DEPARTMENT OF TRANSPORTATION

MnDOT Transportation Systems Management and Operations (TSMO) Implementation Strategies Reference

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http://www.dot.state.mn.us/

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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)
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	Continue and expand traffic management systems, both in the Twin Cities and in	395	Medium-term (2-5 years)

Strategy #	Title	Brief Description	Score	Initiation Timeframe
	Expressway Traffic Management Systems	urbanized and rural areas statewide, as needed.		
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)
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,	355	Short-term (1-2 years)

Strategy #	Title	Brief Description	Score	Initiation Timeframe
		controllers, video cameras, and communications.		
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)

Strategy #	Title	Brief Description	Score	Initiation Timeframe
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	320	Long-term (> 5 years)

Strategy #	Title	Brief Description	Score	Initiation Timeframe
		in situations where alternate routes are planned.		
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	220	Short-term (1-2 years)

Strategy #	Title	Brief Description	Score	Initiation Timeframe
		teleworking, especially during inclement weather or when other major events will contribute to peak period traffic.		

Appendix C – Strategy Descriptions

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

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

Table C-1: Prioritized TMSO Strategy Descriptions

Strategy #1: Update Signal Timing and Coordination	
Description	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.
Comments from TSMO Outreach Meetings	• District 1: Signalized corridors, keeping them coordinated to minimize delays. Include in construction planning and TMP development. Temporary signal plans to reduce congestion. ***(D1 High Priority)*** • District 2: Interconnect standalone signals; update coordination timing at location where there are reduced volumes; provide remote communication to selected signals. • District 3: Identify strategies to address over capacity signals. Learn from others what has worked. ***(D3 High Priority)*** • District 3: District 3 currently has a contract in place for signal retiming; a few signals are isolated. • District 4: Multi-agency coordination, including signal coordination/issues & incident response. Partnering with jurisdictions and use of inter-agency agreements (cost reimbursement). Partnering with state patrol to sell solutions. ***(D4 High Priority)*** • District 6: Signal retiming; optimizing standalone signals; install battery back-ups; replace signal heads at locations that have been modified (flashing yellow arrow implementation) • District 7: Update signal retiming (currently scheduled); coordination with cities including signal maintenance agreements with cities and establish a regional signal timing position. ***(D7 High Priority)*** • 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. ***(OTE/CAV High Priority)*** • OTE/CAV: Upgrade/better maintenance of existing signal systems. Need more frequent maintenance visits and preventative maintenance to assess conditions.

	• Central Office (Maintenance, Transit, OCIC, Freight): Signal timing adjustments for non-motorized traffic. • RTMC – Signal timing • Metro District: Signal timing
Current MN Status	Many traffic signal systems around the state are in need of re-timing and signal coordination updates.
Deployment Approach	This strategy would retime traffic signals on a scheduled basis to assure that all signals are retimed on regular basis. Signals on major arterials should be retimed every three years; Minor and isolated signals should be retimed every 4-7 years.
Anticipated 5 Year Deployment (Location(s) and Estimated Budget Range)	• 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). • 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).

Strategy #2: Increase MnDOT Usage of 3rd Party Data and Increase Sharing with Traveler Information Disseminators (e.g. Google, WAZE, INRIX, HERE)	
Description	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 3rd 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 3rd 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 3rd 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 3rd 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 3rd Party data providers into MnDOT's condition reporting system and traveler information content. WAZE is an example of a 3rd Party provider that allows DOTs to ingest their events, as reported by citizens, often increasing the number of events disseminated by DOT systems.
Comments from TSMO Outreach Meetings	• 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.) ***(D3 – High Priority)*** • District 4: Partnering with Google and other third parties (Sharing MnDOT info with third parties to help routing)

	• District 6: Identify a contact at Google to inform when there is incorrect road information
	• Central Office (Maint, Transit, OCIC, Freight): Incorporate 3rd party data (e.g. Waze) with 511
	  ○ MnDOT is considering expanded information entry for outstate districts
	• OTE, CAV: Sharing MnDOT data with 3rd parties
	  ○ XML feed format for official detours (RTMC)/511;
	  ○ Provide signal phase and timing, work zone and incident management, detours to 3rd parties

Current MN Status	MnDOT operates a real-time XML feed providing access to 3rd party providers of all their events and condition report included in CARS. MnDOT has a well-established set of 3rd party providers that currently ingest and use the data feed.
Deployment Approach	Software, integration and coordination
Anticipated 5 Year Deployment (Location(s) and Estimated Budget Range)	• 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. • RTMC is working with WAZE to ingest WAZE event data into MnDOT systems such as IRIS and 511. • 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.

Strategy #3: Develop Regional Traffic Incident Management (TIM) Programs	
Description	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: – Improve collaboration among TIM partners (MnDOT, law enforcement, cities/counties, etc.) – Establish traffic incident management (TIM) teams – Establish quick clearance goals and procedures – Document incident clearance processes – Conduct After Action Reviews (AARs) – Expand roadway safety service patrols – Integrate computer-aided dispatch (CAD) – Pre-established towing service agreements

	– Develop shared quick clearance goals (Open Roads Policy) – Enact supporting legislation (e.g., driver removal laws, authority removal laws, move over laws) – Enhanced crash reconstruction – (e.g. drones and lidar for recon) – Conduct TIM Training – Coordinate Regional TIM Coordination Meetings – Utilize TRAA vehicle identification guide for towing dispatch guide – Activate special event signal timing plans
Comments from TSMO Outreach Meetings	• Metro District: Improved incident response time ***(Metro District – High Priority)*** • District 2: Document incident response process to minimize delay; useful for new employees to understand through scenarios and debrief meetings. • District 4: Multi-agency coordination: Incident response; Partnering with jurisdictions/inter-agency agreements (cost reimbursement); Partnering with state patrol to sell solutions. ***(District 4 - High Priority)*** • 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.) ***(District 4 - High Priority)*** • 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. • RTMC: Develop shared quick clearance goals with State Patrol for traffic incident management (TIM). • Central Office: Continue and expand TIM training (internal and external). • RTMC: Continued and expanded training on TIM for emergency responders
Current MN Status	National Traffic Incident Management (TIM) Responder Training is provided to MnDOT and partner agencies' incident response staff.
Deployment Approach	Process/Procedure, potential capital improvements for technology needs
Anticipated 5 Year Deployment (Location(s) and Estimated Budget Range)	• 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. • 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. • 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. • Performance Measure: Reduction in the annual average clearance time.

Strategy #4: Implement Low-Cost / High-Benefit Capital Improvements (CMSP)	
Description	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 that 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.
Comments from TSMO Outreach Meetings	• District 3: Strategies for roadways without or minimal shoulders (Amish buggies have been hit in District 3 at a few locations). • District 4: Roadway capacity enhancements. Passing lanes. Prioritizing routes for implementation. Shoulder widening. Commercial vehicle pull-outs for weight measurement. • District 4: Performance management tools to identify areas that would benefit most from safety improvements to reduce crashes ***(D4 – High Priority)*** • District 4: Speed studies through small towns to adherence to speed limits, especially considering transitional speeds. • District 4: Planning studies in which MnDOT works with other agencies cooperatively to identify future projects • District 7: Pavement enhancements. Passing lanes, extending length of turn lane, acceleration lane. ***(D7 High Priority)*** • District 7: Identify locations for low cost safety enhancements. Chevrons, rumbles, edge lines. • District 7: Culvert extensions to eliminate guardrail, which contribute to drifting and snow hazards.
Current MN Status	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 3rd 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

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

Strategy #5: Coordinate Work Zones Across Jurisdictions and Routes	
Description	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.
Comments from TSMO Outreach Meetings	• District 1: Work zone mobility: Simultaneous construction on I-35 and Hwy 61 especially during summer ***(D1 – High Priority)*** • District 2: Continue to improve multi-jurisdictional coordination (Coordinate resources across boundaries) • District 3: Continue to coordinate projects with metro, districts and locals ***(D3 – High Priority)*** • RTMC: Coordinate projects across district boundaries for enhanced work zone management • RTMC: Coordinate projects with local agencies for enhanced work zone management • RTMC: Coordinate construction and maintenance activities/work zones • Central Office (Maint, Transit, OCIC, Freight): Schedule and location coordination of construction projects and truck parking availability across districts and with cities and counties ***(Central Office – High Priority)*** • Metro District: Partner with local agencies and transit on detour routes and diversion routes ○ Consider that local traffic may not follow the signed detour routes;

	○ Consider funding Transportation Management Organizations (TMOs) to educate
Current MN Status	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.
Deployment Approach	Coordination and planning
Anticipated 5 Year Deployment (Location(s) and Estimated Budget Range)	• Years 1-5: Coordinate and communicate, within and between Districts, about planned projects, expected impact area, and conflict with other project impact areas. • Years 1-5: Annually, develop a statewide map and\or database of planned projects in order to identify potential conflicts and to initiate coordination.

Strategy #6: Expand Snow Fence Use through Research and Increased Use	
Description	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.
Comments from TSMO Outreach Meetings	• District 8: Research snow fence options. Living and durable snow fences are utilized; there may be other options to consider. ***(D8 – High Priority)*** • District 4: Snow fences • District 7: Continue with snow fences • Central Office (Maint, Transit, OCIC, Freight): Promote snow fences to farmers and reduce snow traps.
Current MN Status	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: www.dot.state.mn.us/environment/livingsnowfence/

Deployment Approach	Capital improvement, research, outreach
Anticipated 5 Year Deployment (Location(s) and Estimated Budget Range)	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. 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. Operating Cost = $ 300 K per year. Construction Cost= $ 4 M per year.

Strategy #7: Expand the Coverage of Freeway and Expressway Traffic Management Systems	
Description	MnDOT has deployed traffic management systems along freeways and expressways. Traffic management systems perform four broad groups of actions, including: • observation and detection; • data processing and response formulation; • information sharing to other agencies and the public about road conditions and events, multimodal options and status; and • traffic control and management. 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.
Comments from TSMO Outreach Meetings	• District 1: Proactive DMS use & 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) ***(D1 – High Priority)*** • 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) ***(D1 – High Priority)*** • District 3: Install additional detection and DMS to provide travel times on Hwy 10 and I-94 • District 3: Install additional ATR at RWIS sites. Utilize existing power from RWIS sites - need to identify locations.

	• 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. • RTMC: Continued expansion of existing freeway management tools including cameras, detection, etc. • Central Office: DMS expansion to provide information to engage and warn the driver ***(Central Office – High Priority)*** • RTMC: Deploy queue warning systems - congestion/crashes • RTMC: Increase density of DMS in both Twin Cities and Greater Minnesota
Current MN Status	This initiative is an expansion of current techniques and utilizes technology already deployed and readily available.
Deployment Approach	Capital improvement
Anticipated 5 Year Deployment (Location(s) and Estimated Budget Range)	• 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. • 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. • Additional funds would also be needed for maintenance and operations as well as the equipment budget and ongoing replacement cycles.

Strategy #8: Develop Traffic Incident Management (TIM) Strategies for Work Zones	
Description	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.

Comments from TSMO Outreach Meetings	• 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. • RTMC: Develop a better approval/notification process for lane closures to avoid conflicts. • 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. • Central Office (Maintenance, Transit, OCIC, Freight): Maintenance having to reroute traffic, pedestrians etc. when working in areas with not adequate space.
Current MN Status	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.
Deployment Approach	Process/Standard Operating Procedures (SOPs)
Anticipated 5 Year Deployment (Location(s) and Estimated Budget Range)	• 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. • Addressing TIM Strategies in Work Zones would be incorporated into the TMP process for all major construction projects. • Year 1-2, the TEO Operations Sub-committee would identify major projects within their districts that would warrant addition TIM strategies.

Strategy #9 Utilize Intelligent Work Zone Systems Where Appropriate	
Description	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

	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.

Comments from TSMO Outreach Meetings	• Central Office: Work zone traveler safety and mobility ***(Central Office – High Priority)***
	  – In-vehicle messages (cell phones) in work zones
	  – Expand your speed is signs (radar)
	  – Limit driver distractions
	• OTE/CAV: Intelligent Work Zones: Travel time signs; End of queue warning systems; Active Zipper Merge (dynamic lane merge); Electronic workers present speed limit.
	• OTE/CAV: End of queue warning systems. IDIQ doesn't work; takes too long; Need quick implementation.
	• RTMC: Deploy queue warning systems - work zones
	• District 1: Continue and improve work zone safety. Includes queue warning signs, possibly leave as permanent signs for use when needed.
	• District 8: Identify strategies for inattentive driving in work zones. This may include a work zone intrusion alarm for workers, activated by operator. ***(D8 – High Priority)***
	• Central Office: Audible system – warning workers and drivers in work zones ***(Central Office - High Priority)***
	• Metro District: Real-time performance measures. Monitor construction and maintenance delays in real-time, look at distribution to make adjustments to reduce delays. ***(Metro District - High Priority)***
	• 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

Current MN Status	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: http://www.dot.state.mn.us/its/docs/scopingdecisiontree.pdf. 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.
Deployment Approach	Capital improvements, testing and evaluation

Anticipated 5 Year Deployment (Location(s) and Estimated Budget Range)	• Year 1: Include IWZ recommendations in Scoping and TMP process. Define an education and outreach process to increase knowledge of IWZ options. • Year 1: Complete the update of the IWZ Toolbox. • Year 1-2: Utilize non-agency resources to assist with IWZ training, planning, deployments, tracking, and evaluation. • Cost: $ 100 K annually for Years 1-2

Strategy #10: Expand the Use of Ramp Metering	
Description	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.
Comments from TSMO Outreach Meetings	• District 3: Investigate ramp metering, expanding outside of metro area. • RTMC: Continued expansion of existing freeway management tools including ramp metering.
Current MN Status	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.
Deployment Approach	Capital improvement
Anticipated 5 Year Deployment (Location(s) and Estimated Budget Range)	• 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. • In years 3-5, the plan would be budget for $30,000 to build 2-3 metering locations per year. • Cost for metering is $10,000-$15,000 per metering site assuming a traffic management system with fiber and mainline detection already exists.

Strategy #11: Expand Use of Technology at Weigh Stations for Enforcement	
Description	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

	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. 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.
Comments from TSMO Outreach Meetings	• District 3: Weigh in motion screening for mobile enforcement • 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.
Current MN Status	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.
Deployment Approach	Coordination, integration and software, capital improvements
Anticipated 5 Year Deployment (Location(s) and Estimated Budget Range)	• 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. • Year 1-2 Implement Pre-Clearance program after successful completion of current RFP for vendors. • Cost = $ 500 K per year additional allotment, beyond current $ 2.0 M per year

Strategy #12: Increase TSMO Asset Life Cycle Understanding and Management	
Description	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.
Comments from TSMO	• District 1: Appropriately staff field device maintenance and management: Signals (e.g. visit at least twice/year); call out signal maintenance management

Outreach Meetings	during construction; DMS, cameras. Signal improvements (e.g. inverters for battery). • District 3: Know equipment life cycle to assist with project planning. Provides an additional layer of information. ***(D3 High Priority)*** • Central Office (Maintenance, Transit, OCIC, Freight): Manage TSMO assets. Shared location of assets. • Metro District: Increasing asset management life cycle replacement.
Current MN Status	Asset management for signals, lighting and ITS have been addressed at a high level in MnDOT's Transportation Asset Management Plan.
Deployment Approach	Process, Data Management
Anticipated 5 Year Deployment (Location(s) and Estimated Budget Range)	Not yet defined for this strategy.

Strategy #13: Implement Signal Timing Updates for Construction Projects	
Description	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.
Comments from TSMO Outreach Meetings	• OTE, CAV: Work zone tools: ***(OTE, CAV – High Priority)*** o Signal timing updates (plans) for construction; o More non-intrusive detection for construction; o Statewide Traffic Management Plan (TMP) checklist – Pick list for things to do for given situations. o Consistent work zone strategy and coordination between districts; o Mobile barrier – to protect maintenance workers; o 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.)
Current MN Status	Data not available

Deployment Approach	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.
Anticipated 5 Year Deployment (Location(s) and Estimated Budget Range)	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	
Description	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.
Comments from TSMO Outreach Meetings	• RTMC: Improve input of incident information and alternate routes into 511 • Metro: Integrated apps; include transit with traveler information • District 1: Coordination with locals (possible Integrated Corridor Management).
Current MN Status	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.
Deployment Approach	Integration, collaboration
Anticipated 5 Year Deployment (Location(s) and Estimated Budget Range)	Not yet defined for this strategy.

Strategy #15: Expand and Enhance the Deployment of Road Weather Information Systems	
Description	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. *Source: 2018 Minnesota Statewide Regional ITS Architecture (S49)*
Comments from TSMO Outreach Meetings	• District 2: Install additional RWIS and cameras, for maintenance staff to view prior and during weather events. • 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. • 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. ***(D8 High Priority)***
Current MN Status	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.
Deployment Approach	Capital improvement
Anticipated 5 Year Deployment (Location(s) and Estimated Budget Range)	• Years 1-3: Fund and install the current RWIS system expansion sites, as identified by Maintenance. • Cost = $ 4.5 M Total

Strategy #16: Expand Consideration of Innovative Intersection Technology or Design (e.g. RICWS, roundabouts, RCIs, diverging diamonds, etc.)	
Description	This strategy involves increased 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. 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.
Comments from TSMO Outreach Meetings	• District 3: Expand RICWS. Challenges with staff resources to maintain; challenges with county paying power. • District 4: Roundabouts (instead of traffic signals). ***(D4 High Priority)*** • District 7: Replace signals with roundabouts. ***(D7 High Priority)***
Current MN Status	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.
Deployment Approach	Capital improvement and configuration.
Anticipated 5 Year Deployment (Location(s) and Estimated Budget Range)	• Approximately 4 locations per year @ $ 1 M each = $ 4 M annually. • Increased maintenance efforts and costs, for alternative intersections, are acknowledged. No dollar amount specified.

Strategy #17: Expand Dynamic Message Sign (DMS) Use to Include Standard Weather Messages	
Description	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.

Comments from TSMO Outreach Meetings	• District 6: Increase DMS messages:
	  ○ Provide travel times/stopped traffic message on DMS in work zones;
	  ○ Provide travel times on DMS during weather;
	  ○ Use DMS for variable speed limits (VSL) during weather events (e.g. on I-35)
	• District 7: Increase DMS usage and social media messages
	  ○ Include weather such as future conditions, consistent with 511 messages;
	  ○ Challenges with central control of DMS and social media compared to district control.
	• District 8: Simplify DMS messages for weather related road conditions and closures (D8 Messages should mirror 511 descriptions)
	• Central Office (Maint, Transit, OCIC, Freight): Standardize weather messages in districts ***(Central Office – High Priority)***
	  ○ Consistent messages for example on DMS;
	  ○ Provide advanced weather messages
	• RTMC: Provide timely and accurate weather-related messages on DMS for unexpected road conditions.

Current MN Status	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. 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.
Deployment Approach	Capital improvement and software integration and configuration
Anticipated 5 Year Deployment (Location(s) and Estimated	• Expand the use of DMS for other weather messages • Year 1-2, complete current project that will ingest National Weather Service alerts into IRIS. • Year 3-5, identify problem spot locations where sensors could be used to trigger sign messages rather than relying on human observations

Budget Range)	

Strategy #18: Improve Pedestrian and Bicycle Service at Signals	
Description	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.
Comments from TSMO Outreach Meetings	• OTE/CAV - Balancing mobility needs of different modes (peds vs. autos) ***(OTE/CAV – High Priority)*** – 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. – 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.
Current MN Status	The majority of MnDOT intersections fully supports pedestrian movements. The SNTC is meeting on an ongoing basis.
Deployment Approach	Implementation of the guidance developed for the State Non-Motorized Transportation Committee regarding pedestrian and bike safety at signalized intersection. 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.
Anticipated 5 Year Deployment (Location(s) and Estimated Budget Range)	• Year 1: Complete full assessment of existing pedestrian accommodations at MnDOT's signals. Upgrade pedestrian crossing times as part of assessment. • 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.

Strategy #19: Increase Real-time Tracking of Work Zones and Lane Closures for 511	
Description	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 3rd 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.
Comments from TSMO Outreach Meetings	• 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) ***(OTE/CAV High Priority)*** • 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. ***(OTE/CAV High Priority)*** • 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. ***(Metro District High Priority)***
Current MN Status	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.
Deployment Approach	Capital improvement - expand use of work zone technologies and integrate work zone data into a single database.
Anticipated 5 Year Deployment (Location(s) and Estimated Budget Range)	• Expand the arrow board project which developed a system where an arrow board activated in the field triggers an event in 511 and IRIS. • Year 1-2 – $250,000 for further development and deployment of the arrow board system to additional MnDOT arrow boards • Year 3-5 - $100,000 annual to further deploy equipment on other MnDOT arrow boards not covered in the initial project • Develop a spec requiring all contractor provided arrow boards to have this technology by 2022.

Strategy #20: Upgrade Signal Controller and Communications Equipment for Communications to Central System	
Description	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.
Comments from TSMO Outreach Meetings	• District 1: Signal timing and control improvements: Central signal control to see signal remotely, and implement planned timings, small area events. ***(D1 - High Priority)*** • District 3: Central control system for remote monitoring. • District 7: utilize a central system for remote monitoring at some signals ***(D7 High Priority)*** • Metro District: Upgrade signals including communication to central system.
Current MN Status	Some traffic signals are centrally managed through newly procured systems that optimize signals and allow system monitoring and performance analysis.
Deployment Approach	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.
Anticipated 5 Year Deployment (Location(s) and Estimated Budget Range)	• Replace the majority of control and communication equipment within a 5-year period. • The five-year budget would be $5.6 million ($1.12 million per year). • 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.

Strategy #21: Deploy Truck Parking Information for Rest Areas	
Description	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.

Comments from TSMO Outreach Meetings	• Central Office: Provide traveler information and/or connectivity at rest areas. • District 6: Increase freight information. Expansion of real-time truck parking system. Freight restrictions in work zones.
Current MN Status	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.
Deployment Approach	Capital improvement, research and testing.
Anticipated 5 Year Deployment (Location(s) and Estimated Budget Range)	• Year 1-2: Continue and complete the evaluation phase of the systems recently turned on. • Years 3-5: Upon positive evaluation, install parking systems at other rest areas. • Cost = $ 150 K per additional site, including DMS. $1.5 M total years 3-5.

Strategy #22: Develop and Implement Pre-planned Alternative Routes for Incidents	
Description	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.
Comments from TSMO Outreach Meetings	• 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) • District 7: Sign alternate routes. For example, signs on I-90 (floods) and unplanned events/incidents. • Central Office (Maint, Transit, OCIC, Freight): Traveler information improvement - More advanced notification/communication of closures and detour routes for freight (e.g. OS/OW) ***(Central Office - High Priority)***

Current MN Status	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.
Deployment Approach	• Capital improvement, integration and configuration
Anticipated 5 Year Deployment (Location(s) and Estimated Budget Range)	• 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 • Year 3: Implement the routes, install signage, and complete integration with traveler information systems as needed • Cost = $ 150 K Consultant, $ 200 K for signage and installation, $100 K may be needed for integration.

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

Comments from TSMO Outreach Meetings	• OTE, CAV: CAV Readiness Improvements ***(OTE, CAV – High Priority)***
	  ○ Make signals CAV ready (new signals). Determine how to get SPaT data;
	  ○ Prepare IT systems to harvest/use data from CAVs:
	  ○ Consider how to use data from CAVs for better traffic management (long term);

	○ Determine methods for CAV to handle weather data/poor weather
Current MN Status	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.
Deployment Approach	Capital improvement
Anticipated 5 Year Deployment (Location(s) and Estimated Budget Range)	Not yet defined for this strategy.

Strategy #24: Add Additional MnPASS Lanes in the Twin Cities Metro Area	
Description	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. *Source: 2018 MnPASS Systems Study Phase 3*
Comments from TSMO Outreach Meetings	• RMTC – identified as a desirable strategy.
Current MN Status	MnDOT's MnPASS lanes are currently in operation along I-394, I-35E and I-35W in the Twin Cities metro area.
Deployment Approach	Capital improvement
Anticipated 5 Year Deployment (Location(s) and Estimated Budget Range)	Not yet defined for this strategy.

Strategy #25: Provide Enhanced Enforcement Technology (Speed Enforcement, Red Light Running, MnPASS, etc.)	
Description	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.
Comments from TSMO Outreach Meetings	• Metro District: Improvement in speed enforcement. There are legislative challenges. Consider alternative solutions such as a trooper viewing a camera of a speeding vehicle. ***(Metro District – High Priority)*** • Central Office (Maint, Transit, OCIC, Freight): Improvement in speed enforcement – automated / enhanced / extraordinary.
Current MN Status	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.
Deployment Approach	Research and Test Deployments, Capital Improvement (for equipment/technology purchases), Policy
Anticipated 5 Year Deployment (Location(s) and Estimated Budget Range)	Not yet defined for this strategy.

Strategy #26: Expand and Streamline Road Weather Data	
Description	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 3rd party information providers. This increased data would be shared with these providers, therefore expanding the travelers that receive the information.
Comments from TSMO Outreach Meetings	• Central Office (Maint, Transit, OCIC, Freight): Expand and streamline road weather data into different systems. ***(Central Office - High Priority)*** – Data may include MDSS, plow cameras, and RWIS – Automate consistent messages • Central Office (Maint, Transit, OCIC, Freight): Expand plow cameras • District 4: Snow Plow Enhancements (Plow trucks with cameras; Signal priority for snow plows) • 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. ***(D7 – High Priority)*** • District 8: Install plow cameras statewide to display on 511
Current MN Status	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.
Deployment Approach	Capital improvements, Processes, Software and Integration of Data
Anticipated 5 Year Deployment (Location(s) and Estimated Budget Range)	• Expand data sharing of road weather data from MDSS to 511 • Year 1-2, complete current project where 511 will ingest current road conditions from MDSS. • Year 3-5, develop a system where 511 would ingest predicted road conditions from MDSS for 4-hours out - $100,000

Strategy #27: Utilize Alternate Route Signing for Work Zones	
Description	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). 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 is it can be replaced through safe mobile device use.
Comments from TSMO Outreach Meetings	• RTMC: For major construction projects, consider modifications to parallel routes such as temporary lane additions, temporary turn lanes, signal timing, etc. for work zones • 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) ***(D1 - High Priority)*** • District 2: Enhance detour route information (Advanced information before decision points, alternate routes, coordinate with other agencies) • District 4: Magnet lights/solar lights for alternate route signing
Current MN Status	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
Deployment Approach	Capital improvement and configuration.
Anticipated 5 Year Deployment (Location(s)	Not yet defined for this strategy.

and Estimated Budget Range)	

Strategy #28: Expand Dissemination of Travel Times (Work Zones and Geographic Expansion)	
Description	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: - Temporary travel time monitoring and display to drivers approaching and within work zones; - 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); - 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); - 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. As part of this strategy, improvements to existing travel time dissemination will continue, including new and alternate sources of real-time travel time data. 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.
Comments from TSMO Outreach Meetings	• RTMC: Provide travel times in work zones • RTMC: Provide travel time information through 511 for key routes • RTMC: Expand travel times to Metro arterials and Greater MN corridors where applicable • RTMC: Provide travel times via DMS and 511 to encourage diversion around work zones. • District 3: Install additional detection and DMS to provide travel times on Hwy 10 and I-94
Current MN Status	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.

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

Strategy #29: Expand Sharing of Video and Data Between Agencies (Integrated Corridor Management)	
Description	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.) 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. *(Source: 2018 Minnesota Statewide Regional ITS Architecture (S17))* 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.
Comments from TSMO Outreach Meetings	• 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 • 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. • District 1: Coordination with locals (possible Integrated Corridor Management).

Current MN Status	This initiative will integrate existing technology and systems already deployed in the initiative area, with potential expansion to areas outside the Twin Cities metro.
Deployment Approach	Integration, collaboration
Anticipated 5 Year Deployment (Location(s) and Estimated Budget Range)	• Develop streaming video system where video data is shared with other external agencies • Complete current project where RTMC is developing streaming video system. • Year 1, expand video streaming to 511 for general public and other agencies - $150,000 • Year 2, develop applications were high quality video streams could be shared with external agencies/partners rather than sending them to 511 - $150,000

Strategy #30: Deploy Transit Signal Priority	
Description	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.
Comments from TSMO Outreach Meetings	• District 7: Transit signal priority
Current MN Status	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.
Deployment Approach	Capital improvement and configuration.
Anticipated 5 Year Deployment (Location(s) and Estimated Budget Range)	Not yet defined for this strategy.

Strategy #31: Address Bikes and Pedestrians in Construction Detours	
Description	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

	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. 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.
Comments from TSMO Outreach Meetings	• OTE/CAV: Develop a Smart phone app for work zones & signals (visually impaired peds). ***(OTE/CAV – High Priority)*** • Central Office (Maint, Transit, OCIC, Freight): Provide transit, ped and bike detours on larger projects
Current MN Status	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.
Deployment Approach	Integration and software
Anticipated 5 Year Deployment (Location(s) and Estimated Budget Range)	Not yet defined for this strategy.

Strategy #32: Improve Work Zone Data for CAV Readiness	
Description	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 3rd 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

	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.
Comments from TSMO Outreach Meetings	• 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) ***(OTE/CAV High Priority)*** • 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. ***(OTE/CAV High Priority)***
Current MN Status	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.
Deployment Approach	Capital improvement - expand use of work zone technologies and integrate work zone data into a single database.
Anticipated 5 Year Deployment (Location(s) and Estimated Budget Range)	Not yet defined for this strategy.

Strategy #33: Prepare Systems to Obtain/Use Data from CAVs	
Description	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

	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.
Comments from TSMO Outreach Meetings	• OTE, CAV: CAV Readiness Improvements ***(OTE, CAV – High Priority)*** ○ Make signals CAV ready (new signals). Determine how to get SPaT data; ○ Prepare IT systems to harvest/use data from CAVs: ○ Consider how to use data from CAVs for better traffic management (long term); ○ Determine methods for CAV to handle weather data/poor weather
Current MN Status	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.
Deployment Approach	Integration and software development
Anticipated 5 Year Deployment (Location(s) and Estimated Budget Range)	Not yet defined for this strategy.

Strategy #34: Encourage Work Flexibility for Travel Demand Management	
Description	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. 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.

Comments from TSMO Outreach Meetings	• RTMC: Work with major employers to decrease traffic demand during snow and ice events by encouraging employers to allow teleworking during major storms. • 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.
Current MN Status	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.
Deployment Approach	Coordination and outreach, software integration
Anticipated 5 Year Deployment (Location(s) and Estimated Budget Range)	• Year 1-5: Engage private firm to implement education\advertising\outreach campaign for various TDM strategies in Metro area. • Utilize past Humphrey Institute study for information. Coordinate with Met Council CMP Committee. • Cost = $ 250 K Total