



# MnDOT Transportation Systems Management and Operations (TSMO) Implementation Plan

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## Table of Contents

1.0 Introduction .....	1
2.0 TSMO in Minnesota .....	2
3.0 Purpose of Implementation Plan .....	3
4.0 Process for Developing TSMO Strategies.....	4
5.0 Scoring TMSO Strategies.....	5
6.0 Prioritized TSMO Strategies .....	6
7.0 Prioritizing TSMO Deployment Sites and Corridors.....	12
Appendix A – Stakeholder Input .....	A-1
Appendix B – Prioritization Criteria, Weighting, and Scores .....	B-1
Appendix C – Strategy Descriptions.....	C-1

## 1.0 Introduction

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This document represents one of three planning documents that comprise the Minnesota Department of Transportation (MnDOT) Transportation System Management and Operations (TSMO) Plan. As illustrated in Figure 1, the MnDOT TSMO Strategic Plan defines overall direction of the program and the MnDOT TSMO Business Plan addresses the business process and organizational structure to successfully deliver TSMO strategies within Minnesota. As the Implementation Plan, this document provides a prioritized list of detailed TSMO strategies to implement that were identified through input gathered from MnDOT districts and offices through a series of outreach workshops. The list of strategies is intended to be used as MnDOT considers implementing operational improvements through a variety of funding sources. The strategies would compete for funding with other potential projects according to the specific prioritization and selection requirements of those funding programs.



**Figure 1: MnDOT TSMO Program Plan**

TSMO as defined by [FHWA MAP-21](#) are integrated strategies to optimize the performance of existing infrastructure through the implementation of multimodal and intermodal, cross-jurisdictional systems, services, and projects designed to preserve capacity and improve security, safety, and reliability of the transportation system. Examples of TSMO strategies include traffic incident management, traffic signal coordination, transit signal priority, freight management, work zone management, special event management, road weather management, managed lanes, and ridesharing programs.

***Examples of TSMO Strategies:***

- Traffic incident management
- Traffic signal coordination
- Transit signal priority
- Freight management
- Work zone management
- Special event management
- Road weather management
- Managed lanes
- Ridesharing programs

## **2.0 TSMO in Minnesota**

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As described in [MnDOT's TSMO Strategic Plan](#), TSMO is not new to MnDOT nor does it apply to only certain regions of the state. TSMO is a statewide program delivered by all districts and has enjoyed a long history of successful application within MnDOT, imparting significant benefits to its customers. While the overall structure of the three planning documents to describe MnDOT's TSMO activities is new and less familiar to stakeholders, the concepts and strategies are not. TSMO complements MnDOT's ongoing commitment to the state's transportation infrastructure and maximizes the return on investment by operating and managing the system as efficiently and effectively as possible. TSMO includes a host of operational strategies, system management approaches, and specific technical or business processes that:

- Optimize system performance
- Improve safety
- Anticipate and manage traffic congestion and impacts to system reliability

MnDOT has supported, deployed, and operated a variety of strategies for many years that are considered to be components of TSMO. Incident management, road weather management, ramp metering, bus on shoulder operations, traffic signal timing and coordination, and the Freeway Incident Response Safety Team (FIRST) are all longstanding examples of TSMO strategies in Minnesota. MnDOT's extensive experiences with TSMO strategies provides a strong foundation to further improve existing practices and readily expand into new strategy areas. This Implementation Plan focuses on new or expanded strategies and assumes that MnDOT will continue with its ongoing TSMO strategies even though they may not be highlighted in this plan.

### 3.0 Purpose of Implementation Plan



**Implementation Plan Purpose:**


Provide a prioritized list of TSMO strategies for MnDOT to consider that align with the goals and objectives from the MnDOT TSMO Strategic Plan

The purpose of this Implementation Plan is to provide a prioritized set of TSMO strategies for MnDOT to consider for implementation that align with the 3 goals and 16 objectives set forth in the [MnDOT TSMO Strategic Plan](#) as shown in Table 1. It is important to note that the TSMO goals and objectives align with many MnDOT plans, including the Minnesota GO 50-Year Vision, Strategic Operating Plan, Statewide Multimodal

Transportation Plan, Minnesota State Highway Investment Plan (MnSHIP), as well as supporting plans, policies and programs such as the Minnesota Statewide Regional ITS Architecture, MnDOT Project Selection Policy, and Corridors of Commerce. At the tactical level, TSMO strategies are consistent with and in some cases overlap implementations defined in the MnDOT Statewide ITS Plan and the Minnesota Statewide Regional ITS Architecture.

**Table 1: MnDOT TSMO Goals and Objectives**

MnDOT TSMO Goal	Objectives to support the goal
<p><b>Goal #1: Improve Reliability, Mobility, and Efficiency</b></p> <p><i>Maximize existing capacity and reduce recurring (bottlenecks) and non-recurring (work zones, weather, incidents, special events) congestion.</i></p> 	<ol style="list-style-type: none"> <li>1. Reduce congestion for all travel modes on the freeways and arterials in urbanized areas throughout Minnesota</li> <li>2. Provide and promote alternatives to single occupant vehicle travel.</li> <li>3. Increase availability of travel times to travelers for multiple modes</li> <li>4. Reduce the impacts of snow and ice on mobility</li> <li>5. Reduce incident response and clearance times in the Twin Cities and Greater Minnesota</li> <li>6. Increase pre-trip and en-route traveler awareness of multi-modal incidents and alternate options in both the Twin Cities and Greater Minnesota</li> <li>7. Reduce delays associated with construction activities</li> <li>8. Reduce delays associates with maintenance activities</li> </ol>
<p><b>Goal #2: Improve Safety</b></p> <p><i>Reduce the frequency, severity (fatalities and injuries), and clearance times of crashes.</i></p> 	<ol style="list-style-type: none"> <li>9. Reduce crashes related to congestion in urbanized areas throughout Minnesota</li> <li>10. Reduce the frequency of secondary crashes and crashes related to work zones</li> <li>11. Reduce responder and worker exposure to crashes</li> <li>12. Reduce the frequency of single vehicle roadway departures</li> <li>13. Reduce the frequency of crashes at signalized and unsignalized intersections</li> <li>14. Reduce the frequency of crashes related to road weather conditions (e.g. snow, ice, fog, etc.)</li> </ol>

<p><b>Goal #3: Carefully and Responsibly Manage Transportation Operations Assets</b></p> <p><i>Proactively and cost-effectively operate, maintain, upgrade, and manage the assets required for effective operations (staff, data, equipment).</i></p> 	<p>15. Understand and appropriately fund the life-cycle costs of operating, managing, and maintaining the assets needed for operations activities</p> <p>16. Acquire, secure, and manage the data needed for MnDOT to effectively perform operations, performance management and planning</p>
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### 4.0 Process for Developing TSMO Strategies

Ten separate outreach workshops were held with the following MnDOT districts and offices in September and October 2018 to gather input on TSMO strategies for potential implementation.

**Table 2: MnDOT TSMO Workshop Locations**

District/Office	Date	Location	District/Office	Date	Location
District 1	10.11.18	Duluth	District 6	10.4.18	Rochester
District 2	10.5.18	Webinar	District 7	10.15.18	Mankato
District 3	10.8.18	Baxter	District 8	10.2.18	Willmar
District 4	10.12.18	Detroit Lakes	Metro District	10.4.18	Roseville
Office of: <ul style="list-style-type: none"> <li>Traffic Engineering (OTE)</li> <li>Connected and Automated Vehicles (CAV-X)</li> </ul>	9.28.18	Roseville	Office of: <ul style="list-style-type: none"> <li>Maintenance</li> <li>Transit and Active Transportation</li> <li>Construction and Innovative Contracting (OCIC)</li> <li>Freight and CVO</li> </ul>	10.9.18	Shoreview Training Center

**Strategies were also submitted by the Regional Transportation Management Center (RTMC), as a statewide resource for MnDOT’s TSMO-related activities.**

The MnDOT TSMO goals and objectives (See Table 1) were highlighted during the workshops to focus the TSMO strategy discussions. There were nearly 200 strategies identified during the outreach workshops or submitted subsequently as a result of the workshops. Strategies discussed during each workshop were voted on to identify those that

Nearly 200 TSMO strategy ideas were identified by MnDOT Districts and Offices during the outreach

were most important to each district/office. The purpose of the voting exercise was to identify similar priorities across districts/offices and to ensure that high-priority strategies would be further described and scored per the process described in Section 5.0. All of the strategies suggested during the workshops are documented in [Appendix A](#) reflecting the stakeholder input gathered. MnDOT also provided a list of FHWA operations tactical program areas, which were aligned with the strategies stemming from the outreach workshops. After organizing and reviewing all strategies and operations tactical program areas, and combining some of the strategies, a total of 34 TSMO strategies were identified for this implementation plan. These 34 strategies were then defined in more detail (See [Section 6.0](#)) and scored based on a set of defined criteria (See [Section 5.0](#)) to prioritize the TSMO strategy list.

## 5.0 Scoring TSMO Strategies

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TSMO strategies were scored to evaluate them for implementation consideration using existing MnDOT funding programs. It is important to note that a new funding program for TSMO has not been proposed at this time. TSMO strategies must compete for funding using scoring formulas of existing and applicable funding programs.

The 34 TSMO strategies identified through outreach with MnDOT districts and offices were scored based on the following prioritization criteria. The criteria were derived from applicable guiding principles and evaluation criteria from existing plans as noted below and through discussion with members of the MnDOT TSMO Leadership Team.

- Impact (Cost and Benefit) (Minnesota GO 50-Year Vision, MnDOT Project Selection Policy, Corridors of Commerce)
- Planning Consistency (Statewide Multimodal Transportation Plan, MnDOT Project Selection Policy, ITS Program)
- Geographic Scale and Balance (MnSHIP)
- Coordination and Synergy (Minnesota GO 50-Year Vision, MnDOT Project Selection Policy)
- Ease of Implementation (Statewide Multimodal Transportation Plan)
- Maintainable Scale (Minnesota GO-50 Year Vision)
- Accessibility (Minnesota GO 50-Year Vision, Statewide Multimodal Transportation Plan, MnDOT Project Selection Policy, Corridors of Commerce)

An additional criterion – Research, Innovation and Technology (Statewide Multimodal Transportation Plan) is offered as a bonus criterion to give preference for strategies that leverage new innovations, technologies or research results. Because the TSMO strategies may consist of both capital improvements and process improvements, criteria were selected based on the ability to evaluate both types of strategies on an apples-to-apples basis. See [Appendix B](#) for additional details on the scoring criteria and the scores for each of the 34 strategies.

### *TSMO Prioritization Criteria*

- Strategy Impact
- Planning Consistency
- Geographic Scale and Balance
- Ease of Implementation
- Maintainable Scale
- Accessibility
- Research, Innovation and Technology

While the TSMO strategy scoring process serves as a means to systematically select possible TSMO strategies for implementation, the scoring results do not imply that strategies will be implemented in their scored order. Because strategies vary in the objectives they address, strategies are unique in the types of funding programs in which they may compete for funding. Therefore, the strategies are subject to the timetables and requirements of the applicable funding programs. Each strategy will face differing levels of competitiveness against the strategies with which they must compete under each program. Therefore, it is possible that a TSMO strategy scored higher than another may be implemented later based upon the selection process used by the disparate funding programs.

## 6.0 Prioritized TSMO Strategies

The following table provides the 34 MnDOT TSMO strategies in priority order based on their TSMO criteria score (see [Section 5.0](#)). In situations where multiple strategies have the same score, they are arranged alphabetically by strategy title and is not an indication of priority status.

This table also provides an estimated timeframe for initiating the implementation of each strategy, based on the following designations:

- Short-term (1-2 years)
- Medium-term (2-5 years)
- Long-term (Greater than 5 years)

In some cases, medium-term and long-term strategies may be initiated sooner than the timeframes outlined, as steps for implementation may require pre-planning.

[Appendix C](#) provides additional detail on each strategy including comments from the TSMO outreach workshops related to the strategy, current Minnesota status, and the deployment approach.

**Table 3: TSMO Score Prioritization**

Strategy #	Title	Brief Description	Score	Initiation Timeframe
1	Update Signal Timing and Coordination	Identify ways to address operational issues at signalized intersections and implement improvements to signal timing and coordination, especially in urban areas within Greater Minnesota districts.	460	Short-term (1-2 years)
2	Increase MnDOT Usage of 3rd Party Data and Increase Sharing with Traveler Information Disseminators (e.g. Google, WAZE, INRIX, HERE)	Continue and expand activities MnDOT currently performs to enter and maintain event reports (incidents, work zones, detours, other activities) in the MnDOT traveler information system and to share these events with 3rd party information disseminators.	440	Short-term (1-2 years)



Strategy #	Title	Brief Description	Score	Initiation Timeframe
3	Develop Regional Traffic Incident Management (TIM) Programs	Apply multi-agency coordination to improve traffic incident management (TIM) processes by developing regional traffic incident management (TIM) Programs to improve response efforts and incident clearance times.	430	Short-term (1-2 years)
4	Implement Low-Cost / High-Benefit Capital Improvements (CMSP)	Identify relatively low-cost, high-benefit capital improvements that can improve safety and mobility to support TSMO using performance management tools to identify specific stretches of highways where safety improvements should be further considered.	410	Short-term to Medium-term (2-5 years)
5	Coordinate Work Zones Across Jurisdictions and Routes	Uses advanced planning of construction and maintenance projects and Maintenance of Traffic (MOT) approaches across districts and with local agencies to reduce construction impacts on traveler mobility and truck parking.	400	Short-term (1-2 years)
6	Expand Snow Fence Use through Research and Increased Use	Expand the use of snow fences adjacent to MnDOT highways (including outreach) and research new, innovative snow fence options.	395	Short-term (1-2 years)
7	Expand the Coverage of Freeway and Expressway Traffic Management Systems	Continue and expand traffic management systems, both in the Twin Cities and in urbanized and rural areas statewide, as needed.	395	Medium-term (2-5 years)
8	Develop Traffic Incident Management (TIM) Strategies for Work Zones	Improve TIM when work zones are present, and open lanes sooner to improve mobility.	380	Short-term (1-2 years)
9	Utilize Intelligent Work Zone Systems Where Appropriate	Assess work zone conditions and deploy technology-based Intelligent Work Zone (IWZ) systems to improve safety, mobility, and MOT for all involved in work zones.	375	Short-term (1-2 years)
10	Expand the Use of Ramp Metering	Evaluate the need for, and benefits of, additional ramp meter locations in the Twin Cities and beyond, including Greater Minnesota urbanized areas.	370	Medium-term (2-5 years)

Strategy #	Title	Brief Description	Score	Initiation Timeframe
11	Expand Use of Technology at Weigh Stations for Enforcement	Expand the use of roadside truck electronic screening/clearance mechanisms such as mainline weigh-in-motion (WIM) systems and other innovative technology solutions for enhanced enforcement.	370	Medium-term (2-5 years)
12	Increase TSMO Asset Life Cycle Understanding and Management	Leverage available resources to better maintain TSMO assets and improve life cycle understanding and management.	365	Short-term (1-2 years)
13	Implement Signal Timing Updates for Construction Projects	Implement signal timing updates for selected construction projects that have a high likelihood of creating significant traffic impacts along signalized corridors.	360	Short-term (1-2 years)
14	Provide Traveler Information on Alternative Modes and Routes	Provide traveler information to inform motorists of alternative modes of travel and alternate routes to help alleviate congestion as a part of any congestion reduction effort, including integrated corridor management (ICM).	360	Medium-term (2-5 years)
15	Expand and Enhance the Deployment of Road Weather Information Systems	Expand RWIS station deployments throughout the state including deployment at new sites as well as upgrades and replacements of RWIS station equipment, including sensors, controllers, video cameras, and communications.	355	Short-term (1-2 years)
16	Expand Consideration of Innovative Intersection Technology or Design (e.g. RICWS, roundabouts, RCIs, diverging diamonds, etc.)	Increase inclusion of innovative intersection designs and technologies such as roundabouts, reduced conflict intersections (RCIs), diverging diamond interchanges, and Rural Intersection Conflict Warning Systems (RICWS), as alternatives during the planning process for improving or upgrading a signalized or unsignalized intersection.	355	Short-term (1-2 years)

Strategy #	Title	Brief Description	Score	Initiation Timeframe
17	Expand Dynamic Message Sign (DMS) Use to Include Standard Weather Messages	Enhance and expand MnDOT's use of DMS to include route-specific weather and driving condition reports that provide information on current and forecasted roadway conditions.	355	Short-term (1-2 years)
18	Improve Pedestrian and Bicycle Service at Signals	Coordinate with the prioritized efforts of the State non-motorized Transportation Committee (SNTC) to identify and implement signage, accessibility, crossing, or timing enhancements to signalized intersections to better represent pedestrians and bicyclists, with an emphasis on intersections not fully equipped for pedestrian access.	355	Short-term (1-2 years)
19	Increase Real-time Tracking of Work Zones and Lane Closures for 511	Increase provision of real-time work zone and lane closure information for 511.	355	Short-term (1-2 years)
20	Upgrade Signal Controller and Communications Equipment for Communications to Central System	Upgrade signal controllers and communications equipment to accommodate traffic signal control via a central system.	355	Short-term (1-2 years)
21	Deploy Truck Parking Information for Rest Areas	Provide real-time truck parking information for rest areas.	350	Short-term (1-2 years)
22	Develop and Implement Pre-planned Alternative Routes for Incidents	Develop pre-planned detour and alternate routes, improve the provision of recommended alternate routes around roadway closures or heavy congestion caused by incidents or weather events, alternate transit routes, and alternate route signing (with the potential for providing travel times) for traffic incident management.	350	Medium-term (2-5 years)

Strategy #	Title	Brief Description	Score	Initiation Timeframe
23	Ensure New Signals are Connected Automated Vehicle (CAV) Ready	When new traffic signal controllers are installed or when upgrades are performed on existing controllers, MnDOT will perform actions needed to ensure the signal controller will be able to support the output of data needed to support CAV applications.	350	Medium-term (2-5 years)
24	Add Additional MnPASS Lanes in the Twin Cities Metro Area	Construct additional High Occupancy Toll (HOT) lanes, known as MnPASS Express Lanes, similar to the lanes already implemented on I-394, I-35W, and I-35E.	340	Medium-term (2-5 years)
25	Provide Enhanced Enforcement Technology (Speed Enforcement, Red Light Running, MnPASS, etc.)	Develop and deploy enhanced enforcement technology to assist with speed enforcement, red light running, and violations in MnPASS lanes.	340	Medium-term (2-5 years)
26	Expand and Streamline Road Weather Data	Expand and streamline road weather data to enhance road weather management and traveler information to include predictive driving condition reports.	325	Short-term (1-2 years)
27	Utilize Alternate Route Signing for Work Zones	Increase the planning and consideration of alternate routes for work zones and increase the use of alternate route signing in situations where alternate routes are planned.	320	Long-term (> 5 years)
28	Expand Dissemination of Travel Times (Work Zones and Geographic Expansion)	Build upon current activities to display travel time information on DMS by expanding the dissemination of travel time information.	315	Medium-term (2-5 years)
29	Expand Sharing of Video and Data Between Agencies (Integrated Corridor Management)	Utilize integrated corridor management (ICM) principles to expand the sharing of video and data among state and local agencies, including transit and law enforcement, to manage parallel routes and travel options for a corridor.	310	Short-term (1-2 years)

Strategy #	Title	Brief Description	Score	Initiation Timeframe
30	Deploy Transit Signal Priority	Deploy transit signal priority capabilities at specific intersections and corridors with upgraded traffic signal controllers that can support this feature in order to increase transit efficiency and reduce transit delay at intersections.	305	Medium-term (2-5 years)
31	Address Bikes and Pedestrians in Construction Detours	Develop mechanisms to provide transit, pedestrian, and bike lane detours (with associated traveler information) for construction detours, especially on larger construction projects that have significant mobility impacts.	290	Short-term (1-2 years)
32	Improve Work Zone Data for CAV Readiness	Improve work zone data for CAV readiness including increasing situational awareness of work zones and lane closures for operators and 3rd parties.	285	Medium-term (2-5 years)
33	Prepare Systems to Obtain/Use Data from CAVs	Develop the digital infrastructure to be capable of capturing the BSM data, processing it, storing it, securing it, and managing it to benefit MnDOT.	240	Long-term (> 5 years)
34	Encourage Work Flexibility for Travel Demand Management	Perform outreach and coordination with major employers in the urbanized areas within Minnesota to encourage flexible work schedules or increased options for teleworking, especially during inclement weather or when other major events will contribute to peak period traffic.	220	Short-term (1-2 years)

## 7.0 Prioritizing TSMO Deployment Sites and Corridors

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The selection of specific locations for TSMO strategy deployments within Minnesota will be an ongoing process throughout the life of the TSMO Program. Each MnDOT District or functional office will ultimately determine where and when to deploy or implement specific TSMO strategies. Location selections will be a balance of maximizing the end user benefits while leveraging existing human, infrastructure, and technology resources for the most efficient deployments, with the following general guidelines:

- **Continue statewide and site-specific locations for TSMO strategy deployments.** The majority of current and previous TSMO activities in Minnesota are typically either statewide strategies that impact travelers throughout the entire state (e.g. traveler information websites) or site-specific strategy implementations (e.g. snow fences, signal timing improvements, Twin Cities MnPASS lanes, etc.). TSMO strategies defined in this plan will continue to be deployed with these two approaches.
- **Recognize regional commonalities when considering TSMO activities.** Regional areas (e.g. the Twin Cities, Rochester, Arrowhead Region, etc.) represent another approach towards defining common traveler challenges and opportunities for TSMO strategy deployments. These might include regions experiencing rapid expansion, regions with unique freight movement, rural regions, or metropolitan regions.
- **Align to the Greater Minnesota Mobility Study priority areas when appropriate.** As priority areas emerge within the Greater Minnesota Mobility process, consideration of TSMO strategy implementations that align with these locations may encourage a balanced deployment of infrastructure and operations-based solutions.
- **Consider outcomes of planning processes such as the Congestion Management Safety Plan (CMSP) and safety plans.** The CMSP is a funding program that identifies low-cost, high-benefit improvement to address safety and congestion problems on state highways. The findings and outcomes of this and other planning efforts (e.g. Towards Zero Deaths Program) should be considerations for locations of TSMO strategy implementations.
- **Continuously reassess deployment locations.** The MnDOT TSMO Program will regularly assess previously defined locations of TSMO strategy deployments to continuously assess the needs for expanded areas or location changes.
- **Explore the concept of TSMO Managed Corridors through pilot deployments.** During the TSMO planning process, managed corridors that address one or more priorities specific to each corridor (e.g. freight priorities, commuter priorities, safety priorities, seasonal/tourism priorities), were recognized as an additional deployment approach that should be piloted and tested to determine the effectiveness before wide-scale managed corridors are implemented. More details of the managed corridor concept are included below.

### TSMO Managed Corridors Concept

Corridors best describe the travel paths for much of the commuter, commercial/freight, and leisure travel throughout the state. Corridors range from short distance targeted corridors to medium sized single or multi-highway corridors crossing sections of the state to long-distance 'border to border' corridors. Travelers of corridors often encounter similar challenges and the deployment of common TSMO

components along corridors can increase efficiency of both initiating and maintaining the needed aspects of TSMO deployments. Similarly, common aspects of a corridor may be considered when implementing TSMO strategies (e.g. on a commuter corridor, incident management may be emphasized during peak periods to respond quickly to crashes and restore capacity).

TSMO Managed Corridors may be designated temporarily (e.g. during construction/work zones) or designated permanently. The following preliminary Managed Corridor designations have been suggested:

- **Commuter Priority Corridor (CPC):** Corridors with high volumes of commute traffic may be considered for commuter priority and would emphasize commute periods when implementing TSMO strategies (e.g. peak period limits on lane closures, TIM equipment staging, signal timing.)
- **Freight Priority Corridor (FPC):** Corridors that meet specific freight vehicle traffic patterns may be considered for freight priority, and would emphasize commercial traffic needs when implementing TSMO strategies (e.g. limited lane closure during truck movement periods, parking considerations, traveler information regarding freight, etc.)
- **Volume/Congestion/Safety Priority Corridors (VCSPC):** Corridors meeting specific congestion challenges and/or safety factors may be considered for volume/congestion/safety priority and would emphasize local factors common to the corridor (e.g. common traffic, congestion or safety aspects of the corridor) when implementing TSMO strategies.
- **Seasonal/Tourism Priority Corridors (STPC):** Corridors meeting specific tourism or seasonal event criteria may be considered for seasonal/tourism priority and would emphasize key travel days related to seasonal activities and tourism (e.g. Fridays, Sundays, holidays) when implementing TSMO strategies.

## Pilot Corridor Identification

As the short-term TSMO strategies defined in this plan are initiated, it is recommended that MnDOT consider several pilot TSMO Managed Corridors to assess and evaluate the effectiveness of the concept. The pilot TSMO Managed Corridors would accomplish the following:

- Determine criteria to use in order to designate corridors per the designations above (e.g. commuter, freight, etc.);
- Identify ‘corridor based’ approaches to the TSMO strategies, for each designation that is piloted (e.g. if a commuter corridor is piloted, details about the corridor approach would be defined such as limiting lane closures and staging incident response vehicles during peak periods);
- Assess the impacts and costs associated with the Managed Corridors approach.

Once MnDOT conducts a series of pilot TSMO Managed Corridors, if the results are positive, the experiences of the pilot could be used by districts and offices statewide to implement TSMO Managed Corridors where appropriate.

## Candidate Pilot Corridor Example

An example of a potential initial TSMO Managed Corridor was identified as I-94 from the Twin Cities to St. Cloud. This corridor could be considered for designation as a commuter priority corridor (CPC) and a Volume/Congestion/Safety priority corridor (VCSPC) with heavy regular volumes.

## Appendix A – Stakeholder Input

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The tables on the following pages include the TSMO strategy ideas documented during the outreach workshops with each district or office. In addition, the column titled “Strategy #” identifies which of the 34 prioritized TSMO strategies (described in [Section 6](#)) were influenced by the strategy ideas.

- Table A1: [District 1](#)
- Table A2: [District 2](#)
- Table A3: [District 3](#)
- Table A4: [District 4](#)
- Table A5: [District 6](#)
- Table A6: [District 7](#)
- Table A7: [District 8](#)
- Table A8: [Metro District](#)
- Table A9: [Central Office](#)
- Table A10: [OTE and CAV-X](#)
- Table A11: [RTMC](#)



**Table A-1: District 1 Stakeholder Input - TSMO Strategy Ideas**

District 1 TSMO Strategy Idea	Strategy #
<p>Work zone mobility</p> <ul style="list-style-type: none"> <li>• Construction on I-35 weekends, Hwy 61 during summer (5)</li> <li>• Border crossing is another topic. Two national borders in District, need to manage os/ow alternate routes to Canada, width allowed determines how many os/ow cannot get through – possible temporary bridge – signal timing/mgmt. during construction (include in scoping) (27)</li> </ul>	5, 27
<p>Proactive DMS use &amp; freeway management</p> <ul style="list-style-type: none"> <li>• RTMC controlling, outside normal district hours, rely on RTMC</li> <li>• Use cameras to monitor</li> <li>• Construction not using the Hwy 61 signs to post construction msg. other areas</li> </ul>	7
<p>Event management to increase mobility / reduce delays</p> <ul style="list-style-type: none"> <li>• Traveler information and Freeway/arterial management. Need to inform RTMC and city of Duluth about events at the DECC (esp. multiple simultaneous), other special event, plan for events. Notice to locals about expected diversions onto their roads. DECC Bentleyville (Christmas lights)</li> </ul>	7
<p>Signal timing and control improvements</p> <ul style="list-style-type: none"> <li>• Signalized corridors (keeping them coordinated and minimize delays). Small areas events, Central signal control to see signal remotely, and implement planned timings. Include in construction planning and TMP development.</li> </ul>	1
<p>Appropriately staff field device maintenance and management</p> <ul style="list-style-type: none"> <li>• Signals (e.g. visit at least twice/year), also call out signal maint. Mgmt. during construction, also DMS, cameras. Signal improvements e.g. inverters for battery.</li> </ul>	12
<p>Continue and improve work zone safety</p> <ul style="list-style-type: none"> <li>• Queue warning signs, possibly leave as permanent signs for when needed</li> </ul>	9
<p>Traveler information about delays</p> <ul style="list-style-type: none"> <li>• Keep tourists where they are Sundays on the way home</li> </ul>	-
<p>Traveler Incident Management</p> <ul style="list-style-type: none"> <li>• Hwy 61 emergency management plan, issues with alternate routes around incidents. Minimize delays through signal timing improvements. Temporary signal plans to reduce congestion. Had diversion routes developed, never used, didn't need them.</li> </ul>	-
<p>Traffic awareness during construction</p> <ul style="list-style-type: none"> <li>• Open lanes as soon as possible, delays in opening lanes when not needed to be closed during project. Manage contractor to respect traffic needs. Trade-offs of getting construction done vs. managing traffic.</li> </ul>	8
<p>Traveler Information Advertising</p> <ul style="list-style-type: none"> <li>• Are there signs here? 70-80 replied didn't know about it</li> </ul>	-
<p>Coordination with locals (possible Integrated Corridor Management)</p>	29, 14

**Table A-2: District 2 Stakeholder Input - TSMO Strategy Ideas**

MnDOT District 2 TSMO Strategy Idea	Strategy #
Innovative contracting for construction projects <ul style="list-style-type: none"> <li>• Tailoring special provisions so project goes faster</li> <li>• Special funding for additional cost to speed up the project</li> </ul>	-
Enhance detour route information <ul style="list-style-type: none"> <li>• Advanced information before key decision point locations</li> <li>• Provide information on alternate routes for example due to floods</li> <li>• Coordinate with other local agencies, operational coordination</li> </ul>	27
Warn travelers of visibility due to snow, blowing snow, and ice <ul style="list-style-type: none"> <li>• Encourage travelers to get off the roads</li> <li>• Visibility is more of an issue in the western part of District 2</li> <li>• Information is available on 511, are there other mechanisms to provide visibility information to travelers?</li> </ul>	-
Signal enhancements <ul style="list-style-type: none"> <li>• Interconnect standalone signals</li> <li>• Update coordination timing at location where there are reduced volumes</li> <li>• Provide remote communication to selected signals</li> </ul>	1
Enhance 511 information <ul style="list-style-type: none"> <li>• 511 is utilized more in the winter than summer</li> <li>• Include more special events and WZ info in the summer</li> <li>• There may be challenges with maintaining additional technology used to provide information (e.g. real-time arrow board information on 511)</li> </ul>	-
Reduce delays at locations where a trunk highway intersects with a railroad	-
Install additional RWIS and cameras <ul style="list-style-type: none"> <li>• For maintenance staff to view prior and during weather events</li> </ul>	15
Continue to improve multi-jurisdictional coordination <ul style="list-style-type: none"> <li>• Coordinate resources across boundaries</li> </ul>	5
Increase advanced warning flashers prior to a signal <ul style="list-style-type: none"> <li>• Advance warnings is a useful tool for truck drivers</li> </ul>	-
Automated unified permitting system	-
Document incident response process to minimize delay <ul style="list-style-type: none"> <li>• Useful for new employees to understand through scenarios and debrief meetings</li> </ul>	3
Increase portable traffic signals <ul style="list-style-type: none"> <li>• District 2 owns two portable traffic signals</li> </ul>	-

**Table A-3: District 3 Stakeholder Input - TSMO Strategy Ideas**

MnDOT District 3 TSMO Strategy Idea	Strategy #
Coordinate closed routes with mapping services <ul style="list-style-type: none"> <li>MnDOT posts closed routes in 511, but sometime the information is not included for example on Google. If a mapping services routes trucks to the closed routes there are challenges with the trucks turning around.</li> </ul>	2
Know equipment life cycle to assist with project planning <ul style="list-style-type: none"> <li>Provides and additional layer of information</li> </ul>	12
Continue to coordinate projects with metro, districts and locals	5
Identify strategies to address over capacity signals <ul style="list-style-type: none"> <li>Learn from others on what has worked</li> </ul>	1
Promote park n ride/park and pool on commuter routes <ul style="list-style-type: none"> <li>Higher traffic in AM and PM</li> <li>There are only 4 areas identified in a Commuter Study (available on website) set up now in District 3, but there are other routes that could benefit.</li> </ul>	-
Traveler information for recreational travel Fridays and Sundays <ul style="list-style-type: none"> <li>There are challenges with providing route choice as route choice need to be made leaving the cities and a crash may clear</li> </ul>	-
Weigh in motion screening for mobile enforcement	-
Install additional detection and DMS to provide travel times on Hwy 10 and I-94	7, 28
Install additional ATR at RWIS sites <ul style="list-style-type: none"> <li>Utilize existing power from RWIS sites (need to identify locations)</li> </ul>	7
Investigate ramp metering <ul style="list-style-type: none"> <li>Expanding out from metro area</li> </ul>	10
Signal enhancements <ul style="list-style-type: none"> <li>Central control system for remote monitoring) (20)</li> <li>District 3 currently has a contract in place for signal retiming (1)</li> <li>A few signals are isolated in District 3 (1)</li> </ul>	1, 20
Strategies for roadways without or minimal shoulders <ul style="list-style-type: none"> <li>Amish buggies have been hit in District 3 at a few locations</li> </ul>	4
Expand RICWS <ul style="list-style-type: none"> <li>Challenges with staff resources to maintain</li> <li>Challenges with county paying power</li> </ul>	16
Rural intersection lighting <ul style="list-style-type: none"> <li>Challenges with local agencies paying power and maintenance</li> </ul>	-

**Table A-4: District 4 Stakeholder Input - TSMO Strategy Ideas**

MnDOT District 4 TSMO Strategy Idea	Strategy #
Roundabouts (instead of traffic signals)	16
Multi-agency coordination <ul style="list-style-type: none"> <li>Signal coordination/issues &amp; incident response</li> <li>Partnering with jurisdictions/inter-agency agreements (cost reimbursement)</li> <li>Partnering with state patrol to sell solutions</li> </ul>	1, 3
Alternate Routes Signs (Safety and Mobility) <ul style="list-style-type: none"> <li>Flip down signs, DMS, route planning</li> <li>Timeliness/clarity of signing</li> <li>Education on proper use (emergencies)</li> <li>Passive rerouting/advance warning</li> </ul>	22
Performance management tools to identify improvements/low performance areas/crash locations	4
Cable barrier training/education with emergency providers/tow companies <ul style="list-style-type: none"> <li>Vehicle removal. Need refresher training. On-going, regular coordination with law enforcement/commercial vehicles.</li> </ul>	3
Advance warning flashers for traffic signals (for truck benefit) <ul style="list-style-type: none"> <li>Only when needed</li> </ul>	-
Roadway capacity enhancements. <ul style="list-style-type: none"> <li>Passing lanes</li> <li>Prioritizing routes for implementation</li> <li>Shoulder widening</li> <li>Commercial vehicle pull outs for weight measurement</li> </ul>	4
Proactive Internal education <ul style="list-style-type: none"> <li>TSMO strategies benefits/costs</li> <li>Best practices/lessons learned</li> <li>Work zone safety and mobility/onsite reviews</li> </ul>	-
Partnering with Google and other third parties <ul style="list-style-type: none"> <li>Sharing MnDOT info with third parties to help routing</li> </ul>	2
Road closure/hazard info on 511. Adding other agency info onto MnDOT's system.	-
Add a District 511 representative to speed posting of info. <ul style="list-style-type: none"> <li>Need 24/7 coverage for adding events</li> <li>Connectivity/cell service for reporting events</li> </ul>	-
Magnet lights/solar lights for alternate route signing	27
Temp traffic control manual (disseminate to each truck station). Layout sheets to mark-up on-site/enforce and use Red book.	-
Ability to repair DMS <ul style="list-style-type: none"> <li>Allow district staff to clear codes in timely fashion</li> </ul>	-
Snow fences	6
Railroad rerouting <ul style="list-style-type: none"> <li>Auto reroute traffic based on where trains are present</li> </ul>	-
Speed studies (through small towns) <ul style="list-style-type: none"> <li>Revising speeds up or down</li> <li>Transitional speeds</li> </ul>	4

MnDOT District 4 TSMO Strategy Idea	Strategy #
Flashing yellow arrow signals	-
Freight/Manufacturing studies <ul style="list-style-type: none"> <li>• Where does freight go and aligning with plowing routes</li> <li>• Pre-pass for weigh stations</li> </ul>	-
Planning studies to identify future projects <ul style="list-style-type: none"> <li>• Working with other agencies cooperatively</li> </ul>	4
Cohousing law enforcement with DOT truck stations. Inviting to scoping meetings/annual meetings.	-
Funding for rest areas – strategies to prevent fatigue	-
PPP to reduce cost burden. Toll roads, rest areas, etc.	-
Park and Rides between major cities. Train/mobility options.	-
Additional RWIS sites <ul style="list-style-type: none"> <li>• Better forecasting for maintenance</li> <li>• Upgrading RWIS towers with non-intrusive sensors</li> <li>• Add cameras on all RWIS sites</li> <li>• Focus on western parts to see storms coming from west</li> <li>• Take advantage of existing weather sources (other states)</li> </ul>	15
Snow Plow Enhancements <ul style="list-style-type: none"> <li>• Plow trucks with cameras</li> <li>• Signal priority for snow plows</li> </ul>	26

**Table A-5: District 6 Stakeholder Input - TSMO Strategy Ideas**

MnDOT District 6 TSMO Strategy Idea	Strategy #
Increase camera uptime on 511 during weather events	-
Traveler information enhancements <ul style="list-style-type: none"> <li>• Provide a navigation option on 511</li> <li>• Increase 511 road condition updates</li> <li>• Display plow cameras (challenges with reliability and images making the snow disappear)</li> <li>• Display location of plow cameras (AVL) for route information</li> </ul>	-
Identify a contact at Google to inform of incorrect road information	2
Increase DMS messages <ul style="list-style-type: none"> <li>• Provide travel times/stopped traffic message on DMS in work zones</li> <li>• Provide travel times on DMS during weather events</li> <li>• Use DMS for VSL during weather events (e.g. on I-35)</li> </ul>	17
Signal enhancements <ul style="list-style-type: none"> <li>• Signal retiming</li> <li>• Optimizing standalone signals</li> <li>• Install battery backups</li> <li>• Replace signal heads at locations that have been modified (e.g. flashing yellow arrow implementation)</li> </ul>	1
Coordinate with other MnDOT plans and other offices	-
Plow route optimization and truck station location <ul style="list-style-type: none"> <li>• Contact Chris M</li> </ul>	-
Increase freight information <ul style="list-style-type: none"> <li>• Freight restrictions in work zones</li> <li>• Expansion of real-time truck parking system</li> </ul>	21
Identify other uses for DMS <ul style="list-style-type: none"> <li>• If a DMS is used to provide an alert such as truck parking or RICWS, could also possibly be used to provide other types of information</li> </ul>	7

**Table A-6: District 7 Stakeholder Input - TSMO Strategy Ideas**

MnDOT District 7 TSMO Strategy Idea	Strategy #
Traveler information enhancements <ul style="list-style-type: none"> <li>• Predictive 511 - what will the roads be in 5 hours</li> <li>• Fixed cameras</li> <li>• Understanding pavement temps</li> <li>• Leverage data (probe data), vehicle speeds</li> </ul>	26
Signal enhancements <ul style="list-style-type: none"> <li>• Update signal retiming (currently coming up with schedule for retiming (1)</li> <li>• Utilize a central system for remote monitoring at some signals (20)</li> <li>• Coordination with cities                             <ul style="list-style-type: none"> <li>- Signal maintenance agreements with cities (1)</li> <li>- Establish a regional signal timing position (1)</li> </ul> </li> </ul>	1, 20
Replace signals with roundabouts	16
Pavement enhancements <ul style="list-style-type: none"> <li>• Passing lanes, extending length of turn lane, acceleration lane</li> </ul>	4
Drive the work zone with the traffic control plan before it is let to address modifications prior to the start of the project <ul style="list-style-type: none"> <li>• Consider local travelers may not follow signed detour/alternate routes with route planning</li> </ul>	-
Rapid crash clearance with state patrol <ul style="list-style-type: none"> <li>• State patrol currently does not use drones, consider drones and other mechanisms</li> <li>• D7 has hand held lidar unit</li> </ul>	3
Increase DMS usage and social media messages <ul style="list-style-type: none"> <li>• Include weather including future conditions, consistent with 511 messages</li> <li>• Challenges with central control vs. district.</li> </ul>	17
Flood mitigation projects	-
Identify studies reimbursable under TSMO	-
Sign alternate routes <ul style="list-style-type: none"> <li>• Signs on I-90 (floods)</li> <li>• Unplanned events planning</li> </ul>	22
Alert drivers of snow plows and work zones	-
Continue with snow fences	6
Install additional road closed when flashing signs	-
Transit signal priority	30
Identify locations for low cost safety enhancements <ul style="list-style-type: none"> <li>• Chevrons, rumbles, edge lines</li> </ul>	4
Staffing <ul style="list-style-type: none"> <li>• Needs and resources may change with new systems and technology</li> </ul>	-
Culvert extensions to eliminate guardrail, which contribute to drifting and snow hazards	4

**Table A-7: District 8 Stakeholder Input - TSMO Strategy Ideas**

MnDOT District 8 TSMO Strategy Idea	Strategy #
Identify strategies for inattentive driving in work zones <ul style="list-style-type: none"> <li>• Contact Ted Ulven on current efforts.</li> <li>• Strategies may include a work zone intrusion alarm for workers in a work zone, activated by operator (9)</li> </ul>	9
Install weather stations to provide real-time information to travelers on 511 <ul style="list-style-type: none"> <li>• Additional weather stations are needed in the western part of District 8 (15)</li> <li>• Locations selected should consider other locations statewide</li> </ul>	15
Research snow fence options <ul style="list-style-type: none"> <li>• Living and durable snow fences are utilized in District 8</li> <li>• There may be other options through engineering and research for the district to consider (Contact Dan Gullickson for information on current research efforts)</li> </ul>	6
Install snowplow visibility warnings to alert drivers <ul style="list-style-type: none"> <li>• Warning could include strobe lights</li> </ul>	-
Provide 511 data to in-vehicle navigation systems (GPS)	-
Install blow ice warning systems at known locations where blow ice is an issue <ul style="list-style-type: none"> <li>• District 8 has one blow ice warning system</li> <li>• Newer technology should be researched to improve upon the issues (e.g. sensors) from the current system</li> <li>• Maintenance of the newer systems should also be understood for newer technology</li> </ul>	-
Simplify CMS messages for weather related road conditions and closures <ul style="list-style-type: none"> <li>• District 8 uses portable CMS (approximately 14 throughout the district) with remote communications during winter weather conditions. MnDOT posts the messages.</li> <li>• The messages should mirror 511 descriptions</li> </ul>	17
Provide alternate route information (e.g. road conditions, weather) on 511 or other dissemination mechanisms <ul style="list-style-type: none"> <li>• Providing route options with road condition and weather information will assist travelers and freight companies in making informed route choices</li> </ul>	-
Install plow cameras statewide to display on 511	26



**Table A-8: Metro District Stakeholder Input - TSMO Strategy Ideas**

MnDOT Metro District TSMO Strategy Idea	Strategy #
Improved incident response time	3
Display lane closures in real-time (automated) on 511 traveler information <ul style="list-style-type: none"> <li>Longer term lane closures are entered into 511, short term lane closures (less than 45 min) are typically not entered into 511. A display of real-time lane closures would assist with coordination and management.</li> </ul>	19
Improvement in speed enforcement <ul style="list-style-type: none"> <li>There are legislative challenges. Consider alt solutions such as a trooper viewing a camera of a speeding vehicle.</li> </ul>	25
Real-time performance measures <ul style="list-style-type: none"> <li>Monitor construction and maintenance delays in real-time, look at distribution to make adjustments to reduce delays</li> </ul>	9
Improved project planning and program planning between districts, bordering states, other agencies	-
Coordination with the Congestion Management Process in the metro area <ul style="list-style-type: none"> <li>There are competing performance criteria</li> </ul>	-
In-vehicle messages <ul style="list-style-type: none"> <li>Provide options to the use the phone in a safety, for example provide an audible alert to the traveler that they are approaching a work zone.</li> </ul>	-
Signal timing <ul style="list-style-type: none"> <li>Upgrade signals including communication to central system</li> </ul>	20
State lead effort to partner with organizations to increase transit ridership <ul style="list-style-type: none"> <li>Previous mode choice surveys have noted that some individuals can't take transit every day. There is a decision between the parking cost and transit cost. Sometimes you have to buy for an entire month.</li> <li>Continue to participate in the Shared Mobility Collaborative.</li> </ul>	-
Integrated apps <ul style="list-style-type: none"> <li>Include transit with traveler information</li> </ul>	14
Identify opportunities to train work force	-
Establish periodic assessments of projects and procedures <ul style="list-style-type: none"> <li>TSMO criteria may be different in the metro area than out state</li> </ul>	-
Install cameras on non-freeway corridors to verify traffic conditions <ul style="list-style-type: none"> <li>Cameras should provide a view of at least 1 mile</li> </ul>	-
Share cameras and other information with partners <ul style="list-style-type: none"> <li>MnDOT to share for example cameras with cities and counties and for cities and counties to share their camera images with MnDOT</li> </ul>	29
Provide public information about safety on the roadways	-
Partner with employers to encourage employees to tele work, delay start time, or alter work schedule due to weather or congested times of day <ul style="list-style-type: none"> <li>Provide road and weather information to employers</li> </ul>	34
Provide alert mechanisms on workers in a work zone to warn of vehicle close to the worker <ul style="list-style-type: none"> <li>An alarm on workers vest</li> </ul>	9
Parking management systems <ul style="list-style-type: none"> <li>Provide signs on interstates for cars circling for parking</li> </ul>	-

MnDOT Metro District TSMO Strategy Idea	Strategy #
Partner with local agencies and transit on detour routes and diversion routes <ul style="list-style-type: none"> <li>• Consider local traffic may not follow signed detour routes</li> <li>• Fund TMOs to educate</li> </ul>	5
Learn from others on what is effective in work zones <ul style="list-style-type: none"> <li>• Communicate in a work zone the start and end locations</li> </ul>	-
Provide snowplow priority at signals	-
Increasing asset management life cycle replacement	12
Increase maintenance staff shift differential to encourage availability of night workers	-
Utilize automated shadow trucks <ul style="list-style-type: none"> <li>• Truck mounted attenuator (TMA)</li> </ul>	-

**Table A-9: Central Office Stakeholder Input - TSMO Strategy Ideas**

MnDOT Central Office TSMO Strategy Idea	Strategy #
Work zone (WZ) traveler safety and mobility <ul style="list-style-type: none"> <li>• Audible system–warning workers and drivers in WZ</li> <li>• In-vehicle messages (cell phones) in work zones</li> <li>• Expand your speed is signs (radar)</li> <li>• limit driver distractions</li> </ul>	9
Standardize weather messages in districts <ul style="list-style-type: none"> <li>• Consistent messages for example on CMS</li> <li>• Provide advanced weather messages</li> </ul>	17
CMS expansion <ul style="list-style-type: none"> <li>• Information to engage and warn the driver</li> </ul>	7
Expand and streamline road weather data into different systems <ul style="list-style-type: none"> <li>• Data may include MDSS, plow cameras, and RWIS</li> <li>• Automate consistent messages</li> </ul>	26
Traveler information improvement - More advanced notification/communication of closures and detour routes for freight (e.g. OS/OW)	22
Schedule and location coordination of construction projects and truck parking availability across districts and with cities and counties	5
Continue and expand work zone training. <ul style="list-style-type: none"> <li>• Training on traffic attenuators (safety considerations)</li> <li>• MnDOT currently is conducting work zone listening sessions to identify gaps in work zone training</li> </ul>	-
Maintenance having to reroute traffic, pedestrians etc. when working in areas with not adequate space	8
Work zone worker safety and job satisfaction <ul style="list-style-type: none"> <li>• Staff retention- reduce night and weekend shifts, maintain work during day light hours</li> <li>• Audible system – warning workers and drivers in WZ</li> <li>• Expand your speed is signs (radar)</li> <li>• limit driver distractions</li> </ul>	9
Incorporate 3 <sup>rd</sup> party data (e.g. Waze) with 511 <ul style="list-style-type: none"> <li>• MnDOT is considering for outstate</li> </ul>	2
Continue to improve freight mobility <ul style="list-style-type: none"> <li>• Expansion of the use of mainline WIMs for weight enforcement (deploying in D6) to reduce congestion around and in weigh stations</li> </ul>	11
Manage TSMO assets <ul style="list-style-type: none"> <li>• Shared location of assets</li> </ul>	12
Provide traveler information and/or connectivity at rest areas	21
Improvement in speed enforcement <ul style="list-style-type: none"> <li>• Automated/enhanced/extraordinary</li> </ul>	25
Signal timing adjustments for non-motorized traffic	1
VSL for high impact events <ul style="list-style-type: none"> <li>• Weather events</li> </ul>	-
Continue and expand TIM training (Internal and external)	3

MnDOT Central Office TSMO Strategy Idea	Strategy #
Expand plow cameras	26
Promote snow fences to farmers and reduce snow traps	6
Provide transit, ped and bike detours on larger projects	31
Increase ped bike counter data use and collection <ul style="list-style-type: none"> <li>• Consider known non-motorized locations-grocery store</li> </ul>	-
Enhance FIRST vehicles for incident management <ul style="list-style-type: none"> <li>• Support state patrol in moving veh and debris clearance</li> </ul>	-
Coordination with small urban areas <ul style="list-style-type: none"> <li>• Impacts to transit</li> </ul>	-
Shared use mobility options for all TSMO strategies	-

**Table A-10: OTE and CAV-X Stakeholder Input - TSMO Strategy Ideas**

MnDOT OTE and CAV-X TSMO Strategy Idea	Strategy #
<p>CAV Readiness Improvements</p> <ul style="list-style-type: none"> <li>• Make signals CAV ready (new signals). How to get SPaT data.</li> <li>• Prepare IT systems to harvest/use data from CAVs</li> <li>• How to use data from CAVs for better traffic management (long term)</li> <li>• Determine methods for CAV to handle weather data/poor weather.</li> </ul>	23, 33
<p>Intersection timing analysis where issues exists (outstate). Applies mostly to larger cities.</p> <ul style="list-style-type: none"> <li>• Isolated</li> <li>• Coordinated</li> <li>• Construction</li> <li>• Awareness of available CO resources and technical expertise</li> <li>• New intersection counts</li> <li>• Better signal coordination for off-peak</li> <li>• Statewide multi-agency coordination for signal coordination (re-look at this). Signals that others own (non-MnDOT) need to be operated at optimal efficiency</li> <li>• Baseline assessment of signals (performance measures). Proactive signal monitoring.</li> <li>• Free operating signals. Reduce max times (possible outcome). Need to review more often. <ul style="list-style-type: none"> <li>- Need more resources/awareness and training to ID issues and address them.</li> </ul> </li> </ul>	1
<p>Work zone tools</p> <ul style="list-style-type: none"> <li>• Signal timing updates (plans) for construction</li> <li>• More non-intrusive detection for construction</li> <li>• Statewide TMP checklist – Pick list for things to do for given situations.</li> <li>• WZ strategy consistency coordination between districts</li> <li>• Mobile barrier – to protect maintenance workers</li> <li>• Lane closure tools <ul style="list-style-type: none"> <li>- Sketch tool for scheduling of lane closures. Maintenance staff scheduling. Can be used to develop the lane closure manual.</li> <li>- Lane closure manual for all districts. Some have them now and some don't.</li> </ul> </li> </ul>	13
<p>Provide real-time work zone traffic control data to RTMC and 3rd parties</p> <ul style="list-style-type: none"> <li>• Smart arrow boards (RTMC gets notified for on/off). Caution mode. Full deployment would be useful.</li> <li>• Portable CMS messages – need to have a way to see what these signs say/change messages on real-time basis (RTMC only not 3rd parties)</li> </ul>	32, 19
<p>Single location for IWZ information.</p> <ul style="list-style-type: none"> <li>• Currently this info is broken down and not concise. To see status and data. Intrans is developing this system. Hard to get to historical data. Stored on separate databases.</li> <li>• Mobile access</li> <li>• Live monitoring (dashboards, heat map). Speeds and lane occupancy. Auto notification based on conditions.</li> <li>• IWZ alert system</li> </ul>	32, 19
<p>Balancing mobility needs of different modes (peds vs. autos)</p>	31

MnDOT OTE and CAV-X TSMO Strategy Idea	Strategy #
<ul style="list-style-type: none"> <li>Smart phone app for work zones &amp; signals (visually impaired peds). How to implement?</li> <li>Incorporate pedestrian provisions (non-motorized traffic) at signalized intersection where peds are allowed regardless if peds are active in the area. Make sure signage is accurate.</li> <li>Assessing now (to be complete in Dec.) Coordinate with state non-motorized transportation committee (SNTC).</li> </ul>	
Sharing MnDOT data with 3rd parties <ul style="list-style-type: none"> <li>XML feed format for official detours (RTMC)/511</li> <li>Provide signal phasing, work zone and incident management, detours to 3rd parties</li> </ul>	2
Traffic Training <ul style="list-style-type: none"> <li>Training for traffic inspection</li> <li>TMP training and Traffic Control Plans               <ul style="list-style-type: none"> <li>Project Managers</li> <li>Designers</li> </ul> </li> </ul>	-
Intelligent Work zones <ul style="list-style-type: none"> <li>Travel time signs (goal 1)</li> <li>End of queue warning system (goal 2)</li> <li>Active Zipper Merge (dynamic lane merge (goal 1&amp;2)</li> <li>Electronic workers present speed limit (goal 2)</li> </ul>	9
Maintenance Vehicle Enhancement <ul style="list-style-type: none"> <li>Maintenance clearance plows. Vehicle pushes larger debris to side of the road. Operator doesn't have to leave the vehicle.</li> <li>Maint vehicles dashboard and rear mounted camera</li> </ul>	-
Integrate INRIX and HERE data into MnDOT network of detection data <ul style="list-style-type: none"> <li>IWZ application</li> </ul>	-
Signal enhancements <ul style="list-style-type: none"> <li>Upgrade/better maintenance of existing signal systems</li> <li>Need more often maintenance visits/preventative maintenance to assess conditions.</li> </ul>	1
End of queue warning systems <ul style="list-style-type: none"> <li>IDIQ doesn't work – takes too long</li> <li>Need quick implementation</li> </ul>	9
Correlation between RWIS and 511 reports	-
Reduce inaccurate signing <ul style="list-style-type: none"> <li>Signing up to long</li> <li>Working with contractors</li> </ul>	
Remove unwarranted signals	
Work zone Data Initiative <ul style="list-style-type: none"> <li>Predictive models – data driven decisions (work zones)</li> <li>Need good work zone activity data</li> </ul>	
Capacity division study (e.g., 52, I-35) through district <ul style="list-style-type: none"> <li>For each freeway/expressway</li> <li>Parallel route identification</li> </ul>	
More RWIS sites (with cameras)	15

MnDOT OTE and CAV-X TSMO Strategy Idea	Strategy #
Effective methods for managing data (dashboards) <ul style="list-style-type: none"> <li>• For example, easily recording video of work zone. Reduce staff (MNIT) burden. Multiple applications?</li> </ul>	-
Autonomous TMA to follow construction crew to provide protection <ul style="list-style-type: none"> <li>• Colorado application</li> </ul>	-
Make good use of collected data <ul style="list-style-type: none"> <li>• Artificial intelligence (general need)</li> <li>• Actionable data</li> <li>• Staff to analyze</li> <li>• Possibly related to incidents</li> </ul>	-

**Table A-11: RTMC Stakeholder Input - TSMO Strategy Ideas**

MnDOT RTMC TSMO Strategy Idea	Strategy #
Continued expansion of existing freeway management tools such as ramp metering, cameras, detection, etc.	7, 10
Continued expansion of MnPASS lanes in the Twin Cities Metro	24
Signal timing	1
Integrated Corridor Management <ul style="list-style-type: none"> <li>Ability to share data between agencies whether its video feeds, traffic data, incident data, etc.</li> <li>Share data between freeways, arterials, and transit</li> </ul>	29
Expand travel times to Metro arterials and Greater MN corridors where applicable	28
Provide travel times in work zones	28
Provide travel time information through 511 for key routes	28
Work with major employers to decrease traffic demand during snow and ice events by encouraging employers to allow teleworking during major storms.	34
Provide timely and accurate weather-related messages on DMS for unexpected road conditions.	17
Reestablish Traffic Incident Management position at RTMC	-
Establish traffic incident management (TIM) teams	-
Conduct after action reviews for major incidents	-
Develop a towing and recovery incentive program which gives incentives for towing companies to clear incidents involving commercial vehicles within a certain time threshold. (Ohio DOT gives tow companies \$3000 if an incident is cleared with 90 minutes)	-
Develop shared quick clearance goals with State Patrol	3
Pre-plan detour/alternate routes (alternate route signing, traffic control mobilization plan, signal timing plans)	-
Explore new strategies for crash reconstruction (aerial drones, photogrammetry, LIDAR)	-
Continued and expanded training on TIM for emergency responders	3
Increase density of CMS in both Twin Cities and Greater MN	7
Improve input of incident information and alternate routes into 511	14
Coordinate projects across district boundaries	5
Coordinate projects with local agencies	5
Coordinate construction and maintenance activities	5
For major projects, consider modifications to parallel routes such as temp lane additions, temp turn lanes, signal timing, etc.	27
Provide travel times via CMS and 511 to encourage diversion.	28
Develop a better approval/notification process for lane closures to avoid conflicts	8
Develop TIM strategies for work zones. <ul style="list-style-type: none"> <li>TIM response plans for specific work zones</li> <li>Coordination with local response agencies to allow emergency vehicle access on ramps that may be closed to general traffic.</li> <li>Tow truck service patrols or FIRST routes funded by SRC. (FIRST has historically been ½ the price of tow truck service patrols)</li> </ul>	8



MnDOT RTMC TSMO Strategy Idea	Strategy #
Deploy queue warning systems	7, 9

## **Appendix B – Prioritization Criteria, Weighting, and Scores**

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Table B-1 includes additional detail on the criteria scoring and weighting assigned to the scoring criteria. Table B-2 includes the criteria scores for each of the 34 prioritized strategies.

**Table B-1: TSMO Prioritization Scoring Criteria and Scoring Values**

Criteria	Scoring Options	Weight	Max Pts
<p><b>Criteria 1: Impact (Cost and Benefits)</b></p> <p><i>Description: Extent to which the TSMO strategy will positively influence MnDOT District TSMO objectives, especially with consideration of deployment costs. Lower scores for strategies that will have less impact on TSMO objectives when compared to costs. Higher scores for strategies with greater impacts and lower costs.</i></p>	<p>Select one.</p> <p><input type="checkbox"/> 0 – Does not address any TSMO objectives or has estimated costs greater than estimated benefits.</p> <p><input type="checkbox"/> 1 – Addresses at least 1 TSMO objective and the benefits are marginal compared to the cost.</p> <p><input type="checkbox"/> 2 – Addresses at least 1 TSMO objective with significant benefits, but significant cost.</p> <p><input type="checkbox"/> 3 – Addresses at least 1 TSMO objectives with significant benefits and moderate cost.</p> <p><input type="checkbox"/> 4 – Addresses at least 1 TSMO objectives with significant benefits and low cost.</p> <p><input type="checkbox"/> 5 – Addresses at least 1 TSMO objective and has widespread benefits which are much greater than the costs.</p>	30	150
<p><b>Criteria 2: Planning Consistency</b></p> <p><i>Description: Extent that the TSMO strategy is identified in an existing plan and/or addresses a documented need.</i></p>	<p>Select one.</p> <p><input type="checkbox"/> 0 – Strategy does not address a TSMO objective and is not reflected in an existing plan.</p> <p><input type="checkbox"/> 1 Strategy addresses a TSMO objective but does not address a need documented in an existing plan.</p> <p><input type="checkbox"/> 3 – Strategy addresses a TSMO objective and addresses a need in no more than 1 existing plan.</p> <p><input type="checkbox"/> 5 – Strategy addresses a TSMO objective and addresses a need in multiple existing plans.</p>	5	25
<p><b>Criteria 3: Geographic Scale and Balance</b></p> <p><i>Description: Extent to which the TSMO strategy provides benefits across Minnesota. Lower scores for smaller geographic area. Higher scores for statewide benefit.</i></p>	<p>Select one.</p> <p><input type="checkbox"/> 1 – Strategy will benefit one metro area OR is district specific (local benefit).</p> <p><input type="checkbox"/> 3 – Strategy will benefit multiple metro areas OR rural areas (regional benefit).</p> <p><input type="checkbox"/> 5 – Strategy will benefit multiple metro areas AND rural areas (statewide benefit).</p>	10	50

Criteria	Scoring Options	Weight	Max Pts
<p><b>Criteria 4: Coordination and Synergy</b></p> <p><i>Description: Extent to which the TSMO strategy will piggyback on other projects or activities that are already programmed or implemented. Lower scores for strategies that are stand-alone that are not coordinated with other projects or agencies. Higher scores for strategies that are show greater integration with other projects/agencies and leverage external investment.</i></p>	<p>Select one.</p> <p><input type="checkbox"/> 0 – Strategy is stand alone and not coordinated with other projects, programs or agencies</p> <p><input type="checkbox"/> 1 – Strategy supports or is supported by an on-going TSMO related activity or existing program or system</p> <p><input type="checkbox"/> 3 – Strategy provides resources to support or increase efficiency of an on-going, planned or programmed project OR will help avoid repeated traffic disruption and detours by building off an already programmed project.</p> <p><input type="checkbox"/> 5 – Strategy meets all the conditions of a 3-point score AND involves external agencies OR leverages external funds or resources.</p>	15	75
<p><b>Criteria 5: Ease of Implementation</b></p> <p><i>Description: Extent to which strategy is easy to implement and/or the anticipated time to implement and begin recognizing benefits.</i></p>	<p>Select one.</p> <p><input type="checkbox"/> 0 – Difficult to implement.</p> <p><input type="checkbox"/> 1 – Required knowledge and resources required are not well understood or difficult to implement.</p> <p><input type="checkbox"/> 3– Required knowledge and resources well understood but deployment time and/or deployment complexity is moderate to extensive.</p> <p><input type="checkbox"/> 5 – Knowledge and resources well understood, easy to implement and time to deploy is known and minimal time.</p>	20	100
<p><b>Criteria 6: Maintainable Scale</b></p> <p><i>Description: Extent to which the TSMO strategy can be operated and maintained in the future with minimal impacts to existing workforce.</i></p>	<p>Select one.</p> <p><input type="checkbox"/> 1 – Additional staff required for operations and maintenance.</p> <p><input type="checkbox"/> 3 – Challenge to existing workforce.</p> <p><input type="checkbox"/> 5 – Operation and maintenance can be handled by existing workforce.</p>	15	75

Criteria	Scoring Options	Weight	Max Pts
<p><b>Criteria 7: Accessibility</b></p> <p><i>Description: Extent to which the strategy enhances accessibility and affordability of travel. This can improve both personal accessibility as well as modal accessibility such as access to freight routes and terminals.</i></p>	<p>Select all that apply.</p> <p><input type="checkbox"/> 0 – Strategy does not improve accessibility.</p> <p><input type="checkbox"/> 1 – Strategy reduces cost of travel or enhances payment options.</p> <p><input type="checkbox"/> 1 – Strategy improves services or reduces time of travel for users of all modes, incomes and abilities.</p> <p><input type="checkbox"/> 1 – Strategy expands travel choices for all users of all abilities and incomes or dependence on a single mode.</p> <p><input type="checkbox"/> 1 – Strategy improves connections between modes.</p> <p><input type="checkbox"/> 1 – Strategy improves the comfort or convenience of travel for users of all abilities and incomes.</p>	5	25
<p><b>Criteria 8: Research, Innovation and Technology</b></p> <p><b>Bonus Category (potential 5% bonus)</b></p> <p><i>Description: Extent to which the TSMO strategy leverages new innovations, technologies or research results. This implies that the innovations, technologies or research results have not been applied on a previously implemented project. This may be a bonus type category that assigns a potential 5% additional points (25 pts) to strategies that apply new research or new innovations in trying to solve problems.</i></p>	<p>Select one.</p> <p><input type="checkbox"/> 0 – Strategy does not leverage new innovations, technologies or research results.</p> <p><input type="checkbox"/> 5 – Strategy leverages new innovations, technologies or research results.</p>	5	25
<b>Total Points</b>			<b>525</b>

**Table B-2: Strategy Scores by Criteria**

Strategy #	Title	Criteria*	1 – Impact	2 – Planning Consistency	3 – Geographic Scale and Balance	4 – Coordination and Synergy	5 – Ease of Implementation	6 – Maintainable Scale	7 – Accessibility	8 – Research, Innovation and Technology	Total Score
			Weighted Value	30	5	10	15	20	15	5	
1	Update Signal Timing and Coordination	Criterion Score	5	5	3	5	5	5	1	0	460
		Weighted Score	150	25	30	75	100	75	5	0	
2	Increase MnDOT Usage of 3rd Party Data and Increase Sharing with Traveler Information Disseminators (e.g. Google, WAZE, INRIX, HERE)	Criterion Score	3	5	5	5	5	5	0	5	440
		Weighted Score	90	25	50	75	100	75	0	25	
3	Develop Regional Traffic Incident Management (TIM) Programs	Criterion Score	5	5	5	3	5	3	3	0	430
		Weighted Score	150	25	50	45	100	45	15	0	
4	Implement Low-Cost / High-Benefit Capital Improvements (CMSP)	Criterion Score	5	5	5	3	3	5	1	0	410
		Weighted Score	150	25	50	45	60	75	5	0	
5	Coordinate Work Zones Across Jurisdictions and Routes	Criterion Score	5	3	5	3	3	5	1	0	400
		Weighted Score	150	15	50	45	60	75	5	0	
6	Expand Snow Fence Use through Research and Increased Use	Criterion Score	4	3	5	3	3	5	1	5	395
		Weighted Score	120	15	50	45	60	75	5	25	
7	Expand the Coverage of Freeway and Expressway Traffic Management Systems	Criterion Score	3	5	3	5	5	5	0	0	395
		Weighted Score	90	25	30	75	100	75	0	0	
8	Develop Traffic Incident Management (TIM) Strategies for Work Zones	Criterion Score	3	5	3	5	5	3	3	0	380
		Weighted Score	90	25	30	75	100	45	15	0	
9	Utilize Intelligent Work Zone Systems Where Appropriate	Criterion Score	3	5	5	5	3	3	1	5	375
		Weighted Score	90	25	50	75	60	45	5	25	

Strategy #	Title	Criteria*	1 – Impact	2 – Planning Consistency	3 – Geographic Scale and Balance	4 – Coordination and Synergy	5 – Ease of Implementation	6 – Maintainable Scale	7 – Accessibility	8 – Research, Innovation and Technology	Total Score
			Weighted Value	30	5	10	15	20	15	5	
10	Expand the Use of Ramp Metering	Criterion Score	5	5	3	3	5	1	1	0	370
		Weighted Score	150	25	30	45	100	15	5	0	
11	Expand Use of Technology at Weigh Stations for Enforcement	Criterion Score	4	5	5	1	3	5	0	5	370
		Weighted Score	120	25	50	15	60	75	0	25	
12	Increase TSMO Asset Life Cycle Understanding and Management	Criterion Score	4	3	5	3	3	5	0	0	365
		Weighted Score	120	15	50	45	60	75	0	0	
13	Implement Signal Timing Updates for Construction Projects	Criterion Score	4	3	3	3	5	3	1	0	360
		Weighted Score	120	15	30	45	100	45	5	0	
14	Provide Traveler Information on Alternative Modes and Routes	Criterion Score	3	3	3	5	3	5	3	0	360
		Weighted Score	90	15	30	75	60	75	15	0	
15	Expand and Enhance the Deployment of Road Weather Information Systems	Criterion Score	3	5	5	1	5	5	0	0	355
		Weighted Score	90	25	50	15	100	75	0	0	
16	Expand Consideration of Innovative Intersection Technology or Design (e.g. RICWS, roundabouts, RCIs, diverging diamonds, etc.)	Criterion Score	3	5	3	5	3	5	0	0	355
		Weighted Score	90	25	30	75	60	75	0	0	
17	Expand Dynamic Message Sign (DMS) Use to Include Standard Weather Messages	Criterion Score	4	5	3	3	3	5	0	0	355
		Weighted Score	120	25	30	45	60	75	0	0	
18	Improve Pedestrian and Bicycle Service at Signals	Criterion Score	4	5	3	1	4	5	2	0	355
		Weighted Score	120	25	30	15	80	75	10	0	

Strategy #	Title	Criteria*	1 – Impact	2 – Planning Consistency	3 – Geographic Scale and Balance	4 – Coordination and Synergy	5 – Ease of Implementation	6 – Maintainable Scale	7 – Accessibility	8 – Research, Innovation and Technology	Total Score
			Weighted Value	30	5	10	15	20	15	5	
19	Increase Real-time Tracking of Work Zones and Lane Closures for 511	Criterion Score	3	5	5	3	3	3	3	5	355
		Weighted Score	90	25	50	45	60	45	15	25	
20	Upgrade Signal Controller and Communications Equipment for Communications to Central System	Criterion Score	4	5	3	3	3	3	1	5	355
		Weighted Score	120	25	30	45	60	45	5	25	
21	Deploy Truck Parking Information for Rest Areas	Criterion Score	4	5	3	1	3	5	0	5	350
		Weighted Score	120	25	30	15	60	75	0	25	
22	Develop and Implement Pre-planned Alternative Routes for Incidents	Criterion Score	4	5	5	3	3	3	1	0	350
		Weighted Score	120	25	50	45	60	45	5	0	
23	Ensure New Signals are Connected Automated Vehicle (CAV) Ready	Criterion Score	4	5	3	3	1	5	2	5	350
		Weighted Score	120	25	30	45	20	75	10	25	
24	Add Additional MnPASS Lanes in the Twin Cities Metro Area	Criterion Score	3	5	1	5	3	5	1	0	340
		Weighted Score	90	25	10	75	60	75	5	0	
25	Provide Enhanced Enforcement Technology (Speed Enforcement, Red Light Running, MnPASS, etc.)	Criterion Score	3	5	5	1	3	5	0	5	340
		Weighted Score	90	25	50	15	60	75	0	25	
26	Expand and Streamline Road Weather Data	Criterion Score	3	3	5	5	1	3	1	5	325
		Weighted Score	90	15	50	75	20	45	5	25	
27	Utilize Alternate Route Signing for Work Zones	Criterion Score	1	3	5	3	5	5	1	0	320
		Weighted Score	30	15	50	45	100	75	5	0	



Strategy #	Title	Criteria*	1 – Impact	2 – Planning Consistency	3 – Geographic Scale and Balance	4 – Coordination and Synergy	5 – Ease of Implementation	6 – Maintainable Scale	7 – Accessibility	8 – Research, Innovation and Technology	Total Score
			Weighted Value	30	5	10	15	20	15	5	
28	Expand Dissemination of Travel Times (Work Zones and Geographic Expansion)	Criterion Score	3	5	5	3	3	3	0	0	315
		Weighted Score	90	25	50	45	60	45	0	0	
29	Expand Sharing of Video and Data Between Agencies (Integrated Corridor Management)	Criterion Score	3	3	3	5	1	5	1	0	310
		Weighted Score	90	15	30	75	20	75	5	0	
30	Deploy Transit Signal Priority	Criterion Score	3	5	3	1	3	5	2	0	305
		Weighted Score	90	25	30	15	60	75	10	0	
31	Address Bikes and Pedestrians in Construction Detours	Criterion Score	3	3	3	3	1	3	4	5	290
		Weighted Score	90	15	30	45	20	45	20	25	
32	Improve Work Zone Data for CAV Readiness	Criterion Score	2	5	5	3	1	3	3	5	285
		Weighted Score	60	25	50	45	20	45	15	25	
33	Prepare Systems to Obtain/Use Data from CAVs	Criterion Score	1	5	5	3	1	3	0	5	240
		Weighted Score	30	25	50	45	20	45	0	25	
34	Encourage Work Flexibility for Travel Demand Management	Criterion Score	4	1	3	0	1	3	0	0	220
		Weighted Score	120	5	30	0	20	45	0	0	

\*See Table B-1

## Appendix C – Strategy Descriptions

Strategy #	Title
1	<a href="#">Update Signal Timing and Coordination</a>
2	<a href="#">Increase MnDOT Usage of 3rd Party Data and Increase Sharing with Traveler Information Disseminators (e.g. Google, WAZE, INRIX, HERE)</a>
3	<a href="#">Develop Regional Traffic Incident Management (TIM) Programs</a>
4	<a href="#">Implement Low-Cost / High-Benefit Capital Improvements (CMSP)</a>
5	<a href="#">Coordinate Work Zones Across Jurisdictions and Routes</a>
6	<a href="#">Expand Snow Fence Use through Research and Increased Use</a>
7	<a href="#">Expand the Coverage of Freeway and Expressway Traffic Management Systems</a>
8	<a href="#">Develop Traffic Incident Management (TIM) Strategies for Work Zones</a>
9	<a href="#">Utilize Intelligent Work Zone Systems Where Appropriate</a>
10	<a href="#">Expand the Use of Ramp Metering</a>
11	<a href="#">Expand Use of Technology at Weigh Stations for Enforcement</a>
12	<a href="#">Increase TSMO Asset Life Cycle Understanding and Management</a>
13	<a href="#">Implement Signal Timing Updates for Construction Projects</a>
14	<a href="#">Provide Traveler Information on Alternative Modes and Routes</a>
15	<a href="#">Expand and Enhance the Deployment of Road Weather Information Systems</a>
16	<a href="#">Expand Consideration of Innovative Intersection Technology or Design (e.g. RICWS, roundabouts, RCIs, diverging diamonds, etc.)</a>
17	<a href="#">Expand Dynamic Message Sign (DMS) Use to Include Standard Weather Messages</a>
18	<a href="#">Improve Pedestrian and Bicycle Service at Signals</a>
19	<a href="#">Increase Real-time Tracking of Work Zones and Lane Closures for 511</a>
20	<a href="#">Upgrade Signal Controller and Communications Equipment for Communications to Central System</a>
21	<a href="#">Deploy Truck Parking Information for Rest Areas</a>
22	<a href="#">Develop and Implement Pre-Planned Alternative Routes for Incidents</a>
23	<a href="#">Ensure New Signals are Connected Automated Vehicle (CAV) Ready</a>
24	<a href="#">Add Additional MnPASS Lanes in the Twin Cities Metro Area</a>
25	<a href="#">Provide Enhanced Enforcement Technology (Speed Enforcement, Red Light Running, MnPASS, etc.)</a>
26	<a href="#">Expand and Streamline Road Weather Data</a>
27	<a href="#">Utilize Alternate Route Signing for Work Zones</a>
28	<a href="#">Expand Dissemination of Travel Times (Work Zones and Geographic Expansion)</a>

Strategy #	Title
29	<a href="#">Expand Sharing of Video and Data Between Agencies (Integrated Corridor Management)</a>
30	<a href="#">Deploy Transit Signal Priority</a>
31	<a href="#">Address Bikes and Pedestrians in Construction Detours</a>
32	<a href="#">Improve Work Zone Data for CAV Readiness</a>
33	<a href="#">Prepare Systems to Obtain/Use Data from CAVs</a>
34	<a href="#">Encourage Work Flexibility for Travel Demand Management</a>

**Table C-1: Prioritized TMSO Strategy Descriptions**

Strategy #1: Update Signal Timing and Coordination	
<b>Description</b>	<p>This strategy will identify ways to address operational issues at signalized intersections and implement improvements to signal timing and coordination for increased mobility and safety for all modes and roadway users, especially in urban areas within Greater Minnesota districts. Applicable applications for this strategy include enhanced traffic signal operations (e.g., re-timing/optimization, adaptive detection, improved detection such as replacing or adding detection devices) and improved control schemes (signal timing and coordination). This strategy may include coordination across jurisdictions where city and county roads intersect with MnDOT highways. Traffic signal timing and control improvements hold strong potential to reduce traffic congestion in several areas around the state and improve mobility and safety of travelers using all modes, including vulnerable roadway users.</p>
<b>Comments from TSMO Outreach Meetings</b>	<ul style="list-style-type: none"> <li>• District 1: Signalized corridors, keeping them coordinated to minimize delays. Include in construction planning and TMP development. Temporary signal plans to reduce congestion. <b>(D1 High Priority)</b></li> <li>• District 2: Interconnect standalone signals; update coordination timing at location where there are reduced volumes; provide remote communication to selected signals.</li> <li>• District 3: Identify strategies to address over capacity signals. Learn from others what has worked. <b>(D3 High Priority)</b></li> <li>• District 3: District 3 currently has a contract in place for signal retiming; a few signals are isolated.</li> <li>• District 4: Multi-agency coordination, including signal coordination/issues &amp; incident response. Partnering with jurisdictions and use of inter-agency agreements (cost reimbursement). Partnering with state patrol to sell solutions. <b>(D4 High Priority)</b></li> <li>• District 6: Signal retiming; optimizing standalone signals; install battery back-ups; replace signal heads at locations that have been modified (flashing yellow arrow implementation)</li> <li>• District 7: Update signal retiming (currently scheduled); coordination with cities including signal maintenance agreements with cities and establish a regional signal timing position. <b>(D7 High Priority)</b></li> <li>• OTE/CAV: Intersection timing analysis where issues exist (outstate.) Applies mostly to larger cities. Isolated; coordinated; construction; awareness of available Central Office resources and technical expertise; new intersection counts; better signal coordination for off-peak; statewide multi-agency coordination for signal coordination. Signals that others own (non-MnDOT) need to be operated at optimal efficiency; Baseline assessment of signals (performance measures). Proactive signal monitoring; free operating signals. Reduce max times. Need to review more often. Need more resources/awareness and training to identify issues and address them. <b>(OTE/CAV High Priority)</b></li> <li>• OTE/CAV: Upgrade/better maintenance of existing signal systems. Need more frequent maintenance visits and preventative maintenance to assess conditions.</li> </ul>

	<ul style="list-style-type: none"> <li>• Central Office (Maintenance, Transit, OCIC, Freight): Signal timing adjustments for non-motorized traffic.</li> <li>• RTMC – Signal timing</li> <li>• Metro District: Signal timing</li> </ul>
<b>Current MN Status</b>	Many traffic signal systems around the state are in need of re-timing and signal coordination updates.
<b>Deployment Approach</b>	<p>This strategy would retime traffic signals on a scheduled basis to assure that all signals are retimed on regular basis.</p> <p>Signals on major arterials should be retimed every three years; Minor and isolated signals should be retimed every 4-7 years.</p>
<b>Anticipated 5 Year Deployment (Location(s) and Estimated Budget Range)</b>	<ul style="list-style-type: none"> <li>• The plan would be to retime and update all the traffic signals MnDOT operated. The 5-year budget would be \$4.2 – 5.3 Million (\$840K - \$1.4M per year).</li> <li>• The ideal plan would be to update the timing in all MnDOT’s signals over a four-year period, then use signal performance measures to determine an accurate retiming schedule. The 5-year budget would be \$7.0 Million (\$1.1 Million for each of Years 1-4, then \$660K for each Years 5 and beyond).</li> </ul>

**Strategy #2: Increase MnDOT Usage of 3rd Party Data and Increase Sharing with Traveler Information Disseminators (e.g. Google, WAZE, INRIX, HERE)**

<b>Description</b>	<p>This initiative will continue and expand activities MnDOT currently performs to enter and maintain event reports (incidents, work zones, detours, other activities) in the MnDOT traveler information system and to share these events with 3<sup>rd</sup> party information disseminators. While MnDOT operates the 511 Traveler Information System, MnDOT also provides an XML feed of all MnDOT generate event and condition reports, allowing 3<sup>rd</sup> party information disseminators to ingest the data from MnDOT and disseminate it. In this capacity, MnDOT and the Minnesota travelers benefit from the sophisticated information dissemination infrastructures created by 3<sup>rd</sup> party providers such as WAZE, INRIX, HERE, Google, and Streetlight Data. Specific activities in this strategy may include continuing the XML data feed, expanding the data included in the feed (possibly considering CAV data) and also expanding outreach to 3<sup>rd</sup> party providers to ensure they are informed about the availability of the information. An additional aspect to this strategy is to incorporate data provided by 3<sup>rd</sup> Party data providers into MnDOT’s condition reporting system and traveler information content. WAZE is an example of a 3<sup>rd</sup> Party provider that allows DOTs to ingest their events, as reported by citizens, often increasing the number of events disseminated by DOT systems.</p>
<b>Comments from TSMO Outreach Meetings</b>	<ul style="list-style-type: none"> <li>• District 3: Coordinate closed routes with mapping services (MnDOT posts closed routes in 511, but sometime the information is not included, for example, on Google. If a mapping service routes trucks to the closed routes, there are challenges with the trucks turning around.) <b>(D3 – High Priority)</b></li> <li>• District 4: Partnering with Google and other third parties (Sharing MnDOT info with third parties to help routing)</li> </ul>

	<ul style="list-style-type: none"> <li>• District 6: Identify a contact at Google to inform when there is incorrect road information</li> <li>• Central Office (Maint, Transit, OCIC, Freight): Incorporate 3<sup>rd</sup> party data (e.g. Waze) with 511 <ul style="list-style-type: none"> <li>○ MnDOT is considering expanded information entry for outstate districts</li> </ul> </li> <li>• OTE, CAV: Sharing MnDOT data with 3rd parties <ul style="list-style-type: none"> <li>○ XML feed format for official detours (RTMC)/511;</li> <li>○ Provide signal phase and timing, work zone and incident management, detours to 3rd parties</li> </ul> </li> </ul>
<b>Current MN Status</b>	MnDOT operates a real-time XML feed providing access to 3 <sup>rd</sup> party providers of all their events and condition report included in CARS. MnDOT has a well-established set of 3 <sup>rd</sup> party providers that currently ingest and use the data feed.
<b>Deployment Approach</b>	Software, integration and coordination
<b>Anticipated 5 Year Deployment (Location(s) and Estimated Budget Range)</b>	<ul style="list-style-type: none"> <li>• The RTMC shares data with 3rd Party Information Disseminators through a data feed on the 511 system. For example, Google and WAZE use this 511 data feed to get information on incidents and lane closures on the state highway system. Existing RTMC staff will continue outreach to these 3rd Party Information Disseminators to develop procedures for effectively sharing data.</li> <li>• RTMC is working with WAZE to ingest WAZE event data into MnDOT systems such as IRIS and 511.</li> <li>• MnDOT is in the process of purchasing real-time 3rd Party Cellular Probe Data. The first year was funded at \$400,000, however, an additional \$300,000 is needed to maintain the data once it's deployed.</li> </ul>

Strategy #3: Develop Regional Traffic Incident Management (TIM) Programs	
<b>Description</b>	<p>This strategy applies multi-agency coordination to improve traffic incident management (TIM) processes by developing regional traffic incident management (TIM) Programs to improve response efforts and incident clearance times. A specific aspect explored in this strategy will be situations where the agencies involved in TIM vary throughout a region or corridor and will seek to improve coordination and collaboration. This strategy may implement one or more of the following tactics as appropriate for each TIM region, including:</p> <ul style="list-style-type: none"> <li>– Improve collaboration among TIM partners (MnDOT, law enforcement, cities/counties, etc.)</li> <li>– Establish traffic incident management (TIM) teams</li> <li>– Establish quick clearance goals and procedures</li> <li>– Document incident clearance processes</li> <li>– Conduct After Action Reviews (AARs)</li> <li>– Expand roadway safety service patrols</li> <li>– Integrate computer-aided dispatch (CAD)</li> <li>– Pre-established towing service agreements</li> </ul>

	<ul style="list-style-type: none"> <li>- Develop shared quick clearance goals (Open Roads Policy)</li> <li>- Enact supporting legislation (e.g., driver removal laws, authority removal laws, move over laws)</li> <li>- Enhanced crash reconstruction – (e.g. drones and lidar for recon)</li> <li>- Conduct TIM Training</li> <li>- Coordinate Regional TIM Coordination Meetings</li> <li>- Utilize TRAA vehicle identification guide for towing dispatch guide</li> <li>- Activate special event signal timing plans</li> </ul>
<p><b>Comments from TSMO Outreach Meetings</b></p>	<ul style="list-style-type: none"> <li>• Metro District: Improved incident response time (<b><i>Metro District – High Priority</i></b>)</li> <li>• District 2: Document incident response process to minimize delay; useful for new employees to understand through scenarios and debrief meetings.</li> <li>• District 4: Multi-agency coordination: Incident response; Partnering with jurisdictions/inter-agency agreements (cost reimbursement); Partnering with state patrol to sell solutions. (<b><i>District 4 - High Priority</i></b>)</li> <li>• District 4: Cable barrier training/education with emergency providers/tow companies (Vehicle removal. Need refresher training. On-going, regular coordination with law enforcement/commercial vehicles.) (<b><i>District 4 - High Priority</i></b>)</li> <li>• District 7: Rapid crash clearance with state patrol. State patrol currently does not use drones, consider drones and other mechanisms; D7 has hand held lidar unit.</li> <li>• RTMC: Develop shared quick clearance goals with State Patrol for traffic incident management (TIM).</li> <li>• Central Office: Continue and expand TIM training (internal and external).</li> <li>• RTMC: Continued and expanded training on TIM for emergency responders</li> </ul>
<p><b>Current MN Status</b></p>	<p>National Traffic Incident Management (TIM) Responder Training is provided to MnDOT and partner agencies’ incident response staff.</p>
<p><b>Deployment Approach</b></p>	<p>Process/Procedure, potential capital improvements for technology needs</p>
<p><b>Anticipated 5 Year Deployment (Location(s) and Estimated Budget Range)</b></p>	<ul style="list-style-type: none"> <li>• Regional TIM programs will be established within each district to help facilitate discussions between MnDOT, State Patrol, and other emergency response agencies. The regional programs will then develop sub-strategies to reduce incident clearance times within their region.</li> <li>• A TIM Coordinator position is needed to help develop TIM programs across the state and oversee a TIM consultant who would help facilitate meetings and prioritize sub-strategies for the TIM groups to focus on such as towing incentives, drones for reconstruction, etc.</li> <li>• The cost of the TIM position would be \$100,000 annually. Year 1 for the consultant would be \$150,000 to get the program started and then \$100,000 annual in years 2-5 to maintain the program.</li> <li>• Performance Measure: Reduction in the annual average clearance time.</li> </ul>

Strategy #4: Implement Low-Cost / High-Benefit Capital Improvements (CMSP)	
<b>Description</b>	<p>This strategy will identify relatively low-cost, high-benefit capital improvements that can improve safety and mobility to support TSMO. This would involve continued and expanded use of performance management tools (data collection and analysis considering defined performance measures) to identify specific stretches of highways, sidewalks, or bike paths where safety, capacity, or multi-modal improvements should be further considered. Example improvements may include pavement enhancements to widen or add shoulders, sidewalks, bike routes; or to add passing lanes. Other efforts could include the addition of chevrons, rumble strips, edge lines, or culvert extensions to enhance safety on roadways, bike paths, or pedestrian routes. MnDOT has multiple data sources collected by a combination of manual and automated processes and the fusion and integration of this data can help identify those locations where higher than typical crashes per volume of traffic occur. Analysis of data can also help understand locations where higher than normal speeds occur as another indicator where safety improvements should be considered and should include cooperation between MnDOT and local agencies when appropriate. This strategy relates to the funding program for the Congestion Management Safety Plan (CMSP) that implements lower-cost/high-benefit improvements to address congestion and safety problems on MnDOT's Metro District highway system.</p>
<b>Comments from TSMO Outreach Meetings</b>	<ul style="list-style-type: none"> <li>• District 3: Strategies for roadways without or minimal shoulders (Amish buggies have been hit in District 3 at a few locations).</li> <li>• District 4: Roadway capacity enhancements. Passing lanes. Prioritizing routes for implementation. Shoulder widening. Commercial vehicle pull-outs for weight measurement.</li> <li>• District 4: Performance management tools to identify areas that would benefit most from safety improvements to reduce crashes <b>(D4 – High Priority)</b></li> <li>• District 4: Speed studies through small towns to adherence to speed limits, especially considering transitional speeds.</li> <li>• District 4: Planning studies in which MnDOT works with other agencies cooperatively to identify future projects</li> <li>• District 7: Pavement enhancements. Passing lanes, extending length of turn lane, acceleration lane. <b>(D7 High Priority)</b></li> <li>• District 7: Identify locations for low cost safety enhancements. Chevrons, rumbles, edge lines.</li> <li>• District 7: Culvert extensions to eliminate guardrail, which contribute to drifting and snow hazards.</li> </ul>
<b>Current MN Status</b>	<p>In rural areas, rumble strips, signing, delineation, and high friction surface treatments have been implemented. MnDOT operates the Minnesota Crash Mapping Analysis Tool (MnCMAT) that provides analysis and summaries of reported crashes. MnDOT also procures both real-time and historical 3<sup>rd</sup> party data describing traffic volumes and speeds. MnDOT has successfully executed three phases of a Congestion Management Safety Plan (CMSP) for lower-cost/high-benefit improvements on the Metro District highway system. The Greater Minnesota Mobility Study has identified</p>



	locations for implementation of low-cost, high-benefit improvements related to this strategy.
<b>Deployment Approach</b>	Capital improvement and configuration, as well as Research, Integration, and Coordination.
<b>Anticipated 5 Year Deployment (Location(s) and Estimated Budget Range)</b>	Not yet defined for this strategy.

Strategy #5: Coordinate Work Zones Across Jurisdictions and Routes	
<b>Description</b>	This strategy uses advanced planning of construction and maintenance projects across districts and with local agencies to reduce construction impacts on traveler mobility (including multi-modal mobility) and truck parking. The intent is to minimize the situations where simultaneous road work activities impact parallel roads, giving drivers no alternate work zone-free route. Similarly, road work can impact access to transit vehicle stops and multiple work activities can multiply related challenges. Road construction on several segments of the same road (e.g. road work along I-35 in multiple Districts impacting a traveler or transit rider traveling the entire duration of I-35) is another example of undesirable project planning, resulting in driver/traveler frustration and traffic congestion. An approach to technically accomplishing this would be to use the CARS system as a tool for advanced entry and planning of road work for this purpose. This strategy would support MOT plans for the coordinated work zones.
<b>Comments from TSMO Outreach Meetings</b>	<ul style="list-style-type: none"> <li>• District 1: Work zone mobility: Simultaneous construction on I-35 and Hwy 61 especially during summer (<b>D1 – High Priority</b>)</li> <li>• District 2: Continue to improve multi-jurisdictional coordination (Coordinate resources across boundaries)</li> <li>• District 3: Continue to coordinate projects with metro, districts and locals (<b>D3 – High Priority</b>)</li> <li>• RTMC: Coordinate projects across district boundaries for enhanced work zone management</li> <li>• RTMC: Coordinate projects with local agencies for enhanced work zone management</li> <li>• RTMC: Coordinate construction and maintenance activities/work zones</li> <li>• Central Office (Maint, Transit, OCIC, Freight): Schedule and location coordination of construction projects and truck parking availability across districts and with cities and counties (<b>Central Office – High Priority</b>)</li> <li>• Metro District: Partner with local agencies and transit on detour routes and diversion routes <ul style="list-style-type: none"> <li>○ Consider that local traffic may not follow the signed detour routes;</li> </ul> </li> </ul>

	<ul style="list-style-type: none"> <li>○ Consider funding Transportation Management Organizations (TMOs) to educate</li> </ul>
<b>Current MN Status</b>	MnDOT enters planned roadwork into the CARS system, and use of the CARS system could be expanded to allow users to identify simultaneous work zones along parallel routes. MnDOT currently works with impacted jurisdictions, such as across district boundaries, in addition to just using CARS. Sometimes funding source constraints force projects to occur simultaneously.
<b>Deployment Approach</b>	Coordination and planning
<b>Anticipated 5 Year Deployment (Location(s) and Estimated Budget Range)</b>	<ul style="list-style-type: none"> <li>• Years 1-5: Coordinate and communicate, within and between Districts, about planned projects, expected impact area, and conflict with other project impact areas.</li> <li>• Years 1-5: Annually, develop a statewide map and/or database of planned projects in order to identify potential conflicts and to initiate coordination.</li> </ul>

Strategy #6: Expand Snow Fence Use through Research and Increased Use	
<b>Description</b>	Snow fences serve as a barrier to help control blowing snow adjacent to highways in rural areas. Snow fences trap snow in adjacent to highways, reducing drifting and blow ice conditions that can impact road safety. Living snow fences are comprised of vegetation such as trees, shrubs, native grasses, or wildflowers. Hay bales and temporary fencing can also be used for snow fences. Implementation of snow fences requires MnDOT to partner with adjacent landowners, and potential challenges related to these partnerships makes it important to promote the benefits of their use. This strategy will expand the use of snow fences adjacent to MnDOT highways (including outreach) and research new, innovative snow fence options. Related research is underway at the University of Minnesota and this strategy would coordinate and leverage these results.
<b>Comments from TSMO Outreach Meetings</b>	<ul style="list-style-type: none"> <li>• District 8: Research snow fence options. Living and durable snow fences are utilized; there may be other options to consider. <b>(D8 – High Priority)</b></li> <li>• District 4: Snow fences</li> <li>• District 7: Continue with snow fences</li> <li>• Central Office (Maint, Transit, OCIC, Freight): Promote snow fences to farmers and reduce snow traps.</li> </ul>
<b>Current MN Status</b>	MnDOT has deployed snow fences in many locations around the state, especially in known problematic locations where blowing snow creates drifting or slippery conditions. MnDOT has a Living Snow Fence program that provides resources for landowners/farmers and road designers:  <a href="http://www.dot.state.mn.us/environment/livingsnowfence/">www.dot.state.mn.us/environment/livingsnowfence/</a>

<b>Deployment Approach</b>	Capital improvement, research, outreach
<b>Anticipated 5 Year Deployment (Location(s) and Estimated Budget Range)</b>	<p>Year 1-2: Complete the hiring of new positions, in Greater MN and in C.O., of design\development specialists to aid in Snow Control deployments and design.</p> <p>Years 1-5: Build up to 15 miles per year of snow control improvements, either as stand-alone projects or as inclusions in programmed roadway projects.</p> <p>Operating Cost = \$ 300 K per year. Construction Cost= \$ 4 M per year.</p>

Strategy #7: Expand the Coverage of Freeway and Expressway Traffic Management Systems	
<b>Description</b>	<p>MnDOT has deployed traffic management systems along freeways and expressways. Traffic management systems perform four broad groups of actions, including:</p> <ul style="list-style-type: none"> <li>• observation and detection;</li> <li>• data processing and response formulation;</li> <li>• information sharing to other agencies and the public about road conditions and events, multimodal options and status; and</li> <li>• traffic control and management.</li> </ul> <p>This TSMO strategy is to continue and expand traffic management systems, both in the Twin Cities and in urbanized and rural areas statewide, as needed. Expansion of traffic management systems includes, but is not limited to, increased network surveillance with cameras or detectors, use of dynamic message signs (DMS) for special event congestion descriptions, multi-modal option/status information or other traveler information. Examples were identified for the city of Duluth where traffic along I-35 and Hwy 61 could benefit from additional messages posted to DMS describing conditions during heavy travel times, especially in relation to planned event activities at the Duluth Event and Convention Center (DECC). Data collection (e.g. using either intrusive detectors, non-intrusive detectors, or third-party data providers) will be examined and deployed as needed.</p>
<b>Comments from TSMO Outreach Meetings</b>	<ul style="list-style-type: none"> <li>• District 1: Proactive DMS use &amp; Freeway management (RTMC controlling, outside normal district hours, rely on RTMC; Use cameras to monitor; Construction not using the Hwy 61 signs to post construction msg. other areas) <b>(D1 – High Priority)</b></li> <li>• District 1: Event management to increase mobility / reduce delays (Traveler information and Freeway/arterial management. Need to inform RTMC and city of Duluth about events at the DECC (esp. multiple simultaneous), other special event, plan for events. Notice to locals about expected diversions onto their roads. DECC Bentleyville (Christmas lights) <b>(D1 – High Priority)</b></li> <li>• District 3: Install additional detection and DMS to provide travel times on Hwy 10 and I-94</li> <li>• District 3: Install additional ATR at RWIS sites. Utilize existing power from RWIS sites - need to identify locations.</li> </ul>

	<ul style="list-style-type: none"> <li>• District 6: Identify other uses for DMS. E.g. if a DMS is used to provide an alert such as truck parking or RICWS, could also possibly be used to provide other types of information.</li> <li>• RTMC: Continued expansion of existing freeway management tools including cameras, detection, etc.</li> <li>• Central Office: DMS expansion to provide information to engage and warn the driver (<b>Central Office – High Priority</b>)</li> <li>• RTMC: Deploy queue warning systems - congestion/crashes</li> <li>• RTMC: Increase density of DMS in both Twin Cities and Greater Minnesota</li> </ul>
<b>Current MN Status</b>	This initiative is an expansion of current techniques and utilizes technology already deployed and readily available.
<b>Deployment Approach</b>	Capital improvement
<b>Anticipated 5 Year Deployment (Location(s) and Estimated Budget Range)</b>	<ul style="list-style-type: none"> <li>• Year 1-2, the TEO Operations Sub-committee would identify corridors in each district for TMS expansion. Once corridors are identified, they would be prioritized at a high/med/low ranking.</li> <li>• In years 3-5, the plan would be to have \$3 million annually to build 1-2 corridors per year. (Cost would be \$100,000-\$200,000 per mile.) The Highway 52 corridor between Metro District and District 6 would be the first to be constructed and would also serve as a CAV testbed.</li> <li>• Additional funds would also be needed for maintenance and operations as well as the equipment budget and ongoing replacement cycles.</li> </ul>

Strategy #8: Develop Traffic Incident Management (TIM) Strategies for Work Zones	
<b>Description</b>	This strategy encompasses a variety of efforts to improve TIM when work zones are present, and open lanes sooner to improve mobility and MOT. This includes considerations of having maintenance staff re-route traffic, including non-motorized traffic, in space constrained locations, developing and implementing TIM response plans specific to work zones, coordinating with local emergency response entities, leveraging FIRST trucks, and developing a better approval/notification process for lane closures to avoid conflicts.

<b>Comments from TSMO Outreach Meetings</b>	<ul style="list-style-type: none"> <li>• RTMC: Develop TIM strategies for work zones. 1) TIM response plans for specific work zones; 2) Coordination with local response agencies to allow emergency vehicle access on ramps that may be closed to general traffic. 3) Tow truck service patrols or FIRST routes funded by SRC. FIRST has historically been half the price of tow truck service patrols.</li> <li>• RTMC: Develop a better approval/notification process for lane closures to avoid conflicts.</li> <li>• District 1: Traffic awareness during construction. Open lanes as soon as possible, delays in opening lanes when not needed to be closed during project. Manage contractor to respect traffic needs. Trade-offs of getting construction done vs. managing traffic.</li> <li>• Central Office (Maintenance, Transit, OCIC, Freight): Maintenance having to reroute traffic, pedestrians etc. when working in areas with not adequate space.</li> </ul>
<b>Current MN Status</b>	<p>A variety of TIM strategies and technologies are leveraged, including Freeway Incident Response Safety Team (FIRST) trucks covering 220 miles of freeway, Intelligent lane control signals (ILCS) in the Twin Cities, extensive camera network to pinpoint incident locations and subsequent traffic impacts, DMS with messages posted upstream of incidents, maintenance and reactive work zone activities, Intelligent Work Zone (IWZ) Toolbox for selecting and deploying IWZ strategies, coordinated work zone planning via Transportation Management Plans (TMPs), and a pilot deployment integrating lane closure information from arrow boards to traveler information (511 and alerts to TMC operators) for mobile maintenance activities, as well as National Traffic Incident Management (TIM) Responder Training provided to MnDOT and partner agencies' incident response staff.</p>
<b>Deployment Approach</b>	<p>Process/Standard Operating Procedures (SOPs)</p>
<b>Anticipated 5 Year Deployment (Location(s) and Estimated Budget Range)</b>	<ul style="list-style-type: none"> <li>• Similar to the regional TIM programs, this strategy focuses on ways to reduce the impacts incidents within work zones have on the motoring public. The sub-strategies may include deploying temporary cameras, hiring tow truck service patrols, or constructing emergency pull-offs.</li> <li>• Addressing TIM Strategies in Work Zones would be incorporated into the TMP process for all major construction projects.</li> <li>• Year 1-2, the TEO Operations Sub-committee would identify major projects within their districts that would warrant addition TIM strategies.</li> </ul>

<b>Strategy #9 Utilize Intelligent Work Zone Systems Where Appropriate</b>	
<b>Description</b>	<p>This strategy will assess work zone conditions and deploy technology-based Intelligent Work Zone (IWZ) systems to improve safety and mobility for all involved in work zones. This strategy includes more traditional IWZ systems such as queue warnings, active zipper merge, travel times, variable speed limits, excessive speed display, and others. It also encompasses systems that target inattentive drivers and help reduce crash exposure for workers, including intrusion warning, electronic</p>

	<p>workers present speed limit, and newer intrusion alarm systems that detect errant vehicles entering a work zone and provide warning to workers and drivers. In many cases, these IWZ systems have been proven effective in various areas of the state and are ready for more broad deployment statewide. However, additional research and testing may be needed for emerging systems such as work zone intrusion alarm systems. When considering deployment, work zone conditions are assessed and the appropriate IWZ system is selected. This strategy also involves the development and reporting of real-time performance measures in work zones so that operators can monitor delays related to construction and maintenance activities and make adjustments, as appropriate.</p>
<p><b>Comments from TSMO Outreach Meetings</b></p>	<ul style="list-style-type: none"> <li>• Central Office: Work zone traveler safety and mobility (<b>Central Office – High Priority</b>) <ul style="list-style-type: none"> <li>– In-vehicle messages (cell phones) in work zones</li> <li>– Expand your speed is signs (radar)</li> <li>– Limit driver distractions</li> </ul> </li> <li>• OTE/CAV: Intelligent Work Zones: Travel time signs; End of queue warning systems; Active Zipper Merge (dynamic lane merge); Electronic workers present speed limit.</li> <li>• OTE/CAV: End of queue warning systems. IDIQ doesn’t work; takes too long; Need quick implementation.</li> <li>• RTMC: Deploy queue warning systems - work zones</li> <li>• District 1: Continue and improve work zone safety. Includes queue warning signs, possibly leave as permanent signs for use when needed.</li> <li>• District 8: Identify strategies for inattentive driving in work zones. This may include a work zone intrusion alarm for workers, activated by operator. (<b>D8 – High Priority</b>)</li> <li>• Central Office: Audible system – warning workers and drivers in work zones (<b>Central Office - High Priority</b>)</li> <li>• Metro District: Real-time performance measures. Monitor construction and maintenance delays in real-time, look at distribution to make adjustments to reduce delays. (<b>Metro District - High Priority</b>)</li> <li>• Metro District: Provide alert mechanisms on workers in a work zone to warn of vehicle close to the worker, such as an alarm on the worker’s vest</li> </ul>
<p><b>Current MN Status</b></p>	<p>MnDOT currently utilizes a number of IWZ systems, including queue warning, active zipper merge, intrusion warning, excessive speed display, travel time displays, electronic workers present speed limit, truck warning, and others. A decision tree is available to assist designers with identifying appropriate IWZ strategies during the scoping process: <a href="http://www.dot.state.mn.us/its/docs/scopingdecisiontree.pdf">http://www.dot.state.mn.us/its/docs/scopingdecisiontree.pdf</a>.</p> <p>A pilot Work Zone Intrusion Alarm System project is currently being conducted in MnDOT District 3. Upon successful demonstration of the pilot, additional Work Zone Intrusion Alarm System units could be procured and used in work zones.</p>
<p><b>Deployment Approach</b></p>	<p>Capital improvements, testing and evaluation</p>

<b>Anticipated 5 Year Deployment (Location(s) and Estimated Budget Range)</b>	<ul style="list-style-type: none"> <li>• Year 1: Include IWZ recommendations in Scoping and TMP process. Define an education and outreach process to increase knowledge of IWZ options.</li> <li>• Year 1: Complete the update of the IWZ Toolbox.</li> <li>• Year 1-2: Utilize non-agency resources to assist with IWZ training, planning, deployments, tracking, and evaluation.</li> <li>• Cost: \$ 100 K annually for Years 1-2</li> </ul>
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Strategy #10: Expand the Use of Ramp Metering	
<b>Description</b>	MnDOT operates an extensive network of ramp meters in the Twin Cities metro area, to improve travel time reliability within the Twin Cities freeway system. Through the years, MnDOT has gained extensive experience in the use of adaptive ramp metering as an effective traffic management approach. This strategy will evaluate the need for, and benefits of, additional ramp meter locations in the Twin Cities and beyond, including Greater Minnesota urbanized areas.
<b>Comments from TSMO Outreach Meetings</b>	<ul style="list-style-type: none"> <li>• District 3: Investigate ramp metering, expanding outside of metro area.</li> <li>• RTMC: Continued expansion of existing freeway management tools including ramp metering.</li> </ul>
<b>Current MN Status</b>	The Twin Cities metro area has more than 400 ramp meters that operate in peak traffic periods. Traffic analysis may be needed to determine the appropriateness of ramp metering in other urban freeway systems around the state. District 6 has deployed temporary meters and has considered permanent meters on Hwy 52.
<b>Deployment Approach</b>	Capital improvement
<b>Anticipated 5 Year Deployment (Location(s) and Estimated Budget Range)</b>	<ul style="list-style-type: none"> <li>• Year 1-2, the TEO Operations Sub-committee would identify corridors in each district for ramp metering expansion. Once corridors are identified, they would be prioritized at a high/med/low ranking.</li> <li>• In years 3-5, the plan would be budget for \$30,000 to build 2-3 metering locations per year.</li> <li>• Cost for metering is \$10,000-\$15,000 per metering site assuming a traffic management system with fiber and mainline detection already exists.</li> </ul>

Strategy #11: Expand Use of Technology at Weigh Stations for Enforcement	
<b>Description</b>	Efficient movement of freight on Minnesota’s highways is critical to both producing products in Minnesota to be shipped elsewhere and for products developed elsewhere to be transported into Minnesota. This strategy would expand the use of roadside truck electronic screening/clearance mechanisms such as mainline weigh-in-motion (WIM) systems and other innovative technology solutions for enhanced enforcement. This will not only assist with enforcement but will also reduce the



	<p>number of vehicles that must use pull-off weigh stations, especially targeting locations where delays are extensive to freight vehicles. Mainline WIM is a mechanism that can weigh vehicles on the highway and often allow the vehicle to avoid stopping at the weigh station for a more thorough weight measurement.</p> <p>This strategy will coordinate closely with the Weight Enforcement Investment Plan to represent additional TSMO needs as input to consideration for freight investments in WIM or other innovative technology solutions to assist with enforcement.</p>
<b>Comments from TSMO Outreach Meetings</b>	<ul style="list-style-type: none"> <li>• District 3: Weigh in motion screening for mobile enforcement</li> <li>• Central Office (Maint, Transit, OCIC, Freight): Continue to improve freight mobility. Expansion of the use of mainline Weigh in Motion (WIM) for weight enforcement (deploying in District 6) to reduce congestion around and in weigh stations.</li> </ul>
<b>Current MN Status</b>	<p>Minnesota State Patrol (MSP) is responsible for enforcing the safety and vehicle size and weight of freight vehicles. MnDOT owns and operates the weigh facilities used by MSP for this enforcement. MnDOT and MSP are currently collaborating on developing a Weight Enforcement Investment Plan that will prepare a 10-year plan for weight enforcement, including the use of technology solutions. MnDOT has conducted recent research on the accuracy of multiple vendor approaches for WIM. MnDOT's research identified materials costs of approximately \$30,000 per lane for WIM systems and installation costs of approximately \$18,000 per lane.</p>
<b>Deployment Approach</b>	<p>Coordination, integration and software, capital improvements</p>
<b>Anticipated 5 Year Deployment (Location(s) and Estimated Budget Range)</b>	<ul style="list-style-type: none"> <li>• Year 1-5 Complete and initiate the recommendations of the Weight Enforcement Investment Plan, to include use of WIM for mainline screening and for pre-clearance purposes.</li> <li>• Year 1-2 Implement Pre-Clearance program after successful completion of current RFP for vendors.</li> <li>• Cost = \$ 500 K per year additional allotment, beyond current \$ 2.0 M per year</li> </ul>

Strategy #12: Increase TSMO Asset Life Cycle Understanding and Management	
<b>Description</b>	<p>This strategy will seek to leverage available resources to better maintain assets and improve life cycle understanding and management. This may include increasing staffing to conduct maintenance and asset management activities and working to increase asset management life cycle replacement. Specific activities are likely to include: development of a life cycle plan for all of operations related devices with a management plan that includes adequate funding for the maintenance and replacement of the devices.</p>
<b>Comments from TSMO</b>	<ul style="list-style-type: none"> <li>• District 1: Appropriately staff field device maintenance and management: Signals (e.g. visit at least twice/year); call out signal maintenance management</li> </ul>



<b>Outreach Meetings</b>	<p>during construction; DMS, cameras. Signal improvements (e.g. inverters for battery).</p> <ul style="list-style-type: none"> <li>• District 3: Know equipment life cycle to assist with project planning. Provides an additional layer of information. <b>(D3 High Priority)</b></li> <li>• Central Office (Maintenance, Transit, OCIC, Freight): Manage TSMO assets. Shared location of assets.</li> <li>• Metro District: Increasing asset management life cycle replacement.</li> </ul>
<b>Current MN Status</b>	Asset management for signals, lighting and ITS have been addressed at a high level in MnDOT's Transportation Asset Management Plan.
<b>Deployment Approach</b>	Process, Data Management
<b>Anticipated 5 Year Deployment (Location(s) and Estimated Budget Range)</b>	Not yet defined for this strategy.

Strategy #13: Implement Signal Timing Updates for Construction Projects	
<b>Description</b>	This strategy will implement signal timing updates for selected construction projects that have a high likelihood of creating significant traffic impacts along signalized corridors. This will involve pre-planning for signal timing updates prior to construction (reflecting the travel patterns and needs of all modes and roadway users), with the ability to modify signal timing during construction to accommodate changes in traffic patterns as the construction progresses and work zone limits move. This strategy will include all actions to facilitate movement of all modes of travel and all roadways users during construction projects, with specifics defined based local needs at the site where construction is occurring.
<b>Comments from TSMO Outreach Meetings</b>	<ul style="list-style-type: none"> <li>• OTE, CAV: Work zone tools: <b>(OTE, CAV – High Priority)</b> <ul style="list-style-type: none"> <li>○ Signal timing updates (plans) for construction;</li> <li>○ More non-intrusive detection for construction;</li> <li>○ Statewide Traffic Management Plan (TMP) checklist – Pick list for things to do for given situations.</li> <li>○ Consistent work zone strategy and coordination between districts;</li> <li>○ Mobile barrier – to protect maintenance workers;</li> <li>○ Lane closure tools (Sketch tool for scheduling of lane closures. Maintenance staff scheduling. Can be used to develop the lane closure manual. Lane closure manual for all districts.)</li> </ul> </li> </ul>
<b>Current MN Status</b>	Data not available

<b>Deployment Approach</b>	This approach would identify a need in the Traffic Mitigation Plan (TMP) process, the timing of traffic signals affected by construction or that may be used as a diversion route, shall be adjusted to accommodate the changing traffic flows.
<b>Anticipated 5 Year Deployment (Location(s) and Estimated Budget Range)</b>	This should be implemented on all construction projects as discussed in the Traffic Mitigation Plan.

Strategy #14: Provide Traveler Information on Alternative Modes and Routes	
<b>Description</b>	This strategy will provide traveler information to inform motorists of alternative modes of travel and alternate routes, to help alleviate congestion as a part of any congestion reduction effort, including integrated corridor management (ICM). This strategy will seek to expand the corridors that benefit from alternate route information and will coordinate with local agencies to identify appropriate alternate routes that may divert traffic from one freeway to another freeway, major highway, or arterial roads. This strategy will also include partnering with other modal agencies to identify and communicate alternate modes of travel such as public transit, bicycle routes, and pedestrian routes. It will also include providing alternate route information to freight operators. This alternate mode and route information will be communicated via current mechanisms such as DMS, 511 website, and 511 mobile app, and could be expanded to other mechanisms utilized by partner agencies and stakeholders within a specific corridor.
<b>Comments from TSMO Outreach Meetings</b>	<ul style="list-style-type: none"> <li>• RTMC: Improve input of incident information and alternate routes into 511</li> <li>• Metro: Integrated apps; include transit with traveler information</li> <li>• District 1: Coordination with locals (possible Integrated Corridor Management).</li> </ul>
<b>Current MN Status</b>	This initiative will integrate existing technology and systems already in place (e.g. DMS, 511) and will utilize partnerships with state and local entities to identify other potential (e.g. mod-specific) traveler information mechanisms. In addition, Metro Transit is providing transit travel times on I-35W via their own DMS. Finally, the Metro District has included freight specific information on the Metro Construction website.
<b>Deployment Approach</b>	Integration, collaboration
<b>Anticipated 5 Year Deployment (Location(s) and Estimated Budget Range)</b>	Not yet defined for this strategy.

**Strategy #15: Expand and Enhance the Deployment of Road Weather Information Systems**

<p><b>Description</b></p>	<p>This initiative will expand RWIS station deployments throughout the state. This expansion includes deployment at new sites as well as upgrades and replacements of RWIS station equipment, including sensors, controllers, video cameras, and communications. MnDOT, NWS and local agencies use RWIS and AWOS (automated weather observation system) to measure environmental and pavement surface conditions to assist in decisions on snow plowing schedules and chemical applications. Pan/tilt video cameras are added at RWIS sites at locations that are prone to freezing, snow, curves, fog, high wind, and/or flooding to monitor traffic flows and road conditions and to verify incident and severity. Camera images can provide maintenance crews with additional information on pavement conditions. They are also available to travelers through the 511 Traveler Information website.</p> <p><i>Source: 2018 Minnesota Statewide Regional ITS Architecture (S49)</i></p>
<p><b>Comments from TSMO Outreach Meetings</b></p>	<ul style="list-style-type: none"> <li>• District 2: Install additional RWIS and cameras, for maintenance staff to view prior and during weather events.</li> <li>• District 4: Additional RWIS sites. Better forecasting for maintenance; upgrading RWIS towers with non-intrusive sensors; add cameras on all RWIS sites; focus on western parts to see storms coming from west; take advantage of existing weather sources – other states.</li> <li>• District 8: Install weather stations (RWIS) to provide real-time information to travelers on 511. Identified the need for additional RWIS in the western portion of the district. <b>(D8 High Priority)</b></li> </ul>
<p><b>Current MN Status</b></p>	<p>RWIS data is used by MnDOT maintenance staff, the Maintenance Decision Support System (MDSS), and information is displayed on the 511mn.org traveler information website and the MN 511 mobile application. MnDOT currently operates 98 RWIS stations. Approximately 20 additional sites have been funded for construction, with 42 additional sites planned but not yet funded.</p>
<p><b>Deployment Approach</b></p>	<p>Capital improvement</p>
<p><b>Anticipated 5 Year Deployment (Location(s) and Estimated Budget Range)</b></p>	<ul style="list-style-type: none"> <li>• Years 1-3: Fund and install the current RWIS system expansion sites, as identified by Maintenance.</li> <li>• Cost = \$ 4.5 M Total</li> </ul>

**Strategy #16: Expand Consideration of Innovative Intersection Technology or Design (e.g. RICWS, roundabouts, RCIs, diverging diamonds, etc.)**

<p><b>Description</b></p>	<p>This strategy involves increased inclusion of innovative intersection designs and technologies such as roundabouts, reduced conflict intersections (RCIs), diverging</p>
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	diamond interchanges, and Rural Intersection Conflict Warning Systems (RICWS), as alternatives during the planning process for improving or upgrading a signalized or unsignalized intersection. Part of this strategy will be development of an overall strategy for assessing when and where innovative approaches should be included that considers trade-offs to all modal users of the intersection. This strategy will also support and work within the MnDOT Intersection Control Evaluation (ICE) process that is followed to identify the most appropriate intersection control type through a comprehensive analysis.
<b>Comments from TSMO Outreach Meetings</b>	<ul style="list-style-type: none"> <li>• District 3: Expand RICWS. Challenges with staff resources to maintain; challenges with county paying power.</li> <li>• District 4: Roundabouts (instead of traffic signals). <b>(D4 High Priority)</b></li> <li>• District 7: Replace signals with roundabouts. <b>(D7 High Priority)</b></li> </ul>
<b>Current MN Status</b>	MnDOT has deployed several rural intersection conflict warning systems (RICWS) throughout the state. Geometric intersection modifications such as reduced conflict intersections (RCIs) and diverging diamonds have also been implemented by MnDOT.
<b>Deployment Approach</b>	Capital improvement and configuration.
<b>Anticipated 5 Year Deployment (Location(s) and Estimated Budget Range)</b>	<ul style="list-style-type: none"> <li>• Approximately 4 locations per year @ \$ 1 M each = \$ 4 M annually.</li> <li>• Increased maintenance efforts and costs, for alternative intersections, are acknowledged. No dollar amount specified.</li> </ul>

Strategy #17: Expand Dynamic Message Sign (DMS) Use to Include Standard Weather Messages	
<b>Description</b>	MnDOT currently displays driving condition reports on the 511 Traveler Information System. These driving condition reports also include some atmospheric weather reports (e.g. descriptions of current precipitation). While some weather messages are displayed on dynamic message signs (DMS), there is a desire to expand the use of DMS to include standardized weather messages on a more frequent and coordinated basis to describe unexpected weather and road conditions (not every day general weather reports). This strategy will enhance and expand MnDOT's use of DMS to include route-specific weather and driving condition reports in situations of extreme or unexpected road weather conditions. Route-specific reports will include information on current and forecasted roadway conditions, most likely provided either through manual reporting in MnDOT condition reporting system (CARS) or through automated reporting and predictions generated by the MnDOT Maintenance Decision Support System (MDSS). In addition, the Pathfinder initiative recently adopted by MnDOT will be leveraged to facilitate and coordinate the use of high-impact, consistent road weather messaging, for potential use on DMS as appropriate. Providing weather information will increase travelers' understanding of potential impact from critical weather (e.g. pavement conditions, flooding, high

	winds, low visibility, National Weather Service blizzard warnings, etc.) on their route of travel. This strategy will also consider DMS to support dissemination of weather reports at key transit stops or connections, and bicycle/walking paths (e.g. to alert travelers to risks of flooding, limited traction, or other hazards. As part of this strategy, the overall approach to DMS display of weather conditions will be defined and used to influence MnDOT DMS policy and practice on a more consistent, statewide basis. This may include travel times and the definition of a consistent set of messages to be used to convey understandable information to travelers.
<b>Comments from TSMO Outreach Meetings</b>	<ul style="list-style-type: none"> <li>• District 6: Increase DMS messages: <ul style="list-style-type: none"> <li>○ Provide travel times/stopped traffic message on DMS in work zones;</li> <li>○ Provide travel times on DMS during weather;</li> <li>○ Use DMS for variable speed limits (VSL) during weather events (e.g. on I-35)</li> </ul> </li> <li>• District 7: Increase DMS usage and social media messages <ul style="list-style-type: none"> <li>○ Include weather such as future conditions, consistent with 511 messages;</li> <li>○ Challenges with central control of DMS and social media compared to district control.</li> </ul> </li> <li>• District 8: Simplify DMS messages for weather related road conditions and closures (D8 Messages should mirror 511 descriptions)</li> <li>• Central Office (Maint, Transit, OCIC, Freight): Standardize weather messages in districts (<b>Central Office – High Priority</b>) <ul style="list-style-type: none"> <li>○ Consistent messages for example on DMS;</li> <li>○ Provide advanced weather messages</li> </ul> </li> <li>• RTMC: Provide timely and accurate weather-related messages on DMS for unexpected road conditions.</li> </ul>
<b>Current MN Status</b>	<p>DMS are widely available and this strategy expands their use. MDSS is a source of road weather information and is deployed statewide. IRIS is the MnDOT developed ATMS capable of controlling DMS statewide.</p> <p>This strategy leverages activities underway as a part of Pathfinder, an FHWA “Every Day Counts” initiative that encourages coordination among transportation agencies, National Weather Service, weather service providers, local agencies, and other partners to facilitate the use of high-impact, consistent messaging to motorists during inclement weather. MnDOT has adopted Pathfinder (led by Office of Maintenance) and is coordinating messaging in advance of and during weather events; this coordinated effort may influence DMS policies at the RTMC and in districts.</p>
<b>Deployment Approach</b>	Capital improvement and software integration and configuration
<b>Anticipated 5 Year Deployment (Location(s) and Estimated</b>	<ul style="list-style-type: none"> <li>• Expand the use of DMS for other weather messages</li> <li>• Year 1-2, complete current project that will ingest National Weather Service alerts into IRIS.</li> <li>• Year 3-5, identify problem spot locations where sensors could be used to trigger sign messages rather than relying on human observations</li> </ul>

<b>Budget Range)</b>	
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Strategy #18: Improve Pedestrian and Bicycle Service at Signals	
<b>Description</b>	The majority of MnDOT operated signal systems are understood to be fully accessible to pedestrians. Isolated intersections were identified during the TSMO planning process that are either signed as no pedestrian crossing or lack crosswalks (e.g. in locations where there is no continuing sidewalk beyond the intersection). Input suggested upgrades to these and other intersections to support pedestrians and bicyclists would increase the mobility of non-drivers. This strategy would coordinate with the prioritized efforts of the State non-motorized Transportation Committee (SNTC) to identify and implement signage, accessibility, crossing, or timing enhancements to signalized intersections to better represent pedestrians, bicyclists, and all vulnerable roadway users with an emphasis on intersections not fully equipped for pedestrian access.
<b>Comments from TSMO Outreach Meetings</b>	<ul style="list-style-type: none"> <li>• OTE/CAV - Balancing mobility needs of different modes (peds vs. autos) <b>(OTE/CAV – High Priority)</b> <ul style="list-style-type: none"> <li>– Incorporate pedestrian provisions (non-motorized traffic) at signalized intersection where peds are allowed regardless if peds are active in the area. Make sure signage is accurate.</li> <li>– Coordinate with state non-motorized transportation committee (SNTC). The SNTC is conducting an assessment during the time the TSMO Implementation Plan is being developed and outcomes are expected in December 2018.</li> </ul> </li> </ul>
<b>Current MN Status</b>	The majority of MnDOT intersections fully supports pedestrian movements. The SNTC is meeting on an ongoing basis.
<b>Deployment Approach</b>	<p>Implementation of the guidance developed for the State Non-Motorized Transportation Committee regarding pedestrian and bike safety at signalized intersection.</p> <p>This includes upgrade of all pedestrian indications to count down timers, implement leading pedestrian interval at appropriate locations and implementation of appropriate crossing times at all intersections.</p>
<b>Anticipated 5 Year Deployment (Location(s) and Estimated Budget Range)</b>	<ul style="list-style-type: none"> <li>• Year 1: Complete full assessment of existing pedestrian accommodations at MnDOT’s signals. Upgrade pedestrian crossing times as part of assessment.</li> <li>• Year 2 -5: Upgrade pedestrian indications with count down times based on findings in Year 1 assessment. This would be accomplished via a construction contract. Based on the assessment, and upgrade of control equipment may also be required.</li> </ul>

Strategy #19: Increase Real-time Tracking of Work Zones and Lane Closures for 511

<p><b>Description</b></p>	<p>This strategy seeks to increase provision of real-time work zone and lane closure information for 511. This will increase situational awareness of work zones and lane closures for operators and 3<sup>rd</sup> parties by collecting more information on work zone locations and activities. This strategy includes pulling more information from smart arrow boards and portable DMS, establishing a common location to house all available work zone data to facilitate tracking and data usage, automatic notifications based on conditions, and development of new tools for 511 like heat maps or dashboards to show information more effectively.</p>
<p><b>Comments from TSMO Outreach Meetings</b></p>	<ul style="list-style-type: none"> <li>• OTE/CAV: Provide real-time work zone traffic control data to RTMC and 3rd parties. Smart arrow boards (RTMC gets notified for on/off). Caution mode. Full deployment would be useful. Portable DMS messages – need to have a way to see what these signs say/change messages on real-time basis (RTMC only not 3rd parties) <b>(OTE/CAV High Priority)</b></li> <li>• OTE/CAV: Single location for IWZ information. Currently this information is broken down and not concise - to see status and data. InTrans is developing this system. Hard to get to historical data. Stored on separate databases. Mobile access. Live monitoring (dashboards, heat map). Speeds and lane occupancy. Automatic notification based on conditions. IWZ alert system. <b>(OTE/CAV High Priority)</b></li> <li>• Metro District: Display lane closures in real-time (automated) on 511 traveler information. Longer term lane closures are entered into 511, short term lane closures (less than 45 min) are typically not entered into 511. A display of real-time lane closures would assist with coordination and management. <b>(Metro District High Priority)</b></li> </ul>
<p><b>Current MN Status</b></p>	<p>Intelligent Work Zone (IWZ) Toolbox for selecting and deploying IWZ strategies. Pilot deployment integrating lane closure information from arrow boards to traveler information (511 and alerts to TMC operators) for mobile maintenance activities.</p>
<p><b>Deployment Approach</b></p>	<p>Capital improvement - expand use of work zone technologies and integrate work zone data into a single database.</p>
<p><b>Anticipated 5 Year Deployment (Location(s) and Estimated Budget Range)</b></p>	<ul style="list-style-type: none"> <li>• Expand the arrow board project which developed a system where an arrow board activated in the field triggers an event in 511 and IRIS.</li> <li>• Year 1-2 – \$250,000 for further development and deployment of the arrow board system to additional MnDOT arrow boards</li> <li>• Year 3-5 - \$100,000 annual to further deploy equipment on other MnDOT arrow boards not covered in the initial project</li> <li>• Develop a spec requiring all contractor provided arrow boards to have this technology by 2022.</li> </ul>

Strategy #20: Upgrade Signal Controller and Communications Equipment for Communications to Central System	
<b>Description</b>	This strategy will upgrade signal controllers and communications equipment to accommodate traffic signal control via a central system. This will allow for additional functionality such as remote monitoring and the ability to provide real-time control of signal systems, making adjustments as needed for incidents and other changing traffic conditions. This strategy also includes utilizing signal performance measures to monitor conditions in real-time and make adjustments from a remote location as needed. A key benefit of implementing a central system for signal control is the ability to verify conditions, diagnose problems, and modify signal timing without traveling to the site, thereby reducing labor, fuel, and equipment costs that would otherwise be required for on-site signal adjustments.
<b>Comments from TSMO Outreach Meetings</b>	<ul style="list-style-type: none"> <li>• District 1: Signal timing and control improvements: Central signal control to see signal remotely, and implement planned timings, small area events. <b>(D1 - High Priority)</b></li> <li>• District 3: Central control system for remote monitoring.</li> <li>• District 7: utilize a central system for remote monitoring at some signals <b>(D7 High Priority)</b></li> <li>• Metro District: Upgrade signals including communication to central system.</li> </ul>
<b>Current MN Status</b>	Some traffic signals are centrally managed through newly procured systems that optimize signals and allow system monitoring and performance analysis.
<b>Deployment Approach</b>	This approach would replace the signal control (signal controller, malfunction monitor, etc.) and communication equipment (switch, modem, etc.) on a 15-year cycle. This includes adding Ethernet communications to the central management system.
<b>Anticipated 5 Year Deployment (Location(s) and Estimated Budget Range)</b>	<ul style="list-style-type: none"> <li>• Replace the majority of control and communication equipment within a 5-year period.</li> <li>• The five-year budget would be \$5.6 million (\$1.12 million per year).</li> <li>• In year 6, the annual amount would be reduced to \$315K. This would update the vast majority of MnDOT traffic to a 15-year life cycle, then continue to upgrade control equipment at the 15-year point.</li> </ul>

Strategy #21: Deploy Truck Parking Information for Rest Areas	
<b>Description</b>	This strategy involves providing real-time truck parking information for rest areas along corridors with truck parking issues. This may include deployment of data collection technologies at rest areas to support a real-time truck parking system that can be accessed on 511 or other websites by truckers to help identify when and where to park, e.g., ahead of inclement weather or at the end of a driving shift. This strategy is an approach to mitigate the overall challenge of limited truck parking availability but does not replace the need for increased truck parking in some locations.



<b>Comments from TSMO Outreach Meetings</b>	<ul style="list-style-type: none"> <li>• Central Office: Provide traveler information and/or connectivity at rest areas.</li> <li>• District 6: Increase freight information. Expansion of real-time truck parking system. Freight restrictions in work zones.</li> </ul>
<b>Current MN Status</b>	MnDOT is currently deploying Truck Parking and Management Systems (TPIMS) as part of a multi-state effort (TIGER grant) that provides traveler information about available truck parking spaces at rest areas. The Minnesota sites are located at rest areas leading into the Metro area along I-94 and I-35. Not all MnDOT Districts have truck parking issues. Truck parking issues are most common along major freight routes that experience intrastate freight vehicle travel patterns.
<b>Deployment Approach</b>	Capital improvement, research and testing.
<b>Anticipated 5 Year Deployment (Location(s) and Estimated Budget Range)</b>	<ul style="list-style-type: none"> <li>• Year 1-2: Continue and complete the evaluation phase of the systems recently turned on.</li> <li>• Years 3-5: Upon positive evaluation, install parking systems at other rest areas.</li> <li>• Cost = \$ 150 K per additional site, including DMS. \$1.5 M total years 3-5.</li> </ul>

Strategy #22: Develop and Implement Pre-planned Alternative Routes for Incidents	
<b>Description</b>	When a stretch of road is closed due to incidents such as crashes or hazardous weather like flooding or winter storm closures, alternate routes or detours are often not signed. Additionally, the alternate route may include roads that do not support oversize/overweight vehicles or may not be suitable to generally permitted freight vehicles. This strategy will include development of pre-planned detour and alternate routes, improve the provision of recommended alternate routes around roadway closures or heavy congestion caused by incidents or weather events, alternate transit routes, and alternate route signing (with the potential for providing travel times) for traffic incident management. Alternate route information will be provided through existing traveler information systems along with additional signing as needed. Alternate route information will include timely information about allowable vehicle dimensions and weights along these routes, increasing the mobility of freight operators.
<b>Comments from TSMO Outreach Meetings</b>	<ul style="list-style-type: none"> <li>• District 4: Alternate Routes Signs. Safety and Mobility: Flip down signs, DMS, route planning. Timeliness/clarity of signing. Education on proper use (emergencies). Passive rerouting/advance warning. (D4 High Priority)</li> <li>• District 7: Sign alternate routes. For example, signs on I-90 (floods) and unplanned events/incidents.</li> <li>• Central Office (Maint, Transit, OCIC, Freight): Traveler information improvement - More advanced notification/communication of closures and detour routes for freight (e.g. OS/OW) <b>(Central Office - High Priority)</b></li> </ul>

<b>Current MN Status</b>	MnDOT provides information on closures and alternate routes on MnDOT’s 511 System. I-94 and I-35 south of the Twin Cities have signed alternate routes in place. MnDOT also operates a “Trucker” page on the 511mn.org website specific to the needs of freight operators. Detours or impacts to freight vehicles are not always included in the event descriptions. This initiative will also allow other agencies (e.g. local cities or counties) to provide timely information about recommended alternate routes or detours to the public.
<b>Deployment Approach</b>	<ul style="list-style-type: none"> <li>• Capital improvement, integration and configuration</li> </ul>
<b>Anticipated 5 Year Deployment (Location(s) and Estimated Budget Range)</b>	<ul style="list-style-type: none"> <li>• Year 1-2: Engage consultant to assist with planning and designing signing for desired alternate routes, including I-35 between Metro and Duluth, and I-90 flooding areas in D-7</li> <li>• Year 3: Implement the routes, install signage, and complete integration with traveler information systems as needed</li> <li>• Cost = \$ 150 K Consultant, \$ 200 K for signage and installation, \$100 K may be needed for integration.</li> </ul>

**Strategy #23: Ensure New Signals are Connected Automated Vehicle (CAV) Ready**

<b>Description</b>	<p>MnDOT is deploying a ‘Connected Corridor’ in the Twin Cities that will demonstrate vehicle to infrastructure (V2I) communications to support cooperative automated transportation applications such as snow plow priority, transit priority, and pedestrian safety applications. As MnDOT considers additional intersections to deploy roadside units (RSUs) that will expand the V2I capabilities, they will typically require some upgrades to the roadside traffic signal controller to generate the information needed to support such applications.</p> <p>Within this TSMO strategy, when new traffic signal controllers are installed or when upgrades are performed on existing controllers, MnDOT will perform any actions needed to ensure the signal controller will be able to support the output of data needed to support CAV applications (e.g. Signal Phase and Timing (SPaT) data, MAP messages, presence of pedestrians in crosswalks, etc.). The signal controller upgrades may need to be combines with additional detectors (e.g. if pedestrian detection is required) and will also reflect interactions with MnDOT’s Security Credential Management System (SCMS) and backhaul communications needs. NTCIP 1202 Version 3 compliant traffic signal controllers are expected to be capable of outputting this needed data. Findings and documentation of MnDOT’s Connected Corridor Project will help further clarify the data content and formats required by CAV and can provide additional details on these activities.</p>
<b>Comments from TSMO Outreach Meetings</b>	<ul style="list-style-type: none"> <li>• OTE, CAV: CAV Readiness Improvements (<b>OTE, CAV – High Priority</b>) <ul style="list-style-type: none"> <li>○ Make signals CAV ready (new signals). Determine how to get SPaT data;</li> <li>○ Prepare IT systems to harvest/use data from CAVs:</li> <li>○ Consider how to use data from CAVs for better traffic management (long term);</li> </ul> </li> </ul>

	<ul style="list-style-type: none"> <li>○ Determine methods for CAV to handle weather data/poor weather</li> </ul>
<b>Current MN Status</b>	MnDOT is deploying a 'Connected Corridor' in the Twin Cities that will demonstrate vehicle to infrastructure (V2I) communications to support vehicle applications. Upgrades to the roadside traffic signal controller will be required, to generate the information needed to support such applications.
<b>Deployment Approach</b>	Capital improvement
<b>Anticipated 5 Year Deployment (Location(s) and Estimated Budget Range)</b>	Not yet defined for this strategy.

Strategy #24: Add Additional MnPASS Lanes in the Twin Cities Metro Area	
<b>Description</b>	<p>The objective of this initiative is to construct additional High Occupancy Toll (HOT) lanes known as MnPASS Express Lanes similar to the lanes already implemented on I-394, I-35W, and I-35E. Although MnPASS Express Lanes require system expansion, MnPASS utilizes the operational strategy of dynamic pricing to maintain a congestion free trip for transit vehicles, carpool vehicles, motorcycles, and single occupant vehicles willing to pay a toll.</p> <p><i>Source: 2018 MnPASS Systems Study Phase 3</i></p>
<b>Comments from TSMO Outreach Meetings</b>	<ul style="list-style-type: none"> <li>• RMTC – identified as a desirable strategy.</li> </ul>
<b>Current MN Status</b>	MnDOT's MnPASS lanes are currently in operation along I-394, I-35E and I-35W in the Twin Cities metro area.
<b>Deployment Approach</b>	Capital improvement
<b>Anticipated 5 Year Deployment (Location(s) and Estimated Budget Range)</b>	Not yet defined for this strategy.

Strategy #25: Provide Enhanced Enforcement Technology (Speed Enforcement, Red Light Running, MnPASS, etc.)	
<b>Description</b>	Because automated enforcement is not permissible under current Minnesota state statute, alternative technology solutions are desired to assist manual enforcement activities. This strategy will develop and deploy enhanced enforcement technology to assist with speed enforcement, red light running, failure to yield to pedestrians in crosswalks, failure to yield to bicyclists, violations in MnPASS lanes, and other violations that require detection of vehicles, pedestrians, or bicyclists.
<b>Comments from TSMO Outreach Meetings</b>	<ul style="list-style-type: none"> <li>• Metro District: Improvement in speed enforcement. There are legislative challenges. Consider alternative solutions such as a trooper viewing a camera of a speeding vehicle. <b>(Metro District – High Priority)</b></li> <li>• Central Office (Maint, Transit, OCIC, Freight): Improvement in speed enforcement – automated / enhanced / extraordinary.</li> </ul>
<b>Current MN Status</b>	Automated enforcement is not permissible under current Minnesota state statute. MnDOT has conducted a pilot deployment of an “Enhanced Speed Compliance for Work Zones (ESC4WZ) System” used by State Patrol to conduct manual on-site speed enforcement in work zones using a camera and radar-based system that provides advanced notification of speeding vehicles. A test deployment of a MnPASS Enforcement Assistance System (EASy) has also been conducted. Similarly, enhanced red light violation enforcement has been demonstrated.
<b>Deployment Approach</b>	Research and Test Deployments, Capital Improvement (for equipment/technology purchases), Policy
<b>Anticipated 5 Year Deployment (Location(s) and Estimated Budget Range)</b>	Not yet defined for this strategy.

Strategy #26: Expand and Streamline Road Weather Data	
<b>Description</b>	This strategy will expand and streamline road weather data to enhance road weather management and traveler information, to include predictive driving condition reports, enabling travelers to better understand the likely condition changes over the coming hours. MnDOT operates a Maintenance Decision Support System (MDSS) that is capable of processing weather and driving condition reports together with planned pavement treatment activities (e.g. plowing activities, chemical applications) to generate forecasts for what conditions will exist in the coming hours. This effort would likely result in travelers of various modes (e.g. passenger vehicles, transit riders, bicyclists, pedestrians) receiving predicted weather and/or pavement condition reports through DMS and the 511 Traveler Information System, while also expanding the use of technologies such as MDSS and RWIS to gather relevant data and automate consistent messages. Plow

	cameras will be integrated into the traveler information systems to provide travelers with images of current conditions and possibly to support the automated generation of condition reports. It will also streamline this road weather data to automate consistent traveler information messages for various road weather conditions. This strategy may include new data management systems and processes to streamline data and automate messaging. An additional aspect of this strategy will be enhancing the data sharing already performed by the 511 Traveler Information System with 3 <sup>rd</sup> party information providers. This increased data would be shared with these providers, therefore expanding the travelers that receive the information.
<b>Comments from TSMO Outreach Meetings</b>	<ul style="list-style-type: none"> <li>• Central Office (Maint, Transit, OCIC, Freight): Expand and streamline road weather data into different systems. <b>(Central Office - High Priority)</b> <ul style="list-style-type: none"> <li>– Data may include MDSS, plow cameras, and RWIS</li> <li>– Automate consistent messages</li> </ul> </li> <li>• Central Office (Maint, Transit, OCIC, Freight): Expand plow cameras</li> <li>• District 4: Snow Plow Enhancements (Plow trucks with cameras; Signal priority for snow plows)</li> <li>• District 7: Traveler information enhancements. Includes predictive 511 - what will the roads be in 5 hours. Fixed cameras; understanding pavement temps; leverage data (probe data), vehicle speeds. <b>(D7 – High Priority)</b></li> <li>• District 8: Install plow cameras statewide to display on 511</li> </ul>
<b>Current MN Status</b>	MnDOT has a network of approximately 98 RWIS stations (with planned deployment of an additional 62 stations, 20 of which have been funded for construction) and utilizes vehicle-based technologies such as MDSS and plow cameras to monitor road weather conditions, assist with maintenance decisions, and display via on-road DMS and 511. MnDOT has recently adopted Pathfinder, a collaborative process involving the National Weather Service (NWS), MnDOT, and private-sector weather service providers to disseminate clear, consistent road weather information to the traveling public. MnDOT operates the MDSS statewide, and the MDSS generates forecasted conditions. There is currently a link between MDSS and the 511 Traveler Information System to automatically generate the segment-based driving condition reports (at least in some districts with plans for statewide expansion). All new snow plows fabricated for MnDOT are being equipped with plow cameras. This strategy will build upon these existing technologies, systems, and efforts.
<b>Deployment Approach</b>	Capital improvements, Processes, Software and Integration of Data
<b>Anticipated 5 Year Deployment (Location(s) and Estimated Budget Range)</b>	<ul style="list-style-type: none"> <li>• Expand data sharing of road weather data from MDSS to 511</li> <li>• Year 1-2, complete current project where 511 will ingest current road conditions from MDSS.</li> <li>• Year 3-5, develop a system where 511 would ingest predicted road conditions from MDSS for 4-hours out - \$100,000</li> </ul>

Strategy #27: Utilize Alternate Route Signing for Work Zones	
<b>Description</b>	<p>This strategy will increase the planning and consideration of alternate routes for work zones and increase the use of alternate route signing in situations where alternate routes are planned. Within this strategy, there will be an increase in the incident response planning performed before and during work zone operations. Alternate route signing will utilize a variety of static and dynamic signage and technologies. This includes portable DMS, route planning, magnet or solar lights, passive re-rerouting and advance warning on select roadways for work zones. When appropriate, alternate route messages will address needs of multimodal travelers (e.g. assisting bicyclists or pedestrians in understanding how to navigate the work zone, assisting transit riders in understanding changes to routes or bus stops based on the work zone).</p> <p>It is understood that creating and managing relationships with local road authorities for coordination and collaboration will be critical for success of this strategy and may require formal relationships with the local authorities. Finally, activities within this strategy will monitor the effects and penetration rate of mobile applications and regularly consider when and where signage will no longer be needed when it can be replaced through safe mobile device use.</p>
<b>Comments from TSMO Outreach Meetings</b>	<ul style="list-style-type: none"> <li>• RTMC: For major construction projects, consider modifications to parallel routes such as temporary lane additions, temporary turn lanes, signal timing, etc. for work zones</li> <li>• District 1: Work zone mobility at border crossings: Need to manage the dissemination of information about alternate routes, including allowable widths, weights, etc. There are limited routes that cross the border to Canada, and freight haulers need to understand any width, weight, height limitations. – also consider signal timing/management during construction (include information dissemination in scoping of the construction or maintenance project) <b>(D1 - High Priority)</b></li> <li>• District 2: Enhance detour route information (Advanced information before decision points, alternate routes, coordinate with other agencies)</li> <li>• District 4: Magnet lights/solar lights for alternate route signing</li> </ul>
<b>Current MN Status</b>	MnDOT uses DMS with messages posted upstream of incidents, maintenance, and reactive work zone activities. Alternate route signs are sometimes placed for work zones when a detour is required, or it is determined that mobility may be severely impacted on a route with work zone activities; however, increased use of alternate route signing for work zones and incidents will help mitigate congestion by diverting traffic away from congested areas
<b>Deployment Approach</b>	Capital improvement and configuration.
<b>Anticipated 5 Year Deployment (Location(s))</b>	Not yet defined for this strategy.

<b>and Estimated Budget Range)</b>	
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<b>Strategy #28: Expand Dissemination of Travel Times (Work Zones and Geographic Expansion)</b>	
<b>Description</b>	<p>This strategy will build upon the current activities MnDOT performs to display travel time information on DMS. Through this strategy, MnDOT will expand the dissemination of travel time information through any of the following four additional scenarios:</p> <ul style="list-style-type: none"> <li>- Temporary travel time monitoring and display to drivers approaching and within work zones;</li> <li>- Expansion of the geographic coverage of permanent systems to monitor and disseminate travel times to include additional arterials in the Twin Cities and key corridors (freeways and arterials) statewide (Note that Hwy 10 and I-94 between St. Cloud and the Twin Cities were identified as routes that would benefit from travel times displayed on DMS and other candidate routes are expected);</li> <li>- Expand the dissemination of travel time information beyond DMS to also include to the 511mn.org traveler information system (considering phone, mobile application, and the website);</li> <li>- To deploy systems that report comparison travel times between areas with current work zones and alternate routes. Travelers could access this information either when approaching a work zone or pre-trip through access to the MN 511mn.org system.</li> </ul> <p>As part of this strategy, improvements to existing travel time dissemination will continue, including new and alternate sources of real-time travel time data.</p> <p>Implementation of this strategy is expected to develop a set of work zone travel time systems for use in rotating work zones. New locations for travel time monitoring and dissemination will be finalized with the districts through follow-on discussions, and the enhancements to the 511 system will be considered within the annual planning process.</p>
<b>Comments from TSMO Outreach Meetings</b>	<ul style="list-style-type: none"> <li>• RTMC: Provide travel times in work zones</li> <li>• RTMC: Provide travel time information through 511 for key routes</li> <li>• RTMC: Expand travel times to Metro arterials and Greater MN corridors where applicable</li> <li>• RTMC: Provide travel times via DMS and 511 to encourage diversion around work zones.</li> <li>• District 3: Install additional detection and DMS to provide travel times on Hwy 10 and I-94</li> </ul>
<b>Current MN Status</b>	<p>MnDOT disseminates travel times on DMS in the Twin Cities along major freeway routes during the peak commuter periods. Limited travel time have been disseminated on rural corridors during work zone activities.</p>

<b>Deployment Approach</b>	Capital improvement, integration, software
<b>Anticipated 5 Year Deployment (Location(s) and Estimated Budget Range)</b>	Not yet defined for this strategy.

Strategy #29: Expand Sharing of Video and Data Between Agencies (Integrated Corridor Management)	
<b>Description</b>	<p>This strategy will utilize integrated corridor management (ICM) principles, specifically to expand the sharing of video and data among state and local agencies, including transit and law enforcement, to manage parallel routes and travel options for a corridor. This strategy applies to the Twin Cities metro area, but also has application for use in other large urban areas around the state (e.g. Duluth, St. Cloud, Rochester, Moorhead, etc.)</p> <p>The 2018 Minnesota Statewide Regional ITS Architecture defines ICM initiatives as: systems that manage the dispersal of traffic along high-volume corridors by coordinating multiple transportation and transit networks. ICM initiatives will utilize currently deployed technologies or deploy new devices, such as video cameras and dynamic message signs during peak period hours and special events impacting the roadway network. Recurring and non-recurring congestion will be reduced by monitoring and guiding traffic through parallel transportation networks to effectively use the available lane capacity in the area. There are already a number of network and corridor management strategies in place and this initiative will upgrade the existing systems as necessary and integrate these capabilities and the operations of the different facilities and agencies in a more effective manner to decrease congestion. <i>(Source: 2018 Minnesota Statewide Regional ITS Architecture (S17))</i></p> <p>This strategy will focus on sharing camera images, video feeds, traffic data, incident data, transit data, and other information as available to improve overall management of an integrated corridor system. This could also include integrating with computer-aided dispatch (CAD) systems as a part of data sharing. This strategy will leverage existing relationships and partnerships between MnDOT and local agencies and will develop new partnerships as needed.</p>
<b>Comments from TSMO Outreach Meetings</b>	<ul style="list-style-type: none"> <li>• RTMC: Integrated Corridor Management - Ability to share data such as video feeds, traffic data, incident data, etc. between agencies; Share data between freeways, arterials, and transit</li> <li>• Metro District: Share cameras and other information with partners. MnDOT to share cameras with cities and counties and cities and counties to share camera images with MnDOT.</li> <li>• District 1: Coordination with locals (possible Integrated Corridor Management).</li> </ul>



<b>Current MN Status</b>	This initiative will integrate existing technology and systems already deployed in the initiative area, with potential expansion to areas outside the Twin Cities metro.
<b>Deployment Approach</b>	Integration, collaboration
<b>Anticipated 5 Year Deployment (Location(s) and Estimated Budget Range)</b>	<ul style="list-style-type: none"> <li>• Develop streaming video system where video data is shared with other external agencies</li> <li>• Complete current project where RTMC is developing streaming video system.</li> <li>• Year 1, expand video streaming to 511 for general public and other agencies - \$150,000</li> <li>• Year 2, develop applications where high quality video streams could be shared with external agencies/partners rather than sending them to 511 - \$150,000</li> </ul>

Strategy #30: Deploy Transit Signal Priority	
<b>Description</b>	This strategy involves deploying transit signal priority capabilities at specific intersections that have infrastructure to support this strategy (e.g. upgraded traffic signal controllers) and have the potential to achieve benefits for all travelers by granting transit vehicles priority. Deployment of this strategy will increase transit efficiency and reduce transit delay at intersections, with anticipated secondary benefits of increased ridership.
<b>Comments from TSMO Outreach Meetings</b>	<ul style="list-style-type: none"> <li>• District 7: Transit signal priority</li> </ul>
<b>Current MN Status</b>	ITS signals in the Twin Cities allow real-time signal adjustment to maximize throughput and minimize delays. In some cases, this includes functionality for transit signal priority.
<b>Deployment Approach</b>	Capital improvement and configuration.
<b>Anticipated 5 Year Deployment (Location(s) and Estimated Budget Range)</b>	Not yet defined for this strategy.

Strategy #31: Address Bikes and Pedestrians in Construction Detours	
<b>Description</b>	This strategy specifically addresses a need to accommodate pedestrians and bicyclists to navigate construction detours. In particular, the strategy builds on efforts specific to assisting visually impaired pedestrian navigation assistance at

	<p>signals. However, it will also encompass approaches for accommodating all pedestrian and bicyclist travel around work zone detours. This strategy will develop mechanisms to provide transit, pedestrian, and bike lane detours (with associated traveler information) for construction detours, especially on construction projects that have significant mobility impacts.</p> <p>Additionally, this strategy could develop a mobile application to support visually impaired pedestrians as they approach signalized intersections and in work zones. At signalized intersections, the mobile application could either use data supplied locally by the controller or centrally by the central signal control system to download the data needed to determine if the pedestrian cross light is illuminated, providing an indication of the “Walk” or “Don’t Walk” status and the ability to trigger the appropriate crosswalk request. In work zones, the application could alert pedestrians to sidewalk closures (or narrowing of the sidewalk) upstream at the previous intersection with suggestions for changing the path of travel to routes where the sidewalk is open. This strategy is likely not needed equally at all construction projects and specific deployments would be based on an understanding of the need.</p>
<b>Comments from TSMO Outreach Meetings</b>	<ul style="list-style-type: none"> <li>• OTE/CAV: Develop a Smart phone app for work zones &amp; signals (visually impaired peds). <b>(OTE/CAV – High Priority)</b></li> <li>• Central Office (Maint, Transit, OCIC, Freight): Provide transit, ped and bike detours on larger projects</li> </ul>
<b>Current MN Status</b>	MnDOT operates a centralized signal control software that is capable of outputting centralized data describing current phase and timing, and this software could be the basis for providing the output data needed and potentially accepting input from the mobile application. Lane closures are entered into CARS and could include indications of sidewalk and bike lane closures, with output to support mobile applications.
<b>Deployment Approach</b>	Integration and software
<b>Anticipated 5 Year Deployment (Location(s) and Estimated Budget Range)</b>	Not yet defined for this strategy.

Strategy #32: Improve Work Zone Data for CAV Readiness	
<b>Description</b>	This strategy seeks to improve work zone data for CAV readiness. This includes increasing situational awareness of work zones and lane closures for operators and 3 <sup>rd</sup> parties by collecting more information on work zone locations and activities, and house all available work zone data in a single location. This could include real-time smart arrow board information on shoulder and lane closures, portable DMS messages, speeds and lane occupancy in work zones, and other IWZ data. In the

	<p>short-term, this strategy will help support the increased provision of real-time traveler information. These efforts are necessary for CAV readiness in order to streamline the collection and dissemination of timely, accurate, and comprehensive work zone information for CAVs. Within this TSMO strategy, as IWZ and other work zone equipment is procured, MnDOT will consider the requirements and actions that may be needed to ensure the equipment will be able to support the output of data needed to support CAV applications. This includes consideration of MnDOT’s Security Credential Management System (SCMS) needs. Findings and documentation of MnDOT’s Connected Corridor Project can provide additional details on these activities. The definition of exactly what data is needed to ensure CAV readiness is not firmly defined yet, however a series of national activities are helping to define this and will be resources to this strategy.</p>
<b>Comments from TSMO Outreach Meetings</b>	<ul style="list-style-type: none"> <li>• OTE/CAV: Provide real-time work zone traffic control data to RTMC and 3rd parties. Smart arrow boards (RTMC gets notified for on/off). Caution mode. Full deployment would be useful. Portable DMS messages – need to have a way to see what these signs say/change messages on real-time basis (RTMC only not 3rd parties) <b>(OTE/CAV High Priority)</b></li> <li>• OTE/CAV: Single location for IWZ information. Currently this information is broken down and not concise - to see status and data. InTrans is developing this system. Hard to get to historical data. Stored on separate databases. Mobile access. Live monitoring (dashboards, heat map). Speeds and lane occupancy. Automatic notification based on conditions. IWZ alert system. <b>(OTE/CAV High Priority)</b></li> </ul>
<b>Current MN Status</b>	Intelligent Work Zone (IWZ) Toolbox for selecting and deploying IWZ strategies. Pilot deployment integrating lane closure information from arrow boards to traveler information (511 and alerts to TMC operators) for mobile maintenance activities.
<b>Deployment Approach</b>	Capital improvement - expand use of work zone technologies and integrate work zone data into a single database.
<b>Anticipated 5 Year Deployment (Location(s) and Estimated Budget Range)</b>	Not yet defined for this strategy.

Strategy #33: Prepare Systems to Obtain/Use Data from CAVs	
<b>Description</b>	An anticipated rule from the National Highway Traffic Safety Administration (NHTSA) is that all new vehicles transmit and receive Basic Safety Messages (BSM). These messages include, among other information, the vehicle’s speed, location, and direction. Roadside units (RSUs) can intercept this information broadcast from vehicles and use it to calculate travel time, wait times at signals, work zone queue lengths, etc. Obtaining and properly using this data is an integral part of CAV

	<p>technology. However, in order to benefit from this potentially rich data set, MnDOT must prepare to receive, store, and manage the data received from vehicles, especially when considering the vehicles typically broadcast ten messages per second. This strategy will document the intended use of data from CAVs and then develop the digital infrastructure to be capable of capturing the BSM data, processing it, storing it, securing it, and managing it to benefit MnDOT.</p>
<p><b>Comments from TSMO Outreach Meetings</b></p>	<ul style="list-style-type: none"> <li>• OTE, CAV: CAV Readiness Improvements (<i>OTE, CAV – High Priority</i>) <ul style="list-style-type: none"> <li>○ Make signals CAV ready (new signals). Determine how to get SPaT data;</li> <li>○ Prepare IT systems to harvest/use data from CAVs;</li> <li>○ Consider how to use data from CAVs for better traffic management (long term);</li> <li>○ Determine methods for CAV to handle weather data/poor weather</li> </ul> </li> </ul>
<p><b>Current MN Status</b></p>	<p>MnDOT is deploying a Connected Corridor and will demonstrate the capability to receive BSM from vehicles. Beyond this activity, MnDOT has no experience receiving BSM messages from vehicles.</p>
<p><b>Deployment Approach</b></p>	<p>Integration and software development</p>
<p><b>Anticipated 5 Year Deployment (Location(s) and Estimated Budget Range)</b></p>	<p>Not yet defined for this strategy.</p>

Strategy #34: Encourage Work Flexibility for Travel Demand Management	
<p><b>Description</b></p>	<p>A primary contributor to recurring congestion is commuter traffic. This strategy would perform outreach and coordination with major employers in the urbanized areas within Minnesota to encourage flexible work schedules or increased options for teleworking, especially during inclement weather or when other major events will contribute to peak period traffic.</p> <p>A key element to this strategy is the provision of MnDOT data and information describing current or anticipated inclement weather or other congestion causing situations. MnDOT may explore the 511 Traveler Information system alerts as a mechanism for employers (or employees) to receive these notices. MnDOT could define parameters for when employers are recommended to consider implementing ‘teleworking days’. Combined with this strategy would be outreach and informational material to educate employers about the benefits they can contribute to overall demand management by encouraging work shift changes, modal shifts to alternate modes, or teleworking.</p>

<b>Comments from TSMO Outreach Meetings</b>	<ul style="list-style-type: none"> <li>• RTMC: Work with major employers to decrease traffic demand during snow and ice events by encouraging employers to allow teleworking during major storms.</li> <li>• Metro District: Partner with employers to encourage employees to tele work, delay start time, or alter work schedule due to weather or congested times of day. Provide road and weather information to employers.</li> </ul>
<b>Current MN Status</b>	MnDOT operates an alerts component to the 511 Traveler Information System that allows travelers to subscribe to specific routes in order to receive notices of events or conditions.
<b>Deployment Approach</b>	Coordination and outreach, software integration
<b>Anticipated 5 Year Deployment (Location(s) and Estimated Budget Range)</b>	<ul style="list-style-type: none"> <li>• Year 1-5: Engage private firm to implement education\advertising\outreach campaign for various TDM strategies in Metro area.</li> <li>• Utilize past Humphrey Institute study for information. Coordinate with Met Council CMP Committee.</li> <li>• Cost = \$ 250 K Total</li> </ul>