

**MINNESOTA COMMITTEE ON UNIFORM TRAFFIC CONTROL DEVICES**  
**OCT 11, 2017 MEETING MINUTES**  
**WATERS EDGE ROOM 403**

Members				Guests	
Janelle Anderson		Howard Preston		Ken Johnson	
Chris Byrd		Mark Sehr	X	Ted Ulven	
Diane Colton	X	Tom Sohrweide		Mark Vizecky	
Joe Gustafson	X	Will Stein	X	Tom Ravn (OCIC)	
Jon Krieg	X	Josie Tayse	X	Jeff Morey	
Heather Lott	X	Scott Thompson			
Mike Martinez	X				
Tim Plath					
Scott Poska	X				

**Explained Absence:**

Janelle Anderson  
 Scott Thompson  
 Tim Plath  
 Tom Sohrweide

**Unexplained Absence:**

Howard Preston  
 Chris Byrd

cc: Kristi Sebastian

**Introductions**

Group went around the room for introductions and welcomed Mike Martinez to the group.

**Corrections/Updates to the Minutes**

None

**Announcements**

None

**Business from the Floor**

None

**Old Business**

1. FHWA Updates .....Will Stein
2. Requests for Experimentation Update .....Janelle Anderson

**New Business**

1. **AWARE Work Zone Intrusion - Scott Poska** (Attachments 1 & 2)
  - Intelligent work zone application
  - Dynamic warning messages

- Being tested in a couple of states around the country. Comments:
  - Strobe lights an issue? Are they communicating information or providing lighting.
  - Getting attention of the driver?
  - It seems that an intrusion alarm/warning system is not a traffic control device. Similar to lights on a patrol car – so wouldn't need to follow the MUTCD. If it is a communication device it will need to follow the MUTCD.
  - Strobes appear to provide a warning.
  - Whatever device you are using to communicate information to the driver should follow MUTCD criteria.
  - Audible – not mentioned in the MUTCD.
  - Strobes – there is some information in the MUTCD.
  - If these types of applications are deployed what guidance from the MUTCD needs to be followed? New applications may not be addressed in the MUTCD.

Device was developed for paving by the company. We have a project to test it in the spring near Cambridge (with Harddrives).

## **2. Recreational or Cultural Interest Guide and Symbol Signs – Heather Lott**

TEO Signing Committee - 2005 MN MUTCD Section 2H.9.1 needs to be placed into the current MN MUTCD Chapter 2M. The 2005 Standard on page 2H.13 regarding costs of signs can be removed. (Attachment 3).

- Diane will add this to Revision 5.

## **3. Channelizing Devices, Section 5G.3 – Mark Vizecky**

The guidance and standards for the application of channelizing devices in the MN MUTCD are applicable to all roadways and all temporary traffic control zones regardless of traffic speed, traffic volume, and roadway design. The LRRB Task Force recommends that the MCUTCD consider developing guidance for inclusion in PART 5. TRAFFIC CONTROL DEVICES FOR LOW VOLUME ROADS, Chapter 5G. Temporary Traffic Control Zones that allow for the completion of short-term work (up to 12 hours) on low volume (<400 ADT) roadways without channelizing devices where the work space is short, vehicle paths are clearly visible, work space is frequently moving, and risk to workers and the traveling public is not compromised. (Attachment 4)

Comments:

- This is for jobs that move quickly on lower volume roads (e.g. crack and seal jobs).

- Putting cones out takes more time than the actual job.
- Is based on low volume (regardless of speed).

Mark will make some modifications to the new language to include something about clear decision sight distance.

4. **One Direction Large Arrow Sign use for Merging Tapers – Tom Ravn (OCIC)**  
representing the Statewide Work Zone Safety Executive Committee (Attachment 5)

Clarification from the feds regarding the large arrow sign was that it is to be used only for horizontal shifts.

Ken brought this information to the OCIC Executive Committee. Tom Ravn (Workzone Safety Committee Co-Chair) brought the following concerns to the MCUTCD:

- Contractors and signing people are very concerned.
- Large arrow is considered an addition to the federal layouts.
- It has been used for over 30 years.
- Why is the change necessary?
- Believe that the large arrow is a positive safety enhancement.
- Is it possible to take another look at it and reverse the fed decision?

Will Stein comments:

The decision has been made above the division level. The division doesn't have the authority to supersede the MUTCD team. The MUTCD perspective is that standard signs are needed from a nationwide perspective.

Other comments:

- An argument could be made that we are moving traffic over with the arrow and so it does meet the requirement.
- You can use an electronic arrow at 45 MPH or greater to the only time you would use the one direction large arrow would be on slower low volume roads.
- Wisconsin uses the barricade with one direction large arrow in some cases.
- How many states are using it? Other states appear to use the flashing arrow board.
- The arrow is used to tell you to merge and to keep left.

5. **High-Visibility Safety Apparel, Section 6E.2 & 6D.3 – Ken Johnson** (Attachment 6)  
MN MUTCD language modified in flagger area and worker consideration area.  
Ken will modify language and give to Diane for inclusion in Revision 5.

6. **Bump and Dip Signs, Section 2C.28 – Ken Johnson** (Attachment 7)  
Language approved by the committee.

7. **Field Manual Layouts – Ken Johnson** (Attachment 8)  
Ken presented the revised field manual layouts for review.

8. **Field Manual Definitions**  
Deadheading – maybe add a note to layouts like the mowing? Is the word used somewhere in the document? Decision made to leave in the glossary.

9. **Round Robin**

Joe:

- Mentioned Federal manual sign pg. 582, [Fig 6F.2](#)
- Field Manual Bike Layout 95 (now numbered 87) – shorten sign distances? “A” distance is meant for motorists. “A” distance changing in the new manual from 250 ft to 100 ft (for 0 – 30 mph or less).

Will:

- One direction arrow to be used only for horizontal alignment changes. Will send a copy of written response to Diane to include in minutes. (Response attached).

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# Work Zone Intrusion Warning System

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System Requirements

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December 2015

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## **Acknowledgements**

This document was prepared for the Minnesota Department of Transportation (MnDOT) Systems Engineering for Work Zone Challenges project.

## **Project Champion**

Rashmi Brewer, is the MnDOT project champion for this effort. MnDOT stakeholders and a project management team were heavily involved in identifying the key challenges with using Intelligent Transportation Systems to address and enhance safety, operations, mobility and efficiency in work zones. This document covers the system requirements to address some of these challenges.

## **Project Management Team (MnDOT)**

- Ralph Adair
- Tiffany Dagon
- Ted Ulven
- Craig Mittelstadt
- Leigh Kriewall
- Dave Mavec
- Ken Johnson
- Rashmi Brewer

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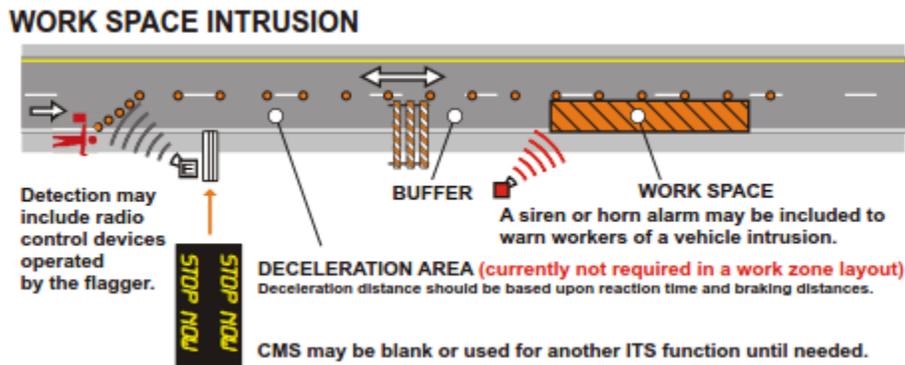
## Introduction

This document provides high-level system requirements for a Work Zone Intrusion Warning System (WIWS) to support enhanced work zone safety. The requirements in this document are derived from the companion Concept of Operations for WIWS, which is one of three Work Zone Challenges identified that may be addressed using Intelligent Transportation System (ITS) technologies. The other two ITS Systems identified to potentially address Work Zone Challenges are: End of Queue Warning System; and Distracted Driver Alert System.

This set of requirements should be considered as a starting point for system requirements development for a project. In addition, a set of requirements that fuses all three ITS Work Zone systems should be considered, as there will be instances when all three systems may be deployed together and several elements of the systems overlap or interoperate.

Work Intrusion Warning Systems are installed upstream of a work zone to address drivers not complying with the work zone and roadway messaging and entering an active work area where workers are located. These systems improve upon existing work zone signage which intends to provide safety to workers, allow sufficient space for roadway work, and provide signs and/or messaging systems that improve roadway safety and inform motorists. WIWS offers an alert to roadway workers when a non-authorized vehicle enters the work zone. WIWS typically consists of static signing, detection devices, Dynamic Message Signs (DMS or CMS), and an alarm or other notification device, as seen in Figure 1. The WIWS configuration in Figure 1 is found in the Minnesota Department of Transportation Intelligent Work Zone (IWZ) Toolbox guidance document.

**Figure 1 Typical Work Space Intrusion Warning System Configuration**



Both the system requirements and concept of operations are intended to illustrate the basic needs and requirements surrounding WIWS, as well as, serve as model documents that may be adapted to meet individual deployments. The materials do not mandate the deployment of such systems, nor do they limit the engineering judgment or policy discretion of the transportation agencies who may consider deploying WIWS. The materials reflect stakeholder needs and they should be adapted as necessary to reflect any unique or additional needs and requirements driven by individual deployments. The remainder of this document presents high-level system functional requirements for WIWS as derived from the previously developed concept of operations.

## System Requirements

High-level system functional requirements are verifiable statements that define what a work zone intrusion warning system will do, but not how it is accomplished (i.e. from a technical/technology standpoint). An important starting point for developing system requirements is to understand where the system is reflected within the National ITS architecture. This section shows how WIWS fit within the National ITS Architecture version 7.1, and then presents a series of high-level system functional requirements associated with the detection, alert, and system operation functions.

## WIWS and the National ITS Architecture

WIWS are considered part of the [Maintenance and Construction Operations User Service](#) in the National ITS Architecture, version 7.1. Systems within in this user service provide Work Zone Management Safety function, which provides support for the effectiveness, safety, and efficiency of roadway operations during all work zone activities. The service will provide information concerning work zone activities.

Within the physical architecture of the National ITS Architecture, WIWS are primarily addressed under the following:

- Roadway (Subsystem)
  - Roadway Work Zone Safety (Equipment Package)
    - MC09 Work Zone Safety Monitoring (Service Package)
- Maintenance and Construction Vehicle (Subsystem)
  - Maintenance and Construction Vehicle (Equipment Package)
    - ATIS09 In Vehicle Signing (Service Package)
    - MC09 Work Zone Safety Monitoring (Service Package)
- Maintenance and Construction Management. (Subsystem)
  - MCM Work Zone Safety Management (Equipment Package)
    - MC09 Work Zone Safety Monitoring (Service Package)

Table 1 presents a series of high-level requirements as they are presented within the Roadway Work Zone Safety Equipment Package, Maintenance and Construction Vehicle Equipment Package, and MCM Work Zone Safety Management Equipment Package of the National ITS Architecture. Currently, the applicable requirements have been incorporated into the document.

### **Table 1 WIWS Functional Requirements from “Roadway Work Traffic Control” and “MCM Work Zone Management” Equipment Packages from National ITS Architecture**

<b>Roadway Work Zone Safety Equipment Package</b>	<b>Functional Requirements</b>
	1. The field element shall include work zone intrusion detection devices that detect when a vehicle has intruded upon the boundary of a work zone, under center control.
	2. The field element shall include work zone intrusion detection devices that detect when crew workers have crossed the boundary between the work zone and vehicle traffic, under center control.
	3. The field element shall include work zone intrusion alerting devices that alert crew workers of a work zone emergency or safety issue such as the intrusion of a vehicle into the work zone area or movement of field crew into the travel lanes.
	4. The field element shall include work zone intrusion alerting devices that notify crew via maintenance vehicles of a work zone emergency or safety issue such as the intrusion of a vehicle into the work zone area or movement of field crew into the travel lanes.
	5. The field element shall include work zone intrusion alerting devices that alert drivers that they have intruded upon the perimeter of the work zone, or are about to do so; may provide alerts to drivers directly or via in-vehicle signing.
	6. The field element shall provide operational status for the work zone intrusion detection devices to the maintenance center.
	7. The field element shall provide fault data for the work zone intrusion detection devices to the maintenance center for repair.
	8. The field element shall provide operational status for the work zone intrusion alerting devices to the maintenance center.
9. The field element shall provide fault data for the work zone intrusion alerting devices to the maintenance center for repair.	

**\*\*“Equipment Package” from National ITS Architecture**

**Table 1 WIWS Functional Requirements from “Roadway Work Traffic Control” and “MCM Work Zone Management” Equipment Packages from National ITS Architecture (cont.)**

<b>MCV Vehicle Safety Monitoring Equipment Package</b>	<b>Functional Requirements</b>
	1. The maintenance and construction vehicle shall detect that a vehicle has intruded upon the boundary of a work zone. The boundary of the work zone represents an area around the maintenance and construction vehicle, which may be stationary or moving.
	2. The maintenance and construction vehicle shall receive work zone warnings from the field equipment at the roadside, other maintenance and construction vehicles.
	3. The maintenance and construction vehicle shall present work zone warnings to the field personnel using direct warning signals or in-vehicle signage functions.
	4. The maintenance and construction vehicle shall monitor the crew movements to identify when a crew member is crossing the boundary between a work zone and vehicle traffic and issue an alert to the crew member.
5. The maintenance and construction vehicle shall provide status of the work zone warning systems to the center.	

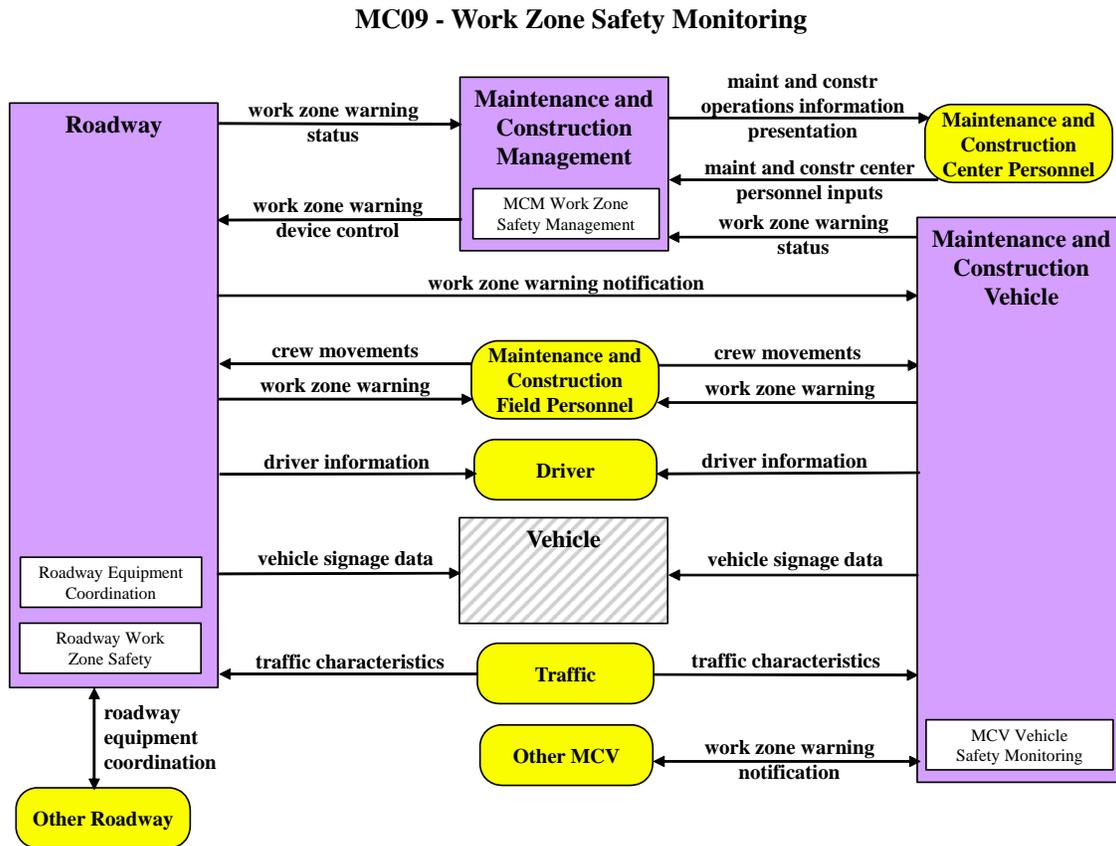
\*\*“Equipment Package” from National ITS Architecture

<b>MCM Work Zone Safety Management Equipment Package</b>	<b>Functional Requirements</b>
	1. The center shall provide remote monitoring and control of work zone safety devices - including intrusion detection devices that have been installed in work zones or maintenance areas.
	2. The center shall provide remote monitoring and control of intrusion alert devices that have been installed in work zones or maintenance areas.
	3. The center shall collect status information of work zone safety device status from field equipment or the maintenance and construction vehicles.
4. The center shall collect and store work zone data collected from work zone monitoring devices (such as intrusion detection or alert devices and speed monitoring devices) on-board the vehicle and at the roadside.	

\*\*“Equipment Package” from National ITS Architecture

Further illustrating how WIWS fit within the National ITS Architecture, Figure 2 shows the potential system components and interconnects within the MC09 – Work Zone Safety Monitoring Service Package.

Figure 2 MC09 – Work Zone Safety Monitoring Service Package Graphic



The information presented in this section should be reviewed, confirmed or modified within the context of any state or regional ITS architecture that may impact individual WIWS deployments.

### High-Level System Functional Requirements

These system requirements are derived from the needs identified in the concept of operations. They address functional aspects of the system. Table 2 presents the requirements. The number references allow for traceability back to the needs identified in the concept of operations. The first identification number references the stakeholder need as presented in the concept of operations. The second number identifies the associated high-level functional requirement. If further derivation is needed, a third reference number is provided.

For many of these requirements, special considerations are noted to explain what details were considered as the requirement was developed or what additional details may need to be considered as the requirement is further refined for individual deployments. In some cases, the consideration may also note if a requirement is relevant to a specific type of WIWS deployment. These considerations are intended to offer context and provide insight that might help support further derivation and tailoring of the requirements to the individual deployment as needed.

**Table 2 WIWS System Requirements**

ID #	Needs	ID #	High Level Requirements	ID #	Detailed System Requirements
1	Workers in a work zone need an alert when a vehicle enters a restricted area.	1.1	WIWS shall detect all unauthorized vehicles entering a work zone.	1.1.1	WIWS shall detect unauthorized vehicles entering a work zone with at least XX% accuracy.
Considerations: This should cover all components needed for the system to function at a rate which is acceptable by the agency.					
				1.1.2	WIWS shall send notification within XX seconds of vehicle entering restricted area.
Considerations: The specified time should include all latency between devices and include data processing needed to generate the notification to the alert system.					
				1.1.3	WIWS shall provide a means to disable detection in the field manually to allow authorized vehicles to enter work zone.
		1.2	WIWS shall alert workers when a vehicle enters a work zone.	1.2.1	WIWS alert may be audible, visual, sensory (e.g. vibration) or a combination of any or all of these alerts.
				1.2.2	WIWS alert shall be activated within XX seconds of vehicle entering a restricted area.
Considerations: The specified time should include all latency between devices and include data processing needed to receive the notification and generate the alert.					
				1.2.3	WIWS shall only alert workers in danger, in the vehicle's path.
Considerations: In an attempt to reduce de-sensitization of the alerts only those works in immediate danger should be notified with alert (proximity of intrusion and downstream workers).					

**Table 2 WIWS System Requirements (Continued)**

ID #	Needs	ID #	High Level Requirements	ID #	Detailed System Requirements
2	Drivers in a work zone need an alert when their vehicle enters a restricted area.	2.1	WIWS shall provide an alert to the driver of an unauthorized vehicle when the driver crosses into a restricted area.	2.1.1	WIWS shall provide an audible and / or visual alert.
Considerations: The advancement of the connected vehicles in the coming years will provide more opportunities for the visual notifications to drivers via En-Route Driver Information. However a work zone protection system with flashing lights when a vehicle enters the restricted area may help reduce unintentional intrusions.					
				2.1.2	WIWS shall provide a physical notification when driver crosses into a restrictive area.
Considerations: Temporary rumble strips or current vehicles lane detection system, may help reduce unintentional intrusions.					
		2.2	WIWS deployment shall follow MN IWZT guidance on spacing before work space.	2.2.1	WIWS shall provide adequate buffer area to allow for braking and exit before entering work space.
Considerations: Ideal placement of signs and detectors will vary per roadway speed, braking distances, and the acceptable driver reaction time.					
		2.3	Warnings and alerts provided shall follow the existing standards to help aid in compliance and understanding.	2.3.1	WIWS messages in and approaching the work zone shall provide information that is compliant and consistent with applicable national standards.
Considerations: The MUTCD should be the starting point for how messages are displayed.					
				2.3.2	WIWS messages integrated with connected vehicles shall provide information that is compliant and consistent with national standards.
Considerations: The National ITS Architecture should be the starting point for user requirements for how En-Route driver information messages are displayed in a vehicle .					
3	Agency and Law Enforcement Officials responsible for the work zone need the system to aid enforcement by generating reports identifying locations where violations are occurring.	3.1	Field devices shall receive alerts from system of a violation.	3.1.1	WIWS shall provide an alert to the central system.
Considerations: Agency will need to determine how enforcement will be handled before requirements are established for how fast an alert to the Central System must be generated.					
				3.1.2	Central System shall provide an alert to the Law enforcement of violation.
Considerations: System should have a reporting structure which allows for notifications of incidents and also the ability to record video after an intrusion is detected for review.					

**Table 2 WIWS System Requirements (Continued)**

ID #	Needs	ID #	High Level Requirements	ID #	Detailed System Requirements
4	Drivers, Agencies, and Law Enforcement monitoring work zones need work zone alerts to be consistent and easily understood by all users.	4.1	Warnings and alerts provided shall follow the existing standards to help aid in compliance and understanding.	4.1.1	WIWS messages shall provide information that is compliant and consistent with national and state specific standards.
Considerations: The MUTCD should be the starting point for how messages are displayed and further requirements should meet requirements included in the MN MUTCD.					
				4.1.2	WIWS messages integrated with connected vehicles shall provide information that is compliant and consistent with national standards.
Considerations: The National ITS Architecture should be the starting point for user requirements for how En-Route driver information messages are displayed in a vehicle.					
5	Agencies with WIWS need ability to communicate with devices at all times.	5.1	Agencies shall be able to communicate remotely with device and check equipment status.	5.1.1	The communication media used for the system and field devices shall have 99.9% uptime (excluding maintenance periods).
Considerations: Agency should determine if one medium is preferred over another.					
				5.1.2	The Central System shall record when system power or communication is lost.
				5.1.3	The Central System shall be able to send alerts via email, text, or phone when communication losses occur.
				5.1.4	WIWS field components shall be capable of being powered via either AC or DC power sources, with solar power as an option.
Considerations: Agency need this type of information to aid in payment, as these systems provide no benefit to workers if there is a breakdown in detection, communication, or power.					
6	Agencies monitoring work zones need access to reports and logs when requested.	6.1	WIWS shall include a data and system archive and reporting function.	6.1.1	The system data archive and reporting function shall be remotely accessible.
Considerations: Agency need this type of information to aid in payment, as these systems provide no benefit to workers if there is a breakdown in detection, communication, or power.					
				6.1.2	The data archive shall include system faults.
Considerations: Agency need this type of information to evaluate the effectiveness of the system, as these systems provide no benefit to workers if there is a breakdown in detection, communication, or power.					
				6.1.3	The system shall allow for configuration and automated generation of system reports.
				6.1.4	The system shall be capable of generating reports in a variety of file formats for ease of use.
Considerations: The system needs to be able to summarize data in an applicable format for end use needs.					
				6.1.5	The system shall be capable of distributing reports generated automatically.

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# Distracted Driving Detection System for Work Zones

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Systems  
Requirements

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December 2015

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## **Acknowledgements**

This document was prepared for the Minnesota Department of Transportation (MnDOT) Systems Engineering for Work Zone Challenges project.

### **Project Champion**

Rashmi Brewer is the MnDOT project champion for this effort. MnDOT stakeholders and a project management team were heavily involved in identifying the key challenges with using Intelligent Transportation Systems to address and enhance safety, operations, mobility and efficiency in work zones. This document covers the system requirements to address some of these challenges.

### **Project Management Team (MnDOT)**

- Ralph Adair
- Tiffany Dagon
- Ted Ulven
- Craig Mittelstadt
- Leigh Kriewall
- Dave Mavec
- Ken Johnson
- Rashmi Brewer

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## Introduction

Some research has been performed has occurred at the university level and some luxury automakers have installed distracted driver detection technologies. To date, there does not appear to be any wide scale, ITS type deployments for this concept. Parts of the technology exist and are in need of customization, where other technologies are still emerging. The best applications are through the detection of a vehicle drifting repeatedly between lane lines and wayward, or unintentional, lane changes. Lane drifting can occur anywhere at any time on our roadway networks, but it can be assumed that unintentional lane changes can occur in areas with lane shifts and lane reduction tapers. These systems can improve upon the existing work zone layouts by providing additional information in advance to travelers about current traffic conditions. These warnings help alert motorists as they enter work zones and areas within work zones where the maintenance of traffic requires unexpected maneuvers.

The Minnesota Department of Transportation Intelligent Work Zone (IWZ) Toolbox guidance document serves as a starting point for discussion within the project team for ways to improve safety and mobility for the public, workers, and constructability of a project.

The concept of operations document articulates the fundamental needs and operational concepts of the detecting distracted drivers. Building on those needs, the model system requirements within this document will describe what detecting distracted drivers must do and set the basis for system design, procurement, installation and operation.

Both the system requirements and concept of operations are intended to illustrate the basic needs and requirements surrounding detecting distracted drivers and serve as model documents that may be adapted to meet individual deployments. The materials do not mandate the deployment of such systems, nor do they limit the engineering judgment or policy discretion of the transportation agencies who may consider deploying detecting distracted drivers. The materials reflect stakeholder needs and they should be adapted as necessary to reflect any unique or additional needs and requirements driven by individual deployments. The remainder of this document presents model system requirements for detecting distracted drivers as they are driven by the previously developed concept of operations.

## System Requirements

System requirements are verifiable details that define what a distracted driver warning system will do, how well it will perform or what conditions it must perform under. An important starting point for developing system requirements is to understand where the system fits within the ITS architecture. This section explains how detecting distracted drivers fits within the National ITS Architecture 7.1 and then presents a series of high –level and detailed system requirements associated with detection, alerts, placement, operations and maintenance.

## ITS Architecture

Detecting distracted drivers are considered part of the [Maintenance and Construction Operations User Service](#) in the National ITS Architecture. Systems within in this user service provide Work Zone Management Safety function, which provides support for the effectiveness, safety, and efficiency of

roadway operations during all work zone activities. The service will provide information concerning work zone activities.

Within the physical architecture of the National ITS Architecture, detecting distracted drivers are primarily addressed under the following:

- Roadway (Architecture Flow)
  - Roadway (Subsystem)
    - Roadway Work Traffic Control (Equipment Package)
      - MC09-Work Zone Safety Monitoring (Service Package)
      - ATMS06-Traffic Information Dissemination (Service Package)
      - ATMS08-Traffic Incident Management System (Service Package)
  - Maintenance and Construction Management. (Subsystem)
    - MCM Work Zone Management (Equipment Package)
      - ATMS21 Roadway Closure Management (Service Package)
      - MC08 Work Zone Management (Service Package)

**Tables 1 and 2** present a series of high-level requirements as they are presented within the Roadway Work Zone Traffic Control and MCM Work Zone Management Equipment Package of the National ITS Architecture. The currently applicable requirements have been incorporated into the document.

**Table 1. Roadway Work Traffic Control Functional Requirements**

Roadway Work Traffic Control Equipment Package	Functional Requirements
	1. The field element shall include work zone intrusion detection devices that detect when crew workers have crossed the boundary between the work zone and vehicle traffic, under center control.
	2. The field element shall include work zone intrusion detection devices that detect when crew workers have crossed the boundary between the work zone and vehicle traffic, under center control.
	3. The field element shall include work zone intrusion alerting devices that alert crew workers of a work zone emergency or safety issue such as the intrusion of a vehicle into the work zone area or movement of field crew into the travel lanes.
	4. The field element shall include work zone intrusion alerting devices that notify crew via maintenance vehicles of a work zone emergency or safety issue such as the intrusion of a vehicle into the work zone area or movement of field crew into the travel lanes.
	5. The field element shall include work zone intrusion alerting devices that alert drivers that they have intruded upon the perimeter of the work zone, or are about to do so; may provide alerts to drivers directly or via in-vehicle signing.
	6. The field element shall provide operational status for the work zone intrusion detection devices to the maintenance center.
	7. The field element shall provide fault data for the work zone intrusion detection devices to the maintenance center for repair.
	8. The field element shall provide operational status for the work zone intrusion alerting devices to the maintenance center.
	9. The field element shall provide fault data for the work zone intrusion alerting devices to the maintenance center for repair.

**\*\*“Equipment Package” from National ITS Architecture**

**Table 2. Maintenance and Construction Management (MCM) Functional Requirements**

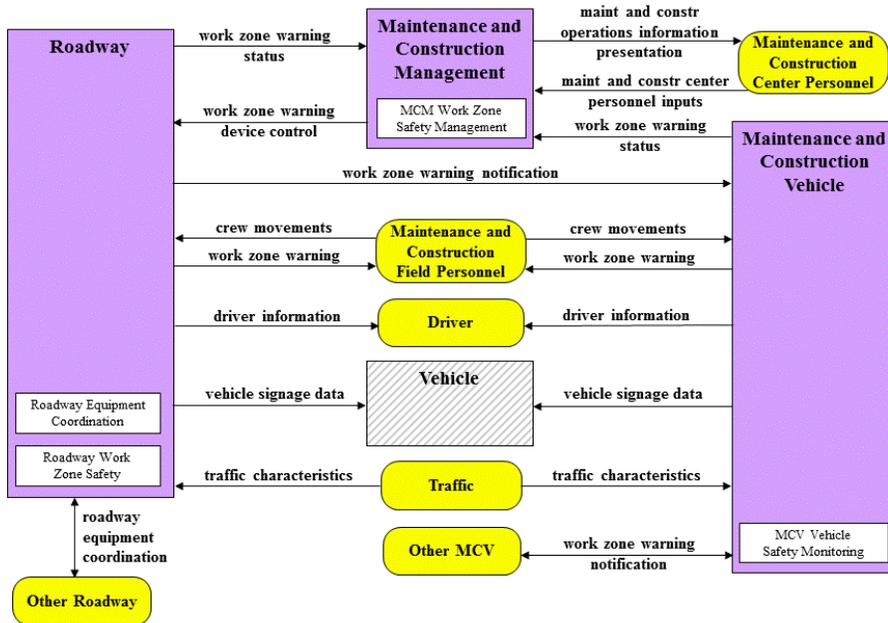
<b>MCM Work Zone Management Equipment Package</b>	<b>Functional Requirements</b>
	1. The center shall generate new work zone activity schedules for use by maintenance and construction vehicles, maintenance and construction operators, and for information coordination purposes.
	2. The center shall control the collection of work zone status information including video images from cameras located in or near the work zone.
	3. The center shall disseminate work zone information to other agencies and centers including traffic, transit, emergency management centers, other maintenance centers, traveler information providers, and the media.
	4. The center shall control traffic in work zones by providing remote control of dynamic message signs, highway advisory radio systems, gates, and barriers located in or near the work zone.
	5. The center shall exchange information with administrative systems to support the planning and scheduling of work zone activities. This information includes: equipment and consumables resupply purchase request status, personnel qualifications including training and special certifications, environmental regulations and rules that may impact maintenance activities, and requests and project requirements from contract administration.
	6. The center shall collect real-time information on the state of the road network including current traffic and road conditions to support work zone scheduling and management.

\*\*“Equipment Package” from National ITS Architecture

Further illustrating how detecting distracted drivers fit within the National ITS Architecture, **Figure 2** shows the potential system components and interconnects within the MC09-Work Zone Safety Monitoring Service Package and **Figure 3** illustrates Driver Safety Monitoring

**Figure 1 MC09-Work Zone Safety Monitoring Service Package Graphic**

### MC09 - Work Zone Safety Monitoring



### AVSS02 - Driver Safety Monitoring

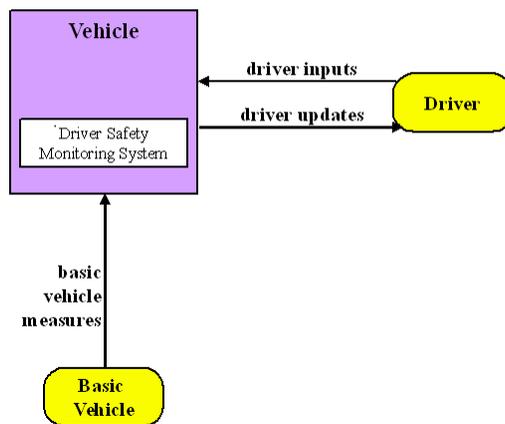


Figure 2 AVSS02 Driver Safety Monitoring

The information presented in this section should be reviewed, confirmed or modified within the context of any state or regional ITS architecture that may impact individual detecting distracted driver deployments.

## High-Level and Detailed System Requirements

These system requirements are defined in direct relation to the needs identified in the concept of operations. They address operational aspects of the system and are noted in **Table 3**. The number references allow for traceability back to those needs and forward to the detailed system requirements. The first identification number references the stakeholder need as presented in the concept of operations. The second number is used to track high level requirements and the third reference number relates to detailed system requirements, where applicable.

For many of these requirements, special considerations are noted to explain what details were considered as the requirement was developed or what additional details may need to be considered as the requirement is further refined for individual deployments. In some cases, the consideration may also note if a requirement is relevant to a specific type of detecting distracted drivers deployment. These consideration are intended to offer context a provide insight that might help support further tailoring the requirements to the individual deployment as needed.

**Table 3 Distracted Driver Detection System (DDDS) Requirements**

ID #	Needs	ID #	High Level Requirements	ID #	Detailed System Requirements
1	Drivers in a work zone need an alert when their vehicle enters a restricted area.	1.1	DDDS shall provide an alert to the driver of an unauthorized vehicle when the driver crosses into a restricted area.	1.1.1	The alert shall be audible and/or visual.
<p>Considerations: The advancement of the connected vehicles in the coming years will provide more opportunities for the visual notifications to drivers via En-Route Driver Information. However a work zone protection system with flashing lights when a vehicle enters the restricted area may help reduce unintentional intrusions.</p>					
				1.1.2	DDDS shall provide a physical notification when driver crosses into a restrictive area.
<p>Considerations: Temporary rumble strips or current vehicles lane detection system, may help reduce unintentional intrusions.</p>					
		1.2	DDDS deployment shall follow MN IWZT guidance on spacing before work space.	1.2.1	DDDS shall provide an adequate buffer area to allow for braking and exit before entering work space.
<p>Considerations: Ideal placement of signs and detectors will vary per roadway speed, braking distances, and the acceptable driver reaction time.</p>					
		1.3	Warnings and alerts provided shall follow the existing standards to help aid in compliance and understanding.	1.3.1	DDDS messages in and approaching the work zone shall provide information that is compliant and consistent with applicable national standards.
<p>Considerations: The National ITS Architecture should be the starting point for how En-Route driver information messages are displayed in a vehicle.</p>					
2	Drivers, Agencies, and Law Enforcement need alerts to be accurate, relevant, easily understood, and reinforced at appropriate intervals through a work zone.	2.1	Warnings and alerts provided shall follow the existing standards to help aid in compliance and understanding.	2.1.1	Central System logic shall recommend standards-compliant messaging to display on all DMS in the system.
<p>Considerations: This need and requirement address the ability to enforce the DDDS advisories, and ensure that messages do not result in additional liability.</p>					
				2.1.2	Central System logic shall recommend standards-compliant messaging to display on all DMS in the system.
<p>Considerations: The MUTCD should be the starting point for how messages are displayed and further requirements should meet requirements included in the MN MUTCD.</p>					
				2.1.3	The DDDS messages integrated with connected vehicles shall provide information that is compliant and consistent with national standards.
<p>Considerations: The National ITS Architecture should be the starting point for user requirements for how information messages are displayed in a vehicle.</p>					

**Table 3 Distracted Driver Detection System (DDDS) Requirements (Continued)**

ID #	Needs	ID #	High Level Requirements	ID #	Detailed System Requirements
3	Agency and Law Enforcement Officials responsible for the work zone need the system to aid enforcement by generating reports identifying locations where violations are occurring.	3.1	Field devices shall receive alerts from system of a violation.	3.1.1	The DDS shall provide an alert to the Central System.
Considerations: Agency will need to determine how enforcement will be handled before requirements are established for how fast an alert to the central system must be generated.					
				3.1.2	Central System shall provide an alert to the Law Enforcement of violation.
Considerations: System should have a reporting structure which allows for notifications of incidents and also the ability to record video after an intrusion is detected for review.					
4	Agencies with DDDS need ability to communicate with devices at all times.	4.1	Agencies shall be able to communicate remotely with device and check equipment status.	4.1.1	The communication media used for the system and field devices shall have 99.9% uptime (excluding maintenance periods).
Considerations: Agency should determine if one medium is preferred over another.					
				4.1.2	The Central System shall record when system power or communication is lost.
				4.1.3	The Central System shall be able to send alerts via email, text, or phone when power or communications losses occur.
				4.1.4	The DDDS field components shall be capable of being powered via either AC or DC power sources, with solar power as an option.
Considerations: Agency need this type of information to aid in payment, as these systems provide no benefit to workers if there is a breakdown in detection, communication, or power.					
5	Agencies monitoring work zones need access to reports and logs when requested.	5.1	The DDDS shall include a data and system archive and reporting function.	5.1.1	The system data archive and reporting function shall be remotely accessible.
Considerations: Agency need this type of information to aid in payment, as these systems provide no benefit to workers if there is a breakdown in detection, communication, or power.					
				5.1.2	The data archive shall include system faults.
Considerations: Agency need this type of information to evaluate the effectiveness of the system, as these systems provide no benefit to workers if there is a breakdown in detection, communication, or power.					
				5.1.3	The system shall allow for configuration and automated generation of system reports.
				5.1.4	The system shall be capable of generating reports in a variety of file formats for ease of use.
Considerations: The system needs to be able to summarize data in an applicable format for end use needs.					
				5.1.5	System shall be capable of distributing reports generated automatically.

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# End of Queue Warning Systems

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Systems  
Requirements

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December 2015

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## **Acknowledgements**

This document was prepared for Minnesota Department of Transportation's (MnDOT) Systems Engineering to Address Work Zone Challenges project.

## **Project Champion**

Rashmi Brewer, is the MnDOT project champion for this effort. MnDOT stakeholders were heavily involved in identifying the key challenges with using Intelligent Transportation Systems to address and enhance safety, operations, mobility and efficiency in work zones. This document covers the system requirements to address some of these challenges.

## **Project Management Team (MnDOT)**

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- Tiffany Dagon
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- Ken Johnson
- Rashmi Brewer

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## Introduction

This document provides high-level functional requirements for an End of Queue Warning System (EQWS) to support improved work zone safety. The requirements in this document are derived from the companion Concept of Operations for EQWS, which is one of three Work Zone Challenges identified by MnDOT Stakeholders that may be addressed using Intelligent Transportation System (ITS) technologies. The other two ITS Systems identified to potentially address Work Zone Challenges are: Work Zone Intrusion Warning System; and Distracted Driver Alert System.

This set of requirements should be considered as a starting point for system requirements development for a project. In addition, a set of requirements that fuses all three ITS Work Zone systems should be considered, as there will be instances when all three systems may be deployed together and several elements of the systems overlap or interoperate.

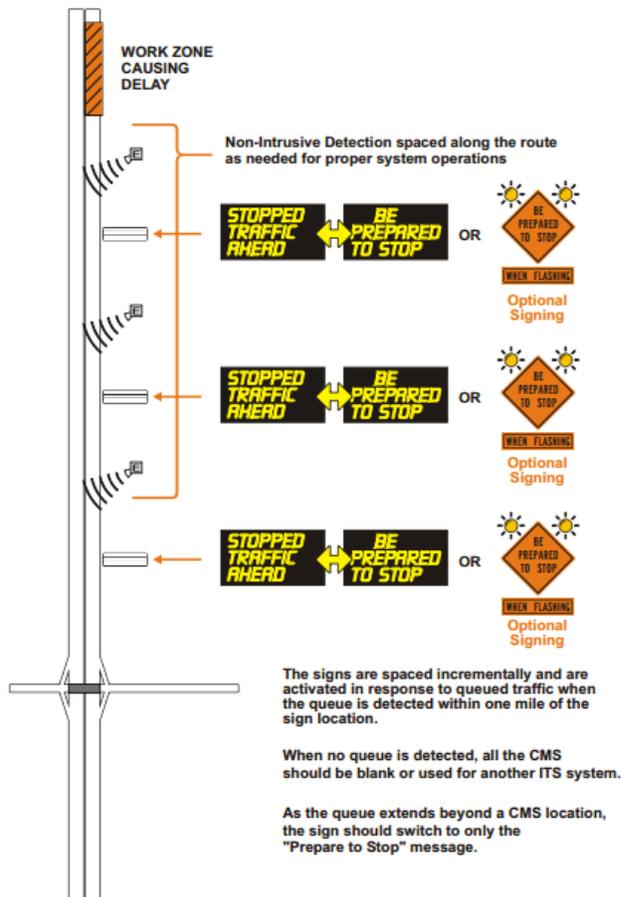
EQWS are installed upstream of a work zone to provide a warning to approaching drivers of stopped or slowed traffic conditions approaching or within the work zone. These systems improve upon the existing work zone warning deployments by providing enhanced information in to drivers about current traffic conditions, improving the drivers ability to anticipate and react to slowed or stopped traffic downstream, even if they cannot see the traffic ahead. In addition, information gathered from these

systems can provide delay time information that may be provided to drivers to support their route choice decisions either in advance of their trip (via traveler information web sites or 511 systems, for example) or enroute (via dynamic message sign (DMS) messages).

EQWS are an emerging set of technologies that have been tested and are available in the market today. A full EQWS consists of static signing, detection devices, and DMS, as shown in Figure 1.

### Figure 1 Stopped Traffic Advisory System Configuration

The EQWS configuration in Figure 1 is from the Minnesota Department of Transportation Intelligent Work Zone (IWZ) Toolbox guidance document, served as a starting point for discussion within the Project Team for approaches to improve



safety and mobility for the public, workers, and to support project constructability.

A separate concept of operations document was prepared to articulate the fundamental needs and operational concepts of the EQWS. Building on those needs, the high-level system functional requirements within this document are intended to describe what EQWS must do and provide the basis for future system design, procurement, installation and operation.

Both this system requirements document and companion concept of operations are, together, intended to provide the basic needs and requirements surrounding EQWS, as well as, to serve as model documents that may be adapted to meet individual deployments. The materials do not mandate the deployment of such systems, nor do they limit the engineering judgment or policy discretion of the transportation agencies who may consider deploying EQWS. The materials reflect stakeholder needs and they should be adapted as necessary to reflect any unique or additional needs and requirements driven by individual deployments. The remainder of this document presents high-level system functional requirements for EQWS as driven by the previously developed concept of operations.

## System Requirements

High-level system functional requirements are verifiable statements that define *what* an end of queue warning system will do, but not how it is accomplished (i.e. from a technical/technology standpoint). An important starting point for developing system requirements is to understand where the system is reflected within the National ITS architecture. This section shows how EQWS fit within the National ITS Architecture version 7.1, and then presents a series of high-level system functional requirements associated with the detection, alert, and system operation functions.

## EQWS in the National ITS Architecture

EQWS are part of the [Maintenance and Construction Operations User Service](#) in the National ITS Architecture. Systems within in this user service provide Work Zone Management Safety functions, which provides support for the effectiveness, safety, and efficiency of roadway operations during all work zone activities. The service provides information concerning work zone activities.

Within the physical architecture of the National ITS Architecture, EQWS are primarily addressed under the followings subsystems, equipment packages and service packages:

- Roadway (Subsystem)
  - Roadway Work Traffic Control (Equipment Package)
    - ATMS21 Roadway Closure Management (Service Package)
    - MC08 Work Zone Management (Service Package)
- Maintenance and Construction Management. (Subsystem)
  - MCM Work Zone Management (Equipment Package)
    - ATMS21 Roadway Closure Management (Service Package)
    - MC08 Work Zone Management (Service Package)

Table 1 presents a series of high-level requirements as they are presented within the Roadway Work Zone Traffic Control and MCM Work Zone Management Equipment Package of the National ITS Architecture. The currently applicable requirements have been incorporated into the document.

**Table 1: EQWS Functional Requirements from “Roadway Work Traffic Control” and “MCM Work Zone Management” Equipment Packages from National ITS Architecture**

<b>Roadway Work Traffic Control Equipment Package</b>	<b>Functional Requirements</b>
	1. The field element shall collect, process, and send work zone images to the center for further analysis and distribution, under center control.
	2. Under traffic and maintenance center control, the field element shall include driver information systems (such as dynamic messages signs and highway advisory radios) that advise drivers of activity around the work zone through which they are currently passing.
	3. Under the control of field personnel within maintenance vehicles, the field element shall include driver information systems (such as dynamic messages signs and highway advisory radios) that advise drivers of activity around a work zone through which they are currently passing.
	4. The field element shall control access to the work zone using automated gate or barrier systems. This includes automated flagger assistance devices that include automated gate arms and other automated gate/barrier systems.
	5. The field element shall provide operational status for the surveillance (e.g. CCTV), driver information systems, and gates/barriers in work zones to the maintenance center.
	6. The field element shall provide fault data for the surveillance (e.g. CCTV), driver information systems, and gates/barriers in work zones to the maintenance center for repair.

**\*“Equipment Package” from National ITS Architecture**

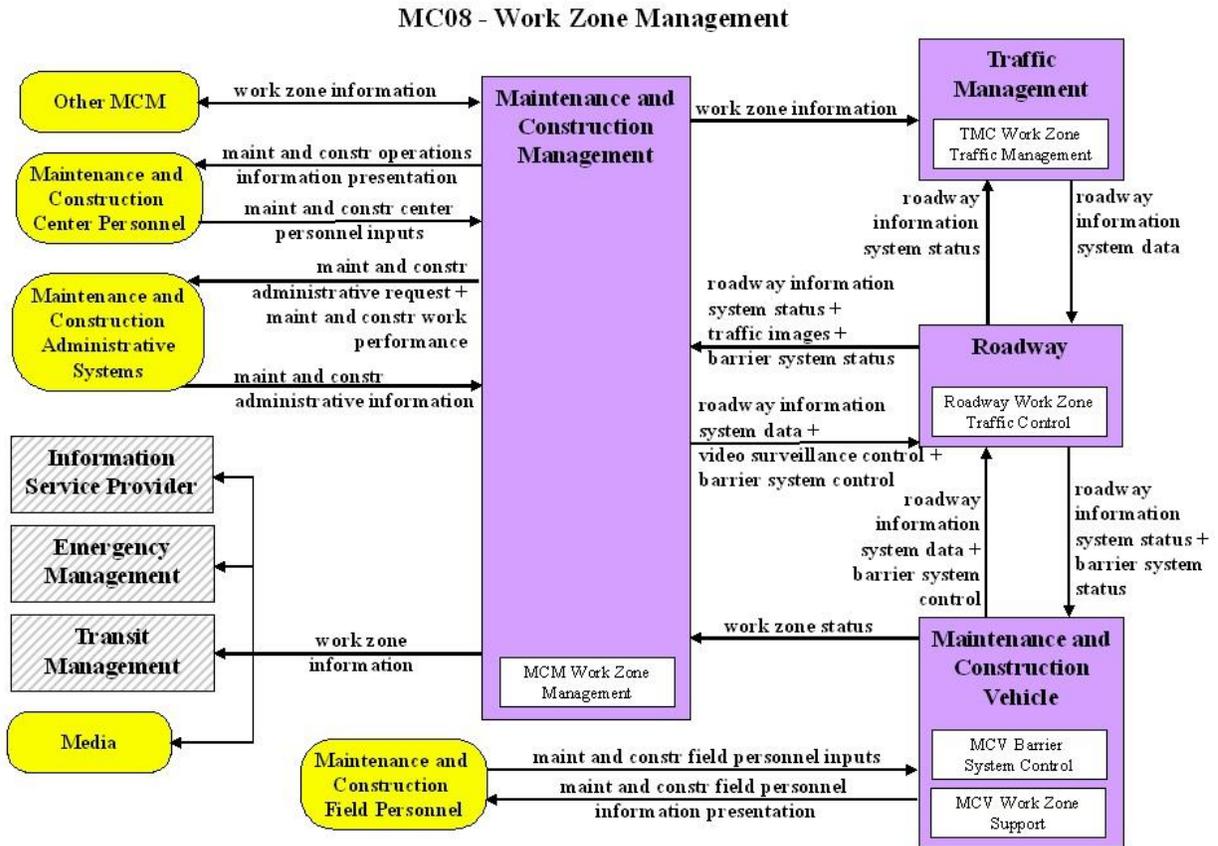
**Table 1: EQWS Functional Requirements from “Roadway Work Traffic Control” and “MCM Work Zone Management” Equipment Packages from National ITS Architecture (continued)**

MCM Work Zone Management Equipment Package	Functional Requirements
	1. The center shall generate new work zone activity schedules for use by maintenance and construction vehicles, maintenance and construction operators, and for information coordination purposes.
	2. The center shall control the collection of work zone status information including video images from cameras located in or near the work zone.
	3. The center shall disseminate work zone information to other agencies and centers including traffic, transit, emergency management centers, other maintenance centers, traveler information providers, and the media.
	4. The center shall control traffic in work zones by providing remote control of dynamic message signs, highway advisory radio systems, gates, and barriers located in or near the work zone.
	5. The center shall exchange information with administrative systems to support the planning and scheduling of work zone activities. This information includes: equipment and consumables resupply purchase request status, personnel qualifications including training and special certifications, environmental regulations and rules that may impact maintenance activities, and requests and project requirements from contract administration.
	6. The center shall collect real-time information on the state of the road network including current traffic and road conditions to support work zone scheduling and management.

**\*“Equipment Package” from National ITS Architecture**

Further illustrating how EQWS fits within the National ITS Architecture, Figure 2 shows the potential system components and interconnects within the MC08 – Work Zone Management Service Package.

Figure 2 MC08 – Work Zone Management Service Package Graphic



The information presented in this section should be reviewed, confirmed or modified within the context of any state or regional ITS architectures that may impact individual EQWS deployments.

## High-Level System Functional Requirements

These system requirements are derived from the needs identified in the concept of operations. They address functional aspects of the system. As follows Table 2, presents the requirements. The number references allow for traceability back to the needs identified in the concept of operations. The first identification number references the stakeholder need as presented in the concept of operations. The second number identifies the associated high-level functional requirement. If further derivation is needed, a third reference number is provided.

For many of these requirements, special considerations are noted to explain what details were considered as the requirement was developed or what additional details may need to be considered as the requirement is further refined for individual deployments. In some cases, the consideration may also note if a requirement is relevant to a specific type of EQWS deployment. These considerations are intended to offer context and provide insight that might help support further derivation and tailoring of the requirements to the individual deployment as needed.

**Table 2 EQWS System Requirements**

ID #	Needs	ID #	High Level Requirements	ID #	Detailed System Requirements
1	Drivers approaching a work zone need an alert regarding the conditions of traffic ahead.	1.1	The EQWS shall continuously detect traffic speed.	1.1.1	The EQWS shall be capable of detecting the full range of traffic speeds including stopped traffic, low speeds (less than 30 MPH), and high speeds (over 30 MPH).
<p>Considerations: The system location and length of deployment will be determined for each work zone based on local conditions including traffic volumes, work zone impact on volumes and speed, approach speed, speed limit within work zone, geometrics, and any other relevant factors.</p>					
				1.1.2	EQWS vehicle detector system shall be XX% accurate regarding speed of vehicles at any speed, including stopped vehicles.
<p>Considerations: The success of this system is highly dependent on the quality of data collected. Speed and Presence of vehicles should be of the highest importance in detection capabilities.</p>					
		1.2	The EQWS shall detect where the traffic is slowed or stopped.	1.2.1	The location of the slowed or stopped traffic shall be accurate to within XXX feet.
<p>Considerations: The success of this system is highly dependent on the quality of data collected. Speed and Presence of vehicles should be of the highest importance in detection capabilities.</p>					
		1.3	The EQWS shall calculate delay time.	1.3.1	The EQWS delay time estimate shall be accurate to within XX minutes.
<p>Considerations: The success of this system is highly dependent on the quality of data collected. Speed and Presence of vehicles should be of the highest importance in detection capabilities.</p>					
		1.4	The EQWS shall generate alert messages warning drivers of upcoming slowed or stopped traffic.	1.4.1	The message shall include the distance to the end of the queue.
				1.4.2	The accuracy of the location of the end of queue shall be within XXX feet.
				1.4.3	The end of queue location shall be updated continuously.
				1.4.4	The end of queue location message shall be updated every XX minutes.
				1.4.5	The message shall be capable of being sent in a variety of formats compatible with DMS.
<p>Considerations: Further review of this functional requirement needs to be accomplished, including the establishment of the end of queue threshold based on speed thresholds. The message updates should include all latency between devices and include data processing needed to receive notification and generate the alert.</p>					

**Table 2 EQWS System Requirements (Continued)**

ID #	Needs	ID #	High Level Requirements	ID #	Detailed System Requirements
1	Drivers approaching a work zone need an alert regarding the conditions of traffic ahead.	1.5	The EQWS shall alert drivers via a DMS message approaching or entering the work zone if they are traveling above the advisory speed.	1.5.1	The EQWS speed trailer (DMS) message shall be activated within X.X seconds of a high speed vehicle detection.
<p>Considerations: Speed trailer message should be agreed upon by Agency. This requirement is intended to support safe travel through the work zone, including the ability to stop or slow in advance of the downstream queue.</p>					
				1.5.2	The EQWS speed trailer (DMS) message shall be removed within X.X seconds of a high speed vehicle
<p>Considerations: This requirement addresses the need to alert the first and following drivers of their speed. The specified time should include all latency between devices and include data processing needed to receive the notification and generate the alert.</p>					
2	Drivers approaching a work zone need an alert if queue extends beyond the advisory signs.	2.1	The EQWS shall alert Agency / Field personnel if queue grows beyond the EQWS placement boundary.	2.1.1	The EQWS notification shall be sent within XX seconds when a queue is detected at the detection boundary.
				2.1.2	The system shall be able to send the notification to specified contacts through the most effective format including email, phone, or text message.
<p>Considerations: The specified time should include all latency between devices and include data processing needed to receive the notification and generate the alert. Once receive the field personnel should add an additional detection and DMS to ensure proper warning is provided as the queue continues to grow.</p>					
3	Drivers, Agencies and Law Enforcement need alerts to be accurate, relevant, easily understood, and reinforced at appropriate intervals through a work zone.	3.1	Warnings and alerts provided shall follow the existing standards to help aid in compliance and understanding.	3.1.1	Central System logic shall recommend standards-compliant messaging to display on all DMS in the system.
<p>Considerations: Central system should process data received and determine appropriate messaging is displayed in the work zone.</p>					
				3.1.2	The EQWS messages integrated with connected vehicles shall provide information that is compliant and consistent with national standards.
<p>Considerations: The National ITS Architecture should be the starting point for user requirements for how information messages are displayed in a vehicle.</p>					

**Table 2 EQWS System Requirements (Continued)**

ID #	Needs	ID #	High Level Requirements	ID #	Detailed System Requirements			
4	Agencies with EQWS need ability to remotely access data for traffic management purposes.	4.1	The EQWS shall include a data and system archive and reporting function.	4.1.1	The system data archive and reporting function shall be remotely accessible.			
				4.1.2	The data archive shall include system faults.			
				Considerations: The Agency need this type of information to evaluate the effectiveness of the system, as these systems provide no benefit to workers if there is a breakdown in detection, communication, or power.				
				4.1.3	The system shall allow for configuration and automated generation of system reports.			
				4.1.4	The system shall be capable of generating reports in a variety of file formats for ease of use.			
Considerations: The system needs to be able to summarize data in applicable format for end user needs.								
				4.1.5	System shall be capable of emailing reports generated by the system automatically.			
5	Agencies with an end of queue warning system need system to be: Mobile, easily configured, and able to operate the system in a temporary environment as power and communications may not be readily available.	5.1	The EQWS shall be mobile.	5.1.1	The components of the EQWS shall be easily transported using standard trailer or trucks.			
						5.2	The EQWS shall be easily configured.	
						5.3	The EQWS field components shall be capable of being powered via either AC or DC power sources.	
						5.4	The EQWS field components shall communicate via wireless media.	
						5.5	The EQWS Central System shall receive notifications of power or communication from all devices.	
						5.2.1	The Central System shall support ready configuration of field components.	
						5.3.1	Solar power shall be an option.	
		5.4.1	The wireless communication shall have XX% uptime (excluding maintenance).					
		5.5.1	The notifications shall be logged in the data archive.					
Considerations: If the system is too difficult to set up and the operations are fragile due to the foundational power and communications, the system will not provide the needed benefits, and Contractors may not want to dedicate resources to operating the system.								

## PART 2. SIGNS

### Chapter 2H. Recreational and Cultural Interest Area Signs

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## PART 2. SIGNS

### Chapter 2H. Recreational and Cultural Interest Area Signs

#### 2H.1 Scope

##### SUPPORT:

Recreational or cultural interest areas are attractions or traffic generators that are open to the general public for the purpose of play, amusement, or relaxation. Recreational attractions include such facilities as parks, campgrounds, gaming facilities, and ski areas, while examples of cultural attractions include museums, art galleries, and historical buildings or sites.

The purpose of recreation and cultural interest area signs is to guide road users to a general area and then to specific facilities or activities within the area.

##### OPTION:

Recreational and cultural interest area signs that depict significant traffic generators may be used on expressway and freeways where there is direct access to these areas as discussed in Section 2H.9.

Recreational and cultural interest area signs may be used off the road network, as appropriate.

#### 2H.2 Application of Recreational and Cultural Interest Area Signs

##### SUPPORT:

Standards for signing recreational or cultural interest areas are subdivided into two different types of signs: (1) symbol signs and (2) destination guide signs.

##### GUIDANCE:

When highway agencies decide to provide recreational and cultural interest area signing, these agencies should have a policy for such signing. The policy should establish signing criteria for the eligibility of the various types of services, accommodations, and facilities. These signs should not be used where they might be confused with other traffic control signs.

##### OPTION:

Recreational and cultural interest area signs may be used

on any road to direct persons to facilities, structures, and places, and to identify various services available to the general public.

These signs may also be used in recreational or cultural interest areas for signing nonvehicular events and amenities such as trails, structures, and facilities.

#### 2H.3 Regulatory and Warning Signs

##### STANDARD:

All regulatory and warning signs installed on public roads and streets within recreational and cultural interest areas shall conform to the requirements of Chapters 2A, 2B, and 2C.

#### 2H.4 General Design Requirements for Recreational and Cultural Interest Area Symbol Signs

##### STANDARD:

Recreational and cultural interest area symbol signs shall be square or rectangular in shape and shall have a white symbol or message and white border on a brown background. The symbols shall be grouped into the following usage and series categories (see the Federal "Standard Highway Signs" book for sign details (see Government Printing Office, page ii):

- A. General Information (RG Series)
- B. Motorist Services (RM Series)
- C. Accommodation Services (RA Series)
- D. Land Recreation (RL series)
- E. Water Recreation (RW Series), and
- F. Winter Recreation (RS Series)

##### SUPPORT:

Table 2H-1 contains a listing of the symbols within each series category. Drawings for these symbols are found in the Federal "Standard Highway Signs" book (see Government Printing Office, page ii).

##### OPTION:

Mirror images of symbols may be used where the reverse image will better convey the message.

<b>General Information</b>		<b>Accommodation Services</b>		<b>Water Recreation</b>	
Automobile	RG-010	Airport	RA-010	Boat Tours	RW-010
Bear Viewing Area	RG-020	Bus Stop	RA-020	Canoeing	RW-020
Dam	RG-030	Campfire	RA-030	Diving	RW-030
Deer Viewing Area	RG-040	Elevator *	RA-040	Diving (Scuba)	RW-040
Drinking Water	RG-050	Kennel	RA-050	Fish	RW-050
Environmental Study Area	RG-060	Laundry	RA-060	Marine Recreation Area	RW-060
Falling Rocks *	RG-070	Locker *	RA-070	Motorboating	RW-070
Firearms	RG-080	Parking	RA-080	Ramp (Launch)	RW-080
Fish Hatchery	RG-090	Rest Room (Men) *	RA-090	RowBoating	RW-090
Information	RG-100	Rest Room (Women) *	RA-100	Sailboating	RW-100
Leashed Pets *	RG-110	Shelter (Sleeping) *	RA-110	Skiing (Water)	RW-110
Lighthouse	RG-120	Shelter Trail (Trail) *	RA-120	Surfing	RW-120
Litter Container	RG-130	Showers *	RA-130	Swimming	RW-130
Lookout Tower	RG-140	Family Rest Area *	RA-150	Wading	RW-140
Ped Xing *	RG-150	Helicopter	RA-160	Fishing Pier	RW-160
Point of Interest	RG-160			Hand Launch	RW-170
Ranger Station	RG-170	<b>Land Recreation</b>		Kayak	RW-190
Smoking *	RG-180	Amphitheater	RL-010	Wind Surf	RW-210
Truck	RG-190	Climbing	RL-020		
Tunnel	RG-200	Climbing (Rock)	RL-030	<b>Winter Recreation</b>	
Dog	RG-240	Hunting	RL-040	Skating (Ice)	RS-010
Seaplane	RG-260	Playground	RL-050	Ski Jumping	RS-020
		Rock Collecting	RL-060	Skiing (Bobbing)	RS-030
<b>Motorist Services</b>		Spelunking	RL-070	Skiing (Cross Country)	RS-040
Camping (Tent)	RM-010	Stable	RL-080	Skiing (Downhill)	RS-050
Camping (Trailer)	RM-020	Trail (Bicycle)	RL-090	Sledding	RS-060
Ferry	RM-030	Trail (Hiking)	RL-100	Snowmobiling	RS-070
First Aid	RM-040	Trail (Horse)	RL-110	Snowshoeing	RS-080
Food	RM-050	Trail (Interpretive, Auto)	RL-120	Winter Recreation Area	RS-090
Gas	RM-060	Trail (Intpretive, Ped.)	RL-130	Chairlift	RS-100
Grocery Store	RM-070	Trail/Road (4 WD Veh.)	RL-140		
Handicapped	RM-080	Trail (Trail Bike)	RL-150		
Lodging	RM-090	Tramway	RL-160		
Mechanic	RM-100	All-Terrain Vehicle	RL-170		
Post Office	RM-110	Archer	RL-190		
Oicnic Area	RM-120	Hang Glider	RL-210		
Picnic Shelter	RM-130				
Rest Room	RM-140				
Telephone	RM-150				
Trailer Sanitary Station	RM-160				
Viewing Area	RM-170				
Motor Home	RM-200				
Group Camping	RM-210				
Group Picnicking	RM-220				

\* For Non-Road Use

**Table 2H-1 Category Chart for Symbols**

## 2H.5 Symbol Sign Sizes

### GUIDANCE:

Recreational and cultural interest area symbol signs should be 600 x 600 mm (24 x 24 in). Where greater visibility or emphasis is needed, larger sizes should be used. Symbol sign enlargements should be in 150 mm (6 in) increments.

Recreational and cultural interest area symbol signs should be 750 x 750 mm (30 x 30 in) when used on expressways or freeways.

### OPTION:

A smaller size of 450 x 450 mm (18 x 18 in) may be used on low-speed, low-volume roadways and on non-road applications.

## 2H.6 Use of Educational Plaques

### GUIDANCE:

Educational plaques should accompany all initial installations of recreational and cultural interest area symbol signs. The educational plaque should remain in place for at least 3 years after the initial installation. If used, the educational plaque should be the same width as the symbol sign.

### OPTION:

Symbol signs that are readily recognizable by the public may be installed without educational plaques.

### SUPPORT:

Figure 2H-1 illustrates some examples of the uses of educational plaques.

## 2H.7 Use of Prohibitive Slash

### STANDARD:

The red diagonal slash, if used on a recreational and cultural interest area sign, shall be placed from the upper left corner to the lower right corner of the sign face. Requirements for retroreflection of the red slash shall be the same as those requirements for legends, symbols, and borders.

### OPTION:

Where it is necessary to indicate a restriction within a recreational or cultural interest area, a red diagonal slash may be used to indicate that the activity is prohibited.

### SUPPORT:

Figure 2H-1 illustrates some examples of the uses of prohibitive slashes.

## 2H.8 Placement of Recreational and Cultural Interest Area Symbol Signs

### STANDARD:

If used, recreational and cultural interest area symbol signs shall be placed in accordance with the general requirements contained in Chapter 2A. The symbol(s) shall be placed in the uppermost part of the sign assembly and the directional information shall be placed below the symbol(s).

Where the name of the recreational or cultural interest area facility or activity is shown on a general directional guide sign and a symbol is used, the symbol shall be placed below the name (see Figure 2H-2).

Recreational and cultural interest area symbols installed for non-road use shall be placed in accordance with the general sign position requirements of the authority having jurisdiction.

### SUPPORT:

Figure 2H-3 illustrates some examples of the height and lateral mounting positions. Figure 2H-4 illustrates typical placement of symbol signs within a recreational or cultural interest area. Figure 2H-5 illustrates some of the symbols that can be used. Illustrations of all of the recreational and cultural interest area symbols that can be used are found in Appendix C of this Manual.

### GUIDANCE:

The number of symbols used in a single sign assembly should not exceed four.

### OPTION:

Symbols for recreational or cultural interest areas may be used as legend components for a directional sign assembly. The symbols may be used singularly, or in groups of two, three, or four on a single sign assembly (see Figures 2H-1, 2H-3, and 2H-4). Smaller-size secondary symbols (see Figure 2H-1) may be placed beneath the primary symbols, where needed.

## 2H.9 Destination Guide Signs

### GUIDANCE:

When recreational or cultural interest area destinations are shown on supplemental guide signs, the sign should be rectangular or trapezoidal in shape. The order of preference for use of shapes and colors should be as follows: (1) rectangular with a white legend and border on a green background; (2) rectangular with a white legend and border on a brown background; or (3) trapezoidal with a white legend and border on a brown background.



b) Directional sign with arrow



b) Directional signs with arrows



c) Directional signs with arrows



d) Directional sign with secondary symbol



NO CAMPFIRES



NO SMOKING

e) Management Symbols with prohibitive slashes and educational plaques



VISITOR  
INFO



f) Directional sign with educational plaque and arrow

Figure 2H-1 Examples of Educational Plaques, Prohibitive Slashes, and Arrows

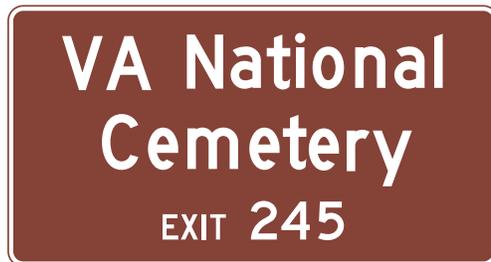
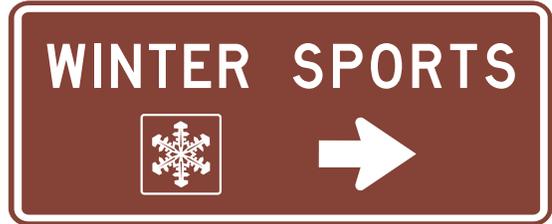
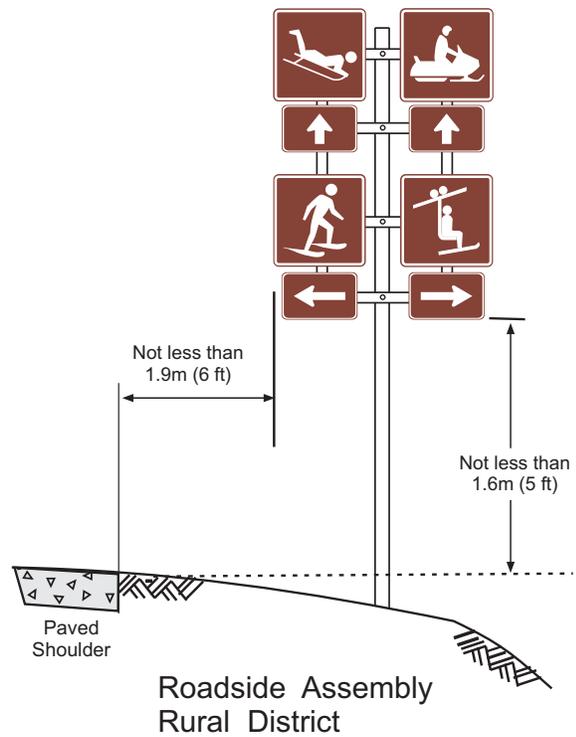
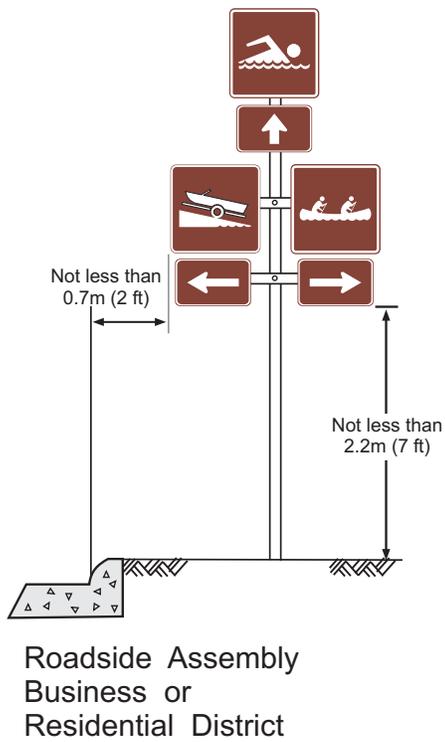
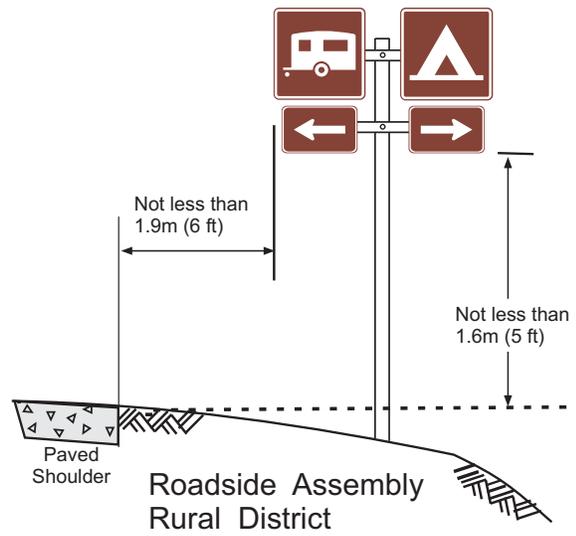
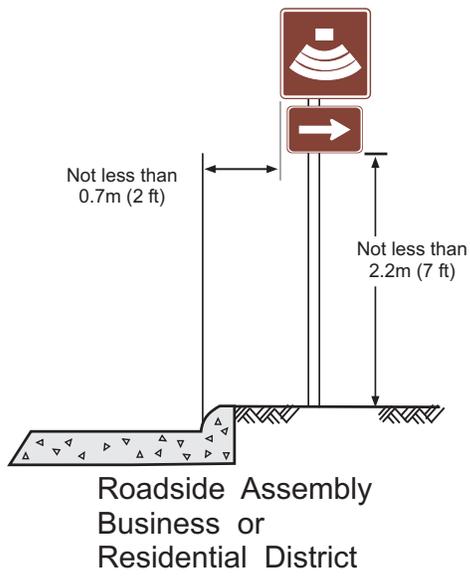


Figure 2H-2 Examples of General Directional Guide Signs for Conventional Roads



Note  
See Section 2A.19 for reduced lateral offset distances that may be used in areas where lateral offsets are limited, and in urban areas where sidewalk width is limited or where poles are close to the curb.

**Figure 2H-3. Height and Lateral Position of Signs Located Within Recreational and Cultural Interest Areas**

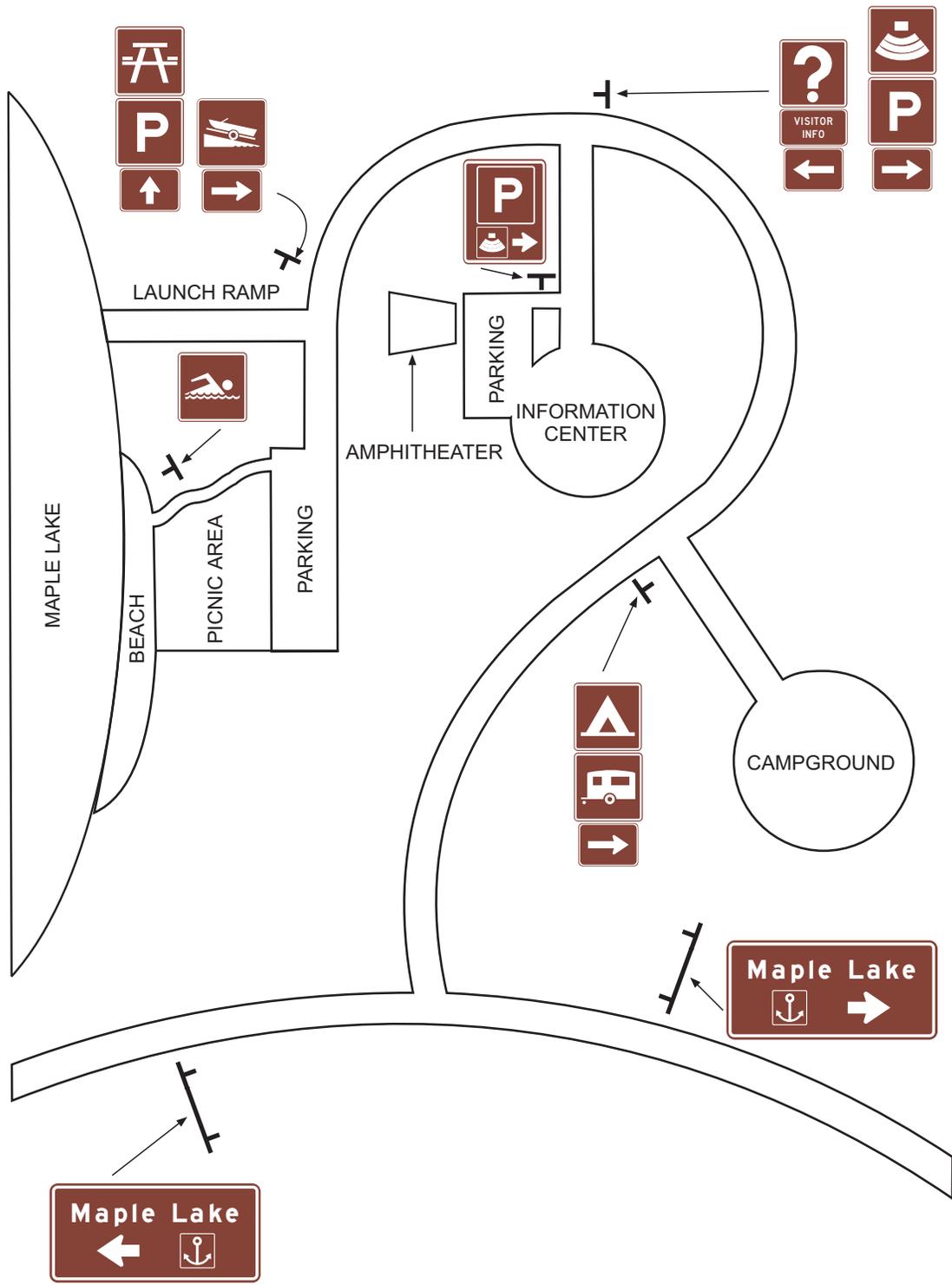


Figure 2H-4 Example of a Symbol Signing Layout



RG-010  
Automobile



RG-020  
Bear Viewing Area



RG-030  
Dam



RG-040  
Deer Viewing Area



RG-050  
Drinking Water



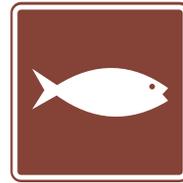
RG-060  
Environmental  
Study Area



RG-070  
Falling Rocks



RG-080  
Firearms



RG-090  
Fish Hatchery



RG-100  
Information



RG-110  
Leashed Pets



RG-120  
Lighthouse



RG-130  
Litter Container



RG-140  
Lookout Tower



RG-150  
Ped Xing



RG-160  
Point of Interest



RG-170  
Ranger Station



RG-180  
Smoking



RG-190  
Truck



RG-200  
Tunnel



RG-240  
Dog



RG-260  
Seaplane



RM-010  
Camping (Tent)

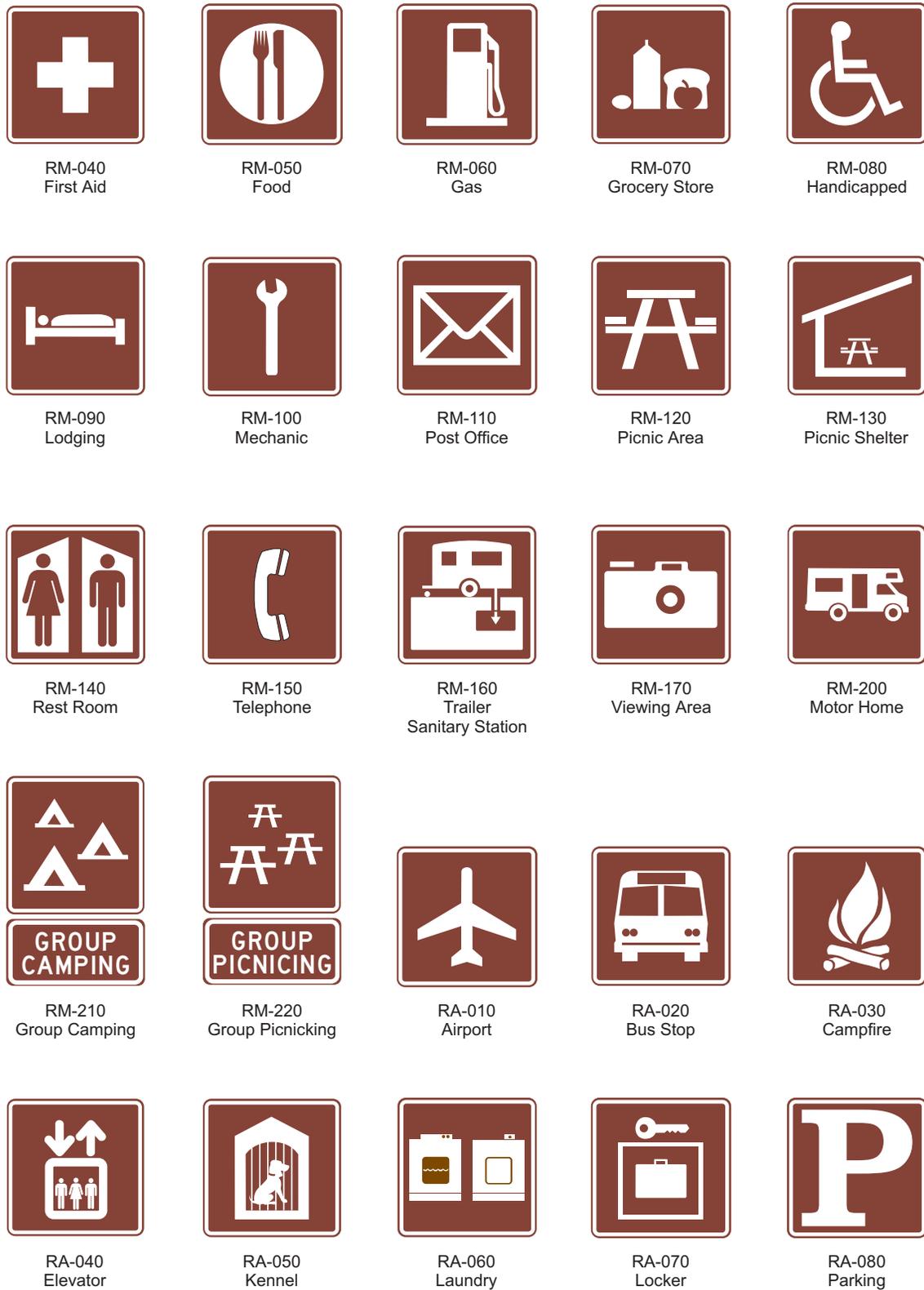


RM-020  
Camping (Trailer)



RM-030  
Ferry

**Figure 2H-5. Recreational and Cultural Interest Area Symbol Signs**  
(Sheet 1 of 5)



**Figure 2H-5. Recreational and Cultural Interest Area Symbol Signs**  
(Sheet 2 of 5)



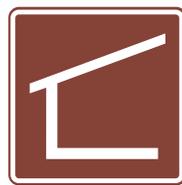
RA-090  
Rest Room (Men)



RA-100  
Rest Room (Women)



RA-110  
Shelter (Sleeping)



RA-120  
Shelter (Trail)



RA-130  
Showers



RA-150  
Family Rest Room



RA-160  
Helicopter



RL-010  
Amphitheater



RL-020  
Climbing



RL-030  
Climbing (Rock)



RL-040  
Hunting



RL-050  
Playground



RL-060  
Rock Collecting



RL-070  
Spelunking



RL-080  
Stables



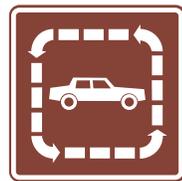
RL-090  
Trail  
(Bicycle)



RL-100  
Trail  
(Hiking)



RL-110  
Trail  
(Horse)



RL-120  
Trail  
(Interpretive, Auto)



RL-130  
Trail  
(Interpretive, Ped.)



RL-140  
Trail/Road  
(4 WD Veh.)



RL-150  
Trail  
(Trail Bike)



RL-160  
Tramway



RL-170  
All-Terrain Vehicle

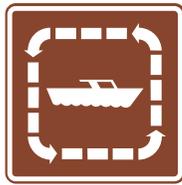


RL-190  
Archer

**Figure 2H-5. Recreational and Cultural Interest Area Symbol Signs**  
(Sheet 3 of 5)



RL-210  
Hang Glider



RW-010  
Boat Tours



RW-020  
Canoeing



RW-030  
Diving



RW-040  
Diving (Scuba)



RW-050  
Fishing



RW-060  
Marine Recreation  
Area



RW-070  
Motorboating



RW-080  
Ramp (Launch)



RW-090  
Rowboating



RW-100  
Sailboating



RW-110  
Skiing (Water)



RW-120  
Surfing



RW-130  
Swimming



RW-140  
Wading



RW-160  
Fishing Pier



RW-170  
Hand Launch



RW-190  
Kayak



RW-210  
Wind Surf



RS-010  
Skating (Ice)



RS-020  
Ski Jumping



RS-030  
Skiing  
(Bobbing)



RS-040  
Skiing  
(Cross Country)



RS-050  
Skiing (Downhill)



RS-060  
Sledding

**Figure 2H-5. Recreational and Cultural Interest Area Symbol Signs**  
(Sheet 4 of 5)



RS-070  
Snowmobiling



RS-080  
Snowshoeing



RS-090  
Winter Recreation  
Area



RS-100  
Chairlift

**Figure 2H-5. Recreational and Cultural Interest Area Symbol Signs**  
(Sheet 5 of 5)

**STANDARD:**

Whenever the trapezoidal shape is used, the color combination shall be a white legend and border on a brown background.

**OPTION:**

White-on-brown destination guide signs may be posted at the first point where an access or crossroad intersects a highway where recreational or cultural interest areas are a significant destination along conventional roads, expressways, or freeways. White-on-brown supplemental guide signs may be used along conventional roads, expressways, or freeways to direct road users to recreational or cultural interest areas. Where access or crossroads lead exclusively to the recreational or cultural interest area, the advance guide sign and the exit direction sign may be white-on-brown.

**STANDARD:**

Linear parkway-type highways that merely function as arterial connectors without providing access to recreational or cultural interest areas shall not qualify for the use of white-on-brown destination guide signs. Directional guide signs used on these highways shall conform to Chapter 2D.

All gore signs shall have a white legend and border on a green background. The background color of the interchange exit number panel shall match the background color of the guide sign. Design characteristics of conventional road, expressway, or freeway guide signs shall conform to Chapter 2D or 2E except as specified in this Section for color combination.

The advance guide sign and the Exit Direction sign shall retain the white-on-green color combination where the crossroad leads to a destination other than a recreational or cultural interest area.

**SUPPORT:**

Figure 2H-2 illustrates destination guide signs commonly used for identifying recreational or cultural interest areas or facilities.

### 2H.9.1 Recreational or Cultural Interest Guide Signs and Symbol Signs on One Structure

**OPTION:**

Symbol signs may be installed below a recreational or cultural interest area advance guide sign located on conventional highways and expressways.

**STANDARD:**

Symbol signs shall not be installed on freeways.

**SUPPORT:**

Advance guide signs are normally installed 800 m (1/2 mi) in advance of the access road to the recreational or cultural interest area.

**OPTION:**

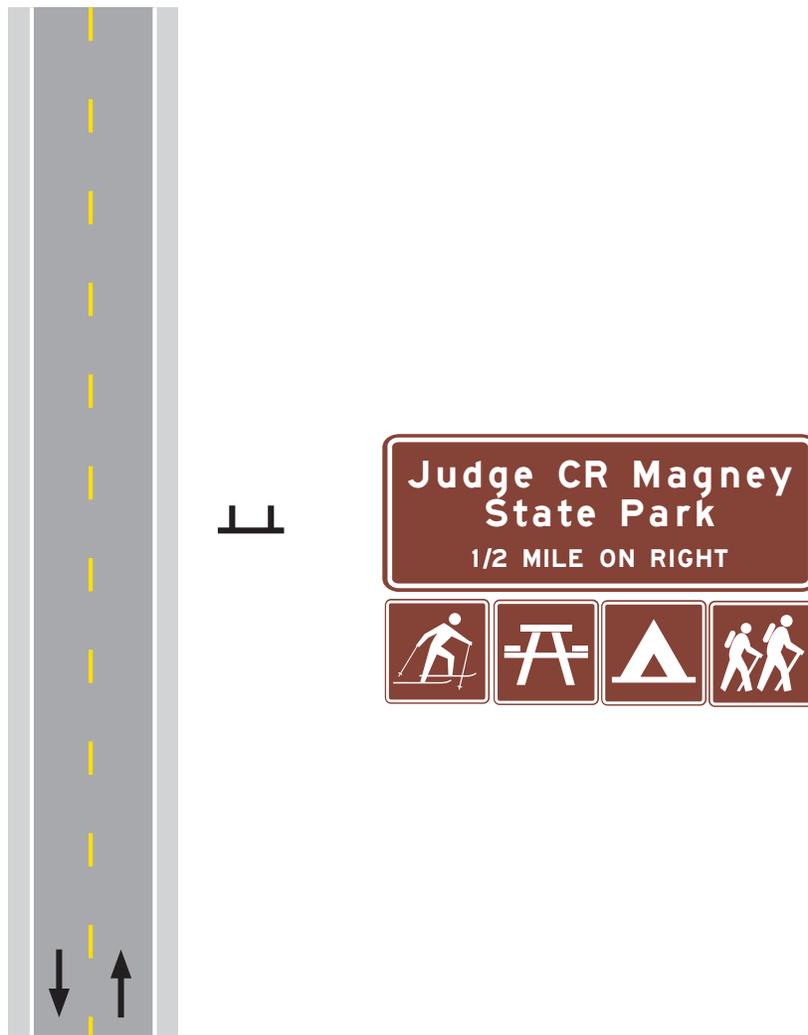
Up to four 600 x 600 mm (24 x 24in) symbol sign panels may be installed horizontally beneath each recreational or cultural interest area guide sign (see Figure 2H-6).

**GUIDANCE:**

For structural and aesthetic reasons, the cumulative overall length of these symbol sign panels should not exceed the length of the recreational or cultural interest area sign.

**STANDARD:**

Sign panels installed beneath recreational or cultural interest area guide signs shall match those shown in Figure 2H-7. Symbol signs not illustrated on Figure 2H-7 shall be mutually agreed upon by Mn/DOT, MN DNR, and the FHWA.



**Figure 2H-6 Typical Placement of Symbol Signs Below a Recreational or Cultural Interest Area Guide Sign**

When symbol sign panels are installed below an existing recreational or cultural interest area sign panel, the sign structure shall meet the requirements of the Mn/DOT Traffic Engineering Manual (See Map & Manual sales Unit, page ii).

In order to provide the proper sign structure design, the existing sign structure shall be modified or replaced with the correct structure. The entire structure shall meet all of the pertinent mounting height requirements as shown in Figure 2H-3. Vertical heights shall be measured to the bottom of the symbol sign panels.

**OPTION:**

Seasonal changes of symbol sign panels may occur when they are mutually agreed upon by the local road authority and the requesting agency. The road authority's personnel will be responsible for changing, storing and re-installing the symbol sign panels on the sign structure. This work may be delegated to the requesting agency's on-site staff.

**STANDARD:**

All signing costs for the fabrication and installation of the symbol sign panels, as well as all sign structure modification or replacement costs, shall be paid by the requesting agency.



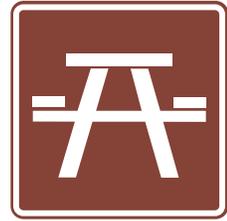
D7-X8A  
Carry-in Access



RG-100  
Information



RM-010  
Campground



RM-120  
Picnic Area



RL-030  
Rock Climbing



RL-090  
Bicycle Trail



RL-100  
Hiking Trail



RL-110  
Horse Trail



RL-X10  
Golf Course



RW-020  
Canoeing



RW-080  
Boat Launch



RW-130  
Swimming



RS-040  
Cross Country Skiing



RS-070  
Snowmobiling



RS-080  
Snowshoeing

**Figure 2H-7 Symbol Signs Approved for Placement Below a Recreational or Cultural Interest Area Guide Sign**

### 5G.3 Channelization Devices

#### **STANDARD:**

Channelization devices for nighttime use shall have the same retroreflective requirements as specified for higher-volume roadways.

#### **OPTION:**

To alert, guide and direct road users through temporary traffic control zones on low-volume roads, tapers may be used to move a road user out of the traffic lane and around the work space using the spacing of devices that is described in Section 6F.63.

### Proposed new language:

#### **STANDARD**

Channelization devices for nighttime use shall have the same retroreflective requirements as specified for higher-volume roadways.

#### **OPTION**

Short-term daylight hour maintenance operations that typically have short work spaces, clearly visible vehicle paths and offer limited risk to workers and road users may omit the routine use of channelization devices. Channelization devices may also be omitted if flaggers give specific instructions to drivers on how to proceed through the work zone.

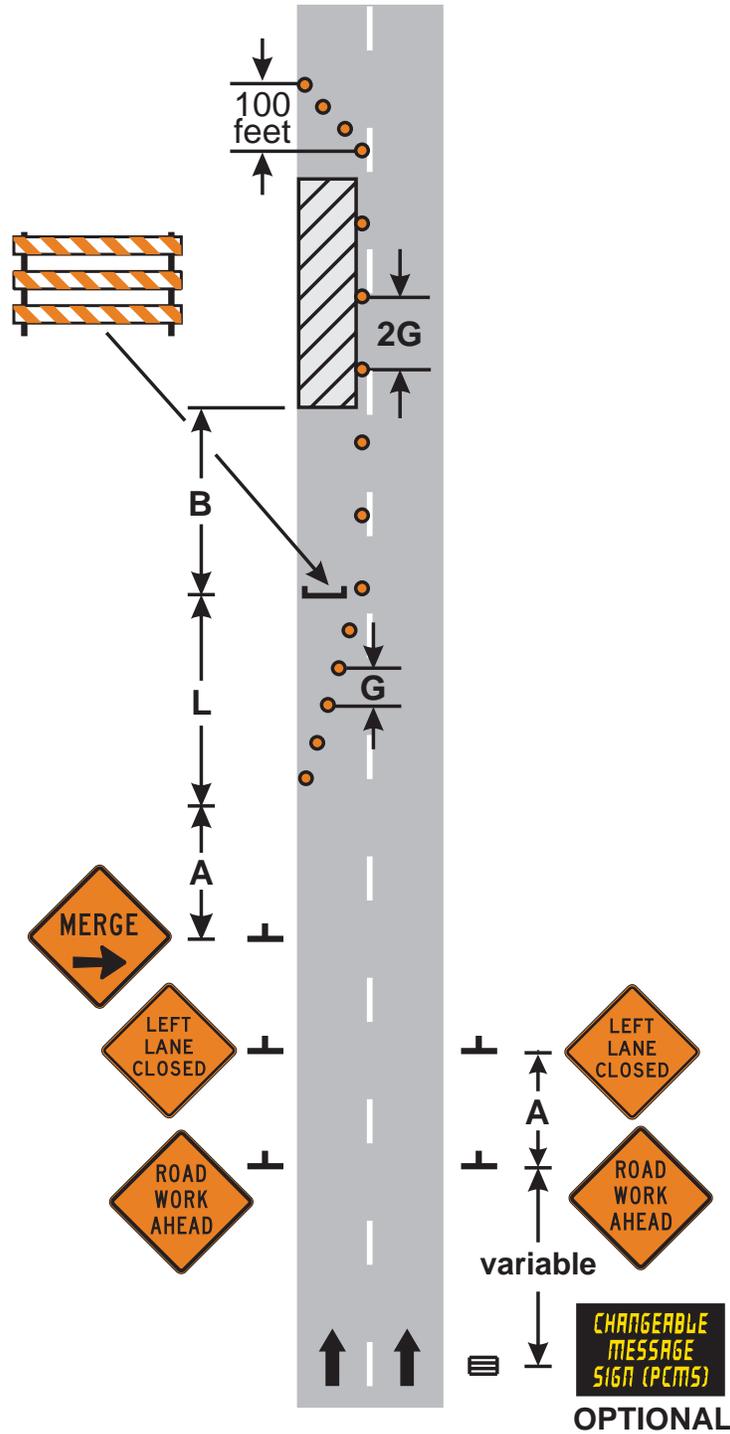
#### **GUIDANCE**

Channelization devices should be used if road users should be guided in a clear and positive manner while approaching and within construction, maintenance, and utility work areas.

**NOTES:**

- ① The Flashing Arrow Board shall be used when the posted speed limit is 45 mph or greater.
- ② The Transition Symbol sign may be omitted when the posted speed limit is 40 mph or less.
- 3. Use the appropriate traffic control devices for a right lane closure.

**10/6/17  
Layout OK**



**LANE CLOSURE  
MULTI-LANE DIVIDED ROAD**

**3 DAYS or LESS**

**LAYOUT 53**

# Proposed MN MUTCD Modifications for High-Vis Apparel

For MCUTCD consideration. Proposed modifications to 6E.2 High-Visibility Apparel & 6D.3 Worker Considerations.

- The MCUTCD voted to require flaggers to wear Class E retro-reflective pants. Should a compliance date be added – perhaps December 31, 2018?
- Move paragraph related to MN OSHA Rules from 6E.2 to 6D.3. These Rules include high-vis requirements for workers exposed to traffic and not specific to flaggers. The Rules are attached.
- Guidance statement for high-vis hat in Worker Considerations should be moved prior to Option statement for emergency responders/law enforcement high-vis apparel.

## 6E.2 High-Visibility Safety Apparel

### STANDARD:

For daytime and nighttime activity, flaggers shall wear high-visibility safety apparel that meets the Performance Class 3 requirements of the ANSI/ISEA 107-2004 publication entitled "American National Standard for High-Visibility Apparel and Headwear" (see Section 1A.11), or equivalent revisions. The Class 3 requirements shall be met by wearing an ANSI/ISEA Class 2 vest, shirt or jacket; as well as ANSI/ISEA Class E pants. The apparel shall be labeled with the ANSI/ISEA Classes.

The apparel background (outer) material color shall be fluorescent orange-red, fluorescent yellow-green, or a combination of the two as defined in the ANSI standard. The retroreflective material shall be orange, yellow, white, silver, yellow-green, or a fluorescent version of these colors, and shall be visible at a minimum distance of 1,000 feet. The retroreflective safety apparel shall be designed to clearly identify the wearer as a person.

### GUIDANCE:

In addition to the Class 3 requirements listed in the above STANDARD, a high visibility hat in the above colors should be worn.

## 6D.3 Worker Considerations

### STANDARD:

All workers, including emergency responders, within the right-of-way who are exposed either to traffic (vehicles using the highway for purposes of travel) or to work vehicles and construction equipment within the TTC zone shall wear high-visibility safety apparel that meets the Performance Class 2 or 3 requirements of the ANSI/ISEA 107-2004 publication entitled "American National Standard for High-Visibility Safety Apparel and Headwear" (see Section 1A.11), or equivalent revisions, and labeled as meeting the ANSI 107-2004 standard performance for Class 2 or 3 risk exposure, except as provided in the OPTION below. A person designated by the employer to be responsible for worker safety shall make the selection of the appropriate class of garment.

High visibility apparel shall comply with current Minnesota OSHA Rules 5207.0100 and 5207.1000.

### GUIDANCE:

When working in an area that does not require the use of a hard hat for head protection, a high visibility hat in the above colors should be worn.

**Moved down [1]:** High visibility apparel shall comply with current Minnesota OSHA Rules 5207.0100 and 5207.1000 and your agency's policies.¶

**Deleted:** 2 or

**Commented [KJ1]:** Not in Federal MUTCD in Flagger Chapter, but needed.

**Deleted:** , and labeled as meeting the ANSI 107- 2004 standard performance for Class 2 or 3 risk exposure

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**Deleted:** For nighttime activity, high-visibility safety apparel that meets the Performance Class 3 requirements of the ANSI/ISEA 107-2004 publication entitled "American National Standard for High-Visibility Apparel and Headwear" (see Section 1A.11), or equivalent revisions, and labeled as meeting the ANSI 107-2004 standard performance for Class 3 risk exposure shall be considered for flagger wear.¶

**Deleted:** 5

**Moved (insertion) [1]**

**Deleted:** and your agency's policies

**Moved (insertion) [2]**

## Proposed MN MUTCD Modifications for High-Vis Apparel

**OPTION:**

Emergency and incident responders and law enforcement personnel within the TTC zone may wear high visibility safety apparel that meets the performance requirements of the ANSI/ISEA 207-2006 publication entitled “American National Standard for High-Visibility Public Safety Vests” (see Section 1A.11), or equivalent revisions, and labeled as ANSI 207-2006, in lieu of ANSI/ISEA 107-2004 apparel.

Moved up [2]: **GUIDANCE:**  
When working in an area that does not require the use of a hard hat for head protection, a high visibility hat in the above colors should be worn.

DRAFT

# Proposed MN MUTCD Modifications for High-Vis Apparel

Minnesota Rules

## 5207.0100 HIGH VISIBILITY PERSONAL PROTECTIVE EQUIPMENT.

Subpart 1. General requirement. Each employee exposed to or working adjacent to moving motor vehicles as part of the employee's assigned job shall be provided with and required to wear a high visibility warning vest or other high visibility garment. A high visibility garment is defined as being a Performance Class 2 garment or greater as specified by ANSI/ISEA Standard 107-2004. Some smaller garments may not meet the background material specifications for Performance Class 2 as defined in ANSI/ISEA 107-2004. In these cases, the garment must be rated by the manufacturer as greater than or exceeding Performance Class 1 requirements.

Subp. 2. Maintenance of garments. If the high visibility personal protective equipment becomes faded, torn, dirty, worn, or defaced, reducing the equipment's performance below the manufacturer's recommendations, the high visibility personal protective equipment shall be immediately removed from service and replaced.

Subp. 3. Exception. Where permanent or semipermanent barricades designed to stop or deflect vehicular traffic upon impact are in place to protect employees from moving motor vehicles, employees are not required to wear high visibility personal protective equipment while working inside these protected areas.

Subp. 4. Electrical work. For work within the flash protection boundary as defined by NFPA 70E, high visibility garments constructed of material that complies with NFPA 70E shall be worn.

Subp. 5. [Repealed, 31 SR 517]

Statutory Authority: MS s 182.655

History: 12 SR 634; 25 SR 1241; 31 SR 517; 40 SR 750

Published Electronically: January 7, 2016

# Proposed MN MUTCD Modifications for High-Vis Apparel

## 5207.1000 OPERATION OF MOBILE EARTH-MOVING EQUIPMENT.

Subpart 1. Scope. This part identifies minimum safety requirements for the safe operation of mobile earth-moving equipment used for earth moving, building, or road construction or demolition, including, but not limited to, bulldozers, motor graders, scrapers, loaders, skid-steer loaders, compaction equipment, backhoes, end dumps, side dumps, and dump trucks. This part pertains to operators of the equipment and exposed employees, including, but not limited to, grade checkers, grade persons, rod persons, stake hops, stake jumpers, and blue toppers working in the area.

### Subp. 2. Training requirements.

A. Mobile earth-moving equipment operators and all other employees working on the ground exposed to mobile earth-moving equipment shall be trained in the safe work procedures pertaining to mobile earth-moving equipment and in the recognition of unsafe or hazardous conditions.

B. Training programs shall be developed and instructed by competent individuals who have knowledge, training, experience, and the demonstrated ability to identify existing and predictable hazards related to the subject matter.

C. Training programs must include the following elements:

(1) safe work procedures on how to approach mobile earth-moving equipment, whether in use or idling, including:

(a) visual, voice, or signal communication that shall be made with the operator prior to approaching earth-moving equipment;

(b) maintaining one's visibility to the operator while approaching the equipment; and

(c) operator responsibilities, such as placing the transmission in neutral, setting the parking brake, and indicating that it is safe to approach the equipment;

(2) identification of the operator's blind spots on various earth-moving equipment used;

(3) instruction for mobile earth-moving equipment operators in conducting daily equipment inspections according to the manufacturer's recommendations, and checking the area around the equipment for a clear path prior to beginning operation;

(4) safe operating procedures of equipment, including traveling, backing, parking, loading for transport, maintenance, and operation;

(5) safe work procedures when working around or adjacent to overhead or underground utilities, as described in Code of Federal Regulations, title 29, parts 1926.600(a)(6) and 1926.651(b); and

(6) additional hazards that could be created by changing conditions.

## Proposed MN MUTCD Modifications for High-Vis Apparel

Subp. 3. Training frequency. Employees shall be trained initially before beginning work that exposes them to mobile earth-moving equipment. Employee training records shall be retained by the employer for the duration of the project.

### Subp. 4. High visibility personal protective equipment.

A. Each employee working on the ground who is exposed to mobile earth-moving equipment shall be provided with and required to wear a high visibility warning vest or other high visibility garments. A high visibility garment is defined as being a Performance Class 2 garment or greater as specified by ANSI/ISEA Standard 107-2004.

B. High visibility apparel, as described in item A, shall comply with the specifications in part 5207.0100.

### Subp. 5. Equipment requirements.

A. All mobile earth-moving equipment shall comply with Code of Federal Regulations, title 29, part 1926.602(a)(9)(ii) for back-up alarms or signal persons if applicable.

B. When mobile earth-moving equipment is operated during times of darkness or low light conditions, the equipment, if designed to function equally in both forward and reverse directions, such as compaction equipment, bulldozers, motor graders, loaders, and skid-steer loaders, shall be equipped with at least two headlights for forward travel and adequate rear lights for reverse travel unless other adequate lighting is provided.

### Subp. 6. Contractor responsibility.

A. If the mobile earth-moving equipment contractor exposes other contractor's employees to the hazard of mobile earth-moving equipment, the controlling employer, such as general contractor or construction manager, for the project shall coordinate a joint contractor-employee safety awareness meeting between contractors and employees on site.

Discussion elements for employee awareness training can be found in subparts 2, item C; and 4.

B. The employee safety awareness meeting shall be documented, identifying when the meeting was held and who attended, including a brief summary of what was reviewed. Documentation shall be retained for the duration of the project.

Subp. 7. Electrical work. For work within the flash protection boundary as defined by NFPA 70E, high visibility garments constructed of material that complies with NFPA 70E may be worn.

Subp. 8. [Repealed, 31 SR 517]

Statutory Authority: MS s 182.655

## **2C.28 BUMP and DIP Signs (W8-1, W8-1a, W8-1b, W8-2)**

### **GUIDANCE**

BUMP (W8-1) and DIP (W8-2) signs should be used to give warning of a sharp rise or depression in the profile of the road.

### **Option:**

These signs may be supplemented with an Advisory Speed plaque (see Section 2C.8) or a 45 Degree Supplemental Arrow plaque.

### **STANDARD:**

The DIP sign (W8-2) shall not be used at a short stretch of depressed alignment that might momentarily hide a vehicle.

### **GUIDANCE**

A short stretch of depressed alignment that might momentarily hide a vehicle should be treated as a no-passing zone when center line striping is provided on a two-lane or three-lane road (see Section 3B.2).

### **Option:**

At severe bumps, a BUMP AHEAD (W8-1a) sign may be placed in advance of the bump location. An appropriate Distance plaque (see Section 2C.55) or Advisory Speed plaque (see Section 2C.8) may be placed below the warning sign.

At areas of multiple bumps, a BUMPS (W8-1b) sign may be placed in advance of the area. An appropriate Distance plaque (see Section 2C.55) may be placed below the warning sign.

**From:** [Stein, William \(FHWA\)](#)  
**To:** [Colton, Diane \(DOT\)](#)  
**Subject:** One-Direction Large Arrow  
**Date:** Thursday, December 21, 2017 3:13:52 PM

Diane—below is the response regarding the One-Direction Large Arrow.

---

**From:** Ferron, Eric (FHWA)  
**Sent:** Wednesday, September 27, 2017 8:11 AM  
**To:** Stein, William (FHWA) <[william.stein@dot.gov](mailto:william.stein@dot.gov)>  
**Cc:** Johnson, Kenneth (DOT) (<[ken.johnson@state.mn.us](mailto:ken.johnson@state.mn.us)> <[ken.johnson@state.mn.us](mailto:ken.johnson@state.mn.us)>); Lott, Heather (<[heather.lott@state.mn.us](mailto:heather.lott@state.mn.us)>); Anderson, Janelle (<[janelle.anderson@state.mn.us](mailto:janelle.anderson@state.mn.us)>); Sylvester, Kevin (FHWA) (<[Kevin.Sylvester@dot.gov](mailto:Kevin.Sylvester@dot.gov)>)  
**Subject:** RE: MUTCD question - need quick response

Will,

There are two uses for the Directional Arrow (W1-6) sign.

The black on orange Direction Arrow sign is used in temporary traffic control situations as part of the Direction Indicator Barricades. (Section 6F.69)

When the Direction Arrow sign is used as a standalone sign (not part of the Directional Indicator Barricades) the use of the sign falls under section 2C.12. The use of the One-Direction Large Arrow sign shall be in accordance with the information shown in Table 2C-5. If used, the One-Direction Large Arrow sign shall be installed on the outside of a turn or curve in line with and at approximately a right angle to approaching traffic. As you pointed out, the One-Direction Large Arrow sign shall not be used where there is no alignment change in the direction of travel.

Additionally, an arrow board is required when a freeway lane is closed (Section 6H.01), there are no corresponding option statements allowing the use of Directional Arrow sign in lieu of the arrow board.

The bottom line is that the use of the arrow board is a standard and there are no supporting statements to allow a deviation from the standard.

I hope this helps

Eric

James "Eric" Ferron, PE  
Federal Highway Administration  
Operations Technical Service Team, MUTCD Team  
[eric.ferron@dot.gov](mailto:eric.ferron@dot.gov)  
(719) 225-3964

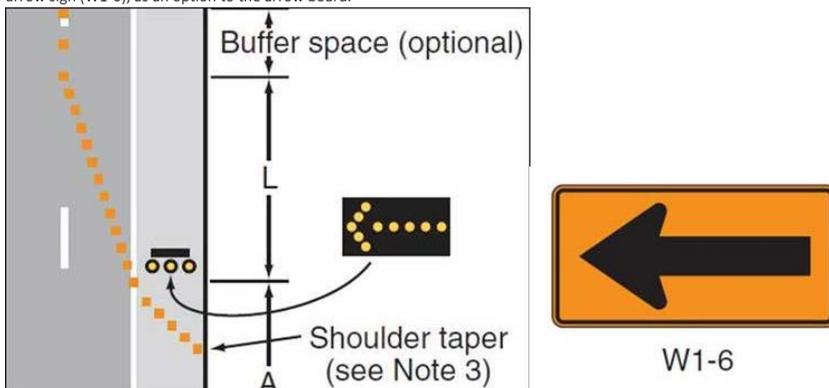
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**From:** Stein, William (FHWA)  
**Sent:** Thursday, September 21, 2017 11:07 AM  
**To:** Ferron, Eric (FHWA) (<[eric.ferron@dot.gov](mailto:eric.ferron@dot.gov)>)  
**Cc:** Johnson, Kenneth (DOT) (<[ken.johnson@state.mn.us](mailto:ken.johnson@state.mn.us)> <[ken.johnson@state.mn.us](mailto:ken.johnson@state.mn.us)>); Lott, Heather (<[heather.lott@state.mn.us](mailto:heather.lott@state.mn.us)>); Anderson, Janelle (<[janelle.anderson@state.mn.us](mailto:janelle.anderson@state.mn.us)>)  
**Subject:** MUTCD question - need quick response

Eric—we have a part 6 question with some connection to Part 2, that we need a quick response to. MnDOT is about to publish their typical work zone layouts, which is why we're in a rush. MnDOT folks: if I missed anything in terms of explaining the question, please chime in.

Here's the fundamental question:

In the MUTCD, an electronic arrow board is shown near the beginning of tapers (such as Figure 6H-33). It's been a long-standing practice in MN to allow a static one-direction large arrow sign (W1-6), as an option to the arrow board.



This seems to conflict with the standard in Section 2C.12, paragraph 06, which says the large arrow sign "shall not be used where there is no alignment change".

- |    |  |
|----|--|
| 05 | <b>If used, the One-Direction Large Arrow sign shall be installed on the outside of a turn or curve in line with and at approximately a right angle to approaching traffic.</b>              |
| 06 | <b>The One-Direction Large Arrow sign shall not be used where there is no alignment change in the direction of travel, such as at the beginnings and ends of medians or at center piers.</b> |

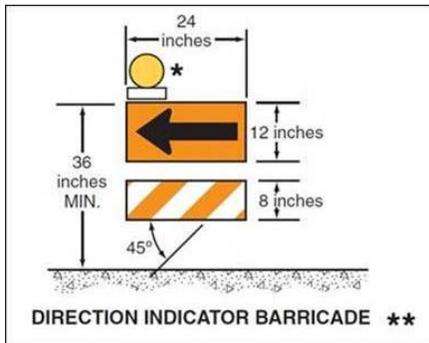
Section 6F.69, however, does allow the use of the arrow sign through tapers when combined with another device as shown below, and used in series.

Option:

03 The Direction Indicator Barricade may be used in tapers, transitions, and other areas where specific directional guidance to drivers is necessary.

Guidance:

04 If used, Direction Indicator Barricades should be used in series to direct the driver through the transition and into the intended travel lane.



So, our question: is our past practice of using the W1-6 arrow board in this way (as an option to the electronic arrow), not MUTCD compliant?

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# Work Zone Intrusion Warning System

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System Requirements

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December 2015

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## **Acknowledgements**

This document was prepared for the Minnesota Department of Transportation (MnDOT) Systems Engineering for Work Zone Challenges project.

## **Project Champion**

Rashmi Brewer, is the MnDOT project champion for this effort. MnDOT stakeholders and a project management team were heavily involved in identifying the key challenges with using Intelligent Transportation Systems to address and enhance safety, operations, mobility and efficiency in work zones. This document covers the system requirements to address some of these challenges.

## **Project Management Team (MnDOT)**

- Ralph Adair
- Tiffany Dagon
- Ted Ulven
- Craig Mittelstadt
- Leigh Kriewall
- Dave Mavec
- Ken Johnson
- Rashmi Brewer

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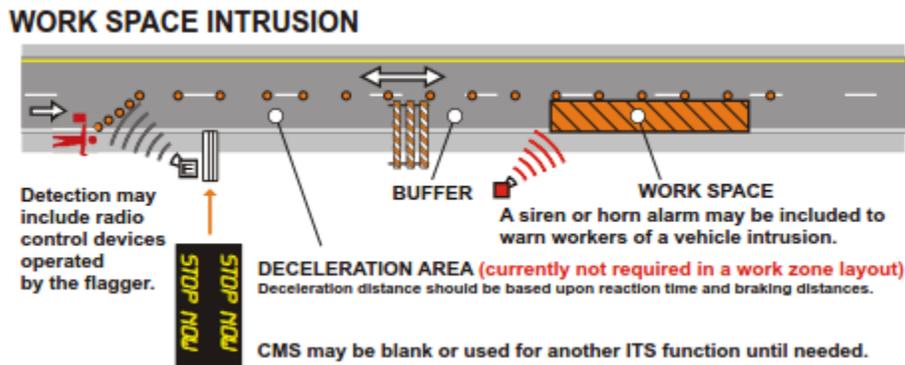
## Introduction

This document provides high-level system requirements for a Work Zone Intrusion Warning System (WIWS) to support enhanced work zone safety. The requirements in this document are derived from the companion Concept of Operations for WIWS, which is one of three Work Zone Challenges identified that may be addressed using Intelligent Transportation System (ITS) technologies. The other two ITS Systems identified to potentially address Work Zone Challenges are: End of Queue Warning System; and Distracted Driver Alert System.

This set of requirements should be considered as a starting point for system requirements development for a project. In addition, a set of requirements that fuses all three ITS Work Zone systems should be considered, as there will be instances when all three systems may be deployed together and several elements of the systems overlap or interoperate.

Work Intrusion Warning Systems are installed upstream of a work zone to address drivers not complying with the work zone and roadway messaging and entering an active work area where workers are located. These systems improve upon existing work zone signage which intends to provide safety to workers, allow sufficient space for roadway work, and provide signs and/or messaging systems that improve roadway safety and inform motorists. WIWS offers an alert to roadway workers when a non-authorized vehicle enters the work zone. WIWS typically consists of static signing, detection devices, Dynamic Message Signs (DMS or CMS), and an alarm or other notification device, as seen in Figure 1. The WIWS configuration in Figure 1 is found in the Minnesota Department of Transportation Intelligent Work Zone (IWZ) Toolbox guidance document.

**Figure 1 Typical Work Space Intrusion Warning System Configuration**



Both the system requirements and concept of operations are intended to illustrate the basic needs and requirements surrounding WIWS, as well as, serve as model documents that may be adapted to meet individual deployments. The materials do not mandate the deployment of such systems, nor do they limit the engineering judgment or policy discretion of the transportation agencies who may consider deploying WIWS. The materials reflect stakeholder needs and they should be adapted as necessary to reflect any unique or additional needs and requirements driven by individual deployments. The remainder of this document presents high-level system functional requirements for WIWS as derived from the previously developed concept of operations.

## System Requirements

High-level system functional requirements are verifiable statements that define what a work zone intrusion warning system will do, but not how it is accomplished (i.e. from a technical/technology standpoint). An important starting point for developing system requirements is to understand where the system is reflected within the National ITS architecture. This section shows how WIWS fit within the National ITS Architecture version 7.1, and then presents a series of high-level system functional requirements associated with the detection, alert, and system operation functions.

## WIWS and the National ITS Architecture

WIWS are considered part of the [Maintenance and Construction Operations User Service](#) in the National ITS Architecture, version 7.1. Systems within in this user service provide Work Zone Management Safety function, which provides support for the effectiveness, safety, and efficiency of roadway operations during all work zone activities. The service will provide information concerning work zone activities.

Within the physical architecture of the National ITS Architecture, WIWS are primarily addressed under the following:

- Roadway (Subsystem)
  - Roadway Work Zone Safety (Equipment Package)
    - MC09 Work Zone Safety Monitoring (Service Package)
- Maintenance and Construction Vehicle (Subsystem)
  - Maintenance and Construction Vehicle (Equipment Package)
    - ATIS09 In Vehicle Signing (Service Package)
    - MC09 Work Zone Safety Monitoring (Service Package)
- Maintenance and Construction Management. (Subsystem)
  - MCM Work Zone Safety Management (Equipment Package)
    - MC09 Work Zone Safety Monitoring (Service Package)

Table 1 presents a series of high-level requirements as they are presented within the Roadway Work Zone Safety Equipment Package, Maintenance and Construction Vehicle Equipment Package, and MCM Work Zone Safety Management Equipment Package of the National ITS Architecture. Currently, the applicable requirements have been incorporated into the document.

### **Table 1 WIWS Functional Requirements from “Roadway Work Traffic Control” and “MCM Work Zone Management” Equipment Packages from National ITS Architecture**

<b>Roadway Work Zone Safety Equipment Package</b>	<b>Functional Requirements</b>
	1. The field element shall include work zone intrusion detection devices that detect when a vehicle has intruded upon the boundary of a work zone, under center control.
	2. The field element shall include work zone intrusion detection devices that detect when crew workers have crossed the boundary between the work zone and vehicle traffic, under center control.
	3. The field element shall include work zone intrusion alerting devices that alert crew workers of a work zone emergency or safety issue such as the intrusion of a vehicle into the work zone area or movement of field crew into the travel lanes.
	4. The field element shall include work zone intrusion alerting devices that notify crew via maintenance vehicles of a work zone emergency or safety issue such as the intrusion of a vehicle into the work zone area or movement of field crew into the travel lanes.
	5. The field element shall include work zone intrusion alerting devices that alert drivers that they have intruded upon the perimeter of the work zone, or are about to do so; may provide alerts to drivers directly or via in-vehicle signing.
	6. The field element shall provide operational status for the work zone intrusion detection devices to the maintenance center.
	7. The field element shall provide fault data for the work zone intrusion detection devices to the maintenance center for repair.
	8. The field element shall provide operational status for the work zone intrusion alerting devices to the maintenance center.
9. The field element shall provide fault data for the work zone intrusion alerting devices to the maintenance center for repair.	

**\*\*“Equipment Package” from National ITS Architecture**

**Table 1 WIWS Functional Requirements from “Roadway Work Traffic Control” and “MCM Work Zone Management” Equipment Packages from National ITS Architecture (cont.)**

<b>MCV Vehicle Safety Monitoring Equipment Package</b>	<b>Functional Requirements</b>
	1. The maintenance and construction vehicle shall detect that a vehicle has intruded upon the boundary of a work zone. The boundary of the work zone represents an area around the maintenance and construction vehicle, which may be stationary or moving.
	2. The maintenance and construction vehicle shall receive work zone warnings from the field equipment at the roadside, other maintenance and construction vehicles.
	3. The maintenance and construction vehicle shall present work zone warnings to the field personnel using direct warning signals or in-vehicle signage functions.
	4. The maintenance and construction vehicle shall monitor the crew movements to identify when a crew member is crossing the boundary between a work zone and vehicle traffic and issue an alert to the crew member.
5. The maintenance and construction vehicle shall provide status of the work zone warning systems to the center.	

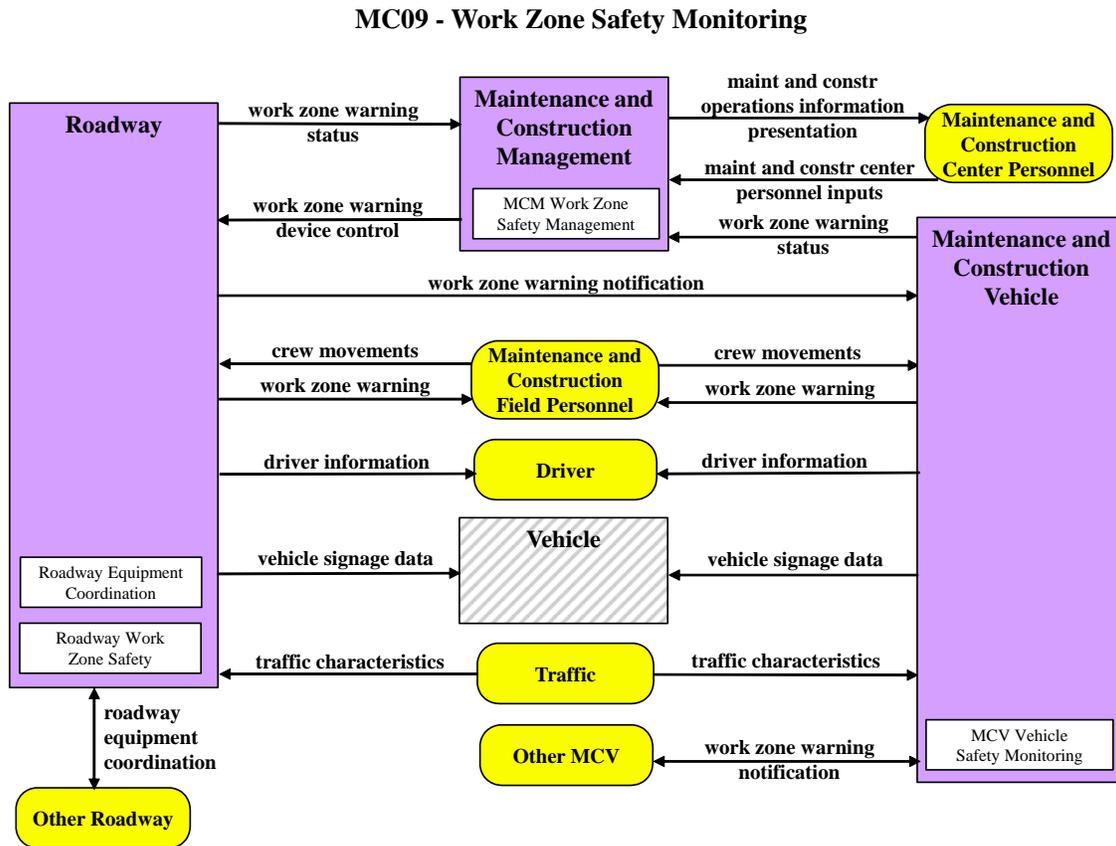
\*\*“Equipment Package” from National ITS Architecture

<b>MCM Work Zone Safety Management Equipment Package</b>	<b>Functional Requirements</b>
	1. The center shall provide remote monitoring and control of work zone safety devices - including intrusion detection devices that have been installed in work zones or maintenance areas.
	2. The center shall provide remote monitoring and control of intrusion alert devices that have been installed in work zones or maintenance areas.
	3. The center shall collect status information of work zone safety device status from field equipment or the maintenance and construction vehicles.
4. The center shall collect and store work zone data collected from work zone monitoring devices (such as intrusion detection or alert devices and speed monitoring devices) on-board the vehicle and at the roadside.	

\*\*“Equipment Package” from National ITS Architecture

Further illustrating how WIWS fit within the National ITS Architecture, Figure 2 shows the potential system components and interconnects within the MC09 – Work Zone Safety Monitoring Service Package.

Figure 2 MC09 – Work Zone Safety Monitoring Service Package Graphic



The information presented in this section should be reviewed, confirmed or modified within the context of any state or regional ITS architecture that may impact individual WIWS deployments.

### High-Level System Functional Requirements

These system requirements are derived from the needs identified in the concept of operations. They address functional aspects of the system. Table 2 presents the requirements. The number references allow for traceability back to the needs identified in the concept of operations. The first identification number references the stakeholder need as presented in the concept of operations. The second number identifies the associated high-level functional requirement. If further derivation is needed, a third reference number is provided.

For many of these requirements, special considerations are noted to explain what details were considered as the requirement was developed or what additional details may need to be considered as the requirement is further refined for individual deployments. In some cases, the consideration may also note if a requirement is relevant to a specific type of WIWS deployment. These considerations are intended to offer context and provide insight that might help support further derivation and tailoring of the requirements to the individual deployment as needed.

**Table 2 WIWS System Requirements**

ID #	Needs	ID #	High Level Requirements	ID #	Detailed System Requirements
1	Workers in a work zone need an alert when a vehicle enters a restricted area.	1.1	WIWS shall detect all unauthorized vehicles entering a work zone.	1.1.1	WIWS shall detect unauthorized vehicles entering a work zone with at least XX% accuracy.
Considerations: This should cover all components needed for the system to function at a rate which is acceptable by the agency.					
				1.1.2	WIWS shall send notification within XX seconds of vehicle entering restricted area.
Considerations: The specified time should include all latency between devices and include data processing needed to generate the notification to the alert system.					
				1.1.3	WIWS shall provide a means to disable detection in the field manually to allow authorized vehicles to enter work zone.
		1.2	WIWS shall alert workers when a vehicle enters a work zone.	1.2.1	WIWS alert may be audible, visual, sensory (e.g. vibration) or a combination of any or all of these alerts.
				1.2.2	WIWS alert shall be activated within XX seconds of vehicle entering a restricted area.
Considerations: The specified time should include all latency between devices and include data processing needed to receive the notification and generate the alert.					
				1.2.3	WIWS shall only alert workers in danger, in the vehicle's path.
Considerations: In an attempt to reduce de-sensitization of the alerts only those works in immediate danger should be notified with alert (proximity of intrusion and downstream workers).					

**Table 2 WIWS System Requirements (Continued)**

ID #	Needs	ID #	High Level Requirements	ID #	Detailed System Requirements
2	Drivers in a work zone need an alert when their vehicle enters a restricted area.	2.1	WIWS shall provide an alert to the driver of an unauthorized vehicle when the driver crosses into a restricted area.	2.1.1	WIWS shall provide an audible and / or visual alert.
Considerations: The advancement of the connected vehicles in the coming years will provide more opportunities for the visual notifications to drivers via En-Route Driver Information. However a work zone protection system with flashing lights when a vehicle enters the restricted area may help reduce unintentional intrusions.					
				2.1.2	WIWS shall provide a physical notification when driver crosses into a restrictive area.
Considerations: Temporary rumble strips or current vehicles lane detection system, may help reduce unintentional intrusions.					
		2.2	WIWS deployment shall follow MN IWZT guidance on spacing before work space.	2.2.1	WIWS shall provide adequate buffer area to allow for braking and exit before entering work space.
Considerations: Ideal placement of signs and detectors will vary per roadway speed, braking distances, and the acceptable driver reaction time.					
		2.3	Warnings and alerts provided shall follow the existing standards to help aid in compliance and understanding.	2.3.1	WIWS messages in and approaching the work zone shall provide information that is compliant and consistent with applicable national standards.
Considerations: The MUTCD should be the starting point for how messages are displayed.					
				2.3.2	WIWS messages integrated with connected vehicles shall provide information that is compliant and consistent with national standards.
Considerations: The National ITS Architecture should be the starting point for user requirements for how En-Route driver information messages are displayed in a vehicle .					
3	Agency and Law Enforcement Officials responsible for the work zone need the system to aid enforcement by generating reports identifying locations where violations are occurring.	3.1	Field devices shall receive alerts from system of a violation.	3.1.1	WIWS shall provide an alert to the central system.
Considerations: Agency will need to determine how enforcement will be handled before requirements are established for how fast an alert to the Central System must be generated.					
				3.1.2	Central System shall provide an alert to the Law enforcement of violation.
Considerations: System should have a reporting structure which allows for notifications of incidents and also the ability to record video after an intrusion is detected for review.					

**Table 2 WIWS System Requirements (Continued)**

ID #	Needs	ID #	High Level Requirements	ID #	Detailed System Requirements
4	Drivers, Agencies, and Law Enforcement monitoring work zones need work zone alerts to be consistent and easily understood by all users.	4.1	Warnings and alerts provided shall follow the existing standards to help aid in compliance and understanding.	4.1.1	WIWS messages shall provide information that is compliant and consistent with national and state specific standards.
Considerations: The MUTCD should be the starting point for how messages are displayed and further requirements should meet requirements included in the MN MUTCD.					
				4.1.2	WIWS messages integrated with connected vehicles shall provide information that is compliant and consistent with national standards.
Considerations: The National ITS Architecture should be the starting point for user requirements for how En-Route driver information messages are displayed in a vehicle.					
5	Agencies with WIWS need ability to communicate with devices at all times.	5.1	Agencies shall be able to communicate remotely with device and check equipment status.	5.1.1	The communication media used for the system and field devices shall have 99.9% uptime (excluding maintenance periods).
Considerations: Agency should determine if one medium is preferred over another.					
				5.1.2	The Central System shall record when system power or communication is lost.
				5.1.3	The Central System shall be able to send alerts via email, text, or phone when communication losses occur.
				5.1.4	WIWS field components shall be capable of being powered via either AC or DC power sources, with solar power as an option.
Considerations: Agency need this type of information to aid in payment, as these systems provide no benefit to workers if there is a breakdown in detection, communication, or power.					
6	Agencies monitoring work zones need access to reports and logs when requested.	6.1	WIWS shall include a data and system archive and reporting function.	6.1.1	The system data archive and reporting function shall be remotely accessible.
Considerations: Agency need this type of information to aid in payment, as these systems provide no benefit to workers if there is a breakdown in detection, communication, or power.					
				6.1.2	The data archive shall include system faults.
Considerations: Agency need this type of information to evaluate the effectiveness of the system, as these systems provide no benefit to workers if there is a breakdown in detection, communication, or power.					
				6.1.3	The system shall allow for configuration and automated generation of system reports.
				6.1.4	The system shall be capable of generating reports in a variety of file formats for ease of use.
Considerations: The system needs to be able to summarize data in an applicable format for end use needs.					
				6.1.5	The system shall be capable of distributing reports generated automatically.

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# Distracted Driving Detection System for Work Zones

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Systems  
Requirements

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December 2015

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## **Acknowledgements**

This document was prepared for the Minnesota Department of Transportation (MnDOT) Systems Engineering for Work Zone Challenges project.

### **Project Champion**

Rashmi Brewer is the MnDOT project champion for this effort. MnDOT stakeholders and a project management team were heavily involved in identifying the key challenges with using Intelligent Transportation Systems to address and enhance safety, operations, mobility and efficiency in work zones. This document covers the system requirements to address some of these challenges.

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- Ken Johnson
- Rashmi Brewer

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## Introduction

Some research has been performed has occurred at the university level and some luxury automakers have installed distracted driver detection technologies. To date, there does not appear to be any wide scale, ITS type deployments for this concept. Parts of the technology exist and are in need of customization, where other technologies are still emerging. The best applications are through the detection of a vehicle drifting repeatedly between lane lines and wayward, or unintentional, lane changes. Lane drifting can occur anywhere at any time on our roadway networks, but it can be assumed that unintentional lane changes can occur in areas with lane shifts and lane reduction tapers. These systems can improve upon the existing work zone layouts by providing additional information in advance to travelers about current traffic conditions. These warnings help alert motorists as they enter work zones and areas within work zones where the maintenance of traffic requires unexpected maneuvers.

The Minnesota Department of Transportation Intelligent Work Zone (IWZ) Toolbox guidance document serves as a starting point for discussion within the project team for ways to improve safety and mobility for the public, workers, and constructability of a project.

The concept of operations document articulates the fundamental needs and operational concepts of the detecting distracted drivers. Building on those needs, the model system requirements within this document will describe what detecting distracted drivers must do and set the basis for system design, procurement, installation and operation.

Both the system requirements and concept of operations are intended to illustrate the basic needs and requirements surrounding detecting distracted drivers and serve as model documents that may be adapted to meet individual deployments. The materials do not mandate the deployment of such systems, nor do they limit the engineering judgment or policy discretion of the transportation agencies who may consider deploying detecting distracted drivers. The materials reflect stakeholder needs and they should be adapted as necessary to reflect any unique or additional needs and requirements driven by individual deployments. The remainder of this document presents model system requirements for detecting distracted drivers as they are driven by the previously developed concept of operations.

## System Requirements

System requirements are verifiable details that define what a distracted driver warning system will do, how well it will perform or what conditions it must perform under. An important starting point for developing system requirements is to understand where the system fits within the ITS architecture. This section explains how detecting distracted drivers fits within the National ITS Architecture 7.1 and then presents a series of high –level and detailed system requirements associated with detection, alerts, placement, operations and maintenance.

## ITS Architecture

Detecting distracted drivers are considered part of the [Maintenance and Construction Operations User Service](#) in the National ITS Architecture. Systems within in this user service provide Work Zone Management Safety function, which provides support for the effectiveness, safety, and efficiency of

roadway operations during all work zone activities. The service will provide information concerning work zone activities.

Within the physical architecture of the National ITS Architecture, detecting distracted drivers are primarily addressed under the following:

- Roadway (Architecture Flow)
  - Roadway (Subsystem)
    - Roadway Work Traffic Control (Equipment Package)
      - MC09-Work Zone Safety Monitoring (Service Package)
      - ATMS06-Traffic Information Dissemination (Service Package)
      - ATMS08-Traffic Incident Management System (Service Package)
  - Maintenance and Construction Management. (Subsystem)
    - MCM Work Zone Management (Equipment Package)
      - ATMS21 Roadway Closure Management (Service Package)
      - MC08 Work Zone Management (Service Package)

**Tables 1 and 2** present a series of high-level requirements as they are presented within the Roadway Work Zone Traffic Control and MCM Work Zone Management Equipment Package of the National ITS Architecture. The currently applicable requirements have been incorporated into the document.

**Table 1. Roadway Work Traffic Control Functional Requirements**

Roadway Work Traffic Control Equipment Package	Functional Requirements
	1. The field element shall include work zone intrusion detection devices that detect when crew workers have crossed the boundary between the work zone and vehicle traffic, under center control.
	2. The field element shall include work zone intrusion detection devices that detect when crew workers have crossed the boundary between the work zone and vehicle traffic, under center control.
	3. The field element shall include work zone intrusion alerting devices that alert crew workers of a work zone emergency or safety issue such as the intrusion of a vehicle into the work zone area or movement of field crew into the travel lanes.
	4. The field element shall include work zone intrusion alerting devices that notify crew via maintenance vehicles of a work zone emergency or safety issue such as the intrusion of a vehicle into the work zone area or movement of field crew into the travel lanes.
	5. The field element shall include work zone intrusion alerting devices that alert drivers that they have intruded upon the perimeter of the work zone, or are about to do so; may provide alerts to drivers directly or via in-vehicle signing.
	6. The field element shall provide operational status for the work zone intrusion detection devices to the maintenance center.
	7. The field element shall provide fault data for the work zone intrusion detection devices to the maintenance center for repair.
	8. The field element shall provide operational status for the work zone intrusion alerting devices to the maintenance center.
	9. The field element shall provide fault data for the work zone intrusion alerting devices to the maintenance center for repair.

\*\*“Equipment Package” from National ITS Architecture

**Table 2. Maintenance and Construction Management (MCM) Functional Requirements**

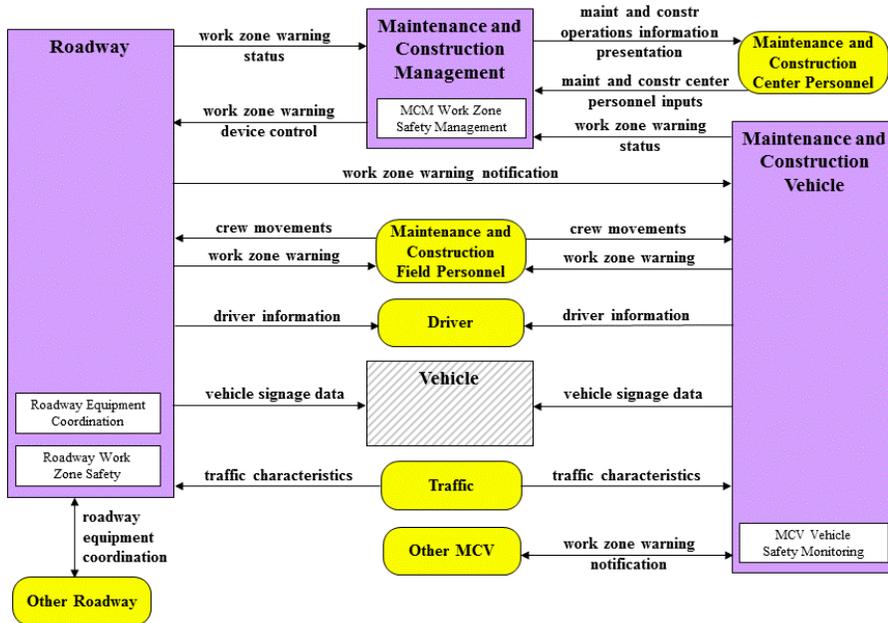
<b>MCM Work Zone Management Equipment Package</b>	<b>Functional Requirements</b>
	1. The center shall generate new work zone activity schedules for use by maintenance and construction vehicles, maintenance and construction operators, and for information coordination purposes.
	2. The center shall control the collection of work zone status information including video images from cameras located in or near the work zone.
	3. The center shall disseminate work zone information to other agencies and centers including traffic, transit, emergency management centers, other maintenance centers, traveler information providers, and the media.
	4. The center shall control traffic in work zones by providing remote control of dynamic message signs, highway advisory radio systems, gates, and barriers located in or near the work zone.
	5. The center shall exchange information with administrative systems to support the planning and scheduling of work zone activities. This information includes: equipment and consumables resupply purchase request status, personnel qualifications including training and special certifications, environmental regulations and rules that may impact maintenance activities, and requests and project requirements from contract administration.
	6. The center shall collect real-time information on the state of the road network including current traffic and road conditions to support work zone scheduling and management.

\*\*“Equipment Package” from National ITS Architecture

Further illustrating how detecting distracted drivers fit within the National ITS Architecture, **Figure 2** shows the potential system components and interconnects within the MC09-Work Zone Safety Monitoring Service Package and **Figure 3** illustrates Driver Safety Monitoring

**Figure 1 MC09-Work Zone Safety Monitoring Service Package Graphic**

### MC09 - Work Zone Safety Monitoring



### AVSS02 - Driver Safety Monitoring

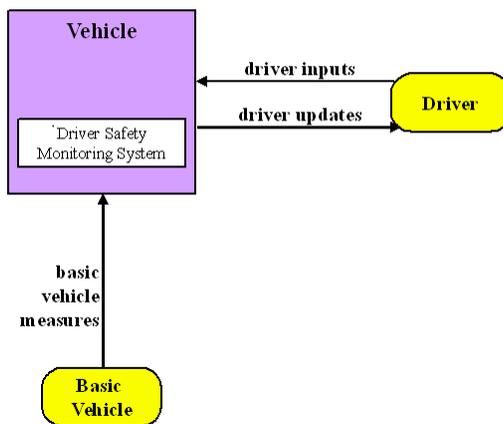


Figure 2 AVSS02 Driver Safety Monitoring

The information presented in this section should be reviewed, confirmed or modified within the context of any state or regional ITS architecture that may impact individual detecting distracted driver deployments.

## High-Level and Detailed System Requirements

These system requirements are defined in direct relation to the needs identified in the concept of operations. They address operational aspects of the system and are noted in **Table 3**. The number references allow for traceability back to those needs and forward to the detailed system requirements. The first identification number references the stakeholder need as presented in the concept of operations. The second number is used to track high level requirements and the third reference number relates to detailed system requirements, where applicable.

For many of these requirements, special considerations are noted to explain what details were considered as the requirement was developed or what additional details may need to be considered as the requirement is further refined for individual deployments. In some cases, the consideration may also note if a requirement is relevant to a specific type of detecting distracted drivers deployment. These consideration are intended to offer context a provide insight that might help support further tailoring the requirements to the individual deployment as needed.

**Table 3 Distracted Driver Detection System (DDDS) Requirements**

ID #	Needs	ID #	High Level Requirements	ID #	Detailed System Requirements
1	Drivers in a work zone need an alert when their vehicle enters a restricted area.	1.1	DDDS shall provide an alert to the driver of an unauthorized vehicle when the driver crosses into a restricted area.	1.1.1	The alert shall be audible and/or visual.
<p>Considerations: The advancement of the connected vehicles in the coming years will provide more opportunities for the visual notifications to drivers via En-Route Driver Information. However a work zone protection system with flashing lights when a vehicle enters the restricted area may help reduce unintentional intrusions.</p>					
				1.1.2	DDDS shall provide a physical notification when driver crosses into a restrictive area.
<p>Considerations: Temporary rumble strips or current vehicles lane detection system, may help reduce unintentional intrusions.</p>					
		1.2	DDDS deployment shall follow MN IWZT guidance on spacing before work space.	1.2.1	DDDS shall provide an adequate buffer area to allow for braking and exit before entering work space.
<p>Considerations: Ideal placement of signs and detectors will vary per roadway speed, braking distances, and the acceptable driver reaction time.</p>					
		1.3	Warnings and alerts provided shall follow the existing standards to help aid in compliance and understanding.	1.3.1	DDS messages in and approaching the work zone shall provide information that is compliant and consistent with applicable national standards.
<p>Considerations: The National ITS Architecture should be the starting point for how En-Route driver information messages are displayed in a vehicle.</p>					
2	Drivers, Agencies, and Law Enforcement need alerts to be accurate, relevant, easily understood, and reinforced at appropriate intervals through a work zone.	2.1	Warnings and alerts provided shall follow the existing standards to help aid in compliance and understanding.	2.1.1	Central System logic shall recommend standards-compliant messaging to display on all DMS in the system.
<p>Considerations: This need and requirement address the ability to enforce the DDDS advisories, and ensure that messages do not result in additional liability.</p>					
				2.1.2	Central System logic shall recommend standards-compliant messaging to display on all DMS in the system.
<p>Considerations: The MUTCD should be the starting point for how messages are displayed and further requirements should meet requirements included in the MN MUTCD.</p>					
				2.1.3	The DDDS messages integrated with connected vehicles shall provide information that is compliant and consistent with national standards.
<p>Considerations: The National ITS Architecture should be the starting point for user requirements for how information messages are displayed in a vehicle.</p>					

**Table 3 Distracted Driver Detection System (DDDS) Requirements (Continued)**

ID #	Needs	ID #	High Level Requirements	ID #	Detailed System Requirements
3	Agency and Law Enforcement Officials responsible for the work zone need the system to aid enforcement by generating reports identifying locations where violations are occurring.	3.1	Field devices shall receive alerts from system of a violation.	3.1.1	The DDS shall provide an alert to the Central System.
Considerations: Agency will need to determine how enforcement will be handled before requirements are established for how fast an alert to the central system must be generated.					
				3.1.2	Central System shall provide an alert to the Law Enforcement of violation.
Considerations: System should have a reporting structure which allows for notifications of incidents and also the ability to record video after an intrusion is detected for review.					
4	Agencies with DDDS need ability to communicate with devices at all times.	4.1	Agencies shall be able to communicate remotely with device and check equipment status.	4.1.1	The communication media used for the system and field devices shall have 99.9% uptime (excluding maintenance periods).
Considerations: Agency should determine if one medium is preferred over another.					
				4.1.2	The Central System shall record when system power or communication is lost.
				4.1.3	The Central System shall be able to send alerts via email, text, or phone when power or communications losses occur.
				4.1.4	The DDDS field components shall be capable of being powered via either AC or DC power sources, with solar power as an option.
Considerations: Agency need this type of information to aid in payment, as these systems provide no benefit to workers if there is a breakdown in detection, communication, or power.					
5	Agencies monitoring work zones need access to reports and logs when requested.	5.1	The DDDS shall include a data and system archive and reporting function.	5.1.1	The system data archive and reporting function shall be remotely accessible.
Considerations: Agency need this type of information to aid in payment, as these systems provide no benefit to workers if there is a breakdown in detection, communication, or power.					
				5.1.2	The data archive shall include system faults.
Considerations: Agency need this type of information to evaluate the effectiveness of the system, as these systems provide no benefit to workers if there is a breakdown in detection, communication, or power.					
				5.1.3	The system shall allow for configuration and automated generation of system reports.
				5.1.4	The system shall be capable of generating reports in a variety of file formats for ease of use.
Considerations: The system needs to be able to summarize data in an applicable format for end use needs.					
				5.1.5	System shall be capable of distributing reports generated automatically.

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# End of Queue Warning Systems

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Systems  
Requirements

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December 2015

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## **Acknowledgements**

This document was prepared for Minnesota Department of Transportation's (MnDOT) Systems Engineering to Address Work Zone Challenges project.

## **Project Champion**

Rashmi Brewer, is the MnDOT project champion for this effort. MnDOT stakeholders were heavily involved in identifying the key challenges with using Intelligent Transportation Systems to address and enhance safety, operations, mobility and efficiency in work zones. This document covers the system requirements to address some of these challenges.

## **Project Management Team (MnDOT)**

- Ralph Adair
- Tiffany Dagon
- Ted Ulven
- Craig Mittelstadt
- Leigh Kriewall
- Dave Mavec
- Ken Johnson
- Rashmi Brewer

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## Introduction

This document provides high-level functional requirements for an End of Queue Warning System (EQWS) to support improved work zone safety. The requirements in this document are derived from the companion Concept of Operations for EQWS, which is one of three Work Zone Challenges identified by MnDOT Stakeholders that may be addressed using Intelligent Transportation System (ITS) technologies. The other two ITS Systems identified to potentially address Work Zone Challenges are: Work Zone Intrusion Warning System; and Distracted Driver Alert System.

This set of requirements should be considered as a starting point for system requirements development for a project. In addition, a set of requirements that fuses all three ITS Work Zone systems should be considered, as there will be instances when all three systems may be deployed together and several elements of the systems overlap or interoperate.

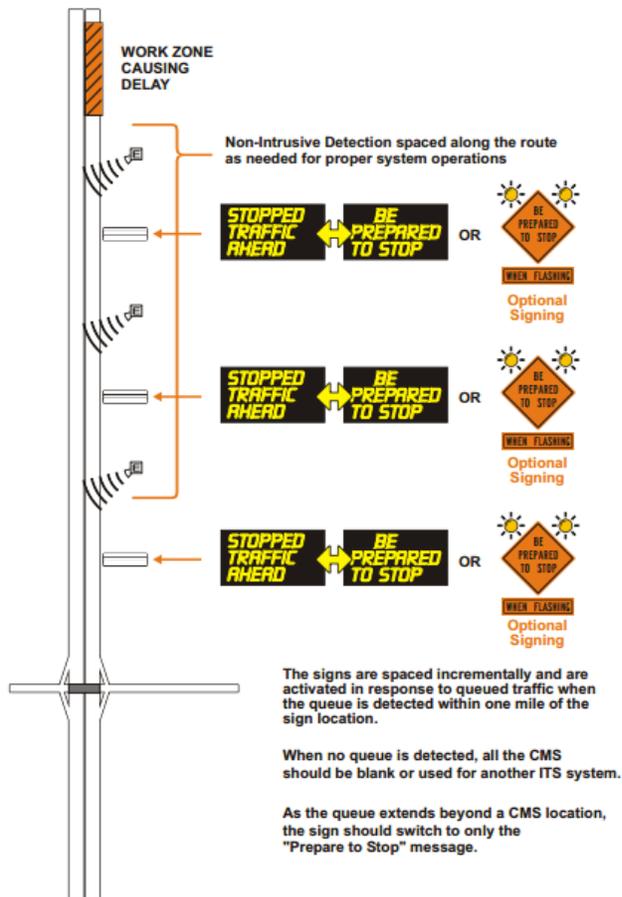
EQWS are installed upstream of a work zone to provide a warning to approaching drivers of stopped or slowed traffic conditions approaching or within the work zone. These systems improve upon the existing work zone warning deployments by providing enhanced information in to drivers about current traffic conditions, improving the drivers ability to anticipate and react to slowed or stopped traffic downstream, even if they cannot see the traffic ahead. In addition, information gathered from these

systems can provide delay time information that may be provided to drivers to support their route choice decisions either in advance of their trip (via traveler information web sites or 511 systems, for example) or enroute (via dynamic message sign (DMS) messages).

EQWS are an emerging set of technologies that have been tested and are available in the market today. A full EQWS consists of static signing, detection devices, and DMS, as shown in Figure 1.

### Figure 1 Stopped Traffic Advisory System Configuration

The EQWS configuration in Figure 1 is from the Minnesota Department of Transportation Intelligent Work Zone (IWZ) Toolbox guidance document, served as a starting point for discussion within the Project Team for approaches to improve



safety and mobility for the public, workers, and to support project constructability.

A separate concept of operations document was prepared to articulate the fundamental needs and operational concepts of the EQWS. Building on those needs, the high-level system functional requirements within this document are intended to describe what EQWS must do and provide the basis for future system design, procurement, installation and operation.

Both this system requirements document and companion concept of operations are, together, intended to provide the basic needs and requirements surrounding EQWS, as well as, to serve as model documents that may be adapted to meet individual deployments. The materials do not mandate the deployment of such systems, nor do they limit the engineering judgment or policy discretion of the transportation agencies who may consider deploying EQWS. The materials reflect stakeholder needs and they should be adapted as necessary to reflect any unique or additional needs and requirements driven by individual deployments. The remainder of this document presents high-level system functional requirements for EQWS as driven by the previously developed concept of operations.

## System Requirements

High-level system functional requirements are verifiable statements that define *what* an end of queue warning system will do, but not how it is accomplished (i.e. from a technical/technology standpoint). An important starting point for developing system requirements is to understand where the system is reflected within the National ITS architecture. This section shows how EQWS fit within the National ITS Architecture version 7.1, and then presents a series of high-level system functional requirements associated with the detection, alert, and system operation functions.

## EQWS in the National ITS Architecture

EQWS are part of the [Maintenance and Construction Operations User Service](#) in the National ITS Architecture. Systems within in this user service provide Work Zone Management Safety functions, which provides support for the effectiveness, safety, and efficiency of roadway operations during all work zone activities. The service provides information concerning work zone activities.

Within the physical architecture of the National ITS Architecture, EQWS are primarily addressed under the followings subsystems, equipment packages and service packages:

- Roadway (Subsystem)
  - Roadway Work Traffic Control (Equipment Package)
    - ATMS21 Roadway Closure Management (Service Package)
    - MC08 Work Zone Management (Service Package)
- Maintenance and Construction Management. (Subsystem)
  - MCM Work Zone Management (Equipment Package)
    - ATMS21 Roadway Closure Management (Service Package)
    - MC08 Work Zone Management (Service Package)

Table 1 presents a series of high-level requirements as they are presented within the Roadway Work Zone Traffic Control and MCM Work Zone Management Equipment Package of the National ITS Architecture. The currently applicable requirements have been incorporated into the document.

**Table 1: EQWS Functional Requirements from “Roadway Work Traffic Control” and “MCM Work Zone Management” Equipment Packages from National ITS Architecture**

<b>Roadway Work Traffic Control Equipment Package</b>	<b>Functional Requirements</b>
	1. The field element shall collect, process, and send work zone images to the center for further analysis and distribution, under center control.
	2. Under traffic and maintenance center control, the field element shall include driver information systems (such as dynamic messages signs and highway advisory radios) that advise drivers of activity around the work zone through which they are currently passing.
	3. Under the control of field personnel within maintenance vehicles, the field element shall include driver information systems (such as dynamic messages signs and highway advisory radios) that advise drivers of activity around a work zone through which they are currently passing.
	4. The field element shall control access to the work zone using automated gate or barrier systems. This includes automated flagger assistance devices that include automated gate arms and other automated gate/barrier systems.
	5. The field element shall provide operational status for the surveillance (e.g. CCTV), driver information systems, and gates/barriers in work zones to the maintenance center.
	6. The field element shall provide fault data for the surveillance (e.g. CCTV), driver information systems, and gates/barriers in work zones to the maintenance center for repair.

**\*“Equipment Package” from National ITS Architecture**

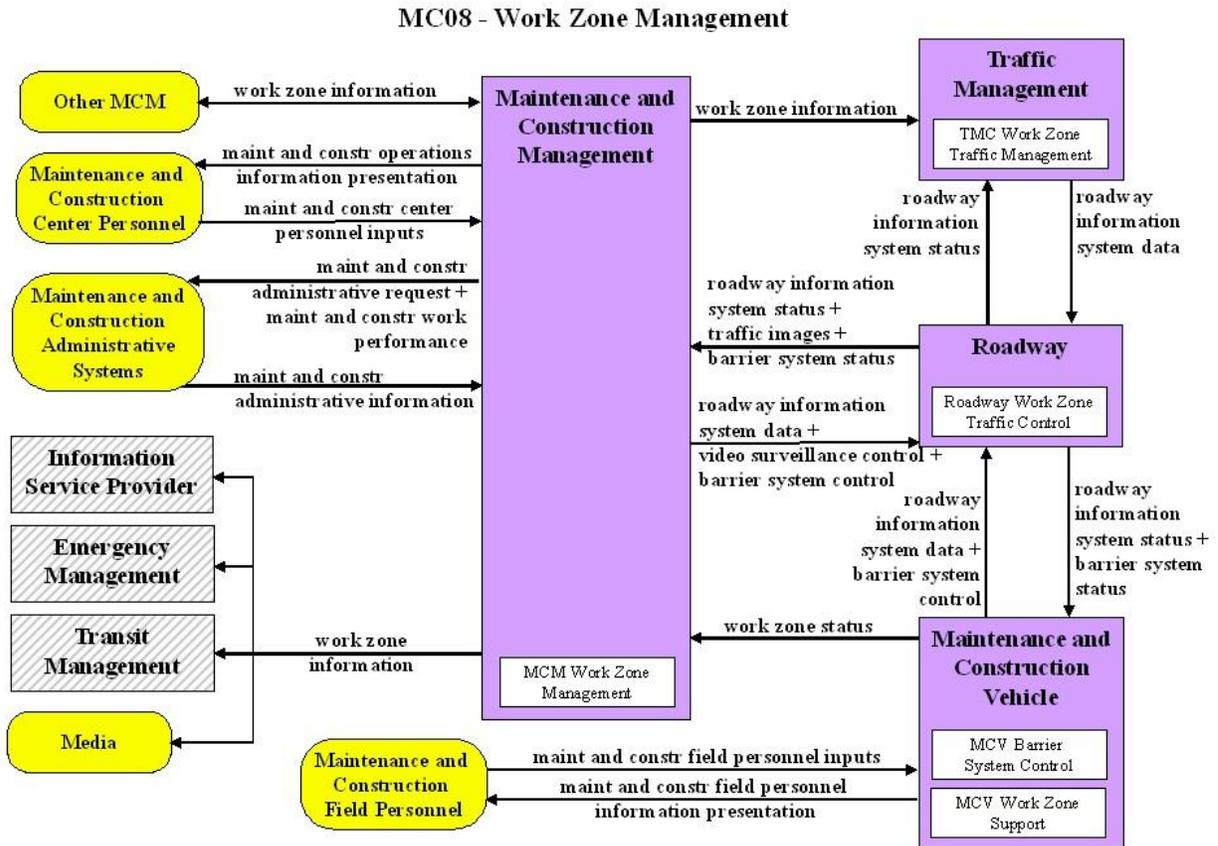
**Table 1: EQWS Functional Requirements from “Roadway Work Traffic Control” and “MCM Work Zone Management” Equipment Packages from National ITS Architecture (continued)**

MCM Work Zone Management Equipment Package	Functional Requirements
	1. The center shall generate new work zone activity schedules for use by maintenance and construction vehicles, maintenance and construction operators, and for information coordination purposes.
	2. The center shall control the collection of work zone status information including video images from cameras located in or near the work zone.
	3. The center shall disseminate work zone information to other agencies and centers including traffic, transit, emergency management centers, other maintenance centers, traveler information providers, and the media.
	4. The center shall control traffic in work zones by providing remote control of dynamic message signs, highway advisory radio systems, gates, and barriers located in or near the work zone.
	5. The center shall exchange information with administrative systems to support the planning and scheduling of work zone activities. This information includes: equipment and consumables resupply purchase request status, personnel qualifications including training and special certifications, environmental regulations and rules that may impact maintenance activities, and requests and project requirements from contract administration.
	6. The center shall collect real-time information on the state of the road network including current traffic and road conditions to support work zone scheduling and management.

**\*\*“Equipment Package” from National ITS Architecture**

Further illustrating how EQWS fits within the National ITS Architecture, Figure 2 shows the potential system components and interconnects within the MC08 – Work Zone Management Service Package.

Figure 2 MC08 – Work Zone Management Service Package Graphic



The information presented in this section should be reviewed, confirmed or modified within the context of any state or regional ITS architectures that may impact individual EQWS deployments.

## High-Level System Functional Requirements

These system requirements are derived from the needs identified in the concept of operations. They address functional aspects of the system. As follows Table 2, presents the requirements. The number references allow for traceability back to the needs identified in the concept of operations. The first identification number references the stakeholder need as presented in the concept of operations. The second number identifies the associated high-level functional requirement. If further derivation is needed, a third reference number is provided.

For many of these requirements, special considerations are noted to explain what details were considered as the requirement was developed or what additional details may need to be considered as the requirement is further refined for individual deployments. In some cases, the consideration may also note if a requirement is relevant to a specific type of EQWS deployment. These considerations are intended to offer context and provide insight that might help support further derivation and tailoring of the requirements to the individual deployment as needed.

**Table 2 EQWS System Requirements**

ID #	Needs	ID #	High Level Requirements	ID #	Detailed System Requirements
1	Drivers approaching a work zone need an alert regarding the conditions of traffic ahead.	1.1	The EQWS shall continuously detect traffic speed.	1.1.1	The EQWS shall be capable of detecting the full range of traffic speeds including stopped traffic, low speeds (less than 30 MPH), and high speeds (over 30 MPH).
<p>Considerations: The system location and length of deployment will be determined for each work zone based on local conditions including traffic volumes, work zone impact on volumes and speed, approach speed, speed limit within work zone, geometrics, and any other relevant factors.</p>					
				1.1.2	EQWS vehicle detector system shall be XX% accurate regarding speed of vehicles at any speed, including stopped vehicles.
<p>Considerations: The success of this system is highly dependent on the quality of data collected. Speed and Presence of vehicles should be of the highest importance in detection capabilities.</p>					
		1.2	The EQWS shall detect where the traffic is slowed or stopped.	1.2.1	The location of the slowed or stopped traffic shall be accurate to within XXX feet.
<p>Considerations: The success of this system is highly dependent on the quality of data collected. Speed and Presence of vehicles should be of the highest importance in detection capabilities.</p>					
		1.3	The EQWS shall calculate delay time.	1.3.1	The EQWS delay time estimate shall be accurate to within XX minutes.
<p>Considerations: The success of this system is highly dependent on the quality of data collected. Speed and Presence of vehicles should be of the highest importance in detection capabilities.</p>					
		1.4	The EQWS shall generate alert messages warning drivers of upcoming slowed or stopped traffic.	1.4.1	The message shall include the distance to the end of the queue.
				1.4.2	The accuracy of the location of the end of queue shall be within XXX feet.
				1.4.3	The end of queue location shall be updated continuously.
				1.4.4	The end of queue location message shall be updated every XX minutes.
				1.4.5	The message shall be capable of being sent in a variety of formats compatible with DMS.
<p>Considerations: Further review of this functional requirement needs to be accomplished, including the establishment of the end of queue threshold based on speed thresholds. The message updates should include all latency between devices and include data processing needed to receive notification and generate the alert.</p>					

**Table 2 EQWS System Requirements (Continued)**

ID #	Needs	ID #	High Level Requirements	ID #	Detailed System Requirements
1	Drivers approaching a work zone need an alert regarding the conditions of traffic ahead.	1.5	The EQWS shall alert drivers via a DMS message approaching or entering the work zone if they are traveling above the advisory speed.	1.5.1	The EQWS speed trailer (DMS) message shall be activated within X.X seconds of a high speed vehicle detection.
<p>Considerations: Speed trailer message should be agreed upon by Agency. This requirement is intended to support safe travel through the work zone, including the ability to stop or slow in advance of the downstream queue.</p>					
				1.5.2	The EQWS speed trailer (DMS) message shall be removed within X.X seconds of a high speed vehicle
<p>Considerations: This requirement addresses the need to alert the first and following drivers of their speed. The specified time should include all latency between devices and include data processing needed to receive the notification and generate the alert.</p>					
2	Drivers approaching a work zone need an alert if queue extends beyond the advisory signs.	2.1	The EQWS shall alert Agency / Field personnel if queue grows beyond the EQWS placement boundary.	2.1.1	The EQWS notification shall be sent within XX seconds when a queue is detected at the detection boundary.
				2.1.2	The system shall be able to send the notification to specified contacts through the most effective format including email, phone, or text message.
<p>Considerations: The specified time should include all latency between devices and include data processing needed to receive the notification and generate the alert. Once receive the field personnel should add an additional detection and DMS to ensure proper warning is provided as the queue continues to grow.</p>					
3	Drivers, Agencies and Law Enforcement need alerts to be accurate, relevant, easily understood, and reinforced at appropriate intervals through a work zone.	3.1	Warnings and alerts provided shall follow the existing standards to help aid in compliance and understanding.	3.1.1	Central System logic shall recommend standards-compliant messaging to display on all DMS in the system.
<p>Considerations: Central system should process data received and determine appropriate messaging is displayed in the work zone.</p>					
				3.1.2	The EQWS messages integrated with connected vehicles shall provide information that is compliant and consistent with national standards.
<p>Considerations: The National ITS Architecture should be the starting point for user requirements for how information messages are displayed in a vehicle.</p>					

**Table 2 EQWS System Requirements (Continued)**

ID #	Needs	ID #	High Level Requirements	ID #	Detailed System Requirements
4	Agencies with EQWS need ability to remotely access data for traffic management purposes.	4.1	The EQWS shall include a data and system archive and reporting function.	4.1.1	The system data archive and reporting function shall be remotely accessible.
				4.1.2	The data archive shall include system faults.
				Considerations: The Agency need this type of information to evaluate the effectiveness of the system, as these systems provide no benefit to workers if there is a breakdown in detection, communication, or power.	
				4.1.3	The system shall allow for configuration and automated generation of system reports.
				4.1.4	The system shall be capable of generating reports in a variety of file formats for ease of use.
Considerations: The system needs to be able to summarize data in applicable format for end user needs.					
				4.1.5	System shall be capable of emailing reports generated by the system automatically.
5	Agencies with an end of queue warning system need system to be: Mobile, easily configured, and able to operate the system in a temporary environment as power and communications may not be readily available.	5.1	The EQWS shall be mobile.	5.1.1	The components of the EQWS shall be easily transported using standard trailer or trucks.
				5.2	The EQWS shall be easily configured.
				5.3	The EQWS field components shall be capable of being powered via either AC or DC power sources.
				5.4	The EQWS field components shall communicate via wireless media.
				5.5	The EQWS Central System shall receive notifications of power or communication from all devices.
				5.2.1	The Central System shall support ready configuration of field components.
				5.3.1	Solar power shall be an option.
5.4.1	The wireless communication shall have XX% uptime (excluding maintenance).				
5.5.1	The notifications shall be logged in the data archive.				
Considerations: If the system is too difficult to set up and the operations are fragile due to the foundational power and communications, the system will not provide the needed benefits, and Contractors may not want to dedicate resources to operating the system.					

## PART 2. SIGNS

### Chapter 2H. Recreational and Cultural Interest Area Signs

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## PART 2. SIGNS

### Chapter 2H. Recreational and Cultural Interest Area Signs

#### 2H.1 Scope

##### SUPPORT:

Recreational or cultural interest areas are attractions or traffic generators that are open to the general public for the purpose of play, amusement, or relaxation. Recreational attractions include such facilities as parks, campgrounds, gaming facilities, and ski areas, while examples of cultural attractions include museums, art galleries, and historical buildings or sites.

The purpose of recreation and cultural interest area signs is to guide road users to a general area and then to specific facilities or activities within the area.

##### OPTION:

Recreational and cultural interest area signs that depict significant traffic generators may be used on expressway and freeways where there is direct access to these areas as discussed in Section 2H.9.

Recreational and cultural interest area signs may be used off the road network, as appropriate.

#### 2H.2 Application of Recreational and Cultural Interest Area Signs

##### SUPPORT:

Standards for signing recreational or cultural interest areas are subdivided into two different types of signs: (1) symbol signs and (2) destination guide signs.

##### GUIDANCE:

When highway agencies decide to provide recreational and cultural interest area signing, these agencies should have a policy for such signing. The policy should establish signing criteria for the eligibility of the various types of services, accommodations, and facilities. These signs should not be used where they might be confused with other traffic control signs.

##### OPTION:

Recreational and cultural interest area signs may be used

on any road to direct persons to facilities, structures, and places, and to identify various services available to the general public.

These signs may also be used in recreational or cultural interest areas for signing nonvehicular events and amenities such as trails, structures, and facilities.

#### 2H.3 Regulatory and Warning Signs

##### STANDARD:

All regulatory and warning signs installed on public roads and streets within recreational and cultural interest areas shall conform to the requirements of Chapters 2A, 2B, and 2C.

#### 2H.4 General Design Requirements for Recreational and Cultural Interest Area Symbol Signs

##### STANDARD:

Recreational and cultural interest area symbol signs shall be square or rectangular in shape and shall have a white symbol or message and white border on a brown background. The symbols shall be grouped into the following usage and series categories (see the Federal "Standard Highway Signs" book for sign details (see Government Printing Office, page ii):

- A. General Information (RG Series)
- B. Motorist Services (RM Series)
- C. Accommodation Services (RA Series)
- D. Land Recreation (RL series)
- E. Water Recreation (RW Series), and
- F. Winter Recreation (RS Series)

##### SUPPORT:

Table 2H-1 contains a listing of the symbols within each series category. Drawings for these symbols are found in the Federal "Standard Highway Signs" book (see Government Printing Office, page ii).

##### OPTION:

Mirror images of symbols may be used where the reverse image will better convey the message.

<b>General Information</b>		<b>Accommodation Services</b>		<b>Water Recreation</b>	
Automobile	RG-010	Airport	RA-010	Boat Tours	RW-010
Bear Viewing Area	RG-020	Bus Stop	RA-020	Canoeing	RW-020
Dam	RG-030	Campfire	RA-030	Diving	RW-030
Deer Viewing Area	RG-040	Elevator *	RA-040	Diving (Scuba)	RW-040
Drinking Water	RG-050	Kennel	RA-050	Fish	RW-050
Environmental Study Area	RG-060	Laundry	RA-060	Marine Recreation Area	RW-060
Falling Rocks *	RG-070	Locker *	RA-070	Motorboating	RW-070
Firearms	RG-080	Parking	RA-080	Ramp (Launch)	RW-080
Fish Hatchery	RG-090	Rest Room (Men) *	RA-090	RowBoating	RW-090
Information	RG-100	Rest Room (Women) *	RA-100	Sailboating	RW-100
Leashed Pets *	RG-110	Shelter (Sleeping) *	RA-110	Skiing (Water)	RW-110
Lighthouse	RG-120	Shelter Trail (Trail) *	RA-120	Surfing	RW-120
Litter Container	RG-130	Showers *	RA-130	Swimming	RW-130
Lookout Tower	RG-140	Family Rest Area *	RA-150	Wading	RW-140
Ped Xing *	RG-150	Helicopter	RA-160	Fishing Pier	RW-160
Point of Interest	RG-160			Hand Launch	RW-170
Ranger Station	RG-170	<b>Land Recreation</b>		Kayak	RW-190
Smoking *	RG-180	Amphitheater	RL-010	Wind Surf	RW-210
Truck	RG-190	Climbing	RL-020		
Tunnel	RG-200	Climbing (Rock)	RL-030	<b>Winter Recreation</b>	
Dog	RG-240	Hunting	RL-040	Skating (Ice)	RS-010
Seaplane	RG-260	Playground	RL-050	Ski Jumping	RS-020
		Rock Collecting	RL-060	Skiing (Bobbing)	RS-030
<b>Motorist Services</b>		Spelunking	RL-070	Skiing (Cross Country)	RS-040
Camping (Tent)	RM-010	Stable	RL-080	Skiing (Downhill)	RS-050
Camping (Trailer)	RM-020	Trail (Bicycle)	RL-090	Sledding	RS-060
Ferry	RM-030	Trail (Hiking)	RL-100	Snowmobiling	RS-070
First Aid	RM-040	Trail (Horse)	RL-110	Snowshoeing	RS-080
Food	RM-050	Trail (Interpretive, Auto)	RL-120	Winter Recreation Area	RS-090
Gas	RM-060	Trail (Intpretive, Ped.)	RL-130	Chairlift	RS-100
Grocery Store	RM-070	Trail/Road (4 WD Veh.)	RL-140		
Handicapped	RM-080	Trail (Trail Bike)	RL-150		
Lodging	RM-090	Tramway	RL-160		
Mechanic	RM-100	All-Terrain Vehicle	RL-170		
Post Office	RM-110	Archer	RL-190		
Oicnic Area	RM-120	Hang Glider	RL-210		
Picnic Shelter	RM-130				
Rest Room	RM-140				
Telephone	RM-150				
Trailer Sanitary Station	RM-160				
Viewing Area	RM-170				
Motor Home	RM-200				
Group Camping	RM-210				
Group Picnicking	RM-220				

\* For Non-Road Use

**Table 2H-1 Category Chart for Symbols**

## 2H.5 Symbol Sign Sizes

### GUIDANCE:

Recreational and cultural interest area symbol signs should be 600 x 600 mm (24 x 24 in). Where greater visibility or emphasis is needed, larger sizes should be used. Symbol sign enlargements should be in 150 mm (6 in) increments.

Recreational and cultural interest area symbol signs should be 750 x 750 mm (30 x 30 in) when used on expressways or freeways.

### OPTION:

A smaller size of 450 x 450 mm (18 x 18 in) may be used on low-speed, low-volume roadways and on non-road applications.

## 2H.6 Use of Educational Plaques

### GUIDANCE:

Educational plaques should accompany all initial installations of recreational and cultural interest area symbol signs. The educational plaque should remain in place for at least 3 years after the initial installation. If used, the educational plaque should be the same width as the symbol sign.

### OPTION:

Symbol signs that are readily recognizable by the public may be installed without educational plaques.

### SUPPORT:

Figure 2H-1 illustrates some examples of the uses of educational plaques.

## 2H.7 Use of Prohibitive Slash

### STANDARD:

The red diagonal slash, if used on a recreational and cultural interest area sign, shall be placed from the upper left corner to the lower right corner of the sign face. Requirements for retroreflection of the red slash shall be the same as those requirements for legends, symbols, and borders.

### OPTION:

Where it is necessary to indicate a restriction within a recreational or cultural interest area, a red diagonal slash may be used to indicate that the activity is prohibited.

### SUPPORT:

Figure 2H-1 illustrates some examples of the uses of prohibitive slashes.

## 2H.8 Placement of Recreational and Cultural Interest Area Symbol Signs

### STANDARD:

If used, recreational and cultural interest area symbol signs shall be placed in accordance with the general requirements contained in Chapter 2A. The symbol(s) shall be placed in the uppermost part of the sign assembly and the directional information shall be placed below the symbol(s).

Where the name of the recreational or cultural interest area facility or activity is shown on a general directional guide sign and a symbol is used, the symbol shall be placed below the name (see Figure 2H-2).

Recreational and cultural interest area symbols installed for non-road use shall be placed in accordance with the general sign position requirements of the authority having jurisdiction.

### SUPPORT:

Figure 2H-3 illustrates some examples of the height and lateral mounting positions. Figure 2H-4 illustrates typical placement of symbol signs within a recreational or cultural interest area. Figure 2H-5 illustrates some of the symbols that can be used. Illustrations of all of the recreational and cultural interest area symbols that can be used are found in Appendix C of this Manual.

### GUIDANCE:

The number of symbols used in a single sign assembly should not exceed four.

### OPTION:

Symbols for recreational or cultural interest areas may be used as legend components for a directional sign assembly. The symbols may be used singularly, or in groups of two, three, or four on a single sign assembly (see Figures 2H-1, 2H-3, and 2H-4). Smaller-size secondary symbols (see Figure 2H-1) may be placed beneath the primary symbols, where needed.

## 2H.9 Destination Guide Signs

### GUIDANCE:

When recreational or cultural interest area destinations are shown on supplemental guide signs, the sign should be rectangular or trapezoidal in shape. The order of preference for use of shapes and colors should be as follows: (1) rectangular with a white legend and border on a green background; (2) rectangular with a white legend and border on a brown background; or (3) trapezoidal with a white legend and border on a brown background.



b) Directional sign with arrow



b) Directional signs with arrows



c) Directional signs with arrows



d) Directional sign with secondary symbol



NO CAMPFIRES



NO SMOKING

e) Management Symbols with prohibitive slashes and educational plaques



VISITOR  
INFO



f) Directional sign with educational plaque and arrow

Figure 2H-1 Examples of Educational Plaques, Prohibitive Slashes, and Arrows

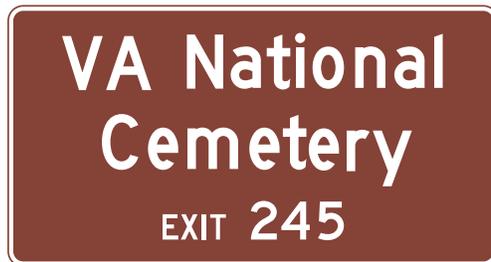
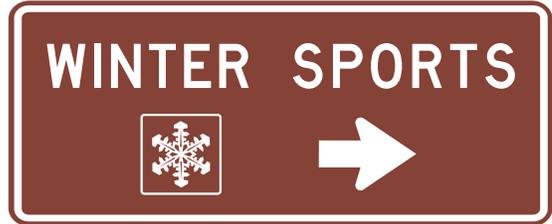
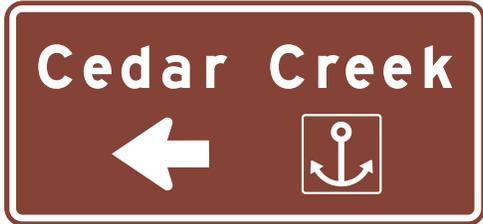
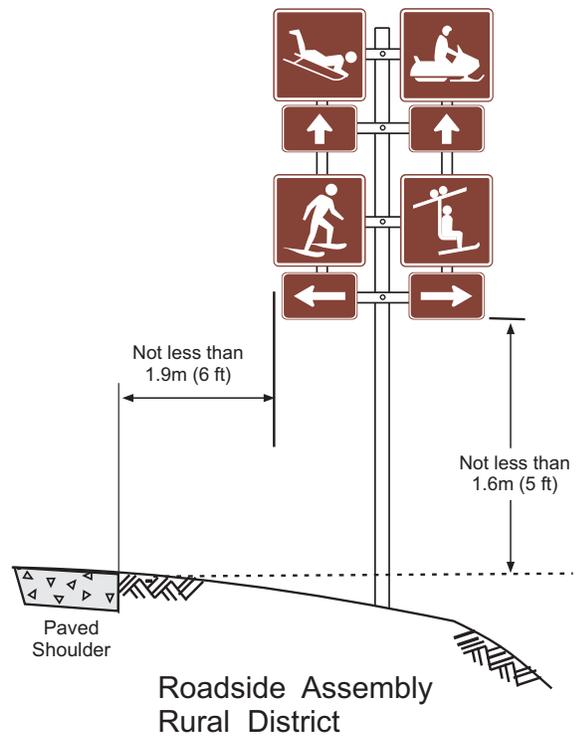
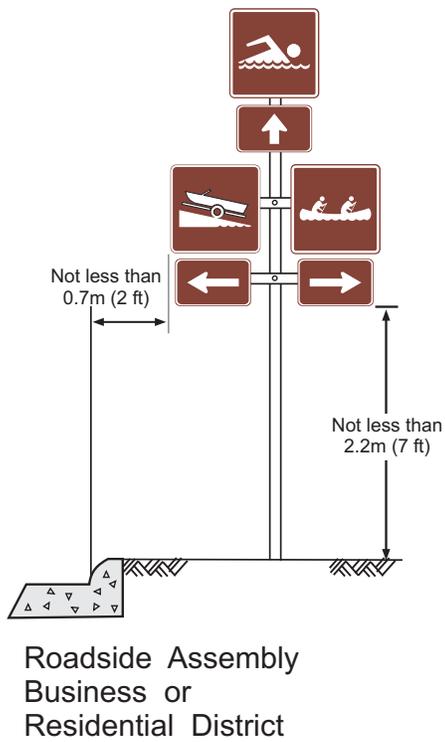
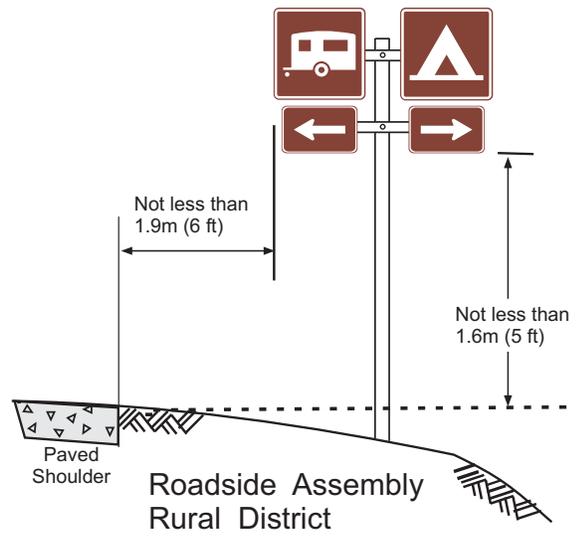
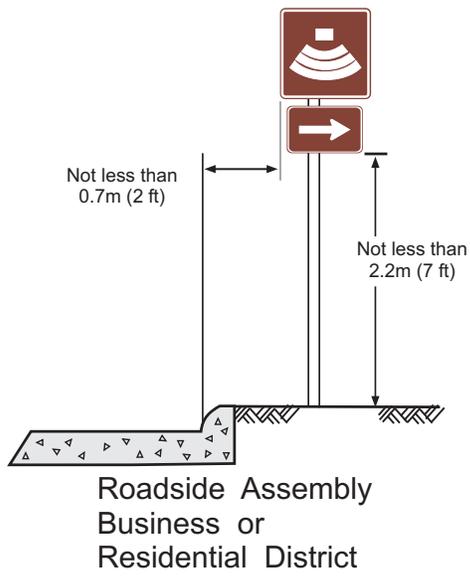


Figure 2H-2 Examples of General Directional Guide Signs for Conventional Roads



Note  
See Section 2A.19 for reduced lateral offset distances that may be used in areas where lateral offsets are limited, and in urban areas where sidewalk width is limited or where poles are close to the curb.

**Figure 2H-3. Height and Lateral Position of Signs Located Within Recreational and Cultural Interest Areas**

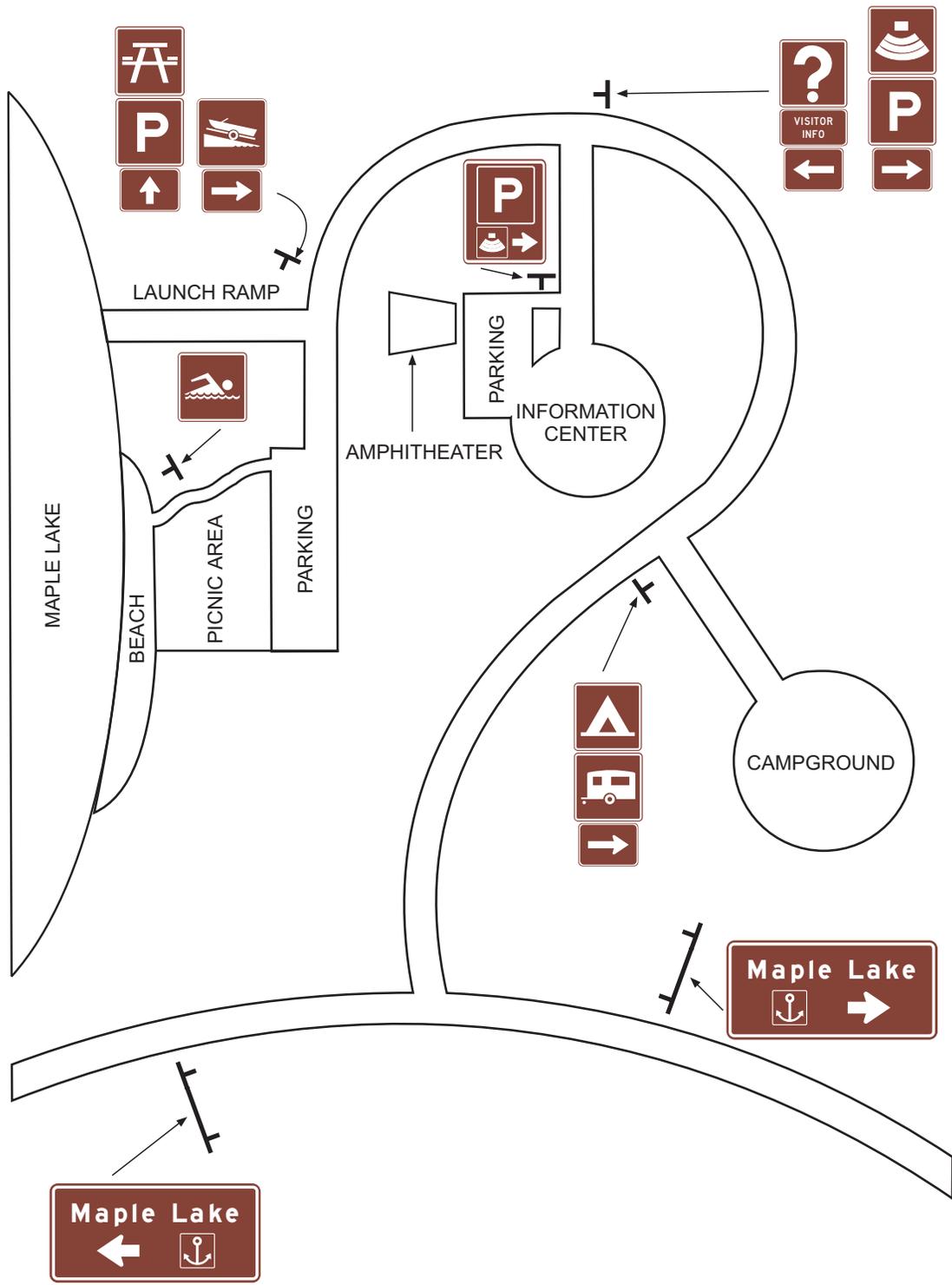


Figure 2H-4 Example of a Symbol Signing Layout



RG-010  
Automobile



RG-020  
Bear Viewing Area



RG-030  
Dam



RG-040  
Deer Viewing Area



RG-050  
Drinking Water



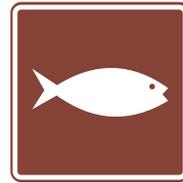
RG-060  
Environmental  
Study Area



RG-070  
Falling Rocks



RG-080  
Firearms



RG-090  
Fish Hatchery



RG-100  
Information



RG-110  
Leashed Pets



RG-120  
Lighthouse



RG-130  
Litter Container



RG-140  
Lookout Tower



RG-150  
Ped Xing



RG-160  
Point of Interest



RG-170  
Ranger Station



RG-180  
Smoking



RG-190  
Truck



RG-200  
Tunnel



RG-240  
Dog



RG-260  
Seaplane



RM-010  
Camping (Tent)

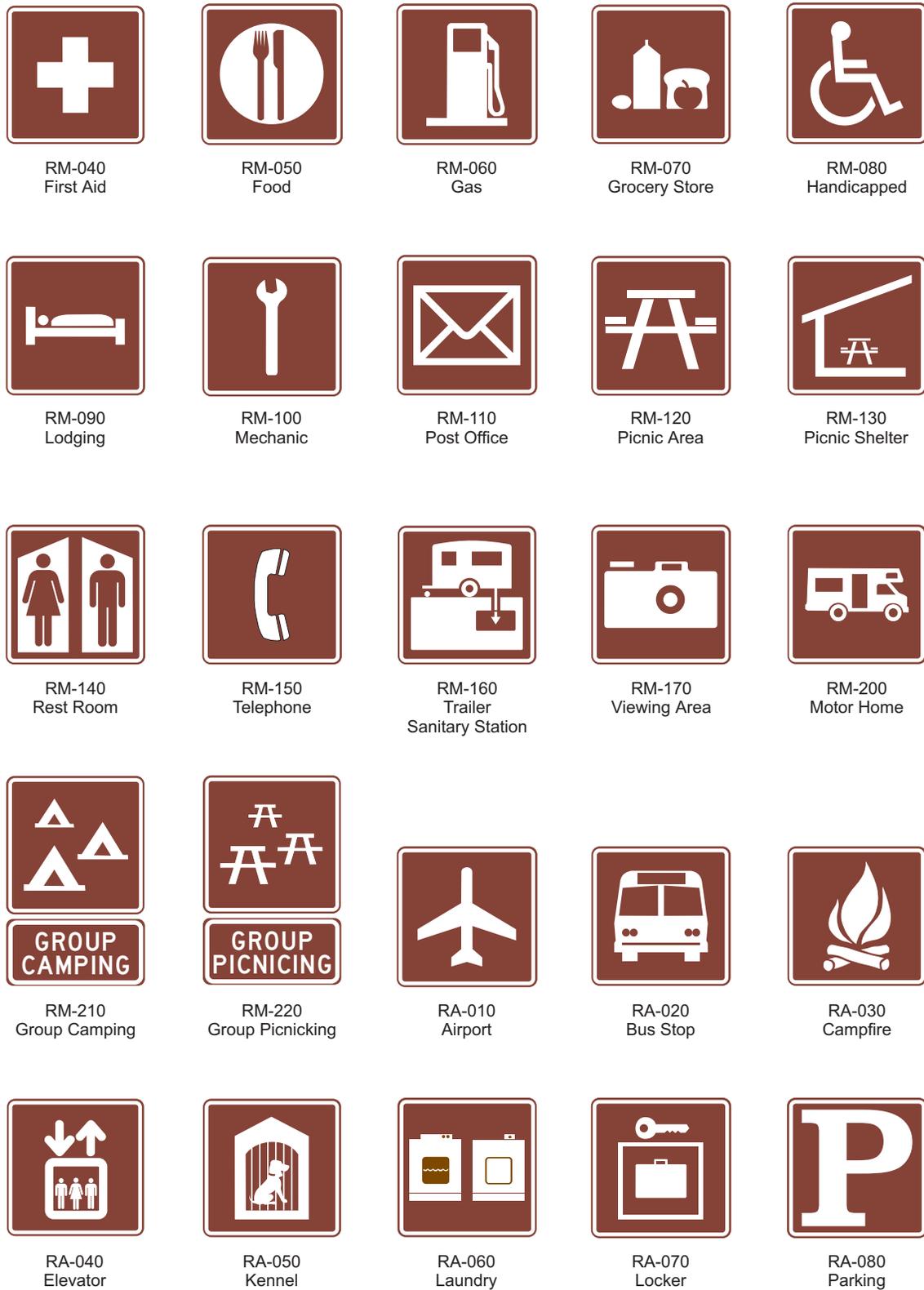


RM-020  
Camping (Trailer)



RM-030  
Ferry

**Figure 2H-5. Recreational and Cultural Interest Area Symbol Signs**  
(Sheet 1 of 5)



**Figure 2H-5. Recreational and Cultural Interest Area Symbol Signs**  
(Sheet 2 of 5)



RA-090  
Rest Room (Men)



RA-100  
Rest Room (Women)



RA-110  
Shelter (Sleeping)



RA-120  
Shelter (Trail)



RA-130  
Showers



RA-150  
Family Rest Room



RA-160  
Helicopter



RL-010  
Amphitheater



RL-020  
Climbing



RL-030  
Climbing (Rock)



RL-040  
Hunting



RL-050  
Playground



RL-060  
Rock Collecting



RL-070  
Spelunking



RL-080  
Stables



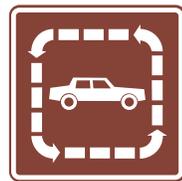
RL-090  
Trail  
(Bicycle)



RL-100  
Trail  
(Hiking)



RL-110  
Trail  
(Horse)



RL-120  
Trail  
(Interpretive, Auto)



RL-130  
Trail  
(Interpretive, Ped.)



RL-140  
Trail/Road  
(4 WD Veh.)



RL-150  
Trail  
(Trail Bike)



RL-160  
Tramway



RL-170  
All-Terrain Vehicle



RL-190  
Archer

**Figure 2H-5. Recreational and Cultural Interest Area Symbol Signs**  
(Sheet 3 of 5)



RL-210  
Hang Glider



RW-010  
Boat Tours



RW-020  
Canoeing



RW-030  
Diving



RW-040  
Diving (Scuba)



RW-050  
Fishing



RW-060  
Marine Recreation  
Area



RW-070  
Motorboating



RW-080  
Ramp (Launch)



RW-090  
Rowboating



RW-100  
Sailboating



RW-110  
Skiing (Water)



RW-120  
Surfing



RW-130  
Swimming



RW-140  
Wading



RW-160  
Fishing Pier



RW-170  
Hand Launch



RW-190  
Kayak



RW-210  
Wind Surf



RS-010  
Skating (Ice)



RS-020  
Ski Jumping



RS-030  
Skiing  
(Bobbing)



RS-040  
Skiing  
(Cross Country)



RS-050  
Skiing (Downhill)



RS-060  
Sledding

**Figure 2H-5. Recreational and Cultural Interest Area Symbol Signs**  
(Sheet 4 of 5)



RS-070  
Snowmobiling



RS-080  
Snowshoeing



RS-090  
Winter Recreation  
Area



RS-100  
Chairlift

**Figure 2H-5. Recreational and Cultural Interest Area Symbol Signs**  
(Sheet 5 of 5)

**STANDARD:**

Whenever the trapezoidal shape is used, the color combination shall be a white legend and border on a brown background.

**OPTION:**

White-on-brown destination guide signs may be posted at the first point where an access or crossroad intersects a highway where recreational or cultural interest areas are a significant destination along conventional roads, expressways, or freeways. White-on-brown supplemental guide signs may be used along conventional roads, expressways, or freeways to direct road users to recreational or cultural interest areas. Where access or crossroads lead exclusively to the recreational or cultural interest area, the advance guide sign and the exit direction sign may be white-on-brown.

**STANDARD:**

Linear parkway-type highways that merely function as arterial connectors without providing access to recreational or cultural interest areas shall not qualify for the use of white-on-brown destination guide signs. Directional guide signs used on these highways shall conform to Chapter 2D.

All gore signs shall have a white legend and border on a green background. The background color of the interchange exit number panel shall match the background color of the guide sign. Design characteristics of conventional road, expressway, or freeway guide signs shall conform to Chapter 2D or 2E except as specified in this Section for color combination.

The advance guide sign and the Exit Direction sign shall retain the white-on-green color combination where the crossroad leads to a destination other than a recreational or cultural interest area.

**SUPPORT:**

Figure 2H-2 illustrates destination guide signs commonly used for identifying recreational or cultural interest areas or facilities.

### 2H.9.1 Recreational or Cultural Interest Guide Signs and Symbol Signs on One Structure

**OPTION:**

Symbol signs may be installed below a recreational or cultural interest area advance guide sign located on conventional highways and expressways.

**STANDARD:**

Symbol signs shall not be installed on freeways.

**SUPPORT:**

Advance guide signs are normally installed 800 m (1/2 mi) in advance of the access road to the recreational or cultural interest area.

**OPTION:**

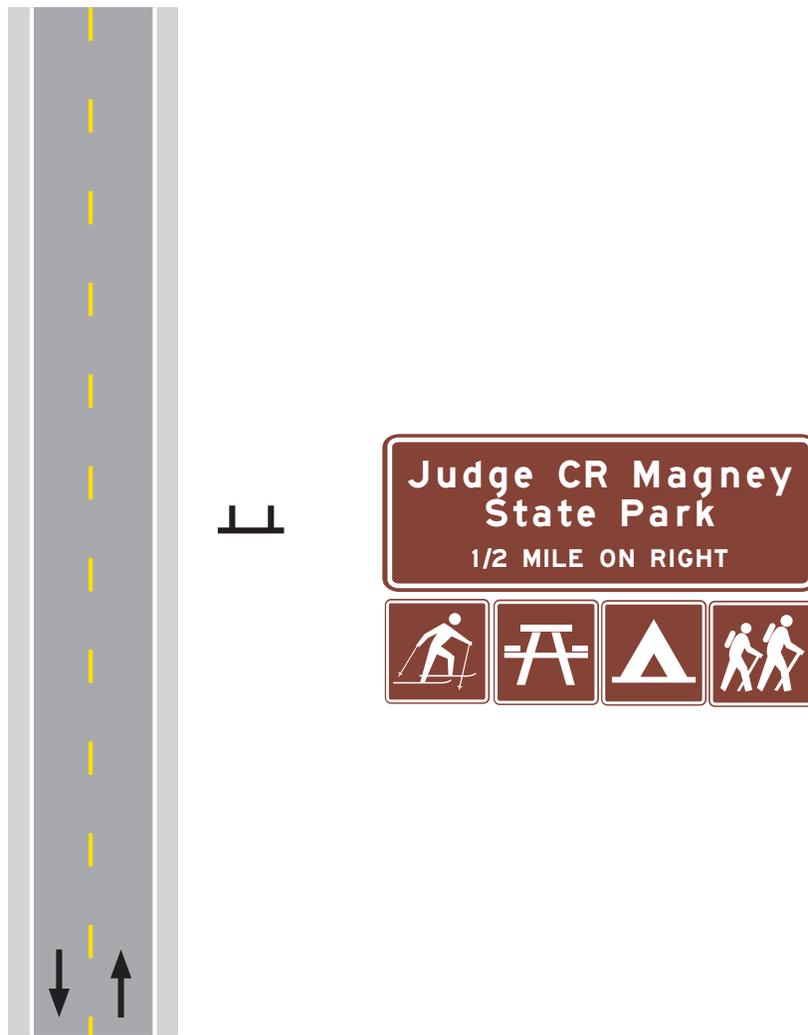
Up to four 600 x 600 mm (24 x 24in) symbol sign panels may be installed horizontally beneath each recreational or cultural interest area guide sign (see Figure 2H-6).

**GUIDANCE:**

For structural and aesthetic reasons, the cumulative overall length of these symbol sign panels should not exceed the length of the recreational or cultural interest area sign.

**STANDARD:**

Sign panels installed beneath recreational or cultural interest area guide signs shall match those shown in Figure 2H-7. Symbol signs not illustrated on Figure 2H-7 shall be mutually agreed upon by Mn/DOT, MN DNR, and the FHWA.



**Figure 2H-6 Typical Placement of Symbol Signs Below a Recreational or Cultural Interest Area Guide Sign**

When symbol sign panels are installed below an existing recreational or cultural interest area sign panel, the sign structure shall meet the requirements of the Mn/DOT Traffic Engineering Manual (See Map & Manual sales Unit, page ii).

In order to provide the proper sign structure design, the existing sign structure shall be modified or replaced with the correct structure. The entire structure shall meet all of the pertinent mounting height requirements as shown in Figure 2H-3. Vertical heights shall be measured to the bottom of the symbol sign panels.

**OPTION:**

Seasonal changes of symbol sign panels may occur when they are mutually agreed upon by the local road authority and the requesting agency. The road authority's personnel will be responsible for changing, storing and reinstalling the symbol sign panels on the sign structure. This work may be delegated to the requesting agency's on-site staff.

**STANDARD:**

All signing costs for the fabrication and installation of the symbol sign panels, as well as all sign structure modification or replacement costs, shall be paid by the requesting agency.



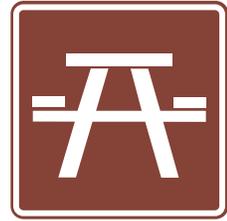
D7-X8A  
Carry-in Access



RG-100  
Information



RM-010  
Campground



RM-120  
Picnic Area



RL-030  
Rock Climbing



RL-090  
Bicycle Trail



RL-100  
Hiking Trail



RL-110  
Horse Trail



RL-X10  
Golf Course



RW-020  
Canoeing



RW-080  
Boat Launch



RW-130  
Swimming



RS-040  
Cross Country Skiing



RS-070  
Snowmobiling



RS-080  
Snowshoeing

**Figure 2H-7 Symbol Signs Approved for Placement Below a Recreational or Cultural Interest Area Guide Sign**

### 5G.3 Channelization Devices

#### **STANDARD:**

Channelization devices for nighttime use shall have the same retroreflective requirements as specified for higher-volume roadways.

#### **OPTION:**

To alert, guide and direct road users through temporary traffic control zones on low-volume roads, tapers may be used to move a road user out of the traffic lane and around the work space using the spacing of devices that is described in Section 6F.63.

### Proposed new language:

#### **STANDARD**

Channelization devices for nighttime use shall have the same retroreflective requirements as specified for higher-volume roadways.

#### **OPTION**

Short-term daylight hour maintenance operations that typically have short work spaces, clearly visible vehicle paths and offer limited risk to workers and road users may omit the routine use of channelization devices. Channelization devices may also be omitted if flaggers give specific instructions to drivers on how to proceed through the work zone.

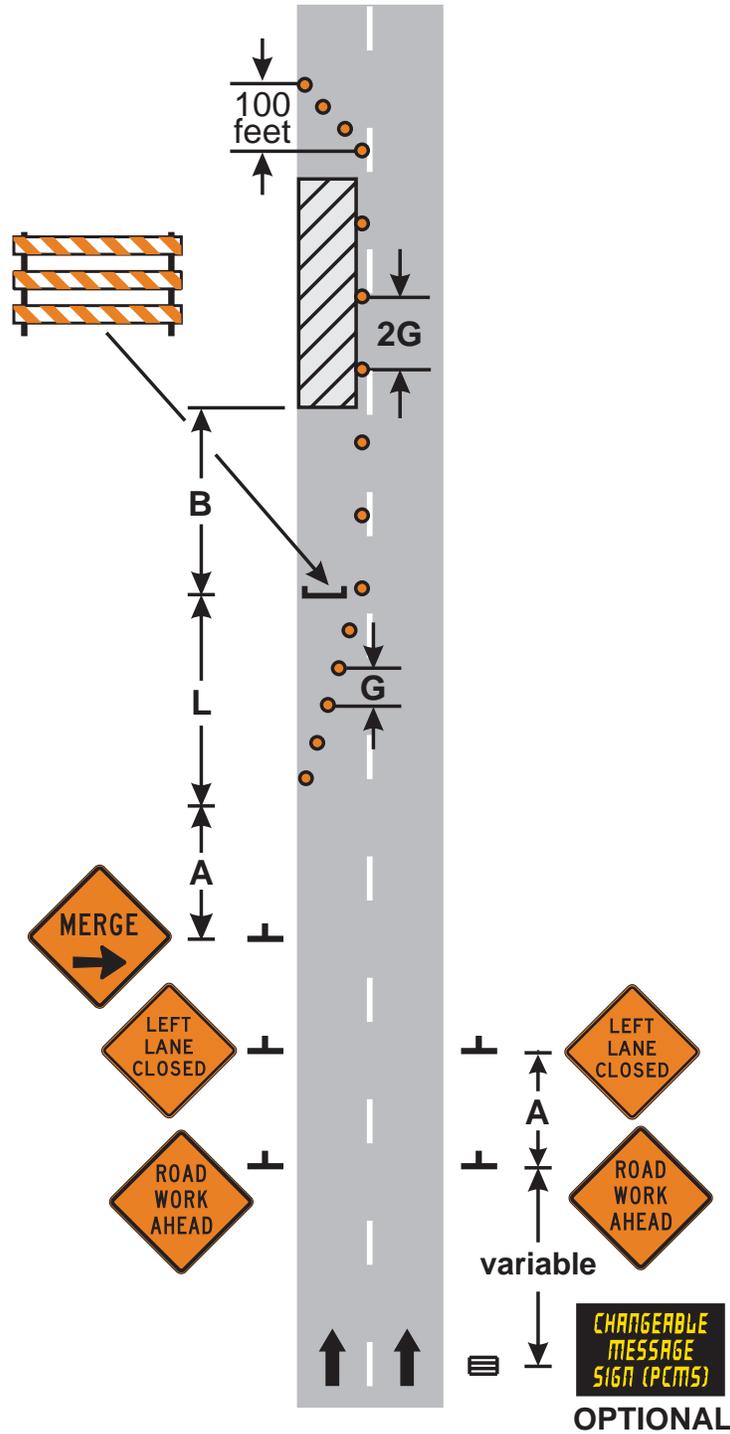
#### **GUIDANCE**

Channelization devices should be used if road users should be guided in a clear and positive manner while approaching and within construction, maintenance, and utility work areas.

**NOTES:**

- ① The Flashing Arrow Board shall be used when the posted speed limit is 45 mph or greater.
- ② The Transition Symbol sign may be omitted when the posted speed limit is 40 mph or less.
- 3. Use the appropriate traffic control devices for a right lane closure.

**10/6/17  
Layout OK**



**LANE CLOSURE  
MULTI-LANE DIVIDED ROAD**

**3 DAYS or LESS**

**LAYOUT 53**

# Proposed MN MUTCD Modifications for High-Vis Apparel

For MCUTCD consideration. Proposed modifications to 6E.2 High-Visibility Apparel & 6D.3 Worker Considerations.

- The MCUTCD voted to require flaggers to wear Class E retro-reflective pants. Should a compliance date be added – perhaps December 31, 2018?
- Move paragraph related to MN OSHA Rules from 6E.2 to 6D.3. These Rules include high-vis requirements for workers exposed to traffic and not specific to flaggers. The Rules are attached.
- Guidance statement for high-vis hat in Worker Considerations should be moved prior to Option statement for emergency responders/law enforcement high-vis apparel.

## 6E.2 High-Visibility Safety Apparel

### STANDARD:

For daytime and nighttime activity, flaggers shall wear high-visibility safety apparel that meets the Performance Class 3 requirements of the ANSI/ISEA 107-2004 publication entitled "American National Standard for High-Visibility Apparel and Headwear" (see Section 1A.11), or equivalent revisions. The Class 3 requirements shall be met by wearing an ANSI/ISEA Class 2 vest, shirt or jacket; as well as ANSI/ISEA Class E pants. The apparel shall be labeled with the ANSI/ISEA Classes.

The apparel background (outer) material color shall be fluorescent orange-red, fluorescent yellow-green, or a combination of the two as defined in the ANSI standard. The retroreflective material shall be orange, yellow, white, silver, yellow-green, or a fluorescent version of these colors, and shall be visible at a minimum distance of 1,000 feet. The retroreflective safety apparel shall be designed to clearly identify the wearer as a person.

### GUIDANCE:

In addition to the Class 3 requirements listed in the above STANDARD, a high visibility hat in the above colors should be worn.

## 6D.3 Worker Considerations

### STANDARD:

All workers, including emergency responders, within the right-of-way who are exposed either to traffic (vehicles using the highway for purposes of travel) or to work vehicles and construction equipment within the TTC zone shall wear high-visibility safety apparel that meets the Performance Class 2 or 3 requirements of the ANSI/ISEA 107-2004 publication entitled "American National Standard for High-Visibility Safety Apparel and Headwear" (see Section 1A.11), or equivalent revisions, and labeled as meeting the ANSI 107-2004 standard performance for Class 2 or 3 risk exposure, except as provided in the OPTION below. A person designated by the employer to be responsible for worker safety shall make the selection of the appropriate class of garment.

High visibility apparel shall comply with current Minnesota OSHA Rules 5207.0100 and 5207.1000.

### GUIDANCE:

When working in an area that does not require the use of a hard hat for head protection, a high visibility hat in the above colors should be worn.

**Moved down [1]:** High visibility apparel shall comply with current Minnesota OSHA Rules 5207.0100 and 5207.1000 and your agency's policies.¶

**Deleted:** 2 or

**Commented [KJ1]:** Not in Federal MUTCD in Flagger Chapter, but needed.

**Deleted:** , and labeled as meeting the ANSI 107- 2004 standard performance for Class 2 or 3 risk exposure

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**Deleted:** For nighttime activity, high-visibility safety apparel that meets the Performance Class 3 requirements of the ANSI/ISEA 107-2004 publication entitled "American National Standard for High-Visibility Apparel and Headwear" (see Section 1A.11), or equivalent revisions, and labeled as meeting the ANSI 107-2004 standard performance for Class 3 risk exposure shall be considered for flagger wear.¶

**Deleted:** 5

**Moved (insertion) [1]**

**Deleted:** and your agency's policies

**Moved (insertion) [2]**

## Proposed MN MUTCD Modifications for High-Vis Apparel

**OPTION:**

Emergency and incident responders and law enforcement personnel within the TTC zone may wear high visibility safety apparel that meets the performance requirements of the ANSI/ISEA 207-2006 publication entitled “American National Standard for High-Visibility Public Safety Vests” (see Section 1A.11), or equivalent revisions, and labeled as ANSI 207-2006, in lieu of ANSI/ISEA 107-2004 apparel.

Moved up [2]: **GUIDANCE:**  
When working in an area that does not require the use of a hard hat for head protection, a high visibility hat in the above colors should be worn.

DRAFT

# Proposed MN MUTCD Modifications for High-Vis Apparel

Minnesota Rules

## 5207.0100 HIGH VISIBILITY PERSONAL PROTECTIVE EQUIPMENT.

Subpart 1. General requirement. Each employee exposed to or working adjacent to moving motor vehicles as part of the employee's assigned job shall be provided with and required to wear a high visibility warning vest or other high visibility garment. A high visibility garment is defined as being a Performance Class 2 garment or greater as specified by ANSI/ISEA Standard 107-2004. Some smaller garments may not meet the background material specifications for Performance Class 2 as defined in ANSI/ISEA 107-2004. In these cases, the garment must be rated by the manufacturer as greater than or exceeding Performance Class 1 requirements.

Subp. 2. Maintenance of garments. If the high visibility personal protective equipment becomes faded, torn, dirty, worn, or defaced, reducing the equipment's performance below the manufacturer's recommendations, the high visibility personal protective equipment shall be immediately removed from service and replaced.

Subp. 3. Exception. Where permanent or semipermanent barricades designed to stop or deflect vehicular traffic upon impact are in place to protect employees from moving motor vehicles, employees are not required to wear high visibility personal protective equipment while working inside these protected areas.

Subp. 4. Electrical work. For work within the flash protection boundary as defined by NFPA 70E, high visibility garments constructed of material that complies with NFPA 70E shall be worn.

Subp. 5. [Repealed, 31 SR 517]

Statutory Authority: MS s 182.655

History: 12 SR 634; 25 SR 1241; 31 SR 517; 40 SR 750

Published Electronically: January 7, 2016

# Proposed MN MUTCD Modifications for High-Vis Apparel

## 5207.1000 OPERATION OF MOBILE EARTH-MOVING EQUIPMENT.

Subpart 1. Scope. This part identifies minimum safety requirements for the safe operation of mobile earth-moving equipment used for earth moving, building, or road construction or demolition, including, but not limited to, bulldozers, motor graders, scrapers, loaders, skid-steer loaders, compaction equipment, backhoes, end dumps, side dumps, and dump trucks. This part pertains to operators of the equipment and exposed employees, including, but not limited to, grade checkers, grade persons, rod persons, stake hops, stake jumpers, and blue toppers working in the area.

### Subp. 2. Training requirements.

A. Mobile earth-moving equipment operators and all other employees working on the ground exposed to mobile earth-moving equipment shall be trained in the safe work procedures pertaining to mobile earth-moving equipment and in the recognition of unsafe or hazardous conditions.

B. Training programs shall be developed and instructed by competent individuals who have knowledge, training, experience, and the demonstrated ability to identify existing and predictable hazards related to the subject matter.

C. Training programs must include the following elements:

(1) safe work procedures on how to approach mobile earth-moving equipment, whether in use or idling, including:

(a) visual, voice, or signal communication that shall be made with the operator prior to approaching earth-moving equipment;

(b) maintaining one's visibility to the operator while approaching the equipment; and

(c) operator responsibilities, such as placing the transmission in neutral, setting the parking brake, and indicating that it is safe to approach the equipment;

(2) identification of the operator's blind spots on various earth-moving equipment used;

(3) instruction for mobile earth-moving equipment operators in conducting daily equipment inspections according to the manufacturer's recommendations, and checking the area around the equipment for a clear path prior to beginning operation;

(4) safe operating procedures of equipment, including traveling, backing, parking, loading for transport, maintenance, and operation;

(5) safe work procedures when working around or adjacent to overhead or underground utilities, as described in Code of Federal Regulations, title 29, parts 1926.600(a)(6) and 1926.651(b); and

(6) additional hazards that could be created by changing conditions.

## Proposed MN MUTCD Modifications for High-Vis Apparel

Subp. 3. Training frequency. Employees shall be trained initially before beginning work that exposes them to mobile earth-moving equipment. Employee training records shall be retained by the employer for the duration of the project.

### Subp. 4. High visibility personal protective equipment.

A. Each employee working on the ground who is exposed to mobile earth-moving equipment shall be provided with and required to wear a high visibility warning vest or other high visibility garments. A high visibility garment is defined as being a Performance Class 2 garment or greater as specified by ANSI/ISEA Standard 107-2004.

B. High visibility apparel, as described in item A, shall comply with the specifications in part 5207.0100.

### Subp. 5. Equipment requirements.

A. All mobile earth-moving equipment shall comply with Code of Federal Regulations, title 29, part 1926.602(a)(9)(ii) for back-up alarms or signal persons if applicable.

B. When mobile earth-moving equipment is operated during times of darkness or low light conditions, the equipment, if designed to function equally in both forward and reverse directions, such as compaction equipment, bulldozers, motor graders, loaders, and skid-steer loaders, shall be equipped with at least two headlights for forward travel and adequate rear lights for reverse travel unless other adequate lighting is provided.

### Subp. 6. Contractor responsibility.

A. If the mobile earth-moving equipment contractor exposes other contractor's employees to the hazard of mobile earth-moving equipment, the controlling employer, such as general contractor or construction manager, for the project shall coordinate a joint contractor-employee safety awareness meeting between contractors and employees on site.

Discussion elements for employee awareness training can be found in subparts 2, item C; and 4.

B. The employee safety awareness meeting shall be documented, identifying when the meeting was held and who attended, including a brief summary of what was reviewed. Documentation shall be retained for the duration of the project.

Subp. 7. Electrical work. For work within the flash protection boundary as defined by NFPA 70E, high visibility garments constructed of material that complies with NFPA 70E may be worn.

Subp. 8. [Repealed, 31 SR 517]

Statutory Authority: MS s 182.655

## **2C.28 BUMP and DIP Signs (W8-1, W8-1a, W8-1b, W8-2)**

### **GUIDANCE**

BUMP (W8-1) and DIP (W8-2) signs should be used to give warning of a sharp rise or depression in the profile of the road.

### **Option:**

These signs may be supplemented with an Advisory Speed plaque (see Section 2C.8) or a 45 Degree Supplemental Arrow plaque.

### **STANDARD:**

The DIP sign (W8-2) shall not be used at a short stretch of depressed alignment that might momentarily hide a vehicle.

### **GUIDANCE**

A short stretch of depressed alignment that might momentarily hide a vehicle should be treated as a no-passing zone when center line striping is provided on a two-lane or three-lane road (see Section 3B.2).

### **Option:**

At severe bumps, a BUMP AHEAD (W8-1a) sign may be placed in advance of the bump location. An appropriate Distance plaque (see Section 2C.55) or Advisory Speed plaque (see Section 2C.8) may be placed below the warning sign.

At areas of multiple bumps, a BUMPS (W8-1b) sign may be placed in advance of the area. An appropriate Distance plaque (see Section 2C.55) may be placed below the warning sign.