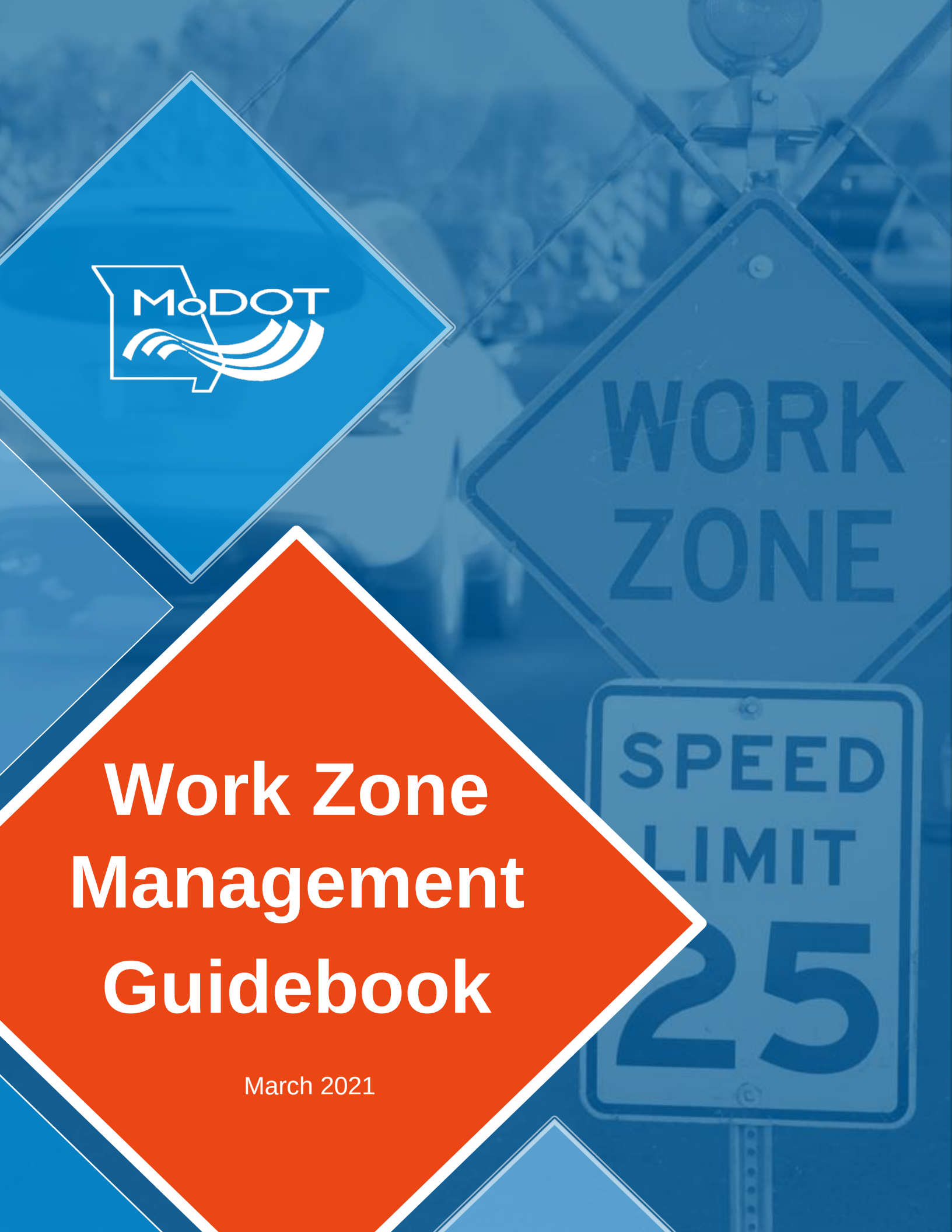

Work Zone Management Guidebook

March 2021

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Introduction

Challenges

Work zones are a necessary part of managing the transportation system. Their presence often creates negative impacts on traffic conditions, violating motorists' expectations and exposing workers to hazardous conditions. Increasing driver inattention aggravates the danger to both drivers and workers.

Some recent statistics[1] include:

- In 2019, 18 people were killed in work zone crashes in Missouri.
- Between 2015 and 2019, 64 people were killed in work zone crashes in Missouri.
- Between 2015 and 2019, 3,685 people were injured in Missouri work zone crashes.
- Since 2000, 19 MoDOT employees have been killed in the line of duty, 13 of them taking place in work zones.

Improvement Efforts

Missouri DOT expends significant efforts to continually improve all aspects of work zone safety, including continual driver education, standards, specifications, processes, materials, research, and methods. Recent advancements in technology have added resources to the work zone toolbox to increase driver information and awareness and improve work zone operations.

Guidebook Purpose

This guidebook provides information about tools and strategies for Work Zone Management (WZM) that will maximize safety and minimize the impacts to traffic. It includes descriptions of the available Smart Work Zone (SWZ) and other strategies (known jointly as *advanced work zone strategies* for this guidebook) and identifies resources to assist in their selection. It also includes information about the use of law enforcement in work zones, contractor management and work zone inspections, and other available resources.

The information in this guidebook is intended to supplement current standards and documents in the Engineering Policy Guide (EPG) and does not replace or supersede them.

[1] https://www.modot.org/work-zone-awareness

Advanced Work Zone Strategies

This section provides descriptions of each of the advanced work zone strategies that can be considered. It also includes guidance to aid in the selection of strategies based on the individual work zone characteristics.

Strategy Descriptions

High-level descriptions of these advanced work zone strategies are provided in the following pages. These descriptions are intended to be high-level, and do not supersede information in the EPG or in any corresponding job special provisions (JSPs).

1. Construction Vehicle Warning System
2. Dynamic Late Merge (Zipper Merge) System
3. Queue Warning System
4. Road Closure
5. Speed Warning System
6. Temporary Rumble Strips
7. Temporary Traffic Incident Management and ITS System
8. Travel Time Advisory System
9. Travel Time Advisory System with Alternate Route

	1. Construction Vehicle Warning System	Revision 09/30/2020	Page 1

Description

One of the crucial aspects of the establishment and maintenance of a work zone is safe access and egress points for construction vehicles. These points are key determinants when it comes to ensuring the safety of both the traveling public and construction workers on a project. The safety challenges include travelers following construction vehicles which are slower than usual traffic, acceleration, and deceleration of work vehicles while entering or exiting work zones, the proximity of work vehicles to passing motorists.

The use of ITS in work zones provides a variety of innovative ways where technologies can be exploited for the improvement of work vehicles access to and egress from work zones. The usage of detectors and CMS helps in notifying the motorists when a construction vehicle is planning to enter or exit from work zones. This display of messages can prepare travelers for a slowdown or potential merging conflicts due to construction vehicles. These warnings also reduce the frequency of incidents where motorists following work vehicles.

Applications

- At least one construction vehicle access point.
- Work zones where a truck acceleration/merge lane is not provided.
- Work zone speed limit is greater than 25 mph
- Traffic Volumes ≥ 1500 vehicles per lane per hour
- ADT is above the level where a truck can easily find a gap in traffic to accelerate within the traffic lane without causing traffic to have to adjust speed or change lanes.

Benefits

- The system should alert drivers of a slowly accelerating construction vehicle crossing into the traffic lane.
- The system should provide drivers sufficient time to react appropriately, such as slowing down.

Costs

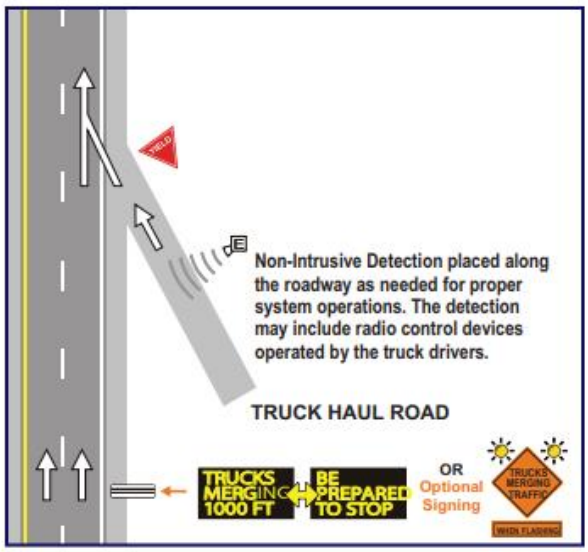
- Sensors and CMS: $15,000 per access/egress points.
- ($13k. High Level MnDOT Cost Estimate.)

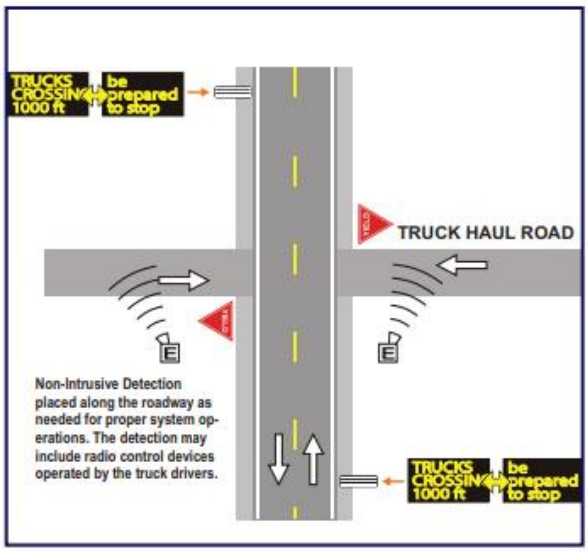
Reference

https://www.workzonesafety.org/files/documents/training/courses_programs/rsa_program/RSP_Guidance_Documents_Download/RSP_Access_Egress_Download.pdf

	1. Construction Vehicle Warning System	Revision 09/30/2020	Page 2

Diagram





Specific examples of ITS application from the Minnesota DOT.

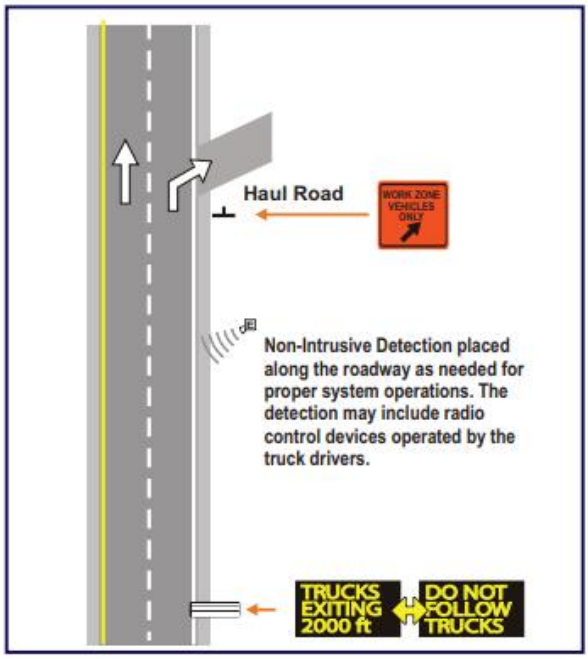


Diagram source: http://www.dot.state.mn.us/trafficeng/workzone/iwz/MN-IWZToolbox.pdf

	2. Dynamic Merge (Zipper Merge) System	Revision 09/30/2020	Page 1

Description

A single lane closure is a common temporary traffic control application. A typical setup traffic control setup includes a series of advance warning signs and arrow boards at the merge point.

The typical traffic control setup works well when traffic demand is less than the capacity of the open lane. Queuing occurs when demand exceeds capacity, introducing various unsafe conditions especially when the congestion extends upstream beyond the advance warning signs. Merging conflicts can occur, and while many drivers try to merge into the open lane early, some become upset when other drivers use the closed lane up until the merge point.

A Dynamic Late Merge system can be utilized to improve the merging movements of approaching traffic and to minimize queueing:

Dynamic Late Merge

A Dynamic Late Merge System can optimize the benefits of both late merge and early or typical merge configuration. The system detects the level of congestion present on the approach to the work zone. When congestion is present, dynamic signs present a late merge system where drivers are encouraged to use both the open and closed lanes all the way to the merge point, then take turns merging. When congestion is not present, dynamic signs present a traditional merge configuration.

Applications

- Posted approach speed limit is greater than 40 mph
- Work zones where traffic demand will occasionally (30 min – 120 min/day) exceed the available capacity of the open lanes in a work zone
- Fluctuating traffic volumes/patterns
- At least 2 open approach lanes and 1 open lane in the work zone
- Work zone is in place for a minimum of 7 days and the lane closure(s) are continuous.

Benefits

- The system should alert drivers of an upcoming traffic slow-down or stopped traffic, and inform them to use both lanes until the designated merge point.
- It is anticipated that the system will reduce the length of the upstream queue by 40%, which may reduce conflicts at nearby intersection.
- By utilizing both traffic lanes, the different speed between lanes is greatly reduced since both lanes travel at approx. the same speed.
- Motorists are given positive directions on lane usage and merging which clears misunderstandings between drivers and reduce road rage.

Costs

- Sensors and CMS: $19,000 per merge point
- $13k. High Level MnDOT Cost Estimate.

Reference

https://www.workzonesafety.org/files/documents/training/courses_programs/rsa_program/RSP_Guidance_Documents_Download/RSP_Access_Egress_Download.pdf

	2. Dynamic Merge (Zipper Merge) System	Revision 09/30/2020	Page 2

Diagram

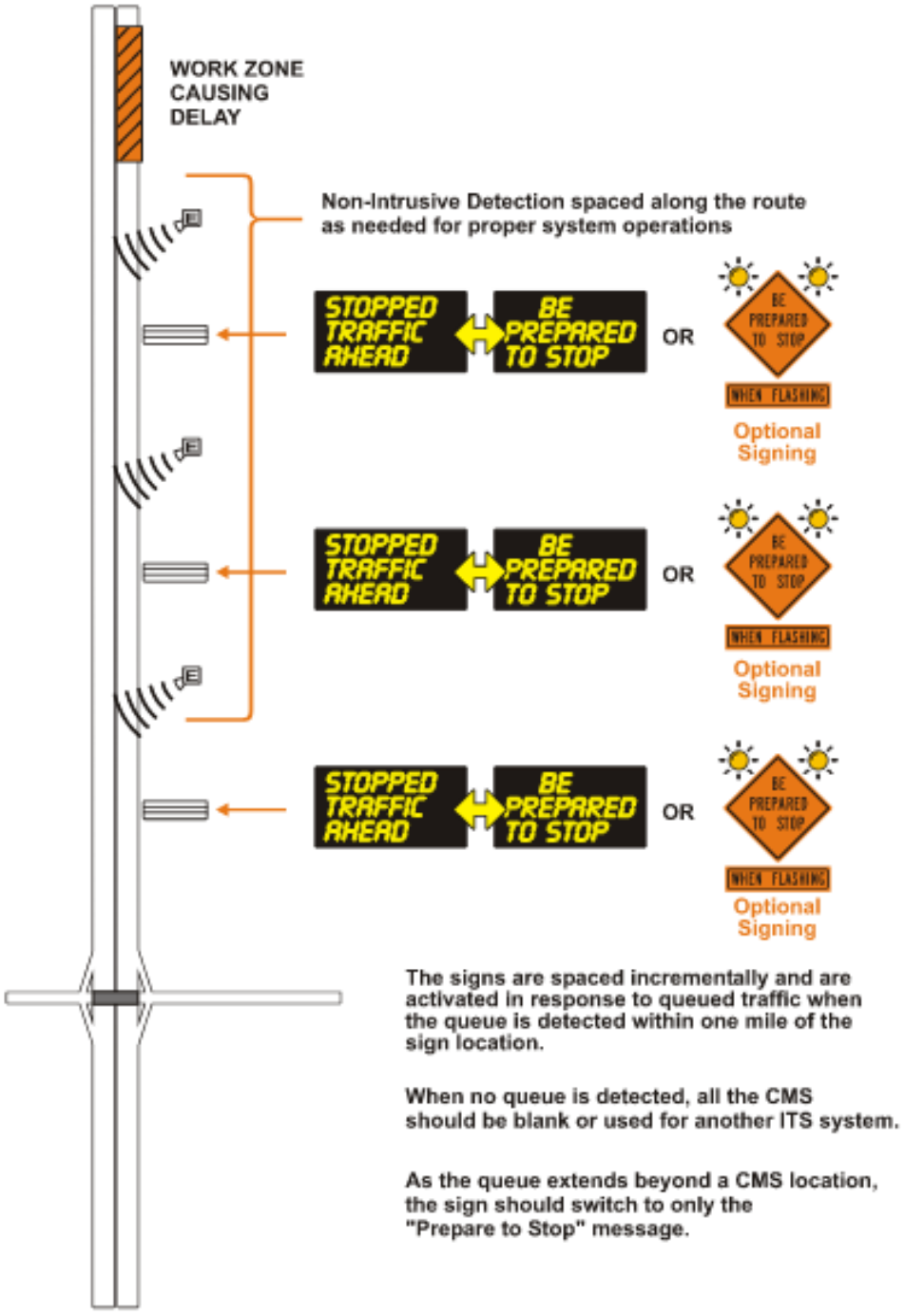


Diagram source: http://www.dot.state.mn.us/trafficeng/workzone/iwz/MN-IWZToolbox.pdf

	3. Queue Warning System	Revision 09/30/2020	Page 1

Description

A Queue Warning system is used to inform travelers about upcoming congested or stopped traffic conditions. The queue warning system informs drivers of an impending traffic situation and to avoid emergency braking and queue-related collisions.

This system typically consists of roadside sensors and Portable Changeable Message Signs (PCMS) placed upstream of the work zone. The basic principle of this system is when sensors detect slowing or stopped vehicles, it sends signals to the PCMS where warning signs are displayed advising travelers about an impending traffic queue. The sensors and PCMS should be placed in such a way that if the queue reaches within 1-2 miles (based on the speed and length of work zone) of PCMS, it should start displaying the warning signs alerting the approaching motorists of queue conditions.

Applications

- Posted approach speed limit is greater than 40 mph
- Fluctuating traffic volumes/patterns
- Work zones where traffic demand will occasionally (30 min – 120 min/day) exceed the available capacity.
- The estimated delay ranges from 5 to 25 min
- Upstream of predictable congested or queue points, such as the traffic merge point.
- Estimated queue lengths range from 0.5 to 3.0 miles
- Limited sight distance due to vertical grades, poor nighttime illumination, or horizontal curves.
- Queues extend past upstream intersections or interchanges

Benefits

- Reduce read end crashes by informing drivers beforehand.
- Also helps in decreasing secondary crashes.
- Delay the onset of congestion

Costs

- Base system cost: $20,000 per mile (queue length and taper length) + $200/mile/week*
- *Cost will be less in an existing ITS system exists in the work zone area

Reference

https://ops.fhwa.dot.gov/wz/practices/best/view_document.asp?ID=396&from=state&State_ID=14
https://www.workzonesafety.org/files/documents/training/courses_programs/rsa_program/RSP_Guidance_Documents_Download/RSP_EndOfQueueWarning_Guidance_Download.pdf
https://mobility.tamu.edu/mip/strategies-pdfs/active-traffic/executive-summary/queue-warning-1-pg.pdf

	3. Queue Warning System	Revision 09/30/2020	Page 2

Diagram

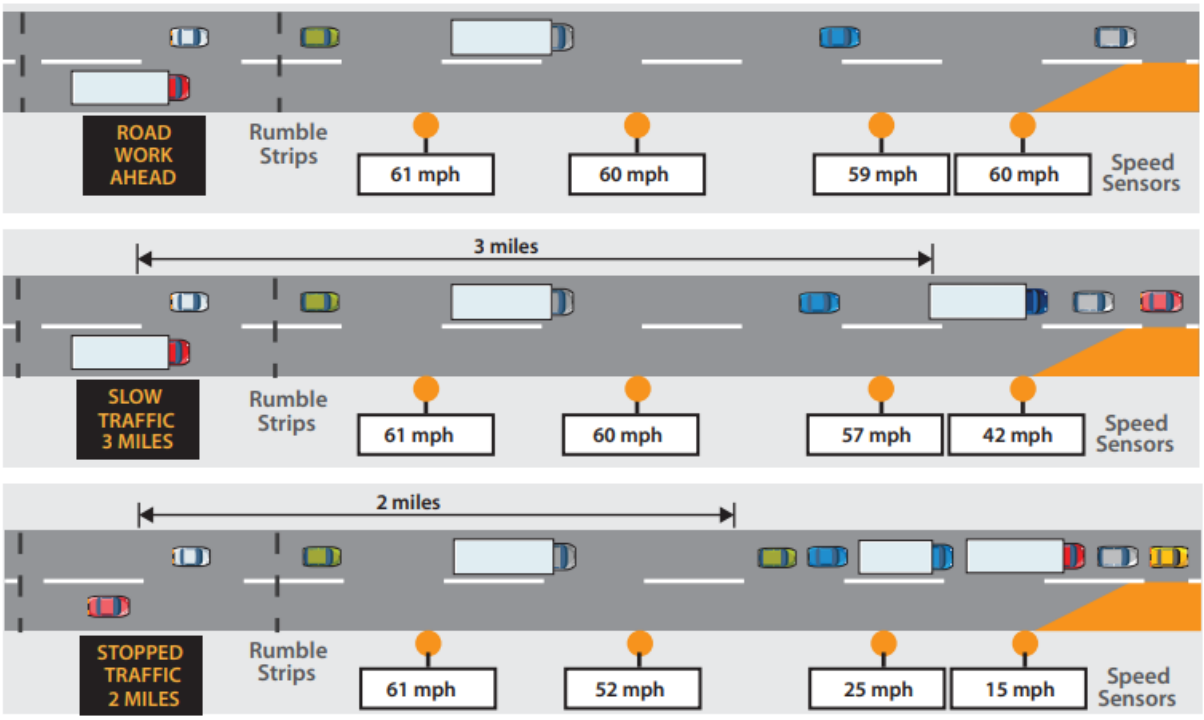


Diagram source: http://www.dot.state.mn.us/trafficeng/workzone/iwz/MN-IWZToolbox.pdf

	4. Road Closure	Revision 03/09/2021	Page 1

Description

Full and partial road closures and lane closures all facilitate the completion of roadway construction projects. A full road closure is meant to eliminate the exposure of motorists to work zones and workers to traffic by temporarily closing a facility for rehabilitation or maintenance. MoDOT does not currently have a defined policy or procedure for full road closures, however this document provides information about some considerations that can be included when considering the strategy.

During the full road closure, traffic is detoured, allowing workers full access to roadway facilities. Allowing full access in this way can accelerate the construction schedule and reduce construction costs in some cases but increases the road user costs and may have other significant safety and other impacts. Therefore, road closures are not suitable for all construction situations depending on the overall impact to traffic, the availability of suitable alternate routes, the duration of the closure, and other factors. A full closure approach may be used for an extended time, on weekends or nights, or directionally on a segment of roadway. Road closures can be considered for very high and very low volume roads where adequate alternate routes are available. FHWA provides the following guidance to consider for road closures:

FHWA Guidance – Considerations Associated with Full Road Closure

- City/county agencies and personnel may need to be consulted regarding of the feasibility of implementing a full closure strategy and the potential benefits that can be realized, compared to traditional means of performing rehabilitation under traffic.
- Full closure projects are typically done on an accelerated schedule. Contractor and supplier ability to provide adequate amounts of resources (materials, equipment, crew) to maintain an accelerated pace should be assessed prior to letting a project as a full closure.
- Meeting the project completion deadline is particularly important when using full closure since this is often highly publicized as the date when the road will re-open. Therefore, full closure projects may carry additional deadline pressure for those involved. This can accelerate decisions and limit the time for researching options when issues arise.
- Impacts to business or entertainment venues can be a factor. Many of the project sites planned closures around events and considered impacts to businesses during the planning process.
- Full closure projects are often scheduled on a 24-hour work basis, so there is potential for impacts to local residents, including noise and light pollution.
- Increases to traffic densities on alternate routes must be assessed, planned for, and managed. Depending on available alternate routes, there is a potential need for capacity improvements and operational enhancements that may require additional funding and coordination during the planning and programming phases

Applications	Benefits
• Very high volume, high impact • Very low volume, low impact • Alternate Routes must be available.	• It may be better in some cases to close the road and get the work done very quickly and avoid overly complex traffic control. • With increased productivity the duration of the project can be reduced.

	5. Speed Warning System	Revision 09/30/2020	Page 1

Description

The regulation of speed during construction is necessary to maintain travelers' and workers' safety as well as making sure of timely completion of the road work. Speed warning systems are speed displays using intelligent transportation system (ITS) technologies that give the driver information about their speed as well as safe driving speeds.

Speed Feedback:

A sensor-based speed warning system used in a work zone is the Speed Advisory display, which informs the approaching motorists of the posted advisory speed and their current speed to warn them if they are driving above the speed limit defined. This speed displays are portable and can be used in the work zone wherever excessive speeding is a problem.

Applications

- Work zones on the interstates, freeways, expressways with a construction zone speed limit of 35 mph or higher.
- For construction activities > 1 week.
- Hazardous roadway conditions require extra driving precautions
- Traffic must reduce speed to safely negotiate a hazardous condition such as an unusually tight curve or a rough road surface.

Benefits

- The system should inform the drivers of the posted speed limit and the speed they are traveling.

Costs

- Base system cost: $13,000 per site
- $13k. High Level MnDOT Cost Estimate

Reference

https://ops.fhwa.dot.gov/wz/traffic_mgmt/wzsm.htm

	5. Speed Warning System	Revision 09/30/2020	Page 2

Diagram

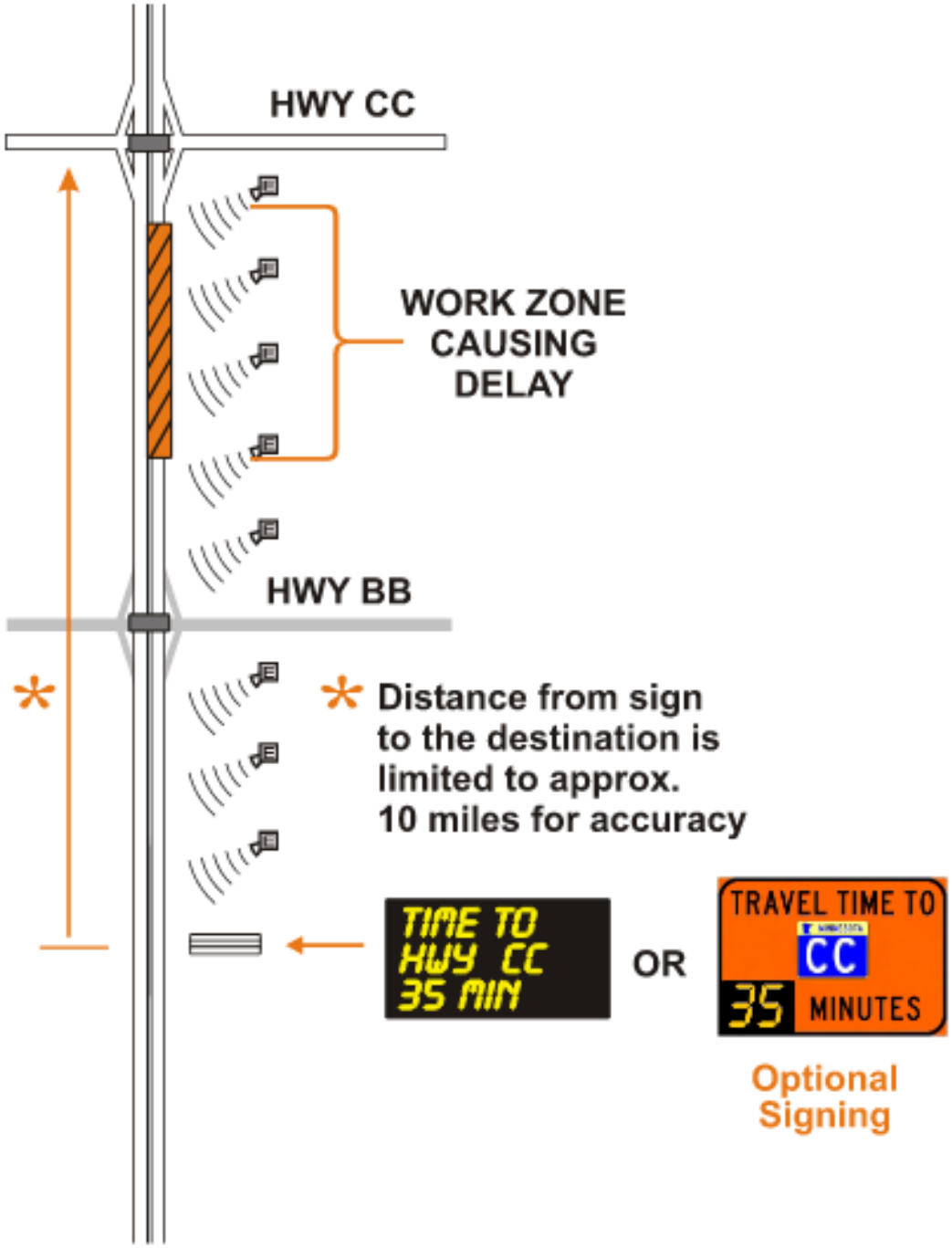


Diagram source: http://www.dot.state.mn.us/trafficeng/workzone/iwz/MN-IWZToolbox.pdf

	6. Temporary Rumble Strips	Revision 09/30/2020	Page 1

Description

Temporary rumble strips are a strategy for reducing distracted driving and achieving MoDOT's work zone safety goals. Temporary rumble strips are comprised of a series of raised elongated bumps placed upon the surface of the roadway to provide an audible and vibratory alert to drivers of the upcoming work zone. Temporary rumble strips are much easier to install and remove compared to permanent rumble strips, and some forms are even reusable; this makes them particularly useful for deployment in work zones.

There are two types of temporary rumble strips:

- Long-term Rumble Strips - The long-term rumble strips are made with an adhesive backing to prevent movement.
- Short-term Rumble Strips - The short-term rumble strips are made to be portable and stable, without using adhesive or other anchoring. They are thicker, wider and heavier than long-term rumble strips, but can be easily moved with the work zone operation.

Applications

- Temporary rumble strips are used on roadways posted 50 mph and above. Temporary rumble strips are optional for posted speed limits lower than 50 mph.
- Temporary rumble strips will be placed before the feature requiring attention (e.g., merge, lane shift, reduced speed) giving the motorist enough time to act safely.
- Short term rumble strips should be used when workers are present to monitor the rumble strips for possible shifting.

Benefits

- It increases driver awareness.
- It also alerts drivers to changes ahead that require them to slow, such as a toll booth.
- They are installed to increase driver awareness of a road condition that is unusual.
- Rumble strips are effective in reducing accidents in work zones.

Costs

- Unit prices have been estimated to range between $0.10 and $1.20 per linear foot

Reference

https://www.workzonesafety.org/training-resources/fhwa_wz_grant/atssa_temporary_rumble_strips/#s2.1

https://epg.modot.org/index.php/616.6_Temporary_Traffic_Control_Zone_Devices_(MUTCD_6F)#616.6.87_Temporary_Rumble_Strips_.28MUTCD_6F.87.29

	6. Temporary Rumble Strips	Revision 09/30/2020	Page 2

Diagram

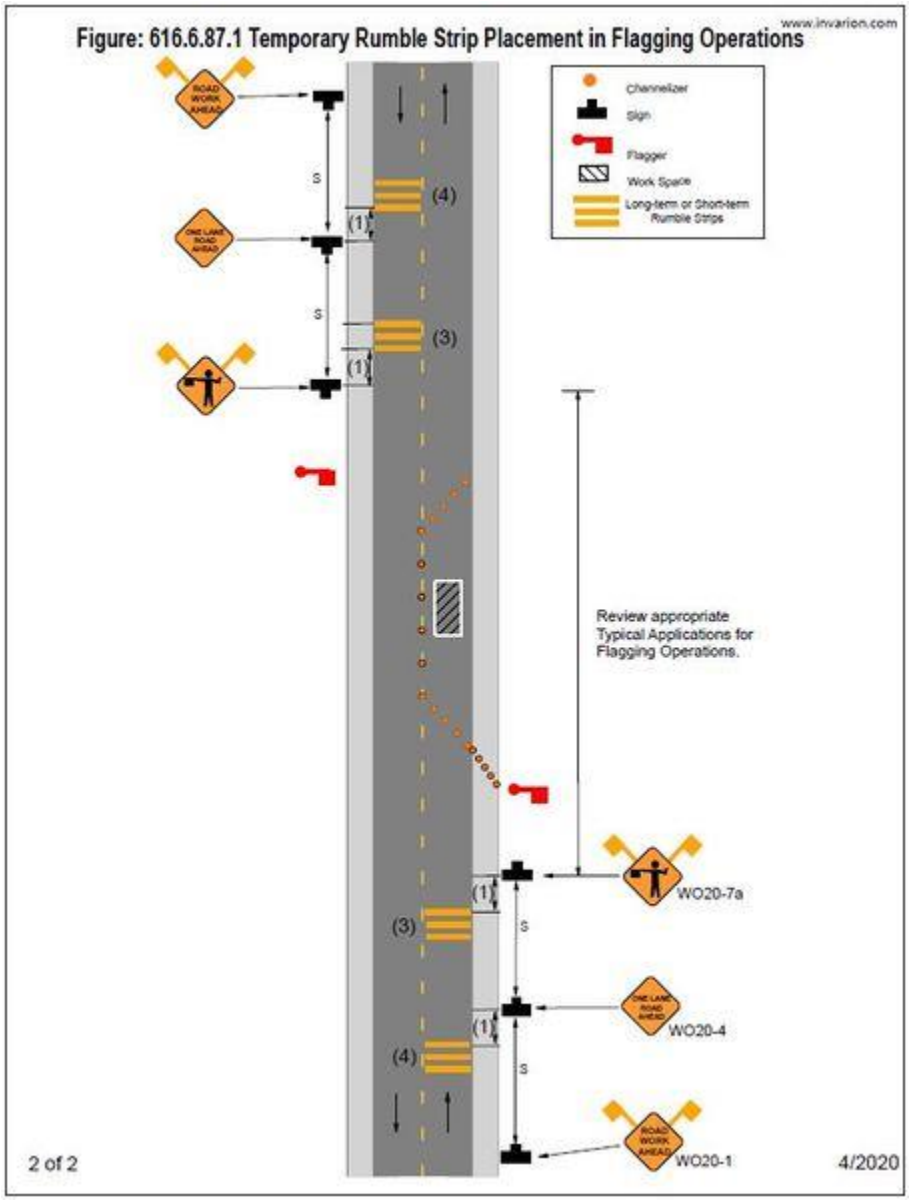


Diagram source: https://epg.modot.org/index.php/616.6_Temporary_Traffic_Control_Zone_Devices_(MUTCD_6F)#616.6.87_Temporary_Rumble_Strips_.28MUTCD_6F.87.29

Diagram

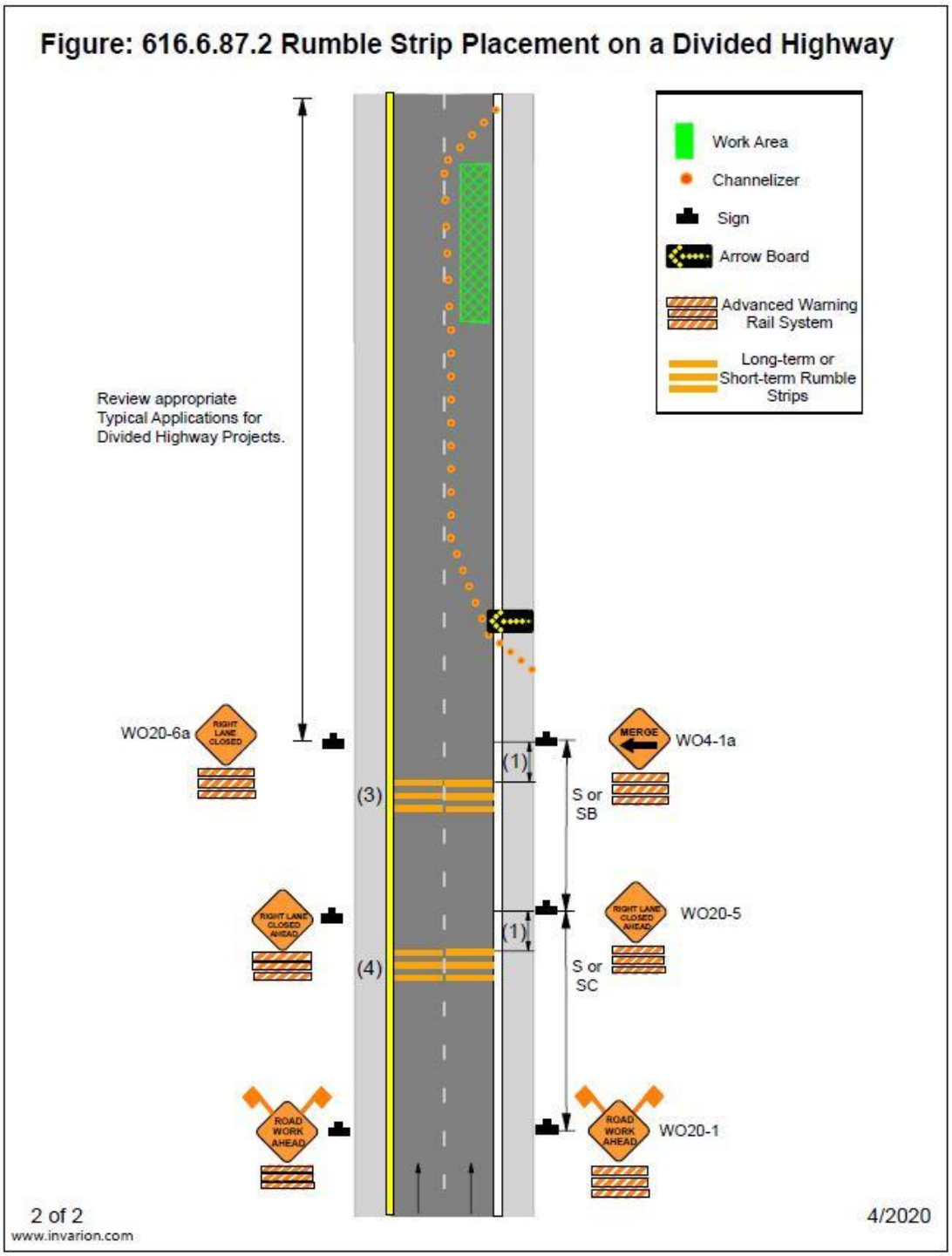


Diagram source: https://epg.modot.org/index.php/616.6_Temporary_Traffic_Control_Zone_Devices_(MUTCD_6F)#616.6.87_Temporary_Rumble_Strips_.28MUTCD_6F.87.29

	7. Temporary Traffic Incident Management and ITS System	Revision 09/30/2020	Page 1

Description

The prompt detection and clearance of traffic incidents in a work zone aids in avoiding secondary crashes and minimizes associated delays. All work zones interrupt the free flow of traffic, resulting in the possibilities of incidents increasing within the work zone. In addition, work zones provide challenges such as reduced access, narrowed lanes, minimum refuge locations, barriers, and limited sight distances, making the management of work zone incidents more challenging. Thus, the presence of a traffic incident management system in a work zone is critical in ensuring the safety and mobility of the traffic.

A Temporary Traffic Incident Management (TTIM) system can be defined as the coordinated, preplanned use of technology, processes, and procedures to reduce the duration and impact of incidents in a work zone. There are following strategies that can be deployed in a work zone for faster and efficient mitigation of incidents:

1. Improving Detection in work zones:

The first step of TTIM is to detect an incident as quickly as possible. The TTIM provides the following tools to detect an incident:

- Video Surveillance- By surveillance of video recorded by closed-circuit cameras at TMC for the immediate detection of and response to incidents.
- ITS traffic sensors- The use of traditional detectors to monitor the traffic flow and an automation algorithm that can inform the TMC of any anomalies in the traffic flow by these sensors.

2. Improving Incident Response:

After the detection of an incident, a timely and proper response plays a vital role. The activation of portable CMS boards after an incident has been detected by sensors would help in informing approaching motorists about impending slowdown.

The other steps to improving the incident response are:

- Remote assessment of the problem – The use of portable CCTV cameras allows the TMC operator to assess the circumstances and better understand the details of the incident
- Determination of needs – During the assessment, the operator can ascertain the various elements of the incident and determine the needs such as the severity of the incident, types of vehicles involved, number of lanes blocked, easiest means of access, possible HazMat needs, etc.
- Notification of appropriate agencies – Based on the determination of the needs, the TMC operator can then provide notification to the agencies and services that are needed for the incident response

By significantly reducing the time to assess the incident details and needs, and to notify the appropriate responders, the clearing of the incident will be performed much more expediently.

	7. Temporary Traffic Incident Management and ITS System	Revision 09/30/2020	Page 2

3. Develop a project Traffic Incident Management Plan:

Working with law enforcement, fire, and other local emergency responders, develop a project Traffic Incident Management Plan to plan and refine the responses to incidents in and approaching a work zone. The following steps are some of the facets of a project Traffic Incident Management Plan:

Improving Incident Clearance – To minimize the impact of an incident, the earliest clearance of the roadway is important. By enforcing Quick Clearance policies, the impact of non-fatality crashes can be greatly reduced.

Improving site management – The key steps in the management of an incident within a work zone consist of:

- Determination of alternate routes for the roadways within a work zone.
- Providing emergency services access gates (providing breaks or access gates in median)
- Dedicated emergency routes for the incident responders.
- Setting up predefined staging areas for emergency vehicles and responders.

Improving Incident Information Dissemination to Travelers:

Uses of Dynamic Message signs to inform travels about the incident and impending slowdown of traffic and posting to Traveler Information websites can improve safety and reduce traffic in the work zone. The uses of Highway advisory radio can also be employed for the communication of incidents and traffic slowdown.

Applications

- Work zones on interstates, freeways, and expressways with AADT > 15,000 vpd
- Work zones where traffic demand will occasionally (30 min – 120 min/day) exceed the available capacity of the open lanes in a work zone
- Work zone has constraints which inhibits responder access

Benefits

- Improves situational awareness
- Decreases incident response time
- Minimizes the impact of an incident to traffic.
- Significant reduction of secondary crashes.

Costs

- Sensors and CMS - $50,000
- Surveillance equipment (videos, drones, etc.) – $40,000
- Maintenance cost - $1,000 per month
- *$1.3M (1.3% of Project Total). Average of three Texas jobs 2016-2017.

Reference

https://ops.fhwa.dot.gov/wz/traffic_mgmt/wzsm.htm

	8. Travel Time Advisory System	Revision 09/30/2020	Page 1

Description

Travel time information is trip-related information provided to a traveler. This information usually consists of travel times through a work zone. Travelers seek accurate, timely, and reliable information regarding their travel routes in a convenient form. Apart from benefitting the individual motorist, travel time information can lead to system-wide benefits when many users respond in a predictable way to the information they received.

The benefits of travel time information for work zones include less stressful conditions for the motorists and more predictable and safe travel conditions.

Work zones are infamous for travel delays and lead to traffic conditions that violate traveler's expectations. Hence, the usage of travel times becomes important rather than a good-to-have for work zones. Travel time systems gather real-time traffic information in work zones with the help of sensors, video cameras, and communicate the scenario to upstream motorists with the help of portable Changeable Message Signs (PCMS).

The messages of travel time are displayed on CMS activated by the sensors. This information helps drivers understand the magnitude of delay they will encounter and to make an informed decision in how to conduct their travels.

Probe data may be used for travel time measurement where available and volumes provide sufficient sample size.

Applications

- Work zones where traffic demand will occasionally (30 min – 120 min/day) exceed the available capacity of the open lanes in a work zone, resulting in queueing.
- Work zone duration is greater than 180 days
- Work zone length is at least 5 miles
- Fluctuating traffic volumes/patterns
- Where traffic demand will occasionally (30 min – 120 min/day) exceed the available capacity.
- The estimated delay ranges from 5 to 25 min
- The estimated lengths of traffic queues ranges from 0.5 miles to 3.0 miles

Benefits

- The system should inform the drivers what the estimated travel time is between their current location and a specific destination beyond them
- The system will give drivers information which will allow them to decide whether to change routes, provide them opportunity to notify others of their estimated arrival time, and generally provide drivers sufficient information to remain calm.

Costs

- Base system cost: $15,000/mile of WZ
- Maintenance cost- $56/week/mile of WZ
- Or: 0.9% of Project Total (Average of 5 MoDOT jobs 2016-2019.
- Cost reductions of 75% apply where ITS devices exist

Reference

https://ops.fhwa.dot.gov/publications/manag_demand_tis/travelinfo.htm
https://ops.fhwa.dot.gov/wz/workshops/accessible/Pant_paper.htm

	8. Travel Time Advisory System	Revision 09/30/2020	Page 2

Diagram

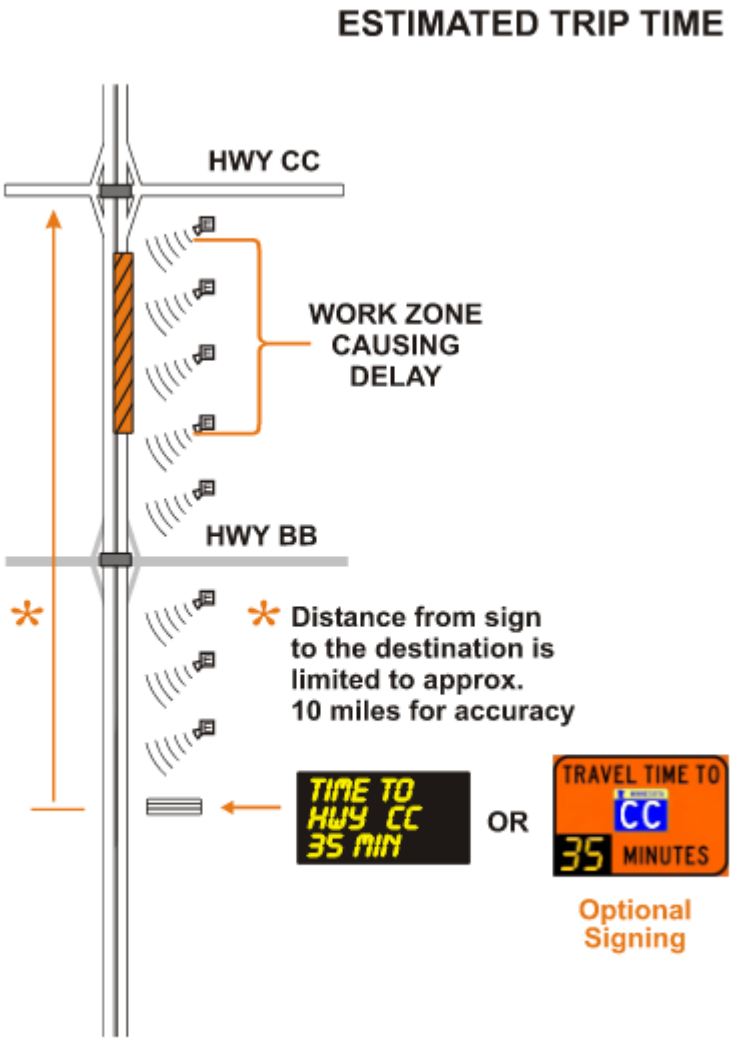


Diagram source: http://www.dot.state.mn.us/trafficeng/workzone/iwz/MN-IWZToolbox.pdf

	9. Travel Time Advisory System with Alternate Route	Revision 09/30/2020	Page 1

Description

Travel time information is trip-related information provided to a traveler. This information usually consists of travel times through a work zone and/or on a designated alternate route for the work zone. Travelers seek accurate, timely, and reliable information regarding their travel routes in a convenient form. Apart from benefitting the individual motorist, travel time information can lead to system-wide benefits when many users respond in a predictable way to the information they received.

The benefits of travel time information for work zones and related designated alternate route include reduced trip time, less stressful conditions for the motorists and more predictable and safe travel conditions.

Work zones are infamous for travel delays and lead to traffic conditions that violate traveler's expectations. Hence, the usage of travel times and alternate route travel time advisories becomes important rather than a good-to-have for work zones. Travel time advisory and alternate route travel time advisory systems gather real-time traffic information in work zones and on designated alternate routes with the help of sensors, video cameras, and communicate the scenario to upstream motorists with the help of portable Changeable Message Signs (PCMS).

The messages of travel time are displayed on CMS activated by the sensors. This information helps drivers understand the magnitude of delay they will encounter and to make an informed decision in how to conduct their travels. Alternate route travel times can aide travelers in determining whether to travel through a work zone or utilize the designated alternate route.

Probe data may be used for travel time measurement where available and volumes provide sufficient sample size.

Applications

- An available alternate route with adequate capacity and reasonable out-of-distance travel.
- Work zones where traffic demand will occasionally (30 min – 120 min/day) exceed the available capacity of the open lanes in a work zone, resulting in queueing.
- Work zone duration is greater than 180 days
- Work zone length is at least 5 miles
- Fluctuating traffic volumes/patterns
- Where traffic demand will occasionally (30 min – 120 min/day) exceed the available capacity.
- The estimated delay ranges from 5 to 25 min
- Estimated queues range from 0.5 miles to 3.0 miles

Benefits

- The system should inform the drivers what the estimated travel time is between their current location and a specific destination beyond them
- The system will give drivers information which will allow them to decide whether to change routes, provide them opportunity to notify others of their estimated arrival time, and generally provide drivers sufficient information to remain calm.

Costs

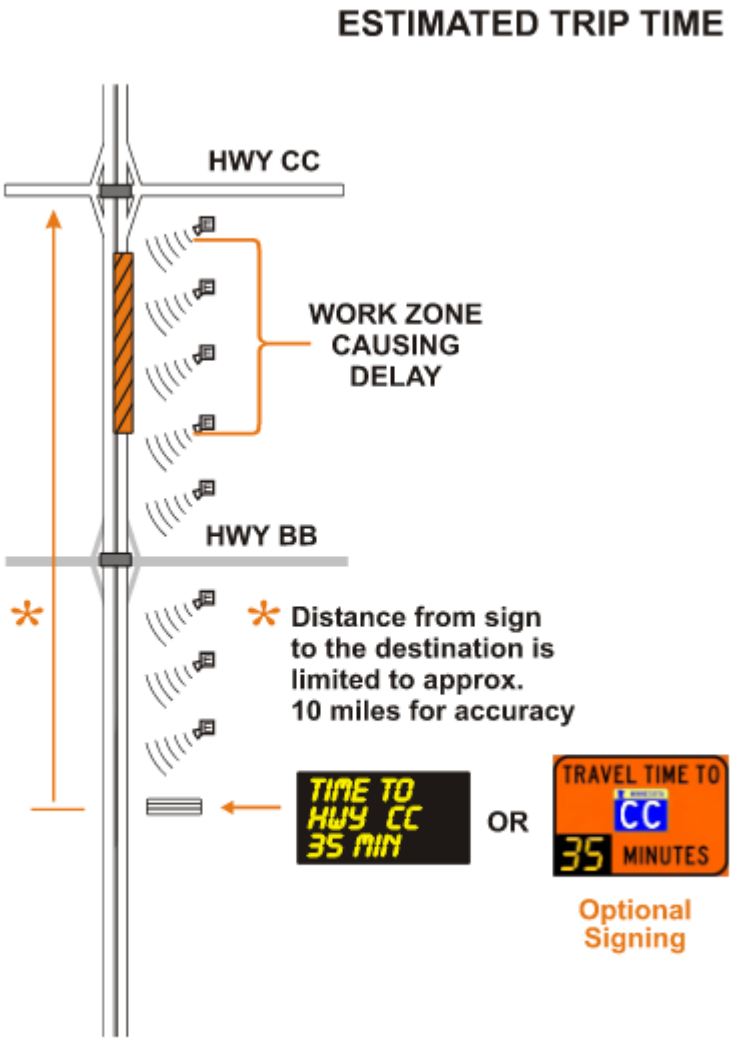
- Base system cost: $15,000/mile of WZ
- Maintenance cost- $56/week/mile of WZ
- Or: 0.9% of Project Total (Average of 5 MoDOT jobs 2016-2019.
- Cost reductions of 75% apply where ITS devices

Reference

https://ops.fhwa.dot.gov/publications/manag_demand_tis/travelinfo.htm
https://ops.fhwa.dot.gov/wz/workshops/accessible/Pant_paper.htm

	9. Travel Time Advisory System with Alternate Route	Revision 09/30/2020	Page 2

Diagram



Consideration should be given to posting an alternate route and travel time for additional driver information.

Diagram source: http://www.dot.state.mn.us/trafficeng/workzone/iwz/MN-IWZToolbox.pdf

Priority Areas

The TSMO WZM committee developed a method for identifying priority segments along major routes throughout the Missouri. The method is intended simply to highlight critical roadway segments for which additional consideration should be given to the application of advanced work zone strategies. The method combines crash history with probe-based congestion data to create a priority index.

Safety Index: The crash history included accident rates for property damage only (PDO), injury, and fatal crashes. These accident rates were weighted by the FHWA Comprehensive Crash Unit Cost for each type, then summed to a total score for the segment. The following table illustrates an example of this calculation:

Crash Index Calculation for One Example Segment

(A) Crash Severity Level	(B) FHWA Comprehensive Crash Unit Cost	(C) Crash Rate from Example Segment	(D) Result (B*D)
Fatality	$4,008,900	0.333	1,334,964
Injury	$82,600	1.000	82,600
PDO	$7,400	5.000	37,000
Total Score for Example Segment			**1,454,564**

The score for all segments were then normalized into values from 0 to 100, where 100 is assigned to the highest score of all segments.

Congestion Index: A congestion index was calculated using probe data available through the Regional Integrated Transportation Information System (RITIS) joined with data from MoDOT's Transportation Management System (TMS). For this version, data was collected from RITIS for June 1 – June 30, 2018 between the hours of 3:00 PM to 6:00 PM. The formula is as follows:

Congestion % = average speed / reference (free flow) speed

To calculate the index, the lowest congestion % for each segment and day was used. This data point was then averaged across the 30 days noted above. This measure was then subtracted from 1, as follows:

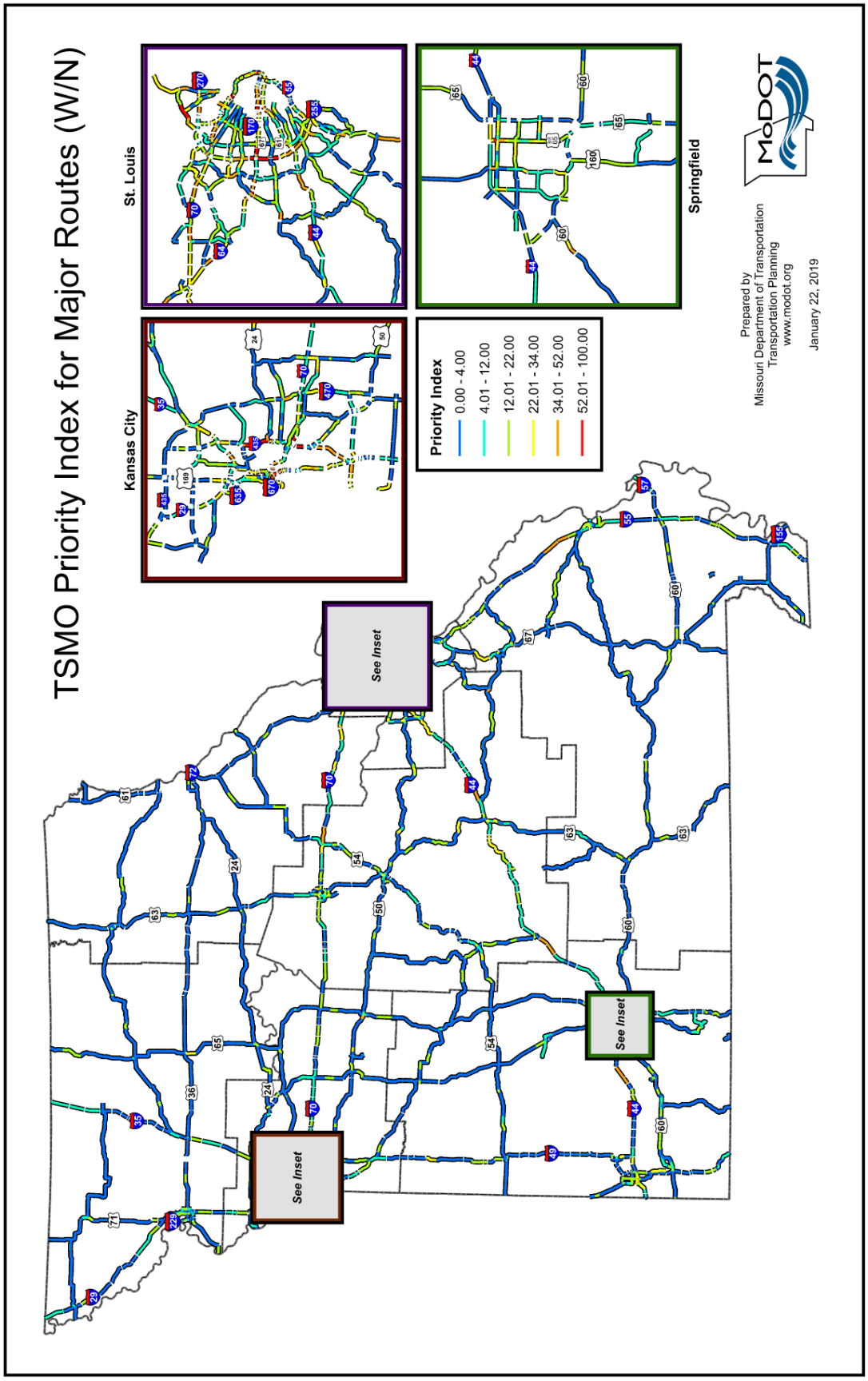
Index = (100% – Congestion %)

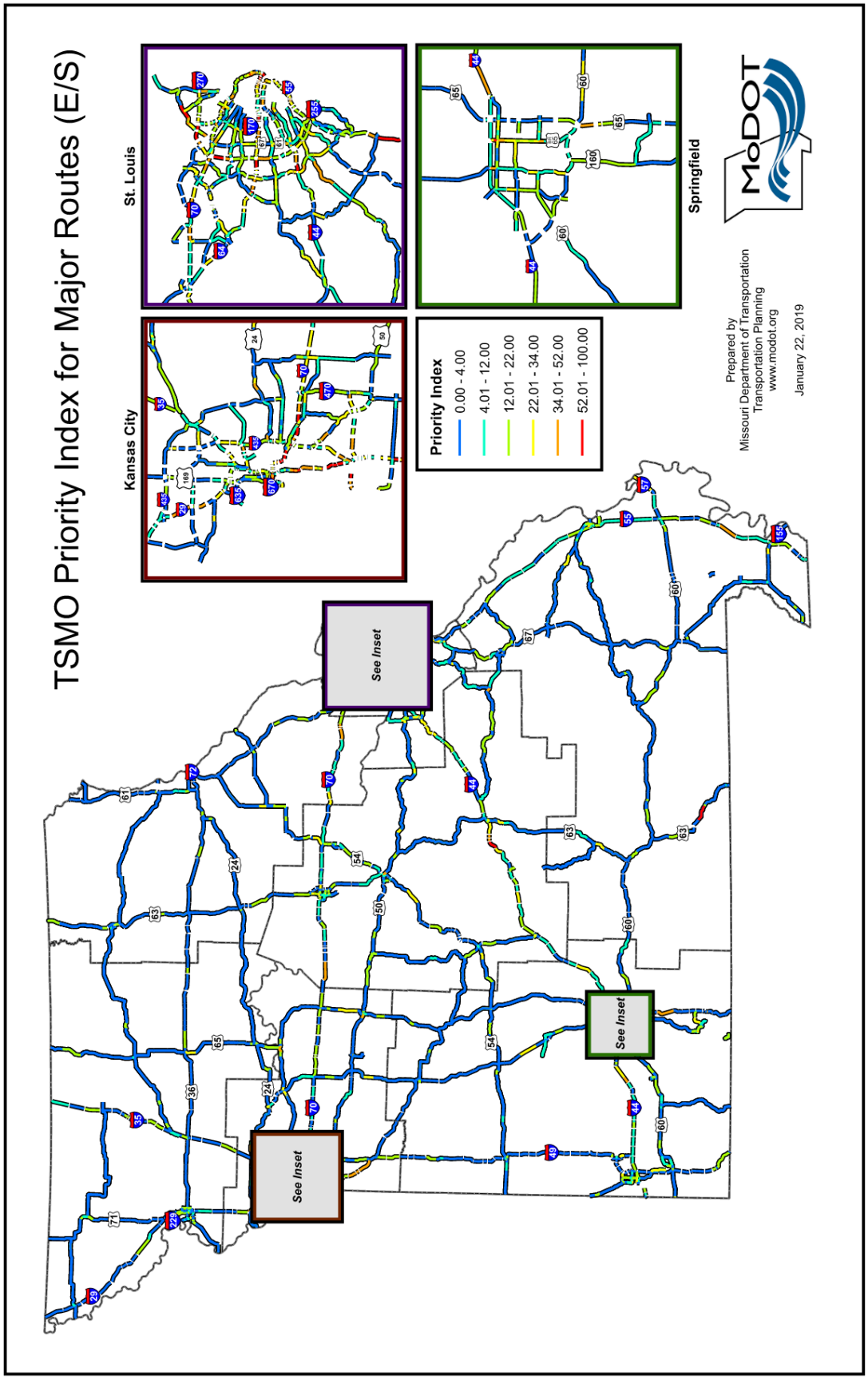
All values were then normalized into values from 1 to 100 similar to the Safety Index.

Combined Priority Index: The Safety and Congestion index where then combined into a single priority index. The safety and congestion indices were added together, then the values were again normalized into an index from 1 to100 through the following formula:

Priority Index = (Safety Index + Congestion Index)/2

For the purposes of this guidebook, calculations were prepared for major routes throughout the state. The following two statewide maps provide a color-coded illustration of the priority index. **Figure 1** shows the priority index for all Northbound and Westbound routes, and **Figure 2** shows priority index for all Southbound and Eastbound directions of the same routes.


TSMO Priority Index for Major Routes (W/N)
St. Louis
Springfield
Kansas City
See Inset
See Inset
See Inset
Priority Index
0.00 - 4.00
4.01 - 12.00
12.01 - 22.00
22.01 - 34.00
34.01 - 52.00
52.01 - 100.00
MoDOT
Prepared by
Missouri Department of Transportation
Transportation Planning
www.modot.org
January 22, 2019


TSMO Priority Index for Major Routes (E/S)
St. Louis
Kansas City
Springfield
See Inset
See Inset
See Inset
Priority Index
0.00 - 4.00
4.01 - 12.00
12.01 - 22.00
22.01 - 34.00
34.01 - 52.00
52.01 - 100.00
MoDOT
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Work Zone Impact Analysis Spreadsheet

MoDOT is committed to providing safe and efficient movement of traffic through work zones and protecting workers within those areas. To assist in this goal, refer to the guidelines outlined in the following EPGs:

- EPG 616.13, Work Zone Capacity, Queue and Travel Delay
- EPG 616.14, Work Zone Safety and Mobility Policy.

MoDOT has developed a Work Zone Impact tool to assist staff during planning and design processes to understand and plan to mitigate the traffic impacts of work zones. The MoDOT Work Zone Impact Analysis Spreadsheet can be found in EPG 616.13 or by using the URL below:

https://epg.modot.org/files/0/04/616.13_WZ_Impact_Dec_2016.xlsm

As part of the WZM team's efforts, the existing tool has been enhanced to include guidance for advanced work zone and contract time acceleration time strategies. The following section provides a high-level description of the use of this tool. A detailed user guide is also available at:

https://epg.modot.org/files/f/ff/616.13.2_Directions_July_2016a.docx

To assure the safety of traffic and workers in work zones, the enhanced Work Zone Impact Analysis Spreadsheet should be utilized during the project planning and scoping phase of project development. Performing this analysis at this stage allows for the appropriate strategies and costs to be included in the project scope and STIP.

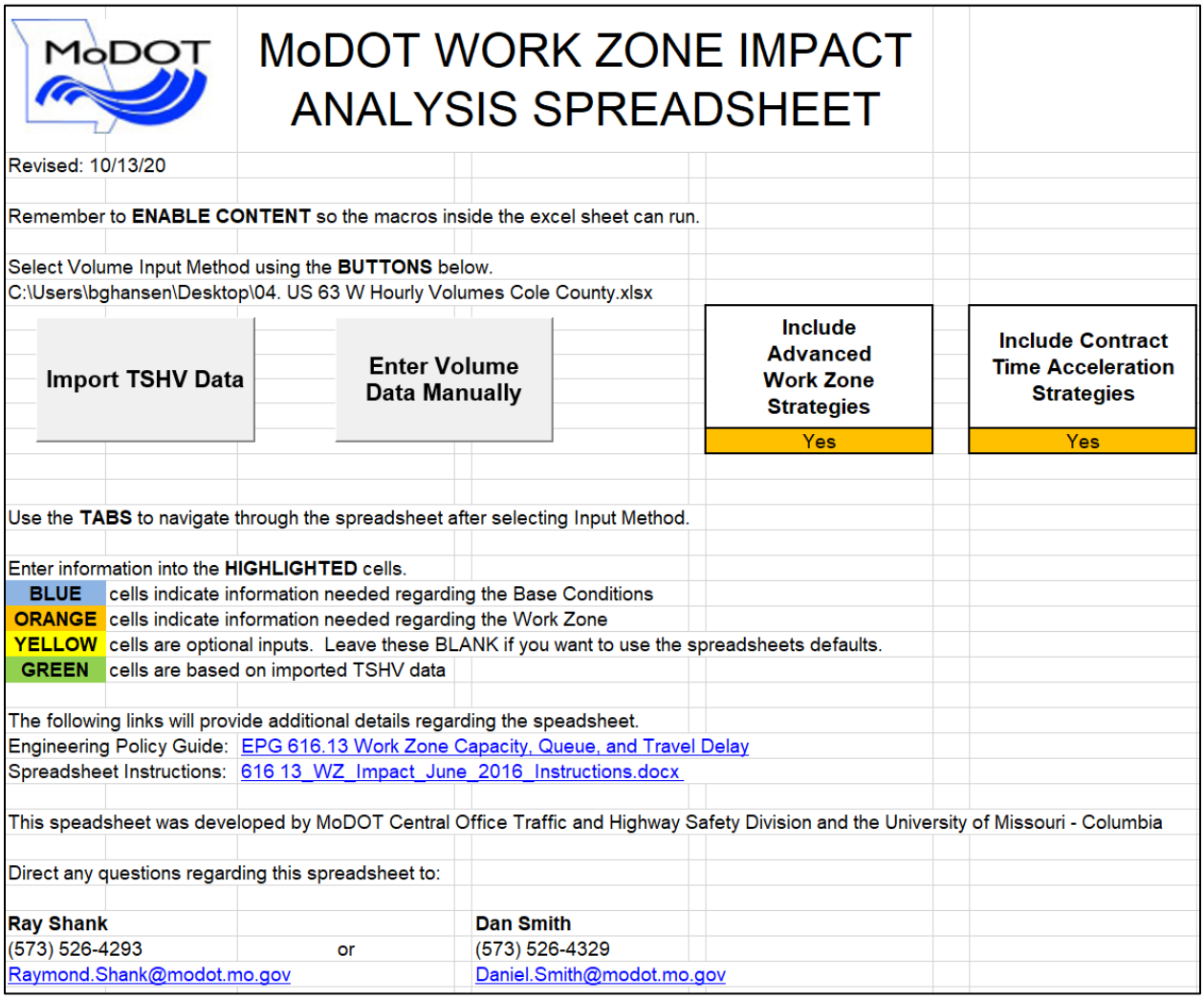
Work Zone Impacts

The core of the tool is to estimate the impact on traffic due to a work zone. This is done in four steps:

- Step 1: Introduction / data source selection
- Step 2: Existing facility data
- Step 3: Work zone characteristics
- Step 4: Synopsis of results

Step 1: Introduction / data source selection

The introductory sheet (shown in Figure 3) provides instructions and allows users to select the data source. Data can either be imported directly from the volume out from the TMS or input manually. Note that two drop-down selections have been added that allow a user to incorporate advanced work zone and contract time acceleration strategies.



MoDOT WORK ZONE IMPACT ANALYSIS SPREADSHEET

Revised: 10/13/20

Remember to **ENABLE CONTENT** so the macros inside the excel sheet can run.

Select Volume Input Method using the **BUTTONS** below.
C:\Users\bghansen\Desktop\04. US 63 W Hourly Volumes Cole County.xlsx

Import TSHV Data	Enter Volume Data Manually	Include Advanced Work Zone Strategies	Include Contract Time Acceleration Strategies
		Yes	Yes

Use the **TABS** to navigate through the spreadsheet after selecting Input Method.

Enter information into the **HIGHLIGHTED** cells.

BLUE	cells indicate information needed regarding the Base Conditions
ORANGE	cells indicate information needed regarding the Work Zone
YELLOW	cells are optional inputs. Leave these BLANK if you want to use the spreadsheets defaults.
GREEN	cells are based on imported TSHV data

The following links will provide additional details regarding the speadsheet.
Engineering Policy Guide: EPG 616.13 Work Zone Capacity, Queue, and Travel Delay
Spreadsheet Instructions: 616 13_WZ_Impact_June_2016_Instructions.docx

This speadsheet was developed by MoDOT Central Office Traffic and Highway Safety Division and the University of Missouri - Columbia

Direct any questions regarding this spreadsheet to:

Ray Shank		**Dan Smith**
(573) 526-4293	or	(573) 526-4329
Raymond.Shank@modot.mo.gov		Daniel.Smith@modot.mo.gov

Figure 3: Work Zone Impact Analysis Step 1 introduction/Data Source Selection

Step 2: Existing Facility Data

Once the user selects the data source, they input the characteristics of the existing facility as shown in Figure 4.

WORK ZONE IMPACT ANALYSIS SPREADSHEET

ANALYST:	DATE OF ANALYSIS:	JOB NUMBER:
	3/20/2021	

BACKGROUND INFORMATION

DISTRICT:	ROUTE (DIRECTION):	LOCATION SEGMENT (LOGS):
	US 54 W	(Logs: 103.072 to 103.355 Display Vol: Selected Dir) CST W

EXISTING ROADWAY DATA

NUMBER OF LANES:	DAILY TRUCK PERCENTAGE (%):	CLIMBING GRADE (%):	LENGTH OF INCLINE GRADE (mi):
2	5%	< 2	1.00

TRAFFIC VOLUME DATA: Obtained from TMS Traffic Segment Hourly Volume (TSHV) Application

Link to Transportation Management System (TMS)

Link to Directions on how to use the TSHV table.

USER COST ($ / hr)	
TRUCKS	$22.70
CARS	$10.30

DEMAND (veh/hr)

		Day of Week	Thursday	Thursday	Thursday	Thursday	Thursday	Thursday	Thursday
		Date of Count	10/22/2020	10/22/2020	10/22/2020	10/22/2020	10/22/2020	10/22/2020	10/22/2020
Time of Day	AM	12:00 MIDNIGHT - 1 AM	91	91	91	91	91	91	91
		1:00 - 2:00 AM	63	63	63	63	63	63	63
		2:00 - 3:00 AM	59	59	59	59	59	59	59
		3:00 - 4:00 AM	91	91	91	91	91	91	91
		4:00 - 5:00 AM	203	203	203	203	203	203	203
		5:00 - 6:00 AM	592	592	592	592	592	592	592
		6:00 - 7:00 AM	1486	1486	1486	1486	1486	1486	1486
		7:00 - 8:00 AM	1596	1596	1596	1596	1596	1596	1596
		8:00 - 9:00 AM	1134	1134	1134	1134	1134	1134	1134
		9:00 - 10:00 AM	1119	1119	1119	1119	1119	1119	1119
		10:00 - 11:00 AM	1143	1143	1143	1143	1143	1143	1143
		11:00 - 12:00 NOON	1151	1151	1151	1151	1151	1151	1151
	PM	12 NOON - 1:00 PM	1166	1166	1166	1166	1166	1166	1166
		1:00 - 2:00 PM	1192	1192	1192	1192	1192	1192	1192
		2:00 - 3:00 PM	1333	1333	1333	1333	1333	1333	1333
		3:00 - 4:00 PM	1554	1554	1554	1554	1554	1554	1554
		4:00 - 5:00 PM	1507	1507	1507	1507	1507	1507	1507
		5:00 - 6:00 PM	1183	1183	1183	1183	1183	1183	1183
		6:00 - 7:00 PM	841	841	841	841	841	841	841
		7:00 - 8:00 PM	665	665	665	665	665	665	665
		8:00 - 9:00 PM	494	494	494	494	494	494	494
		9:00 - 10:00 PM	359	359	359	359	359	359	359
		10:00 - 11:00 PM	251	251	251	251	251	251	251
		11 PM - 12:00 MIDNIGHT	191	191	191	191	191	191	191
TOTAL ADT			19464	19464	19464	19464	19464	19464	19464

Figure 4: Work Zone Impact Analysis Step 2 Existing Facility Data

Step 3: Work Zone Characteristics

Users then input the characteristics of the work zone. This is done for each day of the week, and shows the resulting queues as shown in Figure 5.

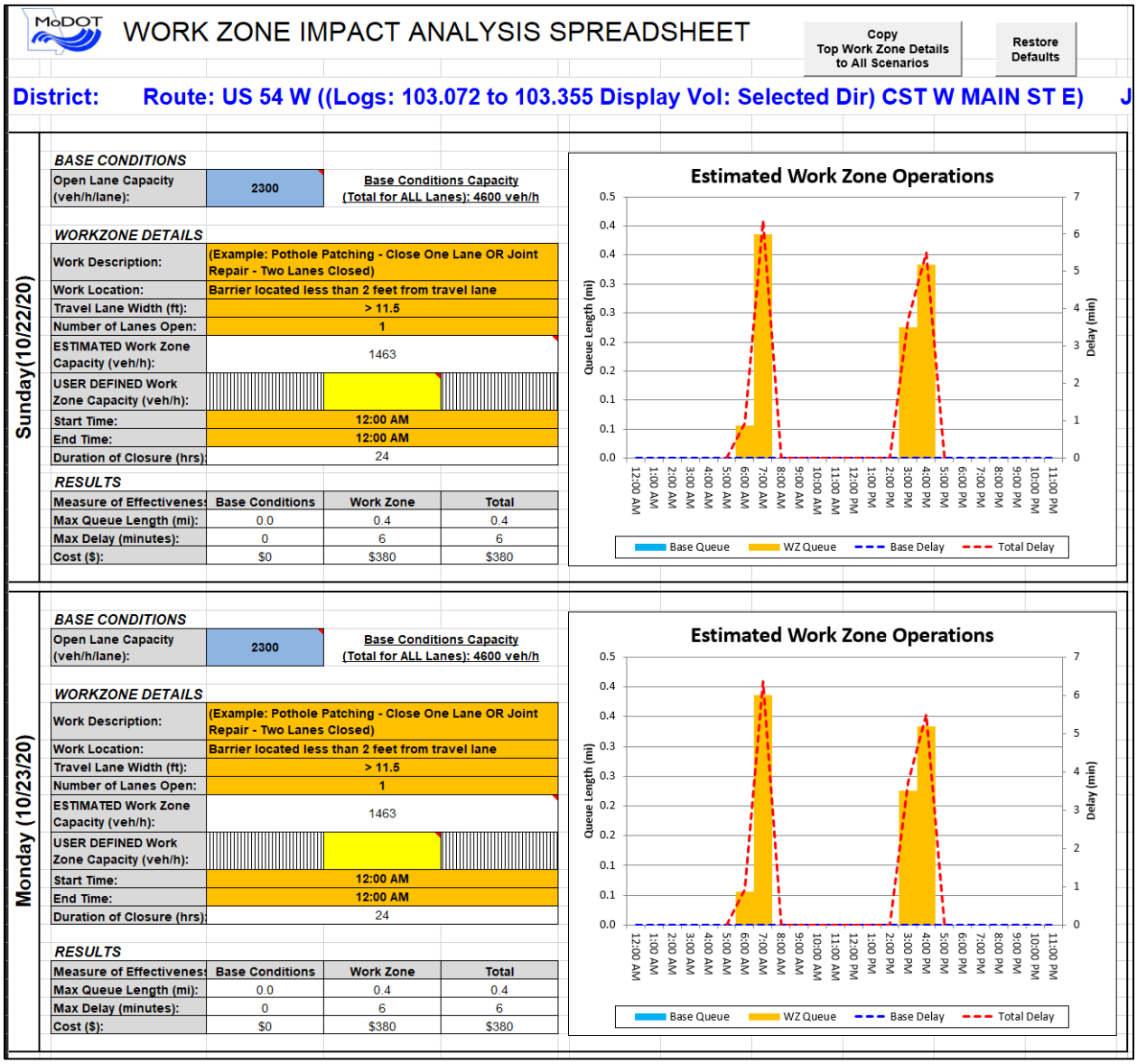


Figure 5: Work Zone Impact Analysis Step 3 Work Zone Characteristics

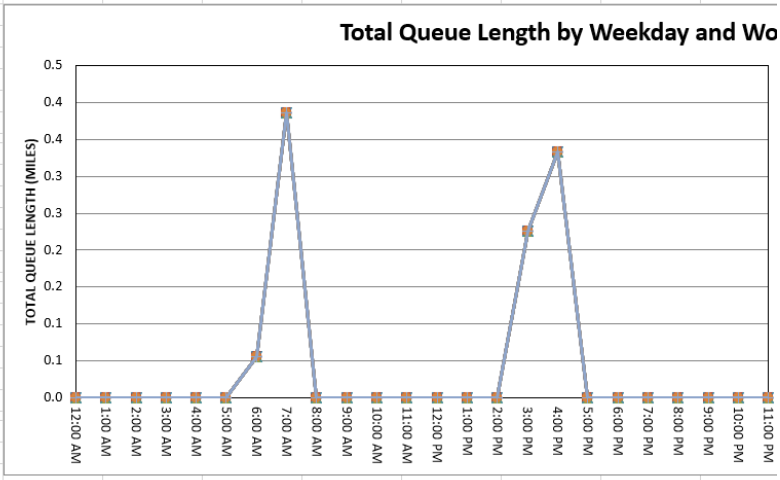
Step 4: Synopsis of Results

The results of the analysis provide an estimate of road user costs, queue lengths by time of day, and total day by time of day. An example is illustrated in Figure 6.

WORK ZONE IMPACT ANALYSIS SPREADSHEET

District: **Route: US 54 W ((Logs: 103.072 to 103.355 Display Vol: Selected Dir) CST W MAIN ST I**

Sunday (10/22/20)	Barrier located less than 2 feet from travel lane	
	Max Queue Length (mi):	0.4
	Max Delay (minutes):	6
	Total User Costs - Work Zone ($)	$380
	Start Time:	12:00 AM
	Duration of Closure (hrs):	24
Monday (10/23/20)	Barrier located less than 2 feet from travel lane	
	Max Queue Length (mi):	0.4
	Max Delay (minutes):	6
	Total User Costs - Work Zone ($)	$380
	Start Time:	12:00 AM
	Duration of Closure (hrs):	24
Tuesday (10/24/20)	Barrier located less than 2 feet from travel lane	
	Max Queue Length (mi):	0.4
	Max Delay (minutes):	6
	Total User Costs - Work Zone ($)	$380
	Start Time:	12:00 AM
	Duration of Closure (hrs):	24
Wednesday (10/25/20)	Barrier located less than 2 feet from travel lane	
	Max Queue Length (mi):	0.4
	Max Delay (minutes):	6
	Total User Costs - Work Zone ($)	$380
	Start Time:	12:00 AM
	Duration of Closure (hrs):	24
Thursday (10/26/20)	Barrier located less than 2 feet from travel lane	
	Max Queue Length (mi):	0.4
	Max Delay (minutes):	6
	Total User Costs - Work Zone ($)	$380
	Start Time:	12:00 AM
	Duration of Closure (hrs):	24
Friday (10/27/20)	Barrier located less than 2 feet from travel lane	
	Max Queue Length (mi):	0.4
	Max Delay (minutes):	6
	Total User Costs - Work Zone ($)	$380
	Start Time:	12:00 AM
	Duration of Closure (hrs):	24
Saturday (10/28/20)	Barrier located less than 2 feet from travel lane	
	Max Queue Length (mi):	0.4
	Max Delay (minutes):	6
	Total User Costs - Work Zone ($)	$380
	Start Time:	12:00 AM
	Duration of Closure (hrs):	24



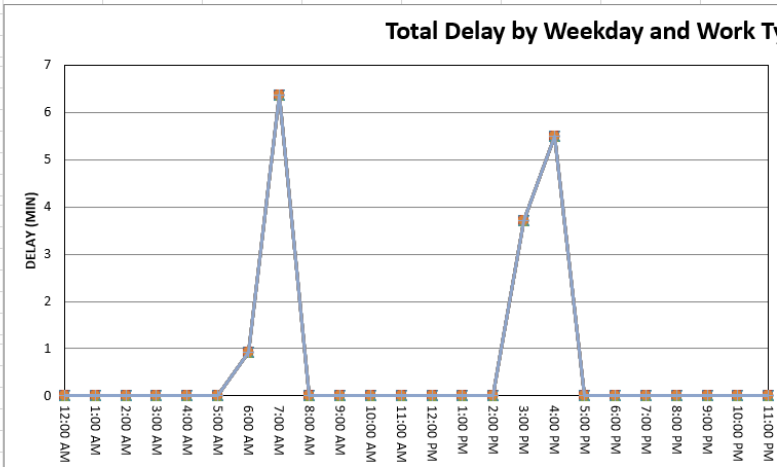


Figure 6 Work Zone Impact Analysis Step 4 Synopsis of Results

SWZ Strategy Selection

The WZM Team has led the modification of the WZ Analysis spreadsheet to include a strategy selection element. This includes both SWZ strategies and other work zone strategies such as full road closures, temporary rumble strips, and speed advisory systems.

The selection uses data from the work zone impact analysis portion of the spreadsheet as described previously in steps 1-4. A set of additional questions is also provided on the "Step 3a – ADV WZ Analysis" sheet and shown in Figure 7. These questions provide additional information and context specific to the use of individual advanced work zone strategies.

Additional Questions for Advanced Work Zone Strategy Recommendation

Additional Existing Facility Information	
Facility Speed Limit (mph)	60
Are traffic patterns inconsistent from day to day? (e.g. unpredictible with substantial variability or impacts from random local traffic genertors)	No
Is the work zone on a route with an existing ITS Travel Time System?	No
Are one or more alternative routes with capacity available?	No
If yes, what is the approximate length of the existing alternative routes (mi)?	
If yes, do the alternatative routes have existing ITS Travel Time capability?	

Additional Work Zone and Project Inputs	
Work Zone Speed Limit (mph)	45
Total approximate work zone length (mi)	2
Total approximate taper length leading up to work zone (mi)	0.11
Number of days the work zone will be in place	180
Will proposed lane closures persist (e.g. not be set up and taken down frequently)?	Yes
Number of access points where low speed construction vehicles will enter the work zone without an adequate dedicated acceleration lane	2
Will sight distance be limited on the approach to the work zone?	No
Are queue lengths anticipated to extend past an upstream intersection or interchange?	Yes
Are there external merging conflicts or hazards on the approach to or within the work zone?	Yes
Will the work zone have navigating contrstraints that inhibit emergency responder access?	No
Total estimate project cost without smart workzone strategies ($)	$3,000,000

Figure 7: Additional Questions for Advanced Work Zone Strategy Selection

With the base work zone information and the additional strategy selection questions answered, the tool provides a rank (1-100) along with a rank, a recommendation level, and a budgetary estimate on "Step 4a – ADV WZ Synopsis" sheet shown in Figure 8.

Advanced Work Zone Strategy	Score*	Rank	Recommendation	Budgetary Estimate
1. Construction Vehicle Warning System	80	3	Strongly Recommended	$40,000
2. Dynamic Late Merge (Zipper Merge) System	72	4	Strongly Recommended	$50,000
3. Queue Warning System	48	5	Should be Considered	$10,000
4. Road Closure	0	-	Not Applicable	$0
5. Speed Warning System	88	2	Strongly Recommended	$43,000
6. Temporary Rumble Strips	100	1	Strongly Recommended	$2,000
7. Temporary Traffic Incident Management and ITS System	0	-	Not Applicable	$0
8. Travel Time Advisory System	29	6	Not Recommended	$48,000
9. Travel Time Advisory System with Alternative Route	0	-	Not Applicable	$0

Figure 8: Sample Advanced Work Zone Strategy Recommendation Output

Contract Time Acceleration

In a similar fashion, the tool has also been modified to include recommendations for contract time acceleration strategies as defined in EPG 237.8 and include the following:

- A+B Bidding
- Liquidated Damages Specified
- Liquidated Savings Specified
- Liquidated Savings / Liquidated Damages Specified

Various additional questions have been added to assess the various work zone elements that impact the selection of a time acceleration strategy, show in Figure 9.

Contract Time Acceleration Considerations

The following questions can apply to the project as a whole, or to specific features or phases*	
Is the project considered "routine?"	No
What is the anticipated number of construction seasons?	much less than one
Is there is a critical completion date (e.g. to enable future work, or other reasons)?	Yes
Does the work zone for the project or one of its features cause unusually high impacts to travelers?	Yes
Does the project include numerous or long detours?	Yes
Are there unusually high safety concerns for the public or workers?	No
Will the project cause significant impacts to the local community or business economies?	No
Is the project is substantially free of third party conflicts (e.g. right of way, utilities)?	No
Are more than two bidders anticipated?	No

Figure 9: Additional Questions for Contract Time Acceleration Strategy Selection

With the base work zone information and the additional contract time acceleration questions answered, the tool provides a rank (1-100) along with a rank, a recommendation level, and a budgetary estimate as shown in Figure 10.

Contract Time Acceleration Strategy	Score**	Rank	Recommendation
A+B Bidding	29	4	Not Recommended
Liquidated Damages Specified	85	1	Strongly Recommended
Liquidated Savings Specified	67	3	Should be Considered
Liquidated Savings / Liquidated Damages Specified	75	2	Strongly Recommended

Figure 10: Sample Contract Time Acceleration Recommendation Output

Law Enforcement Participation

The use of law enforcement can be an effective tool to improve safety in work zones. The effectiveness of the method and the safety of both the participating officers and the travelers is dependent on careful planning and execution. The following tools and guidelines should be included when considering law enforcement participation. Full guidelines for law enforcement participation are outlined in EPG 616.16 at the following link:

https://epg.modot.org/index.php/616.16_Law_Enforcement_Services

MoDOT has developed a website that allows staff to enter a new request for law enforcement participation. This helps to coordinate and track these activities. The site can be found at the following link and is shown in Figure 11.

https://partner.modot.mo.gov/sites/sw/Enforce/SitePages/Home.aspx

Figure 11: Law Enforcement Request SharePoint Site

From this site, users select “Law Enforcement Project Help Request” from the left menu and add a “new item” as shown in Figure 12. Users then input information about the specific request using the online form shown in Figure 13.

In addition, the WZM Team has developed a handout for contractors, law enforcement participants, and other project personnel to identify the primary do’s and don’ts along with standard locations and a worksheet for specific project work zone. There is a link to the handout on the EPG site, and a copy is included in Figure 14. This page provides basic guidance and resources.

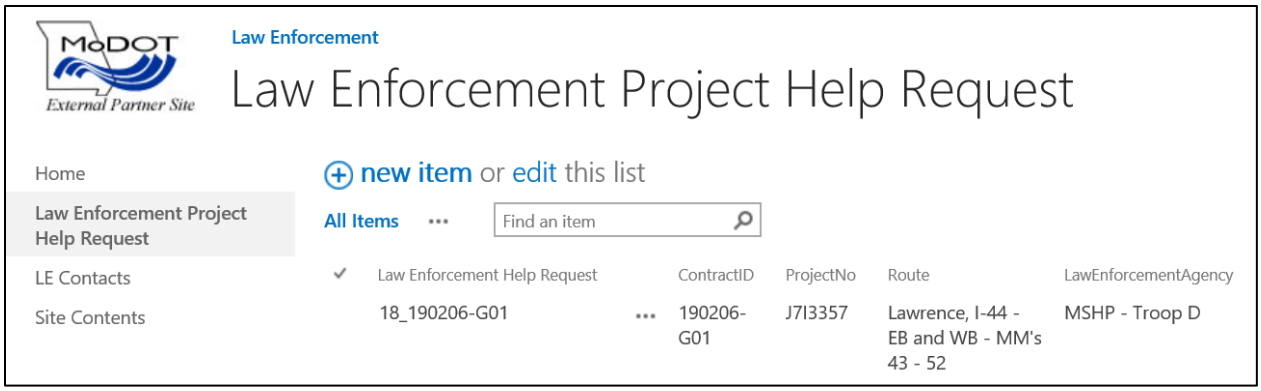


Figure 12: New Law Enforcement Request

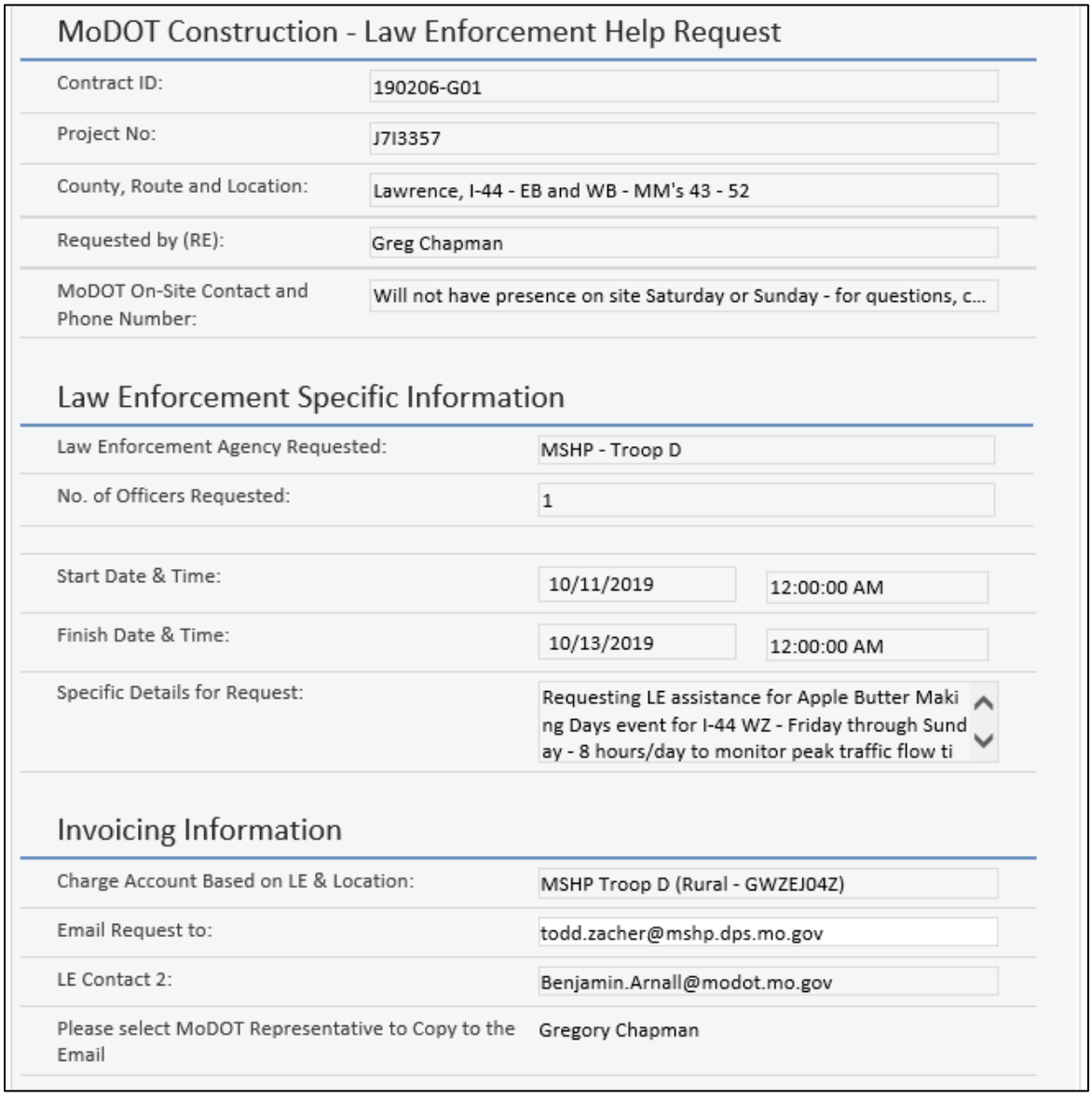


Figure 13: Law Enforcement Request Entry with Sample Data

MoDOT's Strategy for Law Enforcement in Work Zones

MoDOT is on a mission to provide a work zone that is safe for both motorists and workers. Providing enough advanced warning of the work zone or queues forming is critical to this mission. Lack of awareness creates a high-risk situation for workers in the work zone and other motorists, especially if a queue is present. These high-risk situations can be minimized with the use of law enforcement.

Goals and Priorities

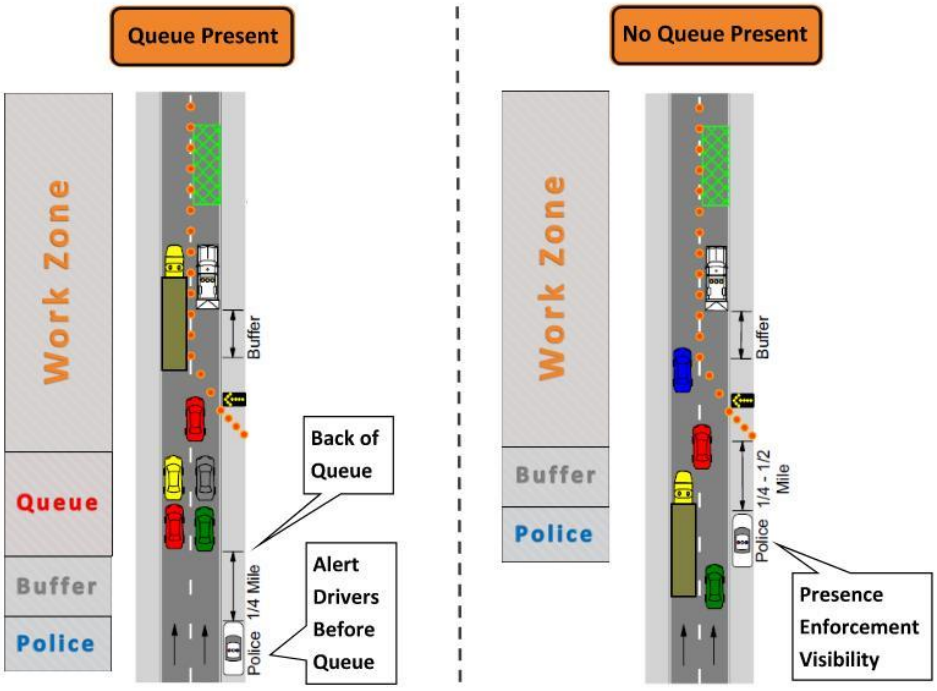
- Work Zone Awareness
- Minimize Queue
- Queue Protection (Minimize High-Speed Rear-End Crashes)
- Quality Traffic Control
- Speed Enforcement

DO's:

- Monitor Queue Lengths
- Relocate Beyond the Work Zone if Creating Queue
- Protect From High-Speed Rear-End Crashes when Queue Exists

DON'Ts:

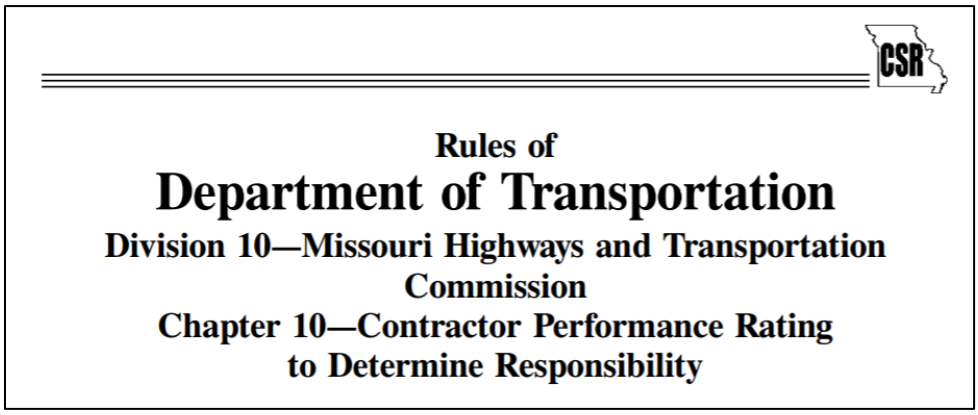
- Inadvertently Cause a Queue
- Park in Tapers or Lane Shifts
- Park in Buffer Spaces



A critical component to promoting a safe work zone environment is the placement of the law enforcement vehicle in different road alignments. When a hill or curve is present, it is important that the officer is placed before the hill or curve, so drivers are aware and not caught off guard.

Contractor Performance Rating and Expectations

Since 1991, MoDOT's Resident Engineers (REs) review and score each of the contractors that work on their projects annually. This process is required by State Statute 7 CSR 10-10 (Figure 15) and was developed jointly with the contractor's association. The score is calculated based on several questions that cover a variety of performance topics, including quality, contract compliance, contract administration, and prosecution and progress. Annually, awards are presented to contractors with an exceptional performance. The ranking can also serve as justification for restricting contractors with significant or repeated poor performance.


CSR

Rules of

Department of Transportation

Division 10—Missouri Highways and Transportation Commission

Chapter 10—Contractor Performance Rating to Determine Responsibility

Figure 15: Missouri 7 CSR 10-10 Defines the Contractor Performance Rating Process

The Work Zone Management Team supported a recent review and update of the approximately 150 existing questions to remove questions that are outdated and to add several new questions related to safety. It is important to note that these new questions do NOT constitute a safety rating for contractors, but instead add a safety dimension to the contractor's overall performance rating. The new safety-related questions are:

- How many occurrences of non-conforming PPE's were cited?
- Did the contractor follow the provisions of their Safety Plan?
- Did the contractor experience worker injuries? (If OSHA finding only)
- Did the contractor experience worker fatalities? (If OSHA Finding only)
- Did the contractor have an active roll in monitoring subcontractor work and addressing issues?
- Did the contractor damage any utilities as a result of no locate services being requested?
- Did the contractor utilize worker protection technology? (Bonus Points)
- Was the work zone specialist readily available?

MoDOT publishes the ranking criteria and process openly, in order for contractors to understand clearly how their performance will be rated. More information about the Contractor Performance Rating process can be found in EPG 102.2 (https://epg.modot.org/index.php/102.2_Contractor_Performance_Rating_System).

Work Zone Quality

A well-planned work zone can be rendered dangerous or ineffective if the quality of the work zone devices is inadequate, or if the execution does not follow appropriate standards. The full range of guidance and specifications outlined in EPG 616 (https://epg.modot.org/index.php/Category:616_Temporary_Traffic_Control) serves as the authoritative source for information. However, to help alleviate the most common issues, the WZM Team has prepared a handout that highlights a few of the most common issues. The handout can be issued to contractors and project staff at the kickoff meeting and at any other time it might be needed throughout the project. A link to the full-sized handout can be found in EPG 616.19 (https://epg.modot.org/index.php/616.19_Quality_Standards_for_Temporary_Traffic_Control_Devices), and scaled version is shown in Figure 16 (2 pages).

Quality Standards for Temporary Traffic Control Devices

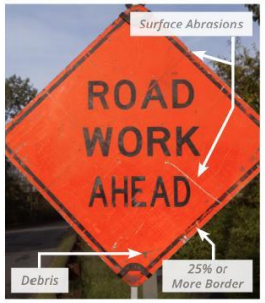
Device Condition

This field guide highlights a few of the commonly observed non-compliance items. Contractors are responsible to know and follow all standards as documented in the plans, specifications, MoDOT standards, industry standards, and the guidance from MoDOT staff. Unacceptable device placement/practices identified by MoDOT staff shall be corrected.

THE CONTRACTOR SHALL FOLLOW ALL MODOT STANDARDS AND SPECIFICATIONS. SEE SHEET 2 OF 2 FOR LIST OF MODOT STANDARDS AND GUIDELINES.

SIGNING

(Including sheeting on Barricade Panels/Paddles)

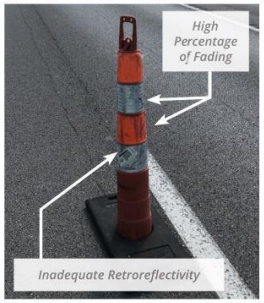


UNACCEPTABLE CONDITION

CONTAINS ANY OF THE FOLLOWING:

- Color fading or surface abrasions
- 25% or more deterioration of any letter/border/symbol day or night
- Bent/deformed from original size
- Debris/rust/residue
- Inadequate retroreflectivity per MUTCD

CHANNELIZERS



UNACCEPTABLE CONDITION

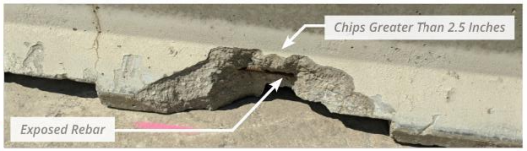
CONTAINS ANY OF THE FOLLOWING:

- Numerous scratches or tears
- 25% or more area with residue, fading, or inadequate/ missing retroreflectivity
- Denting that affects overall dimensions or device stability

Any work zone device in unacceptable condition is subject to removal if directed by MoDOT staff.

Rejected devices must be removed and replaced as directed by MoDOT staff (see MoDOT Standard Specifications 616.4.2.5).

CONCRETE BARRIERS



UNACCEPTABLE CONDITION

CONTAINS ANY OF THE FOLLOWING:

- Spalls, chips, or delamination between 1.5" and 2.5" that have not been adequately repaired
- Spalls, chips, or delamination greater than 2.5" or other defects that are deemed structurally unsound
- Damaged connection loops
- Contains snag points potentially causing vehicle damage

ARROW BOARDS, WARNING LIGHTS, & CHANGEABLE MESSAGE SIGNS (CMS)

DEVICE	UNACCEPTABLE CONTAINS ANY OF THE FOLLOWING NUMBER OF LIGHTS DIMMED, DAMAGED, OR FAILING:
Arrow Boards	• 2 or more lights shall be corrected within one hour (Category 1 Deficiency) • Up to one total light shall be corrected within 96 hours (Category 3 Deficiency)
A, B, C, and Sequential Warning Lights	• 10% or more shall be corrected within one hour (Category 1 Deficiency) • Two lights up to 10% shall be corrected within 24 hours (Category 2 Deficiency) • Up to one total light shall be corrected within 96 hours (Category 3 Deficiency)
Changeable Message Signs (CMS)	• 10% or more lights per character/symbol shall be corrected within one hour (Category 1 Deficiency) • Two lights up to 10% per character/symbol shall be corrected within 24 hours (Category 2 Deficiency) • Up to one total light shall be corrected within 96 hours (Category 3 Deficiency)

See Missouri Standard Specifications for Highway Construction for additional requirements.

Quality Standards for Temporary Traffic Control Devices

Device Placement and Practices

This field guide highlights a few of the commonly observed non-compliance items. Contractors are responsible to know and follow all standards as documented in the plans, specifications, MoDOT standards, industry standards, and the guidance from MoDOT staff. Unacceptable device placement/practices identified by MoDOT staff shall be corrected.

The following general requirements apply to all devices:

- ***Unobstructed*** by vegetation or any other material.
- ***Visible*** from a safe approaching distance as defined by plans, standards, and MoDOT approval.
- ***Placed*** according to plans, standards, and MoDOT approval.

SIGNING

MODOT STANDARD
- Signs shall not obstruct adjacent lanes or pathways with motorized/non-motorized traffic.
- Unused signs shall be removed, covered, or otherwise not displayed.

MoDOT STANDARDS AND SPECIFICATIONS:

Missouri Standard Specifications for Highway Construction
https://www.modot.org/missouri-standard-specifications-highway-construction

Missouri Standard Plans for Highway Construction
https://www.modot.org/missouri-standard-plans-highway-construction

End Terminals, Crash Cushions and Barrier Systems
https://www.modot.org/end-terminals-crash-cushions-and-barrier-systems

MoDOT EPG Section 616.19 - Quality Standards for Temporary Traffic Control Devices
https://epg.modot.org/index.php/616.19_Quality_Standards_for_Temporary_Traffic_Control_Devices

BARRICADES

ACCEPTABLE

UNACCEPTABLE

MODOT STANDARD
- One barricade for every eight feet of pavement
- Vehicles should not be parked in front of barricades or within the recommended buffer space (See Table 616.3.6 of the EPG)
- Openings shall only be allowed for trucks entering/leaving for a maximum of ten minutes

END TREATMENTS

ACCEPTABLE

UNACCEPTABLE

MODOT STANDARD
- Shall be maintained throughout the duration of the work zone
- Shall be aligned correctly according to all manufacturer's recommendations considering speed and other contributing factors

PERSONAL PROTECTIVE EQUIPMENT (PPE)

ACCEPTABLE

UNACCEPTABLE

MODOT STANDARD
- MoDOT safety policies must be practiced at all times, including wearing all MoDOT approved PPE
- If PPE has limited retroreflectivity, significant dirt or damage, significant fading or poor color contrast, it shall be replaced

FLAGGING

ACCEPTABLE

UNACCEPTABLE

MODOT STANDARD
- MoDOT safety policies must be practiced at all times, including wearing all MoDOT approved PPE and using correct flagging procedures
- Flagging operators must be re-certified every four years

Work Zone Inspection Application

To continually monitor and enforce work zone standards, MoDOT has developed a regular work zone inspection program. Currently inspectors are required to fill out a paper inspection form, which can be downloaded from the following link: https://epg.modot.org/index.php/Work_Zone_Safety_and_Mobility_Policy_Resources. They are then required to transfer this information into a central work zone database.

The manual process can be cumbersome, and the data entry of handwritten notes can be error prone. To improve this process, MoDOT has developed a smartphone application that can be used for inspections. Inspectors can use the app to enter the data directly, which is transferred to the central work zone database. The images in Figure 17 illustrate the workflow that an inspector will follow (with steps shown in order) to complete the work zone quality audit.

The data entered through the inspection application is automatically uploaded into TMS for reporting and evaluation. A sample inspection report from TMS is shown in Figure 18, and a summary report for lane closures is shown in Figure 19.

Note: While this application is currently in a pilot phase, project staff is working to advance the application toward readiness for statewide deployment. More information is anticipated as the project advances.

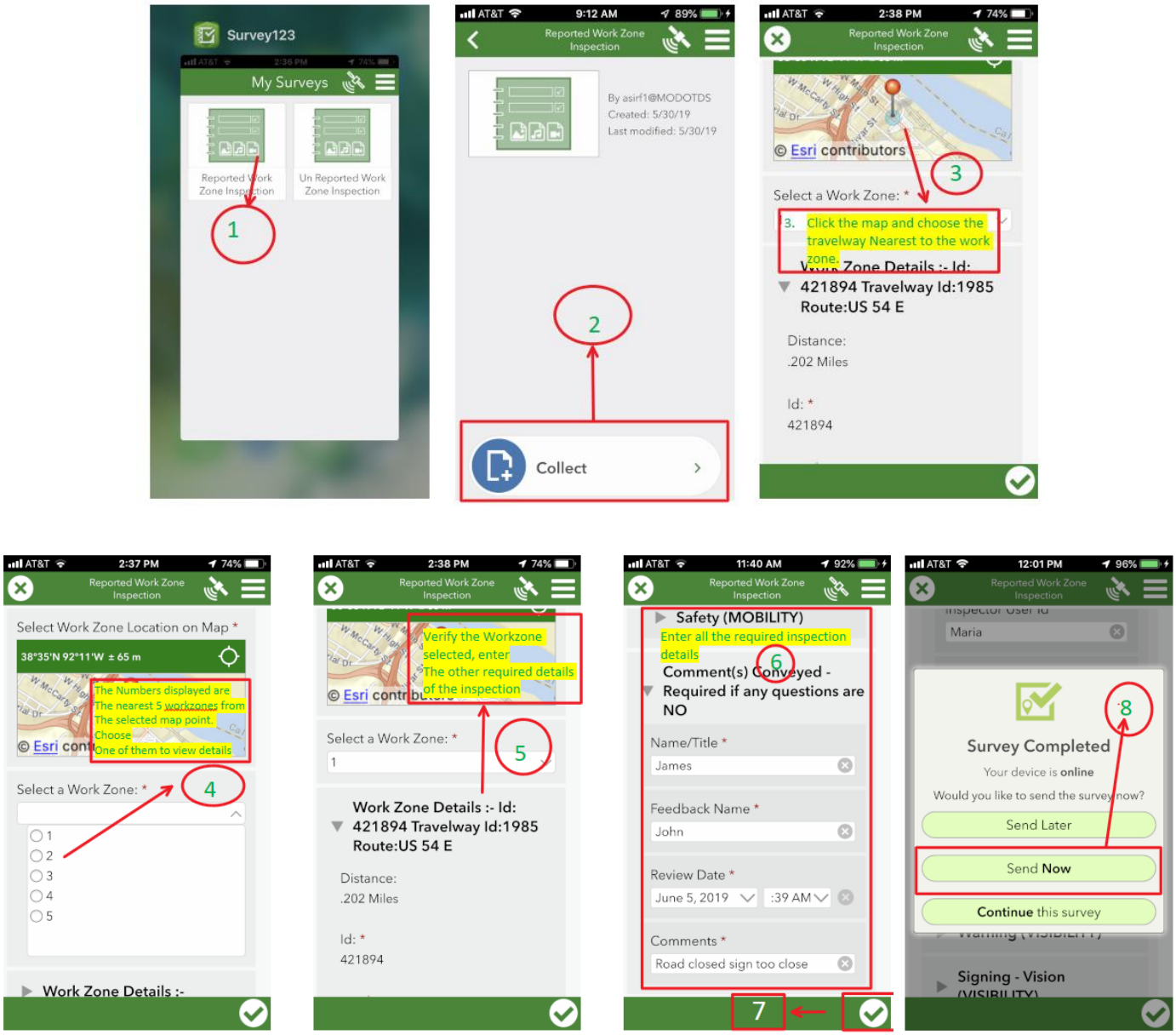
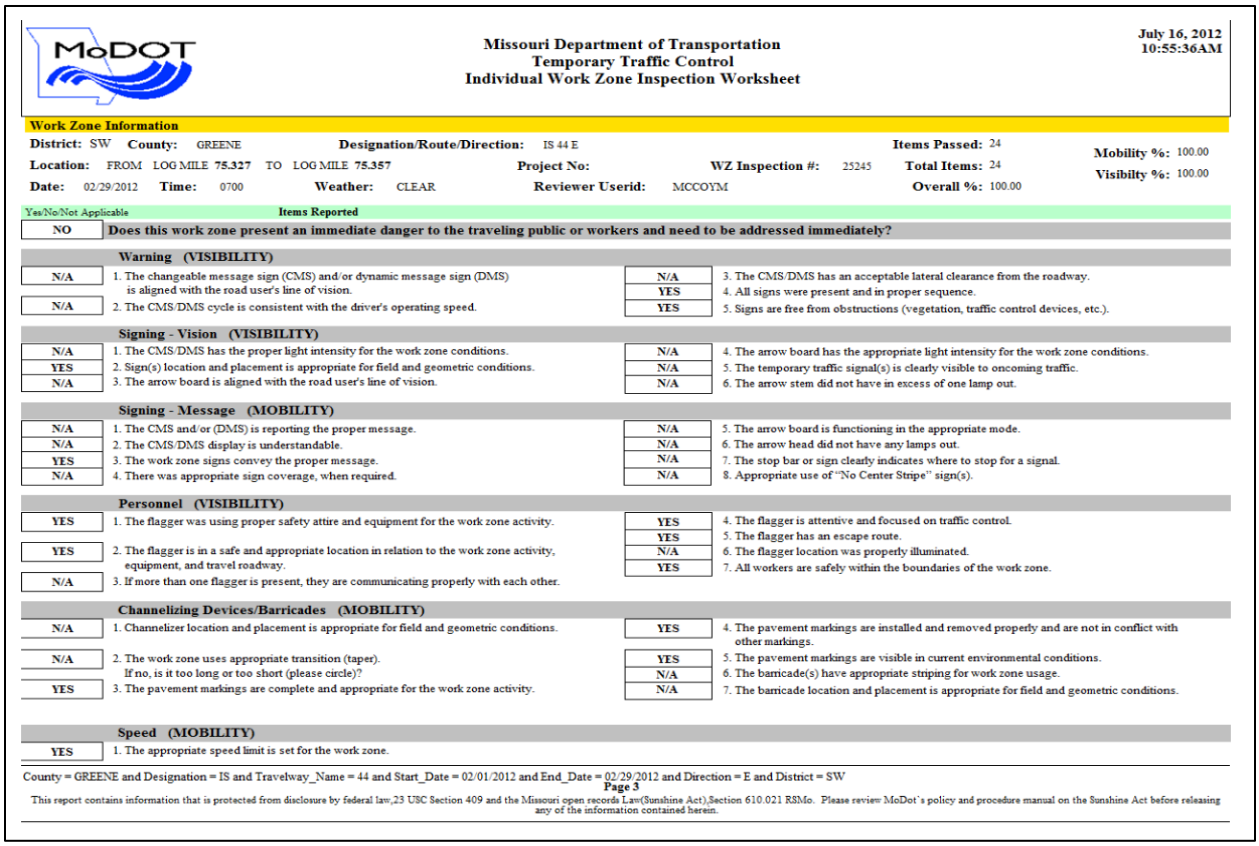


Figure 17: Work Zone Inspection Application Workflow



Missouri Department of Transportation
Temporary Traffic Control
Individual Work Zone Inspection Worksheet

July 16, 2012
10:55:36AM

Work Zone Information

District: SW County: GREENE Designation/Route/Direction: IS 44 E Items Passed: 24
Location: FROM LOG MILE 75.327 TO LOG MILE 75.357 Project No: WZ Inspection #: 25245 Total Items: 24
Date: 02/29/2012 Time: 0700 Weather: CLEAR Reviewer Userid: MCCOYM Overall %: 100.00
Mobility %: 100.00
Visibilty %: 100.00

Yes/No/Not Applicable	Items Reported
NO	Does this work zone present an immediate danger to the traveling public or workers and need to be addressed immediately?

Warning (VISIBILITY)

N/A	1. The changeable message sign (CMS) and/or dynamic message sign (DMS) is aligned with the road user's line of vision.	N/A	3. The CMS/DMS has an acceptable lateral clearance from the roadway.
N/A	2. The CMS/DMS cycle is consistent with the driver's operating speed.	YES	4. All signs were present and in proper sequence.
		YES	5. Signs are free from obstructions (vegetation, traffic control devices, etc.).

Signing - Vision (VISIBILITY)

N/A	1. The CMS/DMS has the proper light intensity for the work zone conditions.	N/A	4. The arrow board has the appropriate light intensity for the work zone conditions.
YES	2. Sign(s) location and placement is appropriate for field and geometric conditions.	N/A	5. The temporary traffic signal(s) is clearly visible to oncoming traffic.
N/A	3. The arrow board is aligned with the road user's line of vision.	N/A	6. The arrow stem did not have in excess of one lamp out.

Signing - Message (MOBILITY)

N/A	1. The CMS and/or (DMS) is reporting the proper message.	N/A	5. The arrow board is functioning in the appropriate mode.
N/A	2. The CMS/DMS display is understandable.	N/A	6. The arrow head did not have any lamps out.
YES	3. The work zone signs convey the proper message.	N/A	7. The stop bar or sign clearly indicates where to stop for a signal.
N/A	4. There was appropriate sign coverage, when required.	N/A	8. Appropriate use of "No Center Stripe" sign(s).

Personnel (VISIBILITY)

YES	1. The flagger was using proper safety attire and equipment for the work zone activity.	YES	4. The flagger is attentive and focused on traffic control.
YES	2. The flagger is in a safe and appropriate location in relation to the work zone activity, equipment, and travel roadway.	YES	5. The flagger has an escape route.
N/A	3. If more than one flagger is present, they are communicating properly with each other.	N/A	6. The flagger location was properly illuminated.
		YES	7. All workers are safely within the boundaries of the work zone.

Channelizing Devices/Barricades (MOBILITY)

N/A	1. Channelizer location and placement is appropriate for field and geometric conditions.	YES	4. The pavement markings are installed and removed properly and are not in conflict with other markings.
N/A	2. The work zone uses appropriate transition (taper). If no, is it too long or too short (please circle)?	YES	5. The pavement markings are visible in current environmental conditions.
YES	3. The pavement markings are complete and appropriate for the work zone activity.	N/A	6. The barricade(s) have appropriate striping for work zone usage.
		N/A	7. The barricade location and placement is appropriate for field and geometric conditions.

Speed (MOBILITY)

YES	1. The appropriate speed limit is set for the work zone.

County = GREENE and Designation = IS and Travelway_Name = 44 and Start_Date = 02/01/2012 and End_Date = 02/29/2012 and Direction = E and District = SW

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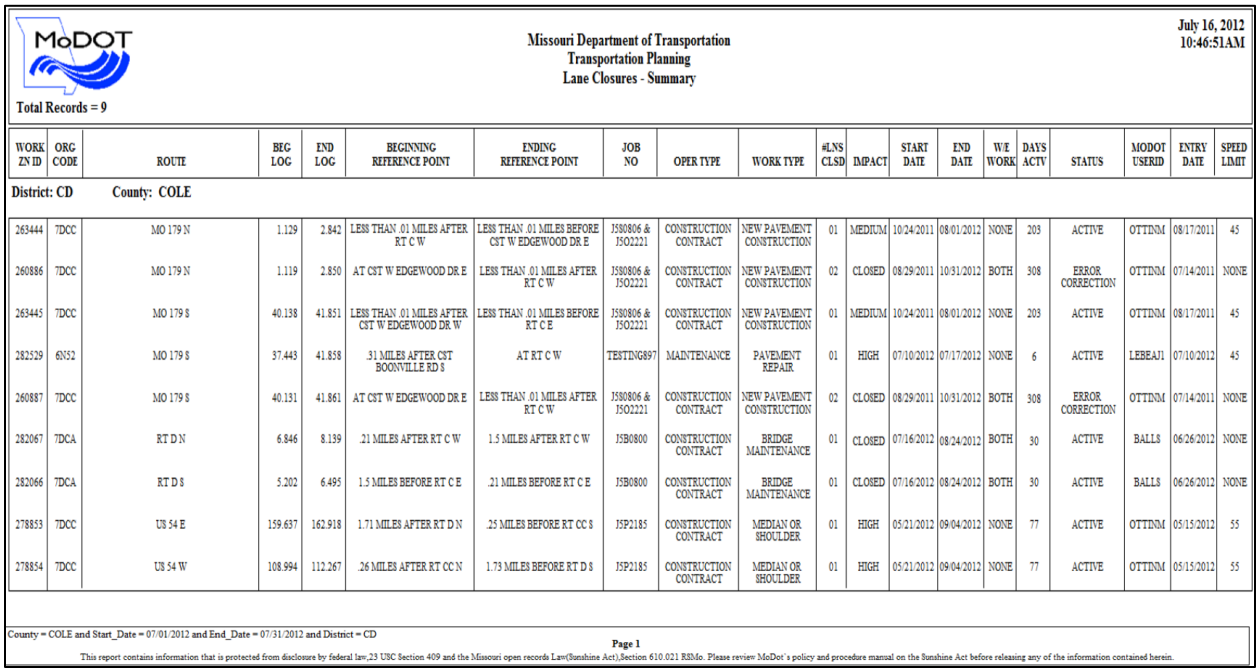
This report contains information that is protected from disclosure by federal law,23 USC Section 409 and the Missouri open records Law(Sunshine Act),Section 610.021 RSMo. Please review MoDot's policy and procedure manual on the Sunshine Act before releasing any of the information contained herein.

Figure 18: Sample Inspection Report from TMS



Missouri Department of Transportation
Transportation Planning
Lane Closures - Summary

July 16, 2012
10:46:51AM

Total Records = 9

WORK ZN ID	ORG CODE	ROUTE	BEG LOG	END LOG	BEGINNING REFERENCE POINT	ENDING REFERENCE POINT	JOB NO	OPER TYPE	WORK TYPE	#LNS CLSD	IMPACT	START DATE	END DATE	W/E WORK	DAYS ACTV	STATUS	MODOT USERID	ENTRY DATE	SPEED LIMIT
District: CD		County: COLE																	
263444	7DCC	MO 179 N	1.129	2.842	LESS THAN .01 MILES AFTER RT C W	LESS THAN .01 MILES BEFORE CST W EDGEWOOD DR E	J5I0806 & J5O2221	CONSTRUCTION CONTRACT	NEW PAVEMENT CONSTRUCTION	01	MEDIUM	10/24/2011	08/01/2012	NONE	203	ACTIVE	OTTINM	08/17/2011	45
260886	7DCC	MO 179 N	1.119	2.850	AT CST W EDGEWOOD DR E	LESS THAN .01 MILES AFTER RT C W	J5I0806 & J5O2221	CONSTRUCTION CONTRACT	NEW PAVEMENT CONSTRUCTION	02	CLOSED	08/29/2011	10/31/2012	BOTH	308	ERROR CORRECTION	OTTINM	07/14/2011	NONE
263445	7DCC	MO 179 S	40.138	41.851	LESS THAN .01 MILES AFTER CST W EDGEWOOD DR W	LESS THAN .01 MILES BEFORE RT C E	J5I0806 & J5O2221	CONSTRUCTION CONTRACT	NEW PAVEMENT CONSTRUCTION	01	MEDIUM	10/24/2011	08/01/2012	NONE	203	ACTIVE	OTTINM	08/17/2011	45
282529	6N52	MO 179 S	37.443	41.858	.31 MILES AFTER CST BOONVILLE RD S	AT RT C W	TESTING897	MAINTENANCE	PAVEMENT REPAIR	01	HIGH	07/10/2012	07/17/2012	NONE	6	ACTIVE	LEBEAJ1	07/10/2012	45
260887	7DCC	MO 179 S	40.131	41.861	AT CST W EDGEWOOD DR E	LESS THAN .01 MILES AFTER RT C W	J5I0806 & J5O2221	CONSTRUCTION CONTRACT	NEW PAVEMENT CONSTRUCTION	02	CLOSED	08/29/2011	10/31/2012	BOTH	308	ERROR CORRECTION	OTTINM	07/14/2011	NONE
282067	7DCA	RT D N	6.846	8.139	.21 MILES AFTER RT C W	1.5 MILES AFTER RT C W	J5B0800	CONSTRUCTION CONTRACT	BRIDGE MAINTENANCE	01	CLOSED	07/16/2012	08/24/2012	BOTH	30	ACTIVE	BALLS	06/26/2012	NONE
282066	7DCA	RT D S	5.202	6.495	1.5 MILES BEFORE RT C E	.21 MILES BEFORE RT C E	J5B0800	CONSTRUCTION CONTRACT	BRIDGE MAINTENANCE	01	CLOSED	07/16/2012	08/24/2012	BOTH	30	ACTIVE	BALLS	06/26/2012	NONE
278853	7DCC	US 54 E	159.637	162.918	1.71 MILES AFTER RT D N	.25 MILES BEFORE RT CC S	J5P2185	CONSTRUCTION CONTRACT	MEDIAN OR SHOULDER	01	HIGH	05/21/2012	09/04/2012	NONE	77	ACTIVE	OTTINM	05/15/2012	55
278854	7DCC	US 54 W	108.994	112.267	.26 MILES AFTER RT CC N	1.73 MILES BEFORE RT D S	J5P2185	CONSTRUCTION CONTRACT	MEDIAN OR SHOULDER	01	HIGH	05/21/2012	09/04/2012	NONE	77	ACTIVE	OTTINM	05/15/2012	55

County = COLE and Start_Date = 07/01/2012 and End_Date = 07/31/2012 and District = CD

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Figure 19: Sample Lane Closure Summary Report from TMS

Work Zone Management Teams, Meetings, and Resources

Knowing that work zone safety and operation are critical components of the MoDOT's operations, various teams and other groups have been formed to focus on continual education and improvement of work zone operations. A few of these groups include the following:

Team/Group	Description	Meetings
Work Zone Quality Circle	Described in EPG 616.14.3.3, The Work Zone Quality Circle consists of members from appropriate Central Office divisions, the districts and the FHWA-MO division. Responsibilities of the Work Zone Quality Circle include: • Reviewing statewide work zone trends. • Evaluating and recommending new devices, methods, and guidelines. • Initiating, coordinating, and participating in annual work zone reviews. • Communicating pertinent work zone information. For more information, contact the Traffic Management and Operations Engineer responsible for coordinating the Work Zone Quality Circle activities. The SharePoint site with all minutes and other information is here: http://sp/sites/ts/qcstteams/workzoneqc/default.aspx	Meets quarterly
Work Zone Review Team	The Work Zone Review Team will consist of representatives of the Work Zone Quality Circle, Central Office divisions, districts, FHWA-MO division, and may consist of other non-state stakeholders. Responsibilities of the Work Zone Review Team include: • Conducting annual reviews of work zone planning, design, implementation, management, and operation in multiple districts for compliance with this policy. • Identifying strengths and weaknesses observed during the review. • Communicating findings and recommendations to MoDOT management and personnel.	
TSMO WZM Team*	Focused on improving statewide work zone management through TSMO strategies. Additional information can be found under the WZM Team folder at the following link: https://partner.modot.mo.gov/sites/ts/tsmoimplntproj/SitePages/Home.aspx	Meets annually at each district.
TSMO WZM Team	Focused on improving work zone management through TSMO strategies.	Meets Monthly