roadways or driveways that have significantly different functions and operating characteristics. For example, regulations should discourage the connection of private driveways to high mobility arterials or expressways.

These ROCOG guidelines are intended as a planning tool to inform decisions by local or state partners as to recommended policy on access connections, and will be most relevant 1) in the early stages of development

Table 14-5: Recommended Access Connection Policy

Roadway Classification	Major Highways (InT/InR/SA/MA)	Secondary Roads (ScA / PC)	Local Roads (Urban/Developing)	Local Roads (Rural / UIA)	Land Use Overlay Zone	Private Access - High (HV) & Medium Volume (MV)[1]	Private Access - Low Volume (LV) & Minimum Use (MU)[1]
Limited Access Roadways / Median Controlled							
Freeway	Connections Permitted Interchange Preferred; See Table 15-for spacing guidance	Direct Connection Not permitted; Overpass Preferred See Table 15-5 for spacing guidance	Connection Not Permitted	Connection Not Permitted	All	Connection Not Permitted	Connection Not Permitted
Planned Freeway	Connection Permitted; Full Median Opening; See Table 15-5 for recommended spacing; Interim Signals @ future interchange location	Interim Connection permitted; Full Median Opening with reversion to Directional median if safety/congestion problems develop; See Table 15-5 for recommended spacing	No new connections permitted; Existing connections permitted to remain on Interim basis with planning for closure	Reversion of Full Median Opening to Directional median or RI/RO if safety or congestion problems develop	All	Connection not permitted except on interim basis where no feasible alternative access exists	Interim access approval must include planning for closure to occur at time alternate access becomes available or when freeway is built
Expressway	Connection permitted via Full Median opening; Spacing of median openings consistent with Divided Roadway Median Opening Guidelines (Table 15-5) Signal spacing consistent with Table 15-6; Signalization only when warranted	Connection permitted via Full or Directional Median Opening; Spacing of median openings consistent with Table 15-5 Signalization permitted if consistent with guidelines of Table 15-6, otherwise reversion to Directional median if safety/congestion problems develop	Permitted if consistent with Local Street Spacing (Table 15-5) subject to finding that higher order road is not needed; Unsignalized with reversion to Directional Median unless location meets signal spacing guidelines (Table 15-6)	Permitted if consistent with Local Street Spacing (Table 15-5) subject to finding that higher order road is not needed; Signalization must be warranted	All	Generally not permitted; HV may be permitted in lieu of local road connection if consistent with Local Street Spacing (Table 15-5) on one leg of intersection subject to finding public street not needed; Unsignalized with reversion to Directional Median unless location meets signal spacing guidelines	Connections not permitted except on interim basis where no feasible alternative access exists; approval of interim access on planned expressway must include agreement for removal of access when local street system is completed or alternate access becomes available
Limited Access Roadways / Median Controlled (Continued)							
Other Regional Major Arterial	Same as Expressway (See Above)	Connection permitted via Full or Directional Median opening consistent with guidelines of Table 15-5; Signalization permitted if consistent with guidelines in Table 15-6 for signal spacing, otherwise reversion to Directional median if safety/congestion problems develop	Connection permitted subject to Divided Road Median Opening guidelines of Table 15-5 & subject to finding that major road not needed at location, Signalization permitted if consistent with Signal Spacing guidelines (Table 15-6); Reversion to Directional Median if signal not permitted	Not Applicable	All	Connection permitted subject to Divided Road Median Opening guidelines of Table 15-5 and subject to finding that public road not needed at location; Signalization permitted only if consistent with Signal Spacing Guidelines (Table 15-6); otherwise reversion to Directional Median or RIRO; Encourage joint access with adjacent properties	Connection not permitted if alternative access available; If no feasible alternative exists consider joint/shared access; Directional median if consistent with Median Opening spacing guidelines of 15-5, otherwise RI/RO
Other Urban Major Arterial							
Limited Access Roadways / Undivided							
Expressway	Connection permitted- Spacing of connections should be consistent with System Development Guidelines of in Chapter 11 Signalization should be consistent with signal spacing guidelines (Table 15-6)	Connection permitted Spacing of connections should be consistent with System Development Guidelines of Chapter 11 Signalization should be consistent with signal spacing guidelines (Table 15-6)	Connection permitted if consistent with Local Road Spacing Guidelines Table 15-5 Signalization of Local Street connections discouraged unless for School or Fire Station		Rural/UIA	Require access to lower level road if available; Otherwise, one access per parcel subject to road authority spacing for corner clearance/Driveway separation Traffic Signal if warranted and consistent with spacing guidelines (15-6)	Require access to lower level road if available, Otherwise one access per parcel subject to Corner clearance and driveway spacing requirements of local road authority
					All Urban		
Super Two					Rural/UIA		
					All Urban		
Main Street					CBD	Connection permitted subject to Driveway Separation & Corner	New connection not permitted; Require access to lower class street or alley

Roadway Classification	Major Highways (InT/InR/SA/MA)	Secondary Roads (ScA / PC)	Local Roads (Urban/Developing)	Local Roads (Rural / UIA)	Land Use Overlay Zone	Private Access - High (HV) & Medium Volume (MV)[1]	Private Access - Low Volume (LV) & Minimum Use (MU)[1]
						Clearance requirements of local road authority.	
Other Regional Major Arterial					Urban Zones	Connection permitted subject to Driveway Separation & Corner Clearance requirements of local road authority. Signalization if warranted consistent with spacing guidelines (Table 13-5)	Require access to lower level road if available; Otherwise one access per parcel subject to Corner clearance and driveway spacing requirements of local road authority
Other Urban Major Arterial					Urban Zones		
Other Urban Roadways							
Regional Secondary Arterials	Connection permitted Signalization controlled by spacing guidelines for major highway	Connection permitted Subject to consistency with System Development Guidelines of Chapter 11 Signalization only if warranted	Connection permitted Subject to Local Road / Driveway Separation / Corner Clearance requirements of local road authority Traffic Signals discouraged	Connection permitted Subject to Local Road / Driveway Separation / Corner Clearance requirements of local road authority Traffic Signals discouraged	All Urban	Connection permitted Subject to Local Road / Driveway Separation / Corner Clearance requirements of local road authority)	Require access to lower level road if available; Otherwise one access per parcel subject to corner clearance guidelines of local road authority
Urban Secondary Arterials					All Urban		
Regional Primary Collectors					All Urban		One access per parcel subject to minimum driveway spacing / corner clearance requirements of local road authority
Urban Primary Collectors					All Urban		
Other Rural Area Roadways							
Regional Major Arterials	Connection permitted Signalization only when warranted and only on a Major Arterial	Connection permitted Subject to consistency with System Development Guidelines of Chapter 11 Signalization Discouraged	Not Applicable	Connection permitted Subject to Local Road / Driveway Separation / Corner Clearance requirements of local road authority	Rural/UIA	Connection permitted Subject to Local Road / Driveway Separation / Corner Clearance requirements of local road authority)	One access per parcel subject to minimum driveway spacing / corner clearance requirements of local road authority On Reg. Major Arterial if frontage < spacing req. consider joint/shared access. On all roadways require access from lower level road if available
Regional Secondary Arterials					Rural/UIA		
Regional Primary Collectors					Rural/UIA		

FOOTNOTES
(1) Volume Ranges for Private Access Connections: High (HV) > 1500 ADT; Medium (MV) 500-1500 ADT; Low (LV) 50-500 ADT; Minimum Use <50ADT
(2) If Driveway Separation requirements cannot be met use of joint or shared access to obtain spacing should first be investigated to determine feasibility

review, 2) in early stages of project development projects, and 3) as the policy basis for a more specific access management regulation. Additional considerations related to permitting processes, variance procedures, review procedures and inspection/enforcement are needed at the jurisdictional level for a full-fledged access management program. It is important to note that while these guidelines are comprehensive, final spacing of medians and driveways will need to be resolved on an individual basis using accepted engineering and planning principles.

The basis on which the guidelines have been established is by roadway classification and median character.

References to other guidelines in the plan inform the connection policies, such as recommended the spacing of median openings, local streets connections or traffic signal spacing. The guidelines do not address the specifics of access design such as grades, sight distance, driveway or roadway widths or vehicle storage needs.

Core Access Management Strategies

In applying the access management policy guidance found herein, ROCOG will work with its partner road agencies to apply the policies through the following five core strategies:

- **Strategy 1:** Preserve the integrity of the major street system with an effective program for managing the frequency of access connections along major street corridors. Plan new higher volume connections to existing arterials at locations where the spacing of traffic signals will preserve two-way traffic progression.
- **Strategy 2:** Coordinate access and development during the zoning and platting process. Coordinate zoning and subdivision reviews with staff responsible for access permitting as early as possible in the development permitting process to minimize later issues when access permits applications are filed.
- **Strategy 3:** Include connection and spacing recommendations as part of all corridor management or congestion mitigation plans. Median treatments, road connection priorities and use of signalization should always be a consideration in these plans.
- **Strategy 4:** Use connection and spacing guidelines in rural areas to balance land use objectives with the primary function of major roads as important regional travel corridors.
- **Strategy 5:** Acquire access control rights consistent with the connection and spacing guidelines of this plan or local access management ordinance requirements when purchasing right of way for future major street construction.

Traffic Operations Planning

A second layer of advanced planning guidance relates to decisions that will have impact on future traffic operations planning related to the placement of traffic signals and control of the median. This guidance will influence efforts to establish signal coordination along a corridor as well as factoring into safety based on management of median openings.

Decisions regarding future signal locations and the nature of median openings should be considered at all levels of planning, including during network plan development and as part of corridor/subarea studies.

Traffic signal spacing should be related to the desired operating speed for the corridor. Signal spacing criteria should take precedence over unsignalized spacing standards in situations where future signalization is likely.

In general, traffic signals should not be installed on high-speed corridors in rural locations. Isolated signals in rural locations are inconsistent with the function and expected performance of the highway. Rural traffic signals are unexpected by the motorist who is unfamiliar with the location, requiring longer than normal time for drivers to react.

Median Opening and Signal Spacing Guidelines

ROCOG and its partners will use the guidelines in Tables 14-6 and 14-7 as minimum benchmarks for the location and design of major street system connections during network planning as well as corridor or subarea studies. It is important to note that while these guidelines are comprehensive, final spacing of medians and signal installation will need to be resolved on an individual project basis using accepted engineering and planning principles.

Table 14-6 includes spacing guidelines for interchange, median openings, and public street connections to major streets. These spacing guidelines identify minimum separation standards for different types of connections, which will improve safety and traffic flow by reducing the number of conflict points through separation of areas where drivers are entering, existing, weaving, or crossing opposing traffic streams. Spacing standards also should provide adequate sight distance and reaction time for motorists in general.

Table 14-6 includes guidelines for traffic signal spacing on different classes of roadways. Spacing between traffic signals is a strategy employed to preserve Level of Service (LOS) of the roadway segment. Optimum signal spacing will provide for greater signal progression and higher arterial speeds. Long and uniform spacing can more efficiently accommodate varying traffic conditions during peak and off peak and are essential to an effective traffic management program. See Chapter 10 for a description of roadway classification and land use context as used on the Functional Designation Map of this plan.

Table 14-6 includes three subsections establishing guidelines for the spacing of different types of connections to the major roadway network. Table 14-6(A)provides guidelines for interchange and overpass spacing along freeways and planned freeways. Table 14-6(B) provides guidelines for the spacing of full and restricted median openings along the various types of divided highways. Table 14-6(C) provides guidelines for the minimum spacing of local public streets along major roadways.

Table 14-7 describes recommended signal spacing for different classifications of roadways and land use environments. Roadway classifications are listed down the left column and land use context zone classifications across the top of the table. See Chapter 10 for a

Table 14-6: Interchange, Median Opening, Local Public Street Spacing

Table 15-5(A) Interchange and Overpass Spacing

	Land Use Overlay Zone				
Road Classification	Rural	Rochester Developing	Rochester Urban / Core	Small City Developing	Small City Urban/Core
Freeway Interchange	4-6 mi	1-2 mi	1 mi	2-3 mi	1-2 mi
Freeway Overpass	2-3 mi	1 mi	1 mi	1-2 mi	1 mi

Table 15-5(B) Divided Roadway Median Spacing

	Full Median Opening			Directional Median Opening			Right-In / Right-Out	
	Land Use Overlay Zone			***Land Use Overlay Zone***			***Land Use Overlay Zone***	
Roadway Classification	Rural	Developing / Urban	Urban Core CBD	Rural	Developing / Urban	Urban Core CBD	Developing / Urban	Urban Core CBD
Planned Freeway	1 mi	1/2 mi	NA	1/2 mi	1/4 mi	NA	1/8 mi	NA
Expressway	1/2 mi	1/2 mi	1/4 mi	1/4 mi	1/4 mi	1/8 mi	1/8 mi	Local Ordinanance
Other Regional Arterial	NA	1/3 mi	1/8 mi	NA	1/8 mi	330 ft	Local Ordinance	Local Ordinance
Other Urban Arterial	NA	1/4 mi	1/8 mi	NA	1/8 mi	330 ft		

Table 15-5(C) Local Public Street Spacing (1)(2)

Road Classification	All Urban Local Street Spacing (ft)	Rural Local Street Spacing (ft)
Interstate / Interregion	***See MNDOT Access Management Policy for spacing requirements***	
Strategic Arterial	1320	2640
Regional Major Arterial	880	2640
Urban Major Arterial	660	NA
Secondary Arterial	480	1320
Primary Collector	330	1320
Local Collector	x	x

NOTES

(1) Adequate Stopping Sight Distance and Intersection Sight Distance should be provided at all connections points

(2) Local Streets and Low to High Volume driveways should be aligned with connection points on the opposite side of the roadway or offset a minimum distance as defined in the following table

Posted Speed	*30 MPH*	*35 MPH*	*40 MPH*	*45 MPH*	*> 45 MPH*
Desirable Offset: Local Street or High Volume Driveway Access	*300 ft*	*425 ft*	*525 ft*	*630 ft*	*750 ft*
Desirable Offset: Low Volume or Moderate Volume Driveway Access	*150 ft*	*200 ft*	*250 ft*	*300 ft*	*400 ft*

Table 14-7: Spacing Guidelines for Signalized Intersections

NOTE: In practice, signals must also meet warrants for signalization

Roadway Classification	Land Use Overlay Zone: Rural	Urban Edge Areas	Urban / Urban Core Areas	CBD Areas
Limited Access Roadways / Median Controlled [(1)].				
Freeway	Not applicable			
Planned Freeway	Interim only; only if warranted / 2 mi	Interim only / 1 mi	Not applicable	
Expressway	Only if warranted and all other options exhausted / 1 mi	1 mile	1/2 mi - Urban Area 1/4 mi - Urban Core	1/8 mile
Other Regional Major Arterial	Not Applicable	1/2 mi	1/4 mile	Not Applicable
Other Urban Major Arterial			1/4 mi	1/8 mile
Limited Access Roadways / Undivided [(1)].				
Expressway	Only if warranted and all other options exhausted / 2 mi	1 mile	1/2 mile	1/8 mile
		1 mile	Not Applicable	
Other Regional Major Arterial	1 mile	1/2 mile	1/4 mile	1/8 mile
Other Urban Major Arterial	1 mile	1/2 mile	1/4 mile	1/8 mile
Other Urban Roadways				
Regional Secondary Arterials				
Urban Secondary Arterials		Signals Spacing at Intersections with major roads controlled by		
Regional Primary Collectors		Major Road Signal Spacing; other locations only where warranted		
Urban Primary Collectors				
Other Rural Area Roadways				
Regional Major Arterials		Signals only considered when other options ineffective and signal must be warranted		
Regional Secondary Arterials		Use of traffic signals highly discouraged on regional secondary arterials		
Regional Primary Collectors		or primary collectors in rural areas ; evaluate other options first		

NOTES

(1) A signalized intersection location may deviate from the ideal location without detailed analysis if within a distance from the preferred location as specified in the table below. Where a proposed distanace is offset by a greater distance, an analysis should be conducted demonstrating that minimum bandwith expectations can be met.

Road Classification	Permissible offset from Desired location	Minimum Bandwidth Criteria: Peak Period	Off-Peak Period
Interregional	100 ft	50%	50%
Strategic Arterial	150 ft	45%	40%
Major Arterial	200 ft	40%	35%

description of roadway classification and land use context as used on the Functional Designation Map of this Plan.

Spacing should be measured from center of intersection to center of intersection, though distances may vary by up to 200 feet without having a significant effect on the ability to establish traffic flow progression (the key goal of this guideline).

TSMO in Land Development and Project Development

Level of Service Guidelines

Level of Service (LOS) is a measure of the quality of service provided by a roadway facility. Quality of service refers to a user's perception of how well a transportation service or facility operates. LOS measurement is tied to a rating scale ranging from A (very high level of satisfaction with freely moving traffic) to F (very poor quality with near gridlock conditions).

ROCOG will use and encourage its partners to use the guidelines for Level of Service described in Table 14-8 to define the minimum operating conditions that should be maintained for the predominant peak or off-peak direction of traffic flow in planning, project development, and the review of private development proposals. Use of the term "Maintain" means operating conditions are preserved at or above the existing level of service through immediate or future improvements in areas where existing service levels are already below the standards in the table.

Table 14-8: Level of Service Guidelines for ROCOG Area

Subarea Land Use Zone	Land Use Area	Functional Designation (1)	Peak Period LOS	Mid-Day LOS	Existing Substandard LOS
CBD	Rochester	InT/InR/SA	Mid-D	C/D	Maintain
		MA/ScA	Mid-D	C/D	
		PC/LC	D/E	Mid-D	
Urban Core	Rochester	All roadways	Mid - D	C/D	Maintain
	Small City				
Urban	Small City	All roadways	C/D	B/C	
	Rochester	All roadways	C/D	Mid-C	
Urban Edge	Small City	All roadways	Mid-C	B/C	
	Rochester	All roadways	C/D	Mid-C	
Urban Influence Area	Rochester	All roadways/2020	B/C	Mid-B	
		All roadways/2035	Mid-C	B/C	
Rural	All	All roadways	B/C	Mid-B	

(1) Functional Designation Abbreviations are as follows:

All roadways - guideline refers to all classes of roadways

InT/InR/SA - guideline refers to Interstate, Interregional, Strategic Arterials

MA/ScA - guideline refers to Major Arterials, Secondary Arterials

PC - guidelines refers to Primary Collectors

While numerous methods have been developed to assess Level of Service, ROCOG recommends use of the methods based on the Highway Capacity Manual as the primary methodology for assessing LOS.

ITS Planning

Intelligent Transportation System technology plays an important role in enabling many TSMO strategies that rely on various communications and information systems in order to monitor conditions, collect and disseminate transportation system information, and provide the ability to adjust systems in response to changing travel conditions. In Minnesota, MnDOT has taken the lead in creating a collaborative vision of the use of ITS as well as leading the deployment of various services that rely on ITS Technologies. A MnDOT Statewide ITS Plan (SITSP) was adopted in 2015 to identify short and mid-term ITS needs, based on the goals and objectives found in Minnesota GO, the State's 50-Year Transportation Vision, and the Statewide Multimodal Transportation Plan.

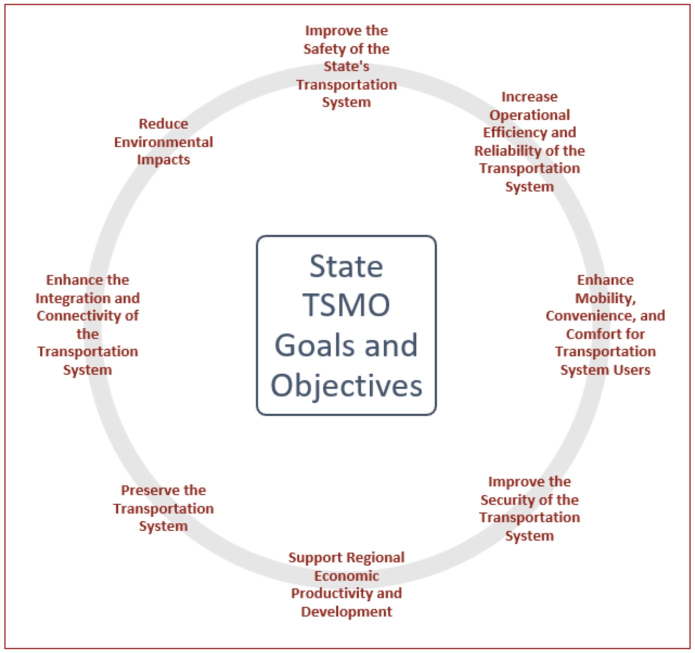
In collaboration with stakeholders, six ITS goals were established:

- **Safety:** Utilize Minnesota's Intelligent Transportation System to reduce fatalities and serious injuries through the use of technology to enhance the overall safety of the transportation system.
- **Mobility:** Minimize overall travel delay by providing and operating systems that maximize highway capacity, reduce delays and communicate information about road conditions to travelers.
- **Fiscal Responsibility and Sustainability:** Establish responsible and sustainable funding for Intelligent Transportation Systems in Minnesota and encourage private investment/research opportunities for continuous improvement.
- **Operations and Maintenance:** Provide an Intelligent Transportation System that is reliable and effective for users and improves operational efficiency of systems and MnDOT.
- **Asset Management:** Improve the management of Minnesota's ITS assets by focusing on risk and life-cycle costs to prioritize maintenance, investment, and system management.
- **Consistency:** Establish an Intelligent Transportation System that provides consistency statewide with technology, processes and procedures, interoperability, operations and maintenance.

Adoption of the SITSP provided the foundation for the next step in Statewide ITS system development with completion of the 2018 Minnesota Statewide Regional ITS Architecture report. This multi-volume report, an update of a prior version developed in 2014, was completed to

- Foster integration of the deployment of regional ITS systems
- Facilitate stakeholder coordination in ITS planning, deployment and operations
- Reflect the current state of ITS planning and deployment

- Provide a high-level planning for enhancing the state transportation systems using current and future ITS technologies
- Conform with the National ITS Architecture



The 15 volumes of the ITS Architecture Report include 12 volumes devoted to specific service packages that can be used as a jumping off point to develop specific service deployments. For MnDOT's partners, an Implementation Volume was prepared that summarizes ITS initiatives and projects concepts that can be used as a handbook not only by MnDOT, but also by its local and regional partners. This document is a resource to identify particular ITS initiatives and project concepts for consideration as part of local capital improvement programs as well as the basis for discussing partnership opportunities with MnDOT and federal or state funding opportunities through the STIP process. The last section of this chapter discusses initiatives and project concepts of particular interest to the ROCOG Planning Area.

Rochester's ITS Introduction

Before looking ahead, it is instructive to look back to the 2004-2006 TH 52 project which involved reconstruction of 10 miles of TH 52 through the Rochester area. As part of the project planning, time was spent on developing an ITS Plan to provide short term support for the construction project in terms of work zone traffic management, traveler information services, and traffic monitoring during construction, transitioning to form the basis for a freeway management system once the work was completed. Along with the focus on the TH 52 corridor, other high priority elements were identified with some likely to be impacted by detour traffic being implemented in advance of the construction, such as installation of traffic signal interconnection, control, monitoring, and timing for arterial street routes. Others, such as rail crossing safety and transit services, became future elements of a Rochester area ITS Strategy.

This ITS implementation was completed as part of a "Quick Start" process under the MnDOT NOVA project, a program begun in the late 1990's focused on kickstarting the deployment of ITS initiatives in urban and rural areas of Greater Minnesota. Table 14-9 lists the ITS components that were identified for deployment in that plan and which were ultimately deployed. Others, such as rail crossing safety, were not deployed as the need for certain projects never materialized as expected.

Looking Ahead: Future TSMO Activities

A solid foundation of TSMO infrastructure and services has been established through the efforts of MnDOT and local agencies over the last two decades in the Rochester area, beginning with planning for installations associated with the ROC 52 reconstruction project in the late 1990s and continuing to this day. It will be important going forward to maintain and enhance the services and infrastructure currently in place while staying abreast of new technologies and innovation that could further enhance the efficiency of the transportation system.

This section is broken into two parts, one discussing actions and activities needed to preserve, maintain, and enhance proven TSMO tools, and one discussing developing and emerging tools that may be of benefit in the future.

Proven Tools: Preserving, Maintaining, and Enhancing Existing TSMO Infrastructure

Maintaining the progress that has been achieved through deployment of various TSMO services/improvements requires first and foremost ensuring that existing services and tools continue to function and provide quality service to travelers in the ROCOG Planning Area. ROCOG supports the following actions of its partners to maintain the effectiveness of deployed TSMO strategies. These actions are grouped into the following five categories:

- Maintenance
- Infrastructure expansion
- Operations
- Planning
- Communications/information

Key Maintenance Activities

1. Continue to conduct routine maintenance and replace as needed key permanent hardware such as signal system hardware, closed circuit traffic cameras, dynamic message boards as well as mobile equipment such as work zone management systems to insure continued service in the future.
2. Maintain signage and pavement markings to assist motorists navigating the transportation network.
3. Maintain and replace as needed equipment associated with the Traffic Management Centers of MnDOT and

Table 14-9: Rochester Area Early 2000's ITS Deployment Plan

Proposed Rochester Area ITS Component	Deployed?	Program Status or Current Deployment Priority
FREEWAY MANAGEMENT		
Transportation Operations Center established at State Patrol Communication Center ($0.4k)	Yes	TOC still in operation
Vehicle detection sensors installed on TH 52,14 and 63 to collect volume/speed data for identifying congestion ($0.4 k)	Yes	Sensors still in operation
Closed circuit television cameras installed at key locations to monitor freeway traffic condition/4 in initial phase and 4 additional in second phase ($0.48k)	Yes	CCTV still in operation
Freeway variable message signs at 8 locations on TH 52 and TH 14 ($1.6m)	Yes	VMS still in operation
Portable traffic management system acquired for use in highway work zones; 1st deployment on 14/52 construction project	Yes	Status unknown
TRAVELER INFORMATION		
Automated telephone system to provide real-time, route specific, on-demand information via telephone managed from Traffic Operations Communications Center (TOCC)	Yes	Integrated in early 511 program
Pavement condition reporting system/maintenance vehicles equipped with mobile data terminal to transmit information by maintenance personnel into Mobile Data Terminal (MDT)	No	MnDOT maintains statewide fleet to collect pavement data
Variable message signs operated by MnDOT on state highways used to alert motorists to construction diversion and travel conditions operated from Rochester Traffic Operations Center	Yes	VMS still in operation

Proposed Rochester Area ITS Component	Deployed?	Program Status or Current Deployment Priority
Real time travel condition information accessible through the Internet/ managed by the Traffic Operations Communications Center	No	Under consideration by MnDOT
Cable television broadcast of traffic channel providing 24-hour information on congestion, travel speeds, accidents, construction and special events	No	Targeted to assist in TH 52 reconstruction but not completed
Establish highway advisory radio channel	No	Low Priority
PUBLIC TRANSIT SERVICES		
Computer aided scheduling and dispatch software system to provide dial-a-ride type service to general public during off-hours	No	Not used in TH 52 project but may receive added impetus through transit / human service agency coordination efforts
Installation of information kiosks at key locations throughout Rochester to provide information on transit services (8 sites)	No	Limited Kiosks ultimately deployed under FTA programs at main bus transfer centers
RAILROAD INTERSECTION SAFETY		
Rail/traffic signal coordination, system established to recognize trains and implement special signal timing plans to minimize disruption to traffic flow (7 crossings/13 signals)	No	Not a priority given uncertain status of DM&E Powder River Basin Project
Variable message signs on secondary arterial roads under local control to alert motorists to approaching trains, construction diversion, and congested travel conditions	No	Not programmed but Rochester has under consideration

Proposed Rochester Area ITS Component	Deployed?	Program Status or Current Deployment Priority
Automatic tracking of trains using sensors with information transmitted to law enforcement/fire/ambulance dispatchers and RTOC to implement signal coordination	No	Not a priority given uncertain status of Powder River Basin Coal Train Project
TRAFFIC SIGNAL CONTROL		
Emergency vehicle pre-emption	Yes	Fully deployed on all vehicles and traffic signals
Traffic signal interconnection, control, monitoring & timing for arterial street network in Rochester	Yes	Rochester in partnership with MnDOT and Olmsted County have implemented across urban area on select corridors (Fig 14-12)
PUBLIC SAFETY SERVICES		
Automatic vehicle location—equipping State Patrol vehicles with AVL	Yes	Program continues (new vehicles)
Mobile Data Terminal (MDT) system for State Patrol Rochester office	Yes	Program continues (new vehicles)

4. the City of Rochester which serve as the control centers for the overall TSMO system.

Infrastructure Expansion

1. Continue to expand fiber optic cable network and supporting wireless networks in order to open up opportunities to provide services such as signal coordination, dynamic messaging, and traffic control on new corridors and in new areas of the region.
2. Provide additional equipment and staffing that may be needed at the Traffic Management Centers as highway networks grow and evolve.
3. Continue to deploy transit signal priority and emergency vehicle pre-emption on new vehicles and at new controlled intersections to provide reliable transit service and timely emergency response in corridors that are seeing or expected to see future traffic growth.

4. Expand the locations where infrastructure such as pedestrian countdown signals and pedestrian activated signals are installed to improve pedestrian safety and security.
5. Pursue funding for Safe Routes to School installations such as crosswalk enhancements and speed control measures to improve the safety and quality of the walk or bike to school experience.
6. Continue to evaluate the benefit of infrastructure-based safety warning systems in rural and suburban locations such as Rural Intersection Conflict Warning System (RICWS), Reduced Conflict Intersections (RCI), Curve Warning Systems (CWS) and other active measures to alert motorists to potentially dangerous traffic conditions.
7. Identify and program improvements to minimize the risk of extended traffic disruption from events such as flooding by identifying potential locations where roadways or bridges are subject to floodwater damage and identifying improvements needed to mitigate the risk.

Operations

1. Budget adequate funding to allow periodic updating of intersection signal timing and corridor level signal coordination plans to maintain efficiencies in traffic flow as conditions change over time. A desirable target would be to provide funding for periodic updates at no more than five-year intervals.
2. Maintain readiness to deal with periodic non-recurring travel delay resulting from everyday incidents such as crashes, special events, and pavement failure.
3. Maintain readiness and preparedness to respond to infrequent incidents that can cause extended travel disruption such as flooding, severe weather, and hazardous materials spills. Coordination between road authorities and emergency operations managers are key to this.

Planning

1. Continue to apply access management and traffic operation guidelines during the project development process and review of private development proposals to establish desirable access management design and placement/control of locations where future median openings or signalization will be provided.
2. In all project development that involves renewal of pavement surfaces such as mill and overlay projects or reconstruction, plan for Complete Street improvements as well as reallocation of pavement use through measures such as restriping or road diets. Intersection improvements at major locations should always weigh the tradeoffs between signals and roundabouts or, in select cases, other innovative intersection treatments.

Information/Communication

1. Working through mechanisms such as the Arrive Rochester Transportation Management Organization, expand travel demand management services and programs to attract more travelers to modes such as transit or carpooling through various service and financial incentive programs.
2. Continue to expand the use of parking management tools such as real time parking availability to reduce the amount of unnecessary circling by motorists attempting to find available parking.
3. Continue to enhance and expand the uses of Traveler Information Systems such as Minnesota 511 and the new Rochester and Olmsted County Construction Impact online information tools.

Developing and Emerging Tools: New Avenues to Enhance Travel Experience

Technology is rapidly evolving, and breakthroughs find their way into new tools that can be adapted to various uses, including within the realm of traffic and travel management. Over the next 10 to 20 years, increasingly ubiquitous data, mobile applications, and technology enabled services are expected to change how transportation is managed in the future. MnDOT has been at the forefront in the state thinking about these potential changes and the application of various tools through its 2017 TSMO Strategic Plan and 2018 Statewide Regional ITS Architecture Reports.

In reviewing these reports and other similar materials from research centers and other states and localities, ROCOG has identified a number of emerging technologies or refinements of existing tools and technologies that likely will command some attention in future years as elements of the local TSMO/ITS infrastructure framework. The following paragraphs describe some of the most promising applications with relevance to Rochester; use of some of the services reviewed here have been suggested for further consideration in various DMC-related studies in the last five years as opportunities to enhance the attractiveness and livability of Rochester's downtown area. The list is not meant to be comprehensive but to provide a sample of key TSMO approaches that could see application in Rochester.

CAV Ready Intersections

"CAV ready intersections" refers to the installation of communication infrastructure that will permit communications between Connected/Autonomous Vehicles (CAVs) and either roadside or cloud-based communication systems to permit the exchange of information between vehicles and systems such as traffic signal system controllers. An example of the information exchanged would be the signal system communicating to the CAV the current signal status such as phase (green/yellow/red) or providing warnings to CAVs of potential traffic signal violations, which intelligence in the CAV would then respond to.

In terms of investment, a major item for public road agencies will be the upgrading or installation of signal systems that are CAV ready, including installation of communications hardware which may be roadside units communicating via wireless means or cloud-based communications. The communication infrastructure is key to permitting the two-way flow of information which can enhance the safety and operations of the intersection.

ROCOG area road agencies should continue to monitor advances in the realm of CAV communications and expect to plan for investment in this type of equipment during the next 20-year horizon of this plan.

Arterial or Expressway Traffic Management Systems & ITS Service Package

Figure 14-4 and Table 14-1 reported on strategic and major arterial corridors in the Rochester urban area that are currently experiencing higher numbers of crashes, are expected to see growth in traffic congestion during the next 20 years, and are targeted for investment in transit infrastructure to support future Bus Rapid Transit service. Analysis of potential future congestion levels and higher absolute number of crashes observed suggest that travel reliability in these corridors may decline over time, impacting mobility as well as the delivery of a high-quality transit service envisioned on the Primary Transit Network. Given these factors, a need may emerge in these corridors for a strategic traffic management plan that includes TSMO strategies as well as transit and other multi-modal enhancements that can preserve the level and quality of service needed to effectively and efficiently provide the mobility warranted on these high level arterial corridors.

The future of traffic management on important arterial corridors such as Broadway and West Circle Drive is likely to include elements of an Intelligent Transportation System (ITS) service package called Active Traffic Management (ATM), also referred to as Active Expressway or Active Arterial Management. ATM service packages typically involve the application of multiple real-time strategies that provide the ability to dynamically manage traffic based on current and expected conditions. Among the individual types of applications that can be combined in ATM package for a corridor include:

- Adaptive ramp metering
- Dynamic speed limits
- Queue warning system
- Dynamic shoulder lanes
- Adaptive traffic signal control

In addition to these active traffic measures, an ATM corridor will typically see enhanced traffic monitoring and communication infrastructure installed as well as potentially upgraded traffic management center hardware and software to operate. However, this approach has been used across the United States for many years as well in some European countries with results showing overall capacity increases of up to 22% over non-managed corridors with increased travel reliability and declines in crashes of up to 30%.

The benefit of deploying ATM infrastructure is that from a cost perspective it provides a significant cost savings over capacity expansion projects, particularly in highly developed corridors such as Broadway or 2nd St SW where right-of-way is at a premium.

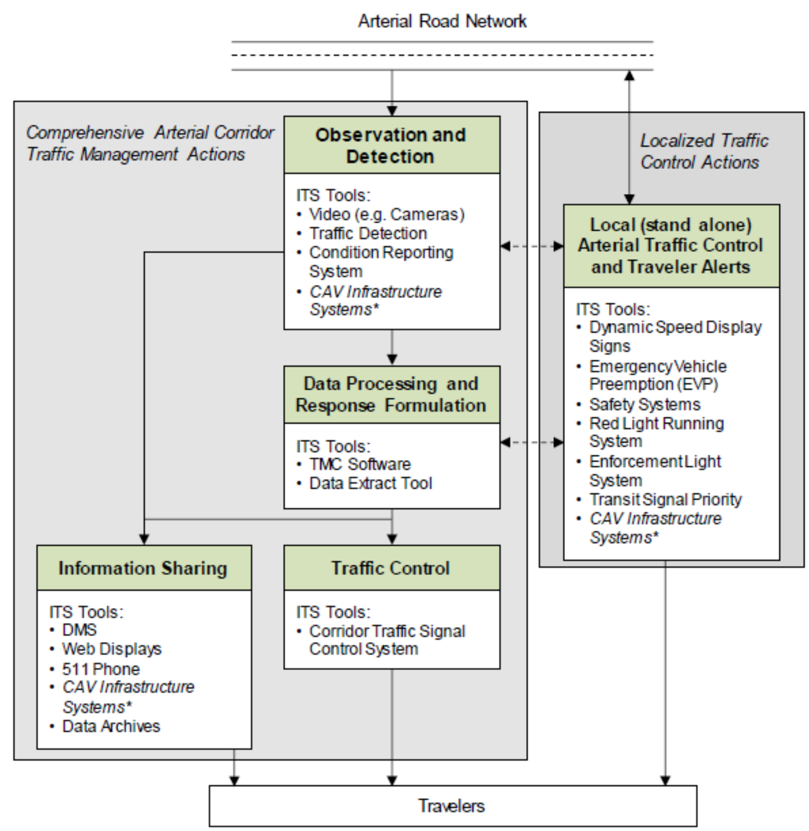
As MnDOT gains experience with ATM in the Twin Cities areas, ROCOG area road agencies and MnDOT District 6 should monitor conditions on these important strategic corridors determine if or when a higher level of traffic management is warranted. Generally, a comprehensive, integrated package of Arterial Corridor Traffic Management Actions as shown in Figure 14-15 exemplifies the type of ATM solution to consider.

Curbside Management

Curbside management is an emerging practice referring to management and allocation of increasingly valuable curb space as its demand multiplies due to

- The emergence of new forms of transportation (including parking for modes such as scooters)
- Increasing package deliveries due to online shopping

Figure 14-15: Illustrative Arterial Traffic Management Corridor Package



- Increased passenger pick-up and drop-off from services such as Uber and Lyft
- Potential need for more curb space to accommodate transit vehicles
- Demand for curb space from services such as food trucks or stationary vendors

- Interest in activating the street frontage with features such as outdoor seating and more landscaping
- Continued demand for on-street parking to serve high turnover customer parking

Furthermore, in Rochester, the implementation of Downtown Rapid Transit will impact streets including 2nd St SW, creating added pressure on valuable curb space. Managing the use of curb space in a vibrant downtown such as Rochester in the future will be more challenging, and among the solutions starting to emerge are online apps that help manage the allocation of curb space and the pricing of that space for different users. It is likely in coming years that additional technology and smart infrastructure applications will begin to emerge to help cities manage this space. It will be important for Rochester to monitor conditions downtown in the near term and start planning for a higher level of management of downtown curb space in the future.