A Systematic Approach on CMS Messaging Selection During Nonrecurring Events: Decision Tree

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FOREWORD

Changeable message signs (CMSs) serve as safe and accessible sources of relevant travel information. The Federal Highway Administration researched various CMS information and messaging that effectively promotes desired changes in traveler behavior to improve safety and ensure the flow of the transportation system during nonrecurring events.

This report takes a guided systematic approach to the selection of CMSs, and it supports CMS operators who construct and choose CMS messages for nonrecurring events. The CMS operators developed that systematic approach based on results of experiments that aimed at exploring specific CMS messages that are most likely to influence traveler behavior. This report includes several nonrecurring event examples and variations of the course of action to choose CMS messages. The report also includes circumstances when multiple messages may be equally valuable to drivers.

This report might be of interest to traffic management center operators, agency leadership, transportation engineers and researchers, and others who share an interest in promoting safe and efficient traffic flow.

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16. Abstract
Changeable message sign (CMS) messaging is an important tool for distributing traveler information to drivers. Careful CMS message selection can help drivers make informed travel decisions and increase the safety and usability of roadways—particularly during nonrecurring events. The current approach is designed to help CMS operators construct CMS messages about nonrecurring events by using research-backed practices. This report introduces the rationale for using CMS messages as well as information on CMS provisions, message construction, and ways to cultivate trust in CMSs. The report also includes a number of decision trees designed to help CMS operators select the specific message components and phrases to include in a CMS message during different nonrecurring events. Finally, the report provides examples of how to use the decision trees to create a final, complete CMS message by using a CMS Message Construction Worksheet. The goal is to improve the safety and flow of the transportation system during nonrecurring events by providing information on documentation of specific CMS messages that effectively promote desired changes in traveler behavior.

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SI* (MODERN METRIC) CONVERSION FACTORS				
APPROXIMATE CONVERSIONS TO SI UNITS				
Symbol	**When You Know**	**Multiply By**	**To Find**	**Symbol**
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yard	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
		NOTE: volumes greater than 1,000 L shall be shown in m^3		
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2,000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
		TEMPERATURE (exact degrees)		
°F	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	°C
		ILLUMINATION		
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m^2	cd/m^2
		FORCE and PRESSURE or STRESS		
lbf	poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa
APPROXIMATE CONVERSIONS FROM SI UNITS				
Symbol	**When You Know**	**Multiply By**	**To Find**	**Symbol**
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
		VOLUME		
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.314	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2,000 lb)	T
		TEMPERATURE (exact degrees)		
°C	Celsius	1.8C+32	Fahrenheit	°F
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/m^2	candela/m2	0.2919	foot-Lamberts	fl
		FORCE and PRESSURE or STRESS		
N	newtons	2.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in^2

*SI is the symbol for International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380. (Revised March 2003)

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LIST OF ABBREVIATIONS

CMS	changeable message sign
FHWA	Federal Highway Administration
MUTCD	*Manual on Uniform Traffic Control Devices for Streets and Highways*
PLA	problem-location-action

CHAPTER 1. INTRODUCTION

Changeable message signs (CMSs), also referred to as variable message signs or dynamic message signs, are programmable, electronic message signs capable of displaying multiple alternative messages (Federal Highway Administration (FHWA) 2009). CMSs offer several advantages as dissemination sources of traveler information. The information displayed on a CMS is accessible to all drivers, including those who do not have radios or personal electronic devices. Drivers can obtain the information from a CMS with minimal distraction from the primary driving task (Inman, Bertola, and Philips 2015). Additionally, CMSs serve as safe, accessible sources of relevant traveler information and are almost always relevant to a current driving situation. They represent one of the most extensively used resources for disseminating traveler information (Robinson et al. 2012).

Research suggests that traveler information is most needed during nonrecurring events or events that lead to temporary changes in the capacity or travel time reliability of a roadway (Lappin and Bottom 2001). Examples of nonrecurring events are traffic incidents, roadwork, adverse weather conditions, and planned special events. Drivers can use traveler information to avoid the delays and potential safety risks associated with nonrecurring events by making appropriate changes to their travel behavior. Traveler information typically provides the greatest reductions in travel time and is most valued by drivers during nonrecurring events (Al-Deek et al. 1989; Wolinetz et al. 2001).

This systematic approach is designed to help CMS operators construct messages that inform drivers about nonrecurring events and thereby enable drivers to make informed travel decisions that can increase the safety and operational efficiency of the road network. The systematic approach consists of three chapters. The current chapter, chapter 1, introduces CMS messaging as well as information on CMS provisions, message construction, and ways of cultivating trust in CMSs. Chapter 2 includes a number of decision trees designed to help CMS operators select the specific message components and phrases to include in a CMS message during different nonrecurring events. Chapter 3 provides examples of how to use the decision trees in chapter 2 to create a final and complete CMS message by using a CMS Message Construction Worksheet.

CMS PROVISIONS

The *Manual on Uniform Traffic Control Devices for Streets and Highways* (MUTCD) has created provisions for CMSs that help ensure adequate message visibility (FHWA 2009). Luminance plays a key role in ensuring visibility—particularly after dark. The MUTCD states that the contrast orientation of CMSs should always be positive, with luminous letters on a darker background to make the signs easier to see. According to the MUTCD, if signs have black backgrounds, then the color on the legends should match the background color that would be used on a standard sign—like white for regulation, yellow for warnings, orange for temporary traffic control, red for stop, and pink for incidents (FHWA 2009). The MUTCD stipulates a minimum height of letters as 18 inches on roadways with speed limits of 45 mph or higher and 12 inches on roadways with speed limits less than 45 mph. Additionally, messages should be composed of only uppercase letters and be center aligned.

The MUTCD also has provisions regarding the amount of information to be displayed on a CMS (FHWA 2009). Drivers' primary task is to attend to the surrounding road and traffic conditions in order to drive safely. When passing a CMS, drivers have a limited amount of time to read and process the displayed information. The MUTCD's provisions aid CMS operators in creating messages that drivers have time to read. Information displayed on a CMS should be broken down into units of information or brief answers to single questions. Table 1 provides an example of different questions that a single unit of information can answer.

Table 1. Example of single questions and units of information that answer those questions.

Question	Unit of Information
What event is occurring?	ROADWORK
What is the effect of this event?	20 MIN DELAY
What action should the driver take?	USE OTHER ROUTE

Only one unit of information is to appear on each line of a CMS (FHWA 2009). Having more than one unit of information on a line decreases processing speed and message comprehension (Lai 2010). By separating units of information by line, drivers have the opportunity to quickly move their attention back and forth between the CMS and the road. Drivers can read one line of information, return their eyes to the road, and then choose to move their attention back to the second line of the message if and when traffic conditions permit (Inman, Bertola, and Philips 2015). This method of moving attention back and forth between tasks is frequently seen in multitasking situations (Vergauwe, Barrouillet, and Camos 2009). The method helps ensure drivers maintain adequate attention on the primary driving task by preventing the need to remove attention from the road for long periods of time.

Only three units of information are to be displayed on a CMS at one time (FHWA 2009). Reductions in speed have been reported in field studies of CMS messages that have more than three lines of text (Erke, Sagberg, and Hagman 2007; Jamson, Tate, and Jamson 2005). If drivers slow down while approaching a CMS, they can cause traffic bottlenecks and become safety hazards. On a congested highway, braking by even a small number of drivers can trigger chain reactions that can significantly reduce the average speed of traffic approaching the CMS and thereby increase the risk of rear-end collisions (Erke, Sagberg, and Hagman 2007).

The amount of information in a CMS message may be increased by either a two-phrase message or a sign that alternates between two different groups of information. When a message has two phrases, some drivers may see only one phrase of the message or may see the phrases in reverse order. Each phrase of a message should be understandable on its own, and drivers' ability to understand the message should not be influenced by the order in which the two phrases are seen. The MUTCD specifies that an entire message contain no more than two phrases and that the number of total units of information presented across those two phrases be no more than four for speeds greater than 35 mph and no more than five for speeds less than 35 mph (FHWA 2009).

If a CMS has two phrases, all of the sign's units of information should change at once. If the first line of a message does not change, drivers are less likely to notice that the sign has changed, and they may miss the information in one of the phrases. Even when no information is missed, research indicates that two-phrase messages that repeat the first line of a message take longer for drivers to read.

Reading speed and comprehension of CMS messages are influenced not only by the length of the message displayed on a CMS but also by the specific words used for conveying that message. Words that are unfamiliar to a driver or that are unexpected take longer to read, are less well understood, and are less likely to result in behavioral change than words a driver is used to seeing on a CMS (Erke, Sagberg, and Hagman 2007; Jindahra and Choocharukul 2013; Guattari, De Blasiis, and Calvi 2012). Literate adults read words as whole units rather than as groups of letters, such that reading speed is influenced more by familiarity and context than by word length. The implications for CMS message design are twofold. First, abbreviations need special attention. Despite having fewer letters, abbreviations that are unfamiliar or difficult to interpret take longer to read than their unabbreviated counterparts. The MUTCD provides a table of acceptable abbreviations specifically for use on CMSs (FHWA 2009). Second, operators should strive for consistency in their use of specific words and phrases. Indeed, research has demonstrated that whereas familiar and expected CMS messaging can lead to appropriate changes in behavior without negatively affecting driving performance, unexpected or difficult-to-process messaging can cause drivers to reduce their speed as they approach a CMS. Unfamiliar messages are also less likely to result in appropriate changes in driving behavior (Ullman, Ullman, and Dudek 2007; Ullman et al. 2005). CMSs serve as unique information contexts, and if the messaging is consistent, drivers can use that context to more quickly read and process the information on the CMS.

CONSTRUCTING A CMS MESSAGE

The MUTCD includes provisions for CMS content, message length, acceptable abbreviations, and color and animation (FHWA 2009). Per the MUTCD, CMS operators are to use these provisions when constructing a specific message to display during any given nonrecurring event. One popular CMS message-generation method is the problem-location-action (PLA) method. A CMS message generated using the PLA method is to contain three basic elements: the problem, the location, and the suggested action. An example of a CMS message generated using the PLA method is shown in figure 1. The first line of the message specifies the problem or situation the driver will encounter. The second line of the message indicates the location of the problem or the distance between the CMS and the problem. The third line suggests an action to drivers. Each of those message components is explored in greater detail in the next section.

Source: FHWA.

Figure 1. Illustration. Example of CMS message generated using the PLA method (Weaver, Balk, and Arnold 2019).

Problem

A CMS message generated using the PLA method should first display the problem or situation the driver can expect to encounter. During a nonrecurring event, identifying the problem is usually straightforward because the problem affecting traffic is typically the nonrecurring event itself. However, in some instances, the problem with the greatest impact on drivers is not the nonrecurring event but the effect that that nonrecurring event is having on the roadway. For example, in a situation in which flooding causes a road to be closed, the event—FLOODING—is of interest, but the effect of that event—ROAD CLOSED—will have the largest effect on driving behavior, and thus the PLA method would consider ROAD CLOSED the larger problem.

Whether it is best to identify on a CMS message the nonrecurring event or the effect that event is having on the roadway as the problem is not always clear. Research has shown that event information increases changes in driver behavior (Wardman, Bonsall, and Shires 1997). Studies have also found that effects of event have helped promote changes in driver behavior by highlighting the severity of the event (Wardman, Bonsall, and Shires 1997; Bushman, Berthelot, and Chan 2004; Lerner et al. 2009). The appropriate choice varies depending on the specific situation described in the message, and a departure from the PLA structure may sometimes be helpful so as to include both event and effect-of-event information within the same CMS message (Jindahra and Choocharukul 2013).

Location

CMS messages frequently include location information to enable drivers to understand where an event is occurring and thereby gauge their opportunity for making route changes before reaching the event. When surveyed about the type of information they wish to see on CMSs, drivers reported valuing location information (Muizelaar and Van Arem 2007; Peeta and Pasupathy 2000). However, including location information in a message does not always influence how drivers react to the message (Peeta and Pasupathy 2000). Research on CMS messaging can inform CMS operators on when to use location information and what types of messages are most useful to drivers.

Action

Including an action suggestion in a CMS message can be effective in influencing travel behavior, with more specific actions often leading to increased action compliance (Bushman, Berthelot, and Chan 2004; Khattack, Polydoropoulou, and Ben-Akiva 1996; Schroeder and Demetsky 2010). Nevertheless, the number of actions available to travelers midtrip is somewhat limited, and not all actions will apply to all drivers. Thus, in some instances, CMS messages may forgo providing a specific action selection for drivers and instead display messages that give more details about conditions on the roadway. Providing more roadway details can enable drivers to select the specific action or actions they feel are most appropriate.

Other Units of Information

The PLA method serves as a helpful starting point for constructing CMS messages. The ordering of information within PLA is intuitive and easy for drivers to follow. However, messages that strictly follow the PLA method may not always contain all of the relevant information regarding a nonrecurring event. As noted earlier, in the section on CMS Provisions, separating a CMS message into units of information that describe both the event itself (e.g., MAJOR CRASH) and the effect the event is having on the roadway (e.g., RIGHT LANE CLOSED) can be beneficial. Other units of information that may be helpful to include in a CMS message are the intended audience—meaning, the specific portion of drivers the message is intended to target—and event timing—meaning, the date or expected duration of the event.

Message Length and Component Prioritization

Publications on CMS messaging have identified several different units of information that could be included in a CMS message, such as event type, effect of event, event location, action suggestion, intended audience, and event timing. Chapter 2, section 2L.05, of the MUTCD sets limits on the maximum amount of information to be included in a message (FHWA 2009). CMS operators must work within those limits in their attempt to determine the optimal amount of information to provide to drivers during any specific situation. Since the amount of time and effort required to read CMS messages increases with increased content, only necessary words and phrases are to be included in a CMS message (Lerner et al. 2009). The research on optimal message length on a CMS has been mixed. In some instances, the proportion of drivers who indicate they would make changes to their behavior in response to a CMS message increases as the number of units of information available to the drivers increases (Peeta, Ramos, and Pasupathy 2000; Matanat, Yank, and Yen 1995). In other situations, too much information appears to cause confusion and reduce the proportion of drivers who respond to a message (Jeihani et al. 2018). Conflicting findings on the value of information quantity may be results of the specific messages used. Some CMS phrases may be more impactful than others, such that when those phrases are used, the quantity of required information is reduced (Weaver, Balk, and Arnold 2019). In effect, how effective a specific CMS message is in influencing driver behavior may depend more on the message's content than on its length. Thus, when researchers construct CMS messages, they should prioritize units of information that will be most impactful on drivers and may result in the most widespread effectiveness.

PROMOTING TRUST IN CMSs

The use of CMS information is influenced not only by the message itself but also by a driver's general sense of trust in CMS messaging (Peng, Guequierre, and Blakeman 2004; Kattan, Habib, and Shahid 2011). Cultivating and maintaining trust in CMS messaging are important goals. Drivers who trust the traveler information messages they see on CMSs are more likely to use that information. Likewise, drivers who successfully use CMS messaging increase their trust in such messages because of their positive experiences. Thus, the relationship between trust in CMS information and use of CMS information is somewhat circular and appears to be part of a larger cycle of trust in and use of traveler information more generally (Weaver, Balk, and Arnold 2019). Drivers who seek out traveler information can use the information they gather to form a more complete picture of the road network. Those drivers are then in a position to take advantage of the alternate routes available within that network, and they would be more likely to use those alternate routes after encountering a CMS message about a delay on their current route (Kattan et al. 2011). In contrast, drivers who view incorrect or out-of-date information lose trust in the messaging (Lerner et al. 2009; Richards and McDonald 2007). They are more likely to ignore CMS messages and therefore cannot benefit from the information the messages contain. Drivers are somewhat tolerant of occasional errors in CMS messages; however, repeated inaccuracies lead to mistrust and disuse (Lerner et al. 2009).

One potential source of perceived CMS inaccuracies is outdated messaging. Even small changes in the frequency with which CMS messages are updated can have a large impact on the accuracy of those messages (Srinivasan and Krishnamurthy 2003). Including time stamps that indicate when a message was last updated has been proposed as one means of maintaining drivers' trust in CMS messaging (Benson 1996). Drivers tend to show increased responsiveness to messages when they watch a message change and therefore infer that the message is up-to-date (Foo, Abdulhai, and Hall 2008). However, direct assessments of the effect of time stamps on CMS messages found that time stamps increased reading time without influencing drivers' behavior. A more beneficial solution is to reduce the frequency with which messages need to be updated by avoiding CMS messages that are overly specific (Durkop and Balke 2000).

Drivers also lose trust in CMS messaging if those drivers are exposed to messages that are vague or overly simplistic or that display information that can be easily observed (Dudek and Ullman 2006). For example, information about adverse weather conditions that are not visible (e.g., BLACK ICE) can help drivers take appropriate action, whereas information about an event that is already visible on the roadway (e.g., FALLING SNOW) does not provide any new information. Similarly, messages about the length of a delay (e.g., 20 MIN DELAY) can help drivers make travel decisions. However, travel information about a general delay or congestion is beneficial only if the information is distributed far enough upstream that drivers cannot already see the congestion associated with the delay (Pan and Khattak 2008). Limiting CMS use to informative and helpful messaging can help maintain driver trust in and use of CMSs.

CHAPTER 2. CMS COMPONENTS AND DECISION TREES

Careful and consistent CMS message selection can help drivers make informed travel decisions and increase the safety and usability of roadways—particularly during nonrecurring events. This chapter discusses constructing CMS messages about nonrecurring events and the specific practices, units of information, and phrases that may help promote desired changes in traveler behavior.

The chapter has several sections, each corresponding to a different CMS component. Each section names the topic covered in the section and is followed by a brief introduction providing relevant, high-level information on that topic. Next is a decision-tree diagram to help users determine when to include that unit of information in the CMS message, the type of information likely to be most relevant, and examples of the types of phrases users can apply for conveying the information. The decision tree also indicates which topical section within this chapter users should proceed to in order to learn more about that topic. The discussion documents the relevant research that motivated the decision tree's construction. The discussion gives context that can inform message selection. Finally, key references serve as resources of relevant literature and documents that interested parties can use to gain even more in-depth information on the topic.

The decision trees in each section help users determine only a single unit of information as part of a more complete CMS message. That single unit of information is not intended to be displayed alone on the CMS, and separate units of information are not intended to be displayed together in the same message.

The chapter is divided into seven sections and five subsections. The first section discusses potential goals of a CMS message. Each of the remaining sections corresponds to a different unit of information that can be included in a CMS message.

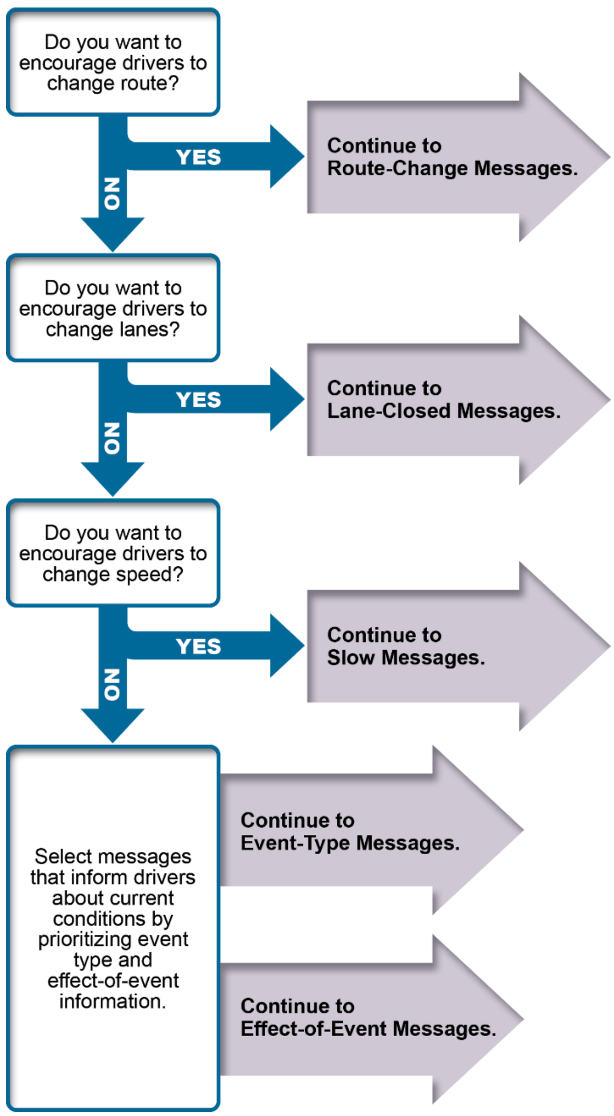
Following is the list of sections:

- Message Goal.
- Event Type.
  - Weather Events.
- Effect of Event.
  - Lane Closure.
  - Travel Time Delay.
- Event Location.
- Suggested Action.
  - Route Change.
  - Reduce Speed.
- Intended Audience.
- Event Time.

MESSAGE GOAL

Introduction

The first step in constructing a CMS message is to determine the goal of the message. Messages can inform drivers about a nonrecurring event, help drivers prepare for conditions they will encounter on the road ahead, or encourage drivers to take specific actions. Understanding the goal of each message before beginning the message's construction can help CMS operators decide which units of information to prioritize within the message and enable them to select phrases aimed at accomplishing that goal. The decision tree in figure 2 references sections in this chapter that correspond to some common message goals. However, since multiple phrases can accomplish a goal, operators may be helped by working through each of the sections during message construction.



Source: FHWA.

Figure 2. Diagram. Decision tree for determining message goal.

Discussion

Drivers can use traveler information to avoid the delays and potential safety risks associated with nonrecurring events by making appropriate changes to their travel behavior. Careful CMS message selection can help drivers make informed travel decisions and increase the safety and usability of roadways.

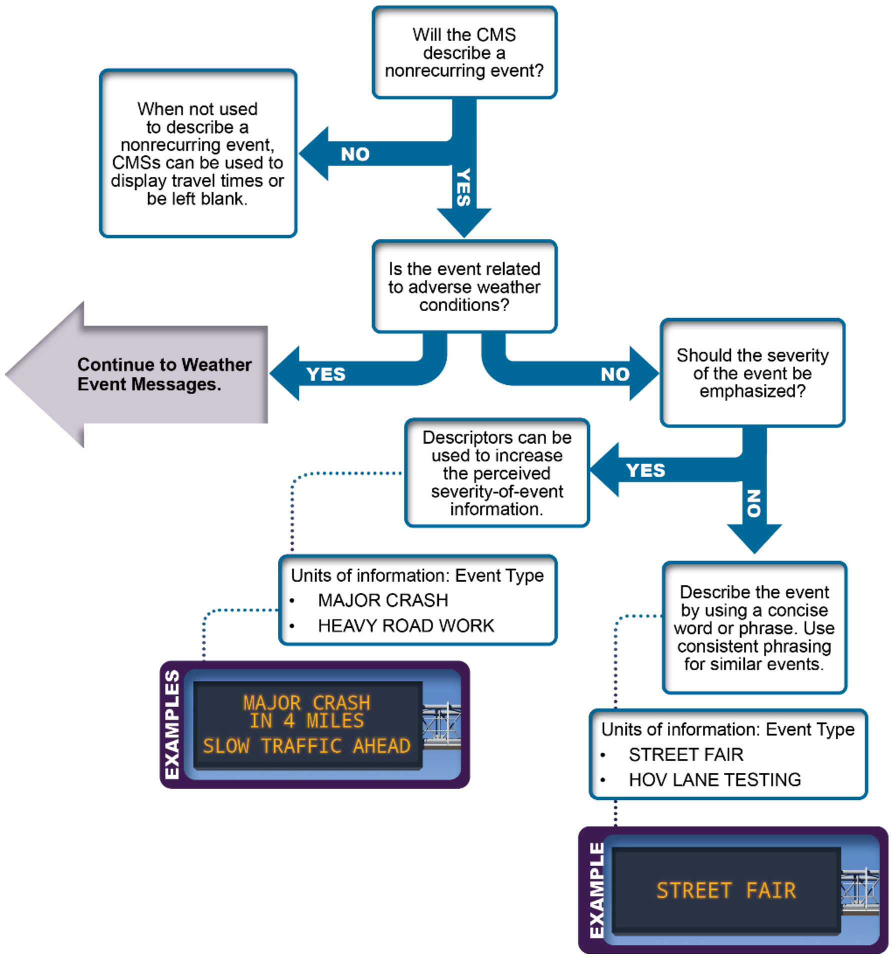
Even drivers who do not make changes in their driving behavior can still benefit from receiving traveler information via CMSs. Weaver, Balk, and Arnold (2019) found that participants who received traveler information before encountering a nonrecurring event reported less stress during their drive than drivers who did not receive any information. Traveler information seems to reduce the potential frustration associated with driving during nonrecurring events. Indeed, many drivers report feeling better informed after viewing traveler information on a CMS (Luoma et al. 2000). Drivers also report using the information to confirm that they are on the correct route and feel safer after viewing CMS messages because they know that other drivers on the roadway have been informed about an upcoming nonrecurring event (Wardman, Bonsall, and Shires 1997; Lerner et all 2009). Thus, using CMSs simply to inform drivers about a nonrecurrent event without anticipating any overt change in driving behavior is a valid and appreciated use of CMS messaging as long as the messages are relevant and informative.

Another common goal of CMS messaging is to encourage drivers to take action. When encouraging drivers to take action is the goal, the specific words and phrases used in the CMS message can affect how likely drivers are to make changes in their behavior. Specific examples of message types that encourage different types of driver behavior are provided throughout this approach.

EVENT TYPE

Introduction

Event type refers to the type of nonrecurring event that is currently affecting travel. Giving information to drivers about the problem or situation that is affecting travel keeps drivers informed and enables them to make changes to their driving behavior that they feel are appropriate for safely dealing with the event. Figure 3 shows the decision tree for determining event type. The decision tree is used to develop only a single unit of information for event type as part of a more complete CMS message. A single unit of information for event type is not intended to be displayed alone on the CMS, and separate units of information for event type are not intended to be displayed together in the same message.



Source: FHWA.
HOV = high-occupancy vehicle.

Figure 3. Diagram. Decision tree for determining event type.

Discussion

CMS messages are used to convey information about different types of nonrecurring events, including incidents such as crashes or disabled vehicles, roadwork such as pavement repair or construction, weather events such as ice or flooding, planned events that cause excess traffic such as concerts or athletic events, or planned events that block roads, such as street fairs or parades. Past research suggests that including event type in a CMS message leads to increased positive changes in driver behavior (Wolinetz, Khattak, and Yim 2001) compared with a CMS message that does not include event information (Wolinetz, Khattak, and Yim 2001; Al-Deek et al. 1989). The specific changes that drivers make, however, and the proportion of drivers who choose to make changes depend on the perceived severity of that event and the range of actions that drivers feel are available to them on the current roadway (Wolinetz, Khattak, and Yim 2001; Al-Deek et al. 1989; Weaver, Balk, and Arnold 2019).

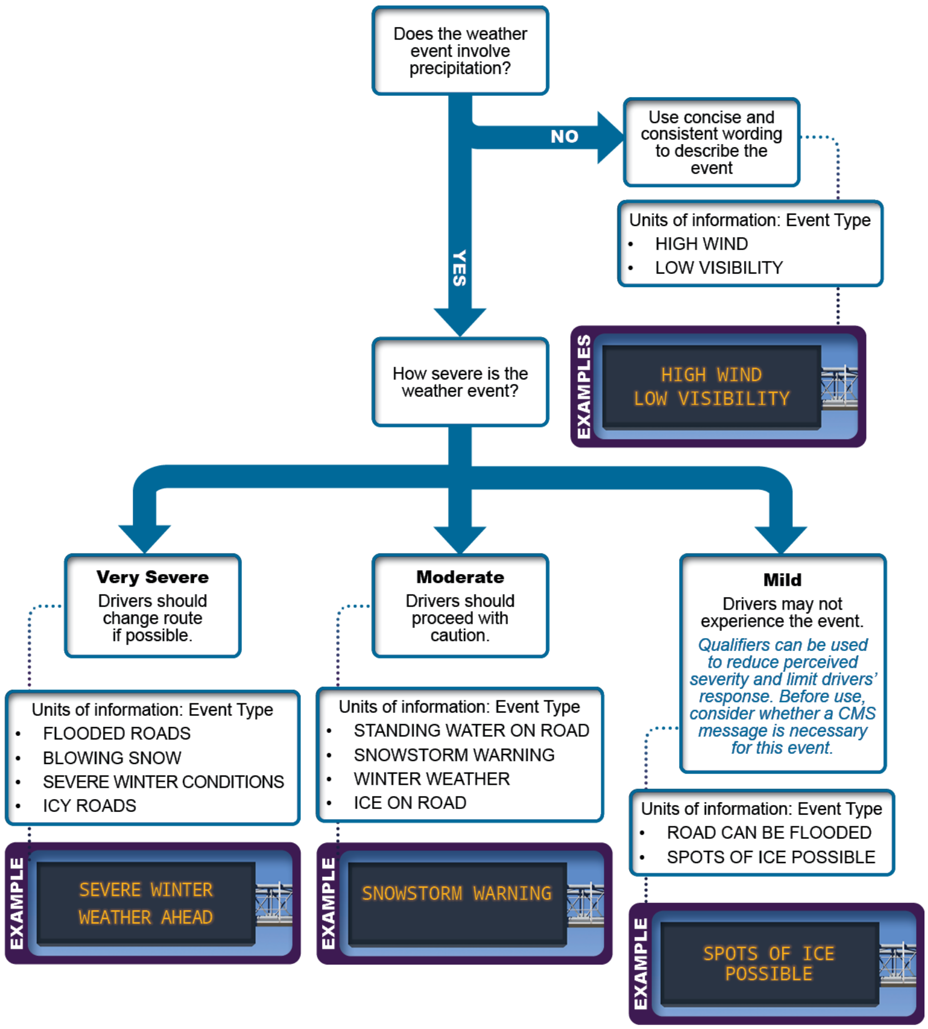
Descriptions of similar nonrecurring events are to contain carefully consistent word choices. Research indicates that unfamiliar or unexpected words take longer to read, are less well understood, and are less likely to change behavior than words a driver is used to seeing on a CMS (Erke, Sagberg, and Hagman 2007; Jindahra and Choocharukul 2013; Guattari, De Blasiis, and Calvi 2012). In some instances, the specific word choice can also manipulate perceptions of severity. For example, adjectives or descriptors (e.g., MAJOR) can be added to an event-type description to change the perceived severity of the event (Lichty et al. 2012).

When a nonrecurring event is not announced by a CMS message, a CMS can display travel times (Haghani et al. 2013). If travel times update automatically, they can begin providing a warning about a developing delay even before a message about the event triggering the delay can be created. Other options include displaying all-clear or safety messages (Finley, Gates, and Dudek 2001; Cheng and Firmin 2004). However, universal support for such practices is lacking. While all-clear messages have been shown to reduce diversion rates relative to blank signs, which could increase route congestion (Wardman, Bonsall, and Shires, 1997), proponents of blank message signs argue that drivers who typically encounter messages that are not relevant to their commute may come to ignore CMS messaging altogether, leading to extremely low rates of message compliance (Chatterjee et al. 2002). Choosing to leave a sign blank can prevent drivers from being overloaded with uninformative messaging and can also reduce CMS energy and maintenance costs (Finley, Gates, and Dudek, 2001).

Weather Events

Introduction

CMS messages about weather events can result in multiple positive effects on driving behavior as drivers make changes they feel are most appropriate for dealing with those events. As a result, when a weather event is occurring, CMS operators may consider using a message that prioritizes event-type information. Figure 4 shows the decision tree used for determining messaging related to weather events. The decision tree is used to develop only a single unit of information for weather events as part of a more complete CMS message. A single unit of information for weather events is not intended to be displayed alone on the CMS, and separate units of information for weather events are not intended to be displayed together in the same message.



Source: FHWA.

Figure 4. Diagram. Decision tree for determining weather events.

Discussion

Adverse weather conditions represent a type of nonrecurring event that can have a particularly large impact on the roadway. Weather events often affect entire roadway systems rather than specific routes and can have long durations. Such events can both increase congestion as travel speeds slow and directly affect visibility and traction. As a result, the safety impacts of a weather event often exceed those associated with other nonrecurring events.

Drivers make greater changes in their travel behavior in response to weather information than in response to other types of nonrecurring events, particularly when provided with information in advance of the event (Weaver, Balk, and Arnold 2019; Barjenbruch et al.; Drobot 2007). Changes may include reducing their speed, increasing their following distances, reducing overtaking, and turning on their headlights (Weaver, Balk, and Arnold 2019; Luoma, et al. 2000). Since CMS messages about a weather event can result in multiple positive effects on driving behavior, CMS operators should consider prioritizing event-type information during weather events.

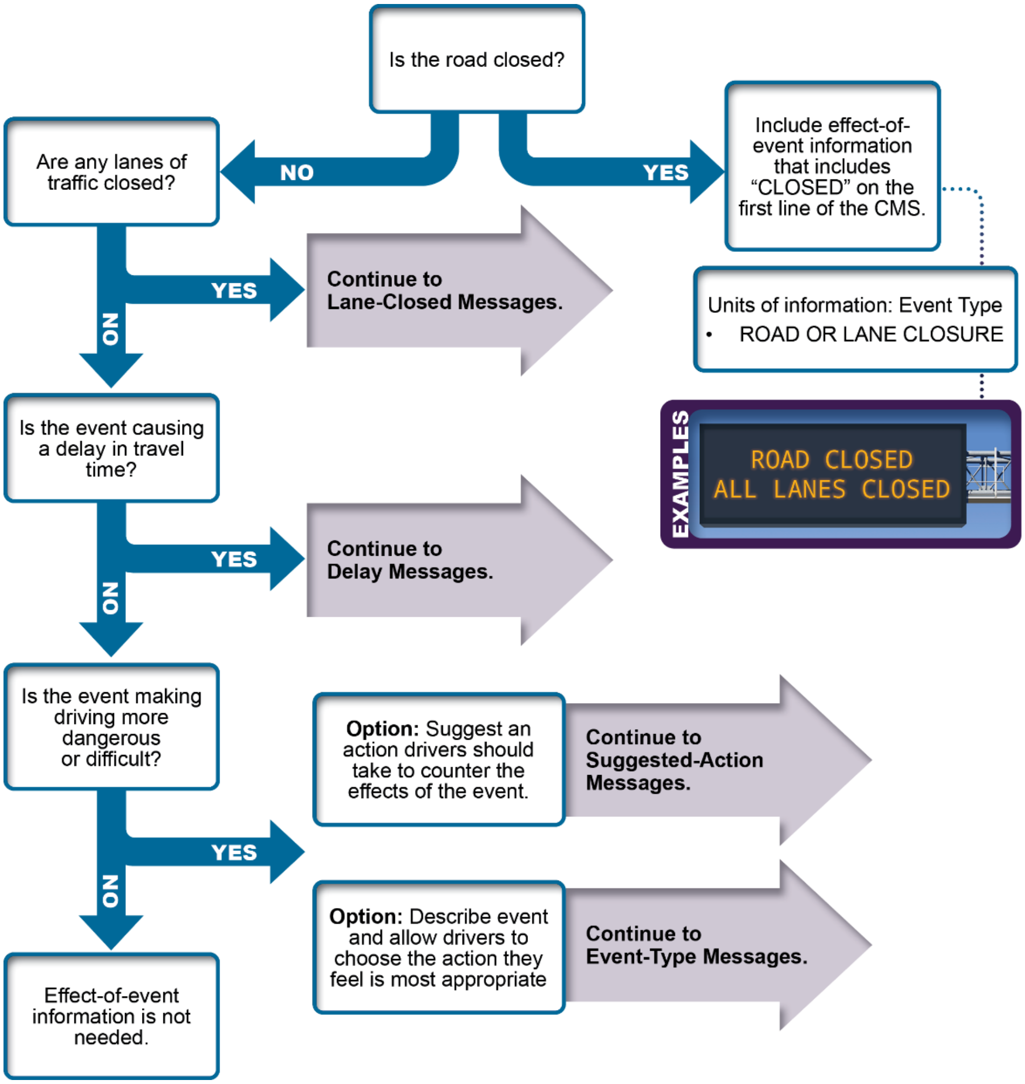
During adverse weather, the specific phrase used for describing the event type can influence drivers' perception of the severity of the event (Ullman et al. 2005). Examples used in this section are categorized based on drivers' stated responses and ranking of messages in different categories of weather events (Weaver, Balk, and Arnold 2019). More generally, descriptors such as SEVERE increase perceived severity of an event and the likelihood that drivers would change their behavior in response to it. Qualifiers such as POSSIBLE have the opposite effect (Weaver, Balk, and Arnold 2019). Some CMS operators choose to temper CMS messages about weather events by including qualifiers, since predicting the precise duration, severity, and location of a weather event can be difficult (Richard et al. 2010; Lichty et al. 2012). Early work on this topic suggests that drivers seem more tolerant of inaccuracies in weather messages than in nonweather messages (Weaver, Balk, and Arnold 2019). As a result, qualifiers may not always be necessary to preserve drivers' trust in weather messages.

Not all weather events are equally influenced by the addition of descriptors, however. Weaver, Arnold, and Jannat (2024, forthcoming) found that the addition of descriptors did not change how drivers perceived or responded to wind or visibility messages. For those events, CMS operators may consider using messaging that prioritizes consistency.

EFFECT OF EVENT

Introduction

Effect-of-event information communicates to drivers the impact a nonrecurring event is having on the roadway and can provide a reason to change driving behavior. Some of the most common effects of event are road or lane closures and travel time delays. Some events can also affect a road by making it more difficult or dangerous to drive on. Figure 5 shows the decision tree for determining effect of event. The decision tree is used for developing only a single unit of information for effect of event as part of a more complete CMS message. A single unit of information for effect of event is not intended for display alone on the CMS, and separate units of information for effect of event are not intended for display together in the same message.



Source: FHWA.

Figure 5. Diagram. Decision tree for determining effect of event.

Discussion

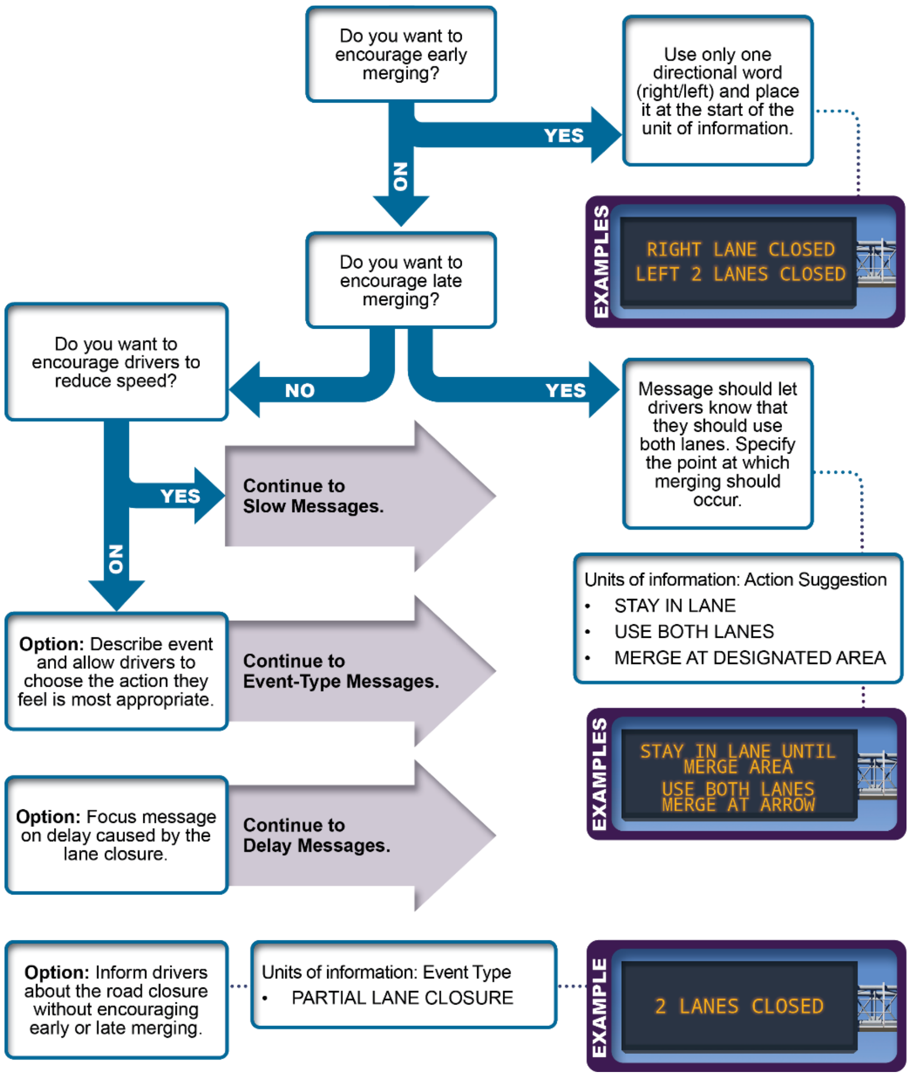
Nonrecurring events that have the most severe impacts on travel plans are those that result in road closures. When a road is closed, all travelers who had intended to use the road must change their travel plans. Dudek and Ullman (2006) indicate that ROAD CLOSED always be prioritized as the first line of the CMS message about such an event type. Participants given road closure information tend to have diversion rates that are near ceiling, such that additional information about event type or suggested actions provides little additional change in driver behavior (Guattari, De Blasiis, and Calvi 2012; Weaver, Balk, and Arnold 2019). Messages that use the term CLOSED (i.e., ROAD CLOSED or ALL LANES CLOSED) have been rated as more effective than those that use the term BLOCKED (i.e., ALL LANES BLOCKED) (Weaver, Balk, and Arnold 2019).

Placing the effect-of-event ROAD CLOSED on the first line of a CMS runs counter to the PLA method, which involves placing the problem or the event that led to the road closure on the first line of the CMS. In a driving simulator study, Weaver, Arnold, and Jannat (2024, forthcoming) explored the potential value of including event information on the first line of a CMS message that included ROAD CLOSED. Participants who saw ROAD CLOSED as the first line of a message changed lanes slightly more quickly and had stress ratings slightly lower than those who saw event information (e.g., FLOODING) as the first line of the message. The findings demonstrate that including event information in a road closure message did not benefit drivers. Since event information increases the size of the message without providing any benefit, operators may exclude event information from messages warning about a road closure. Instead, when a nonrecurring event results in a road closure, the road closure information may be placed on the first line of the CMS message.

Lane Closure

Introduction

When a nonrecurring event results in a lane reduction, the specific CMS message to use depends on the goal of the message. Messages can encourage different types of merging behavior, inform drivers about the lane closure, or focus on reductions in travel times and travel speeds that are likely to occur as results of the lane closure. Figure 6 shows the decision tree for determining lane closure. The decision tree is used for developing only a single unit of information about lane closure as part of a more complete CMS message. A single unit of information for lane closure is not intended for display alone on the CMS, and separate units of information about lane closure are not intended for display together in the same message.



Source FHWA.

Figure 6. Diagram. Decision tree for determining lane closure.

Discussion

Lane closures can reduce a roadway's capacity and lead to vehicle queuing, slow or stopped traffic, and travel delays. The most appropriate action for drivers approaching a lane closure depends on the availability of alternate routes, the roadway's capacity, and current traffic volume and speeds. CMS messages can encourage drivers to make the changes most appropriate for a specific lane closure.

Early merging, or merging that occurs before a driver reaches the end of the queue, has been found to reduce cut-ins and decrease anger among queuing drivers (Nemeth and Rouphail 1982; Tarko, Kanipakapatnam, and Wasson 1998). However, because it increases queue length, early merging also functionally extends the length of the lane closure. The reduced capacity of the roadway negatively affects traffic throughput, especially when traffic volumes are high (Tarko, Kanipakapatnam, and Wasson 1998; Mousa, Rouphail, and Azadivar 1990; McCoy and Pesti 2001). CMS messages that are most effective in encouraging early merging are also associated with reduced rates of route diversion and higher speeds on the approach to the lane closure (Schroeder and Demetsky 2010).

Early merging is encouraged by messages that indicate the direction of the lane closure (Schroeder and Demetsky 2010). Since the directional terms RIGHT and LEFT can sometimes be confusing, messages that contain opposite directional words are discouraged—particularly within the same sign (e.g., RIGHT LANE CLOSED/MERGE LEFT) (Proffit and Wade 1998). Work zone signing (i.e., W20-5) describes lane closures by referencing the closed lane (FHWA 2009). CMS operators can achieve consistency in messaging by using the same message phrase to encourage early merging.

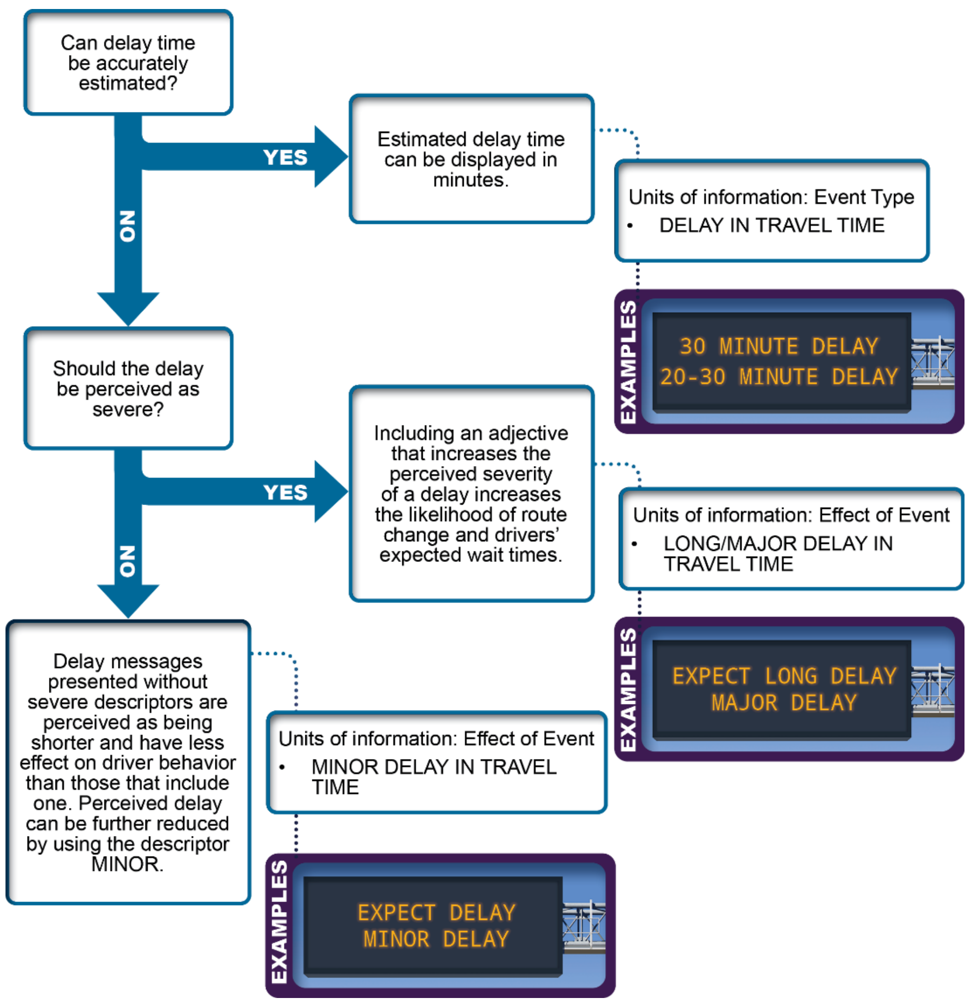
Late merging encourages drivers to merge as close to the lane closure as possible. By encouraging use of both lanes for longer times, late merges increase traffic throughput (Grillo, Datta, and Hartner 2008; Kang, Chang, and Paracha 2006; Radwan, Zaidi, and Harb, 2011). Signing that emphasizes that the use of both lanes is appropriate may also reduce the aggressive behaviors sometimes seen from queuing drivers during a lane closure (McCoy and Pesti 2001). Nevertheless, since the lane reduction signing provision in the MUTCD is not designed to encourage late merging, the conflicting messages provided by a CMS encouraging late merge and any lane reduction signs could potentially cause confusion about where drivers should actually merge (Proffitt and Wade 1998).

To encourage a late merge, signs may warn about the upcoming lane closure but encourage drivers to remain in their lanes until they reach a specific merge point. An additional portable CMS that indicates the appropriate merge point may be positioned just before the lane reduction to help drivers recognize when to merge (United Research Services 2004).

Travel Time Delay

Introduction

One common effect of nonrecurring events is a delay in travel time. Drivers who receive information about the presence of a delay are more likely to select an alternate route (Inman, Bertola, and Philips 2015; Weaver, Balk, and Arnold 2019; Pent, Guequierre, and Blakeman 2004). Delay messages often attempt to specify the magnitude of the delay—a practice that helps drivers understand the severity of the nonrecurring event and promotes changes in driver behavior (Lappin and Bottom 2001; Al-Deek et al. 1989; Kattan et al. 2011). Figure 7 shows the decision tree used for determining travel time delay. The decision tree is used for developing only a single unit of information for travel time delay as part of a more complete CMS message. A single unit of information for travel time delay is not intended for display alone on the CMS, and separate units of information for travel time delay are not intended for display together in the same message.



Source FHWA.

Figure 7. Diagram. Decision tree for determining travel time delay.

Discussion

Delay messages can be broadly divided into quantitative and qualitative messages. Quantitative delay messages use numbers to quantify the magnitude of the expected delay. Delays can be quantified in terms of queue length, traffic speed, total travel time, or delay time (Lerner et al. 2009; Srinivasan and Krishnamurthy 2003; Yim and Ygnace 1996). While all of these methods of indicating a quantitative delay have been shown to influence driver behavior, drivers can process more quickly delay messages that include time than messages involving speed (Lerner et al. 2009). Lerner et al. (2009) also found that drivers processed messages more quickly if the unit of measurement was included in the message (i.e., MINS), while Dudek and Ullman (2006) found that drivers expect the time displayed on a CMS to refer to the additional delay the event is causing rather than to the total travel time. Using added delay time instead of estimated trip time also helps engender driver trust in CMS messages, since total travel time can be more difficult for CMS operators to estimate and easier for drivers to invalidate.

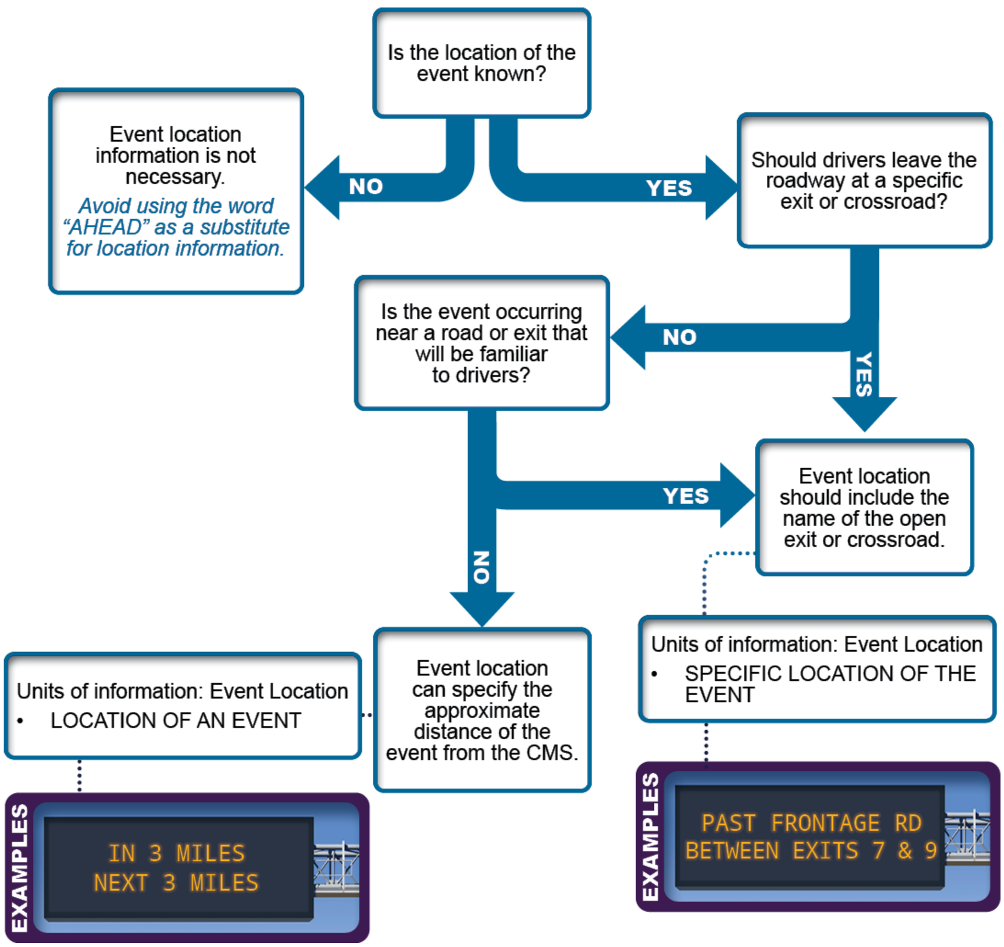
If CMS operators cannot accurately estimate the precise timing associated with a delay, they might use qualitative delay messages, which use adjectives to describe the magnitude of a delay. Research suggests that drivers are sensitive to delay descriptions such that descriptor words indicating high and low severity (e.g., MAJOR and MINOR) influence both how likely drivers are to change their behavior and the amount of time they expect to be delayed (Peng, Guequierre, and Blakeman 2004; Boyle and Mannering 2004). CMS operators have used a variety of adjectives to describe the magnitude of a delay. Findings regarding which descriptor is associated with the greatest delay times have been inconsistent (Wardman, Bonsall, and Shires 1997; Dudek and Ullman 2006; Chaurand, Bossart, and Delhomme 2015).

Expected delay times for different qualitative delay messages likely vary based on geographic region; individual driving history, including previous delay exposure; and the specific nonrecurring event that is causing the delay. Nevertheless, the specific lengths of delay estimated for different descriptors may not be particularly influential in determining how drivers respond to delay messages. Field and simulation studies suggest that diversion rates tend to follow a stepwise pattern wherein a large increase in diversion rates is found once a particular delay threshold has been reached (Yim and Ygnace 1996; Ardeshiri, Jeihani, and Peeta 2015). Indeed, Weaver, Arnold, and Jannat (2024, forthcoming) found increased stated diversion rates for delay messages that included the descriptors LONG, MAJOR, or HEAVY, but differences in the perceived travel time for each of those messages did not result in changes in the frequency of ratings of behavior change. In the presentation of information about a delay, consistent and accurate information may be more important than the specific words used for conveying that information.

EVENT LOCATION

Introduction

Location information is frequently included in CMS messages. Location information enables drivers to know where an event is occurring relative to their position and to gauge the opportunity for making changes to their behavior before reaching the event. When included in a CMS, location information is to be placed on the second line of the CMS—directly below event information or, when appropriate, effect-of-event information. Figure 8 shows the decision tree used for determining event location. The decision tree is for developing only a single unit of information for event location as part of a more complete CMS message. A single unit of information for event location is not intended for display alone on the CMS, and separate units of information for event location are not intended for display together in the same message.



Source FHWA.

Figure 8. Diagram. Decision tree for determining event location.

Discussion

When surveyed about the type of information they wish to see on CMSs, drivers report valuing location information (Muizelaar and Van Arem 2007; Peeta, Ramos, and Pasupathy 2000) and cite being unsure of where an event is located as one reason for not changing behavior after seeing a CMS message (Chatterjee et al. 2002). However, including location information in a CMS message does not always influence how drivers react to that message (Peeta, Ramos, and Pasupathy 2000). The usefulness of location information is likely to vary as a function of the availability of alternate routes on the road network, the actual distance between the CMS and the event, and event type (Weaver, Balk, and Arnold 2019; Richards and McDonald 2007).

CMS operators can convey location information by naming a specific place, such as an exit or cross street. The use of specific exits and street names is most appropriate when the information will be known to drivers, such as when the route is frequented by local drivers or when drivers can use the street names to avoid the event. When a CMS includes specific locations or street names, drivers tend to assume that the named street or exit is open, such that the event described on the CMS would not block access to the road. That assumption is true both for location information that includes only a single location (e.g., EVENT/AT EXIT X) and for location information that uses two locations to specify a range the event takes place within (e.g., EVENT FROM X TO X). For consistency with drivers' expectations, location information that includes a specific road or exit is to reference a location upstream from the nonrecurring event and, when possible, refer to open exits or streets drivers can use to avoid the event (Ullman et al. 2005).

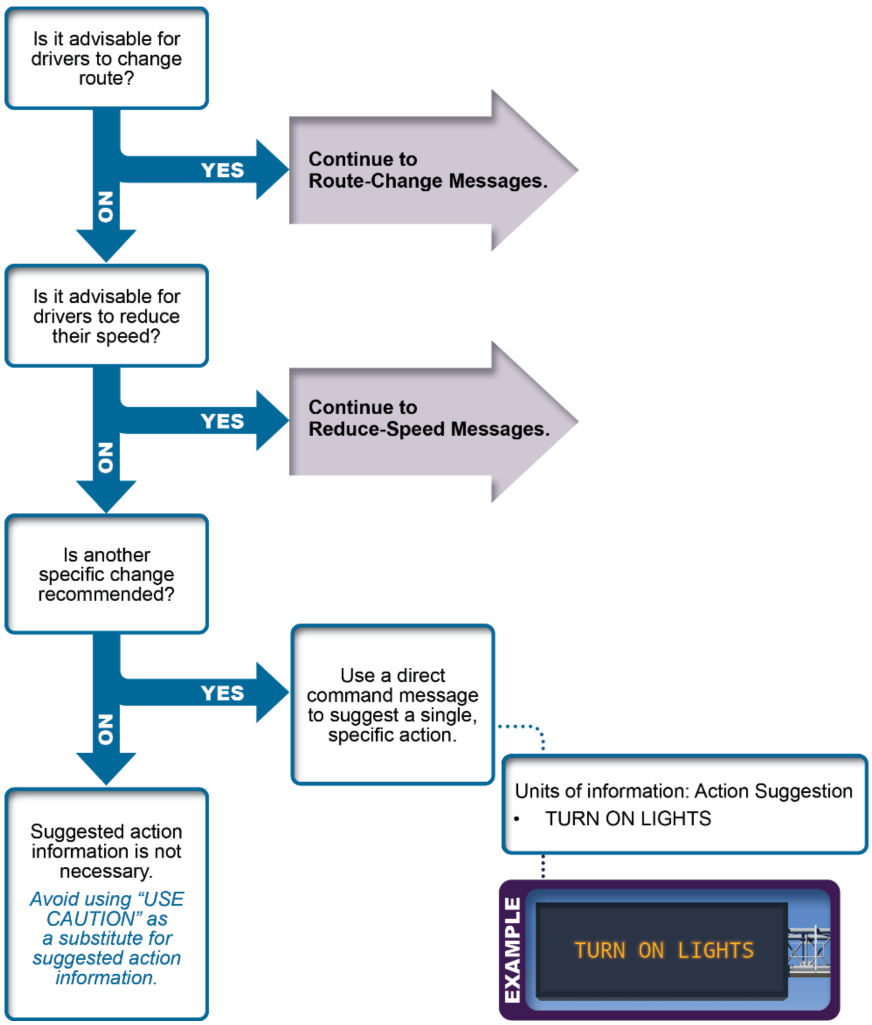
When the location information refers to distance, phrases such as 5 MILES can sometimes be mistakenly interpreted as indicating the length of the nonrecurring event rather than the distance to the event—especially for nonrecurring events such as roadwork, which can extend for several miles (Weaver, Balk, and Arnold 2019). Adding the preposition IN to the beginning of the phrase (e.g., IN 5 MILES) or AHEAD to the end of the phrase (e.g., 5 MILES AHEAD) may help eliminate confusion.

While the word "AHEAD" may provide clarity when it is part of a location phrase that specifies distance, using AHEAD as a substitute for more detailed location information (e.g., ROADWORK AHEAD) is discouraged. Dudek and Ullman (2006) refer to AHEAD as a dead word and encourage operators to remove it from CMS messages whenever possible. Because drivers always assume that an event described on a CMS will occur ahead of them, the word "AHEAD" increases message length and, thus, the reading time of a message without providing any valuable information for drivers.

SUGGESTED ACTION

Introduction

Suggested action messages encourage drivers to make specific changes in their driving behavior. The promotion of a single specified behavior via suggested actions offloads the decisionmaking process for how to respond to a nonrecurring event and makes compliance more likely. Figure 9 shows the decision tree used for determining suggested actions. The decision tree is used for developing only a single unit of information for suggested action as part of a more complete CMS message. A single unit of information for suggested action is not intended for display alone on the CMS, and separate units of information for suggested action are not intended for display together in the same message.



Source FHWA.

Figure 9. Diagram. Decision tree for determining suggested action.

Discussion

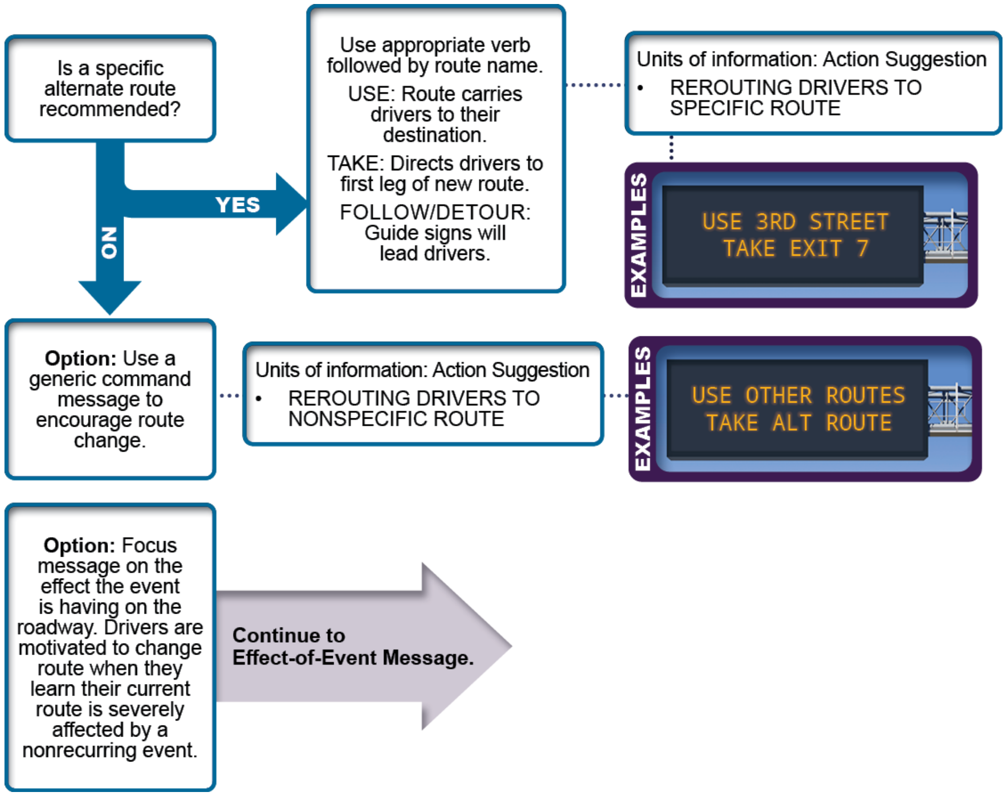
Providing drivers with a direct action suggestion is an effective way of influencing travel behavior (Vergauwe, Barrouillet, and Vamos 2009; Jamson, Tate, and Jamson 2005; Jeihani et al. 2018). Driving during a nonrecurring event can often be more cognitively demanding than typical driving. Drivers may have limited time and cognitive resources for drawing safety inferences while driving during nonrecurring events. Direct action suggestions, which offload the task of deciding how to respond to an event, can be especially helpful in such situations, with more specific suggestions leading to greater rates of compliance behavior (Vergauwe, Barrouillet, and Vamos 2009).

CMS messages with direct action suggestions can encourage drivers to make specific changes in their behavior. Nevertheless, the number of actions available to travelers midtrip is somewhat limited. Drivers can be encouraged to take an alternate route or to take precautionary measures such as adjusting their speed or preparing to stop. When none of those actions are applicable, CMS operators sometimes display the phrase USE CAUTION as a potential action. Phrases like USE CAUTION or WARNING are designed to capture drivers' attention and to signal to them that extra care is needed. However, research does not support the use of signal words on CMSs (Lichty et al. 2012; Proffitt and Wade 1998). Signal words have not been found to increase participants' stated diversion rates (Weaver, Balk, and Arnold 2019). That lack of influence is not surprising given basic research on selective attention. Surface characteristics such as color, size, or sudden onset are capable of capturing attention; however, semantic processing can occur only after the reader has attended to a word or phrase. In the context of CMS messages, semantic processing means that drivers would have already had to direct their attention to the CMS in order to read the signal word, at which point capturing their attention with a signal word is no longer necessary. Thus, signal words increase the length of the message without providing a verified benefit to travelers (Proffitt and Wade 1998). Rather than including signal words, a CMS message might instead either specify the actual action for drivers to take (e.g., REDUCE SPEED or USE LIGHTS) or simply describe the event that is influencing the roadway and allow drivers to select the action they feel is most appropriate.

Route Change

Introduction

A frequent goal of CMS messaging is to alleviate the traffic backup generated by a nonrecurring event by encouraging a portion of drivers to divert to an alternate route. Messages that include a specific action request tend to be successful in eliciting route change, with increases in specificity of the request leading to increased diversion rates. However, route change can be elicited by messages that provide drivers with a good reason to change routes, such as messages that warn about an upcoming delay. Figure 10 shows the decision tree used for determining route change. The decision tree is used for developing only a single unit of information for route change as part of a more complete CMS message. A single unit of information for route change is not intended for display alone on the CMS, and separate units of information for route change are not intended for display together in the same message.



Source FHWA.

Figure 10. Diagram. Decision tree for determining route change.

Discussion

Increases in rates of route change are frequently reported effects of CMS messaging. Increased alternate route use has been reported in response to various messages, including those that report road closures, delays, congestions, and travel times (Erke, Sagberg, and Hagman 2007; Lerner et al. 2009; Peeta, Ramos and Pasupathy 2000; Foo, Abdulhai, and Hall 2008; Harder, Bloomfield, and Chihak 2003). High rates of diversion are also found for CMS messages that directly suggest a driver change routes (Jindahra and Choocharukul 2013; Madanat, Yang, and Yen 1995; Jeihani et al. 2018; Weaver, Balk, and Arnold 2019).

Increases in the specificity of a suggested action displayed via CMS lead to increases in the proportion of vehicles that comply with that suggested action (Schroeder and Demetsky 2010). Specifically, messages indicating incidents or delays were present without suggesting alternate routes were associated with low diversion rates. Messages suggesting drivers take alternate routes without specifying the specific route to be used led to moderate diversion rates, while messages that suggested drivers use a specific alternate route were associated with the highest rates of diversion. As long as drivers are familiar with the suggested route, the highest levels of diversion will result by instructing drivers to take a specific alternate route (Jindahra and Choocharukul 2013).

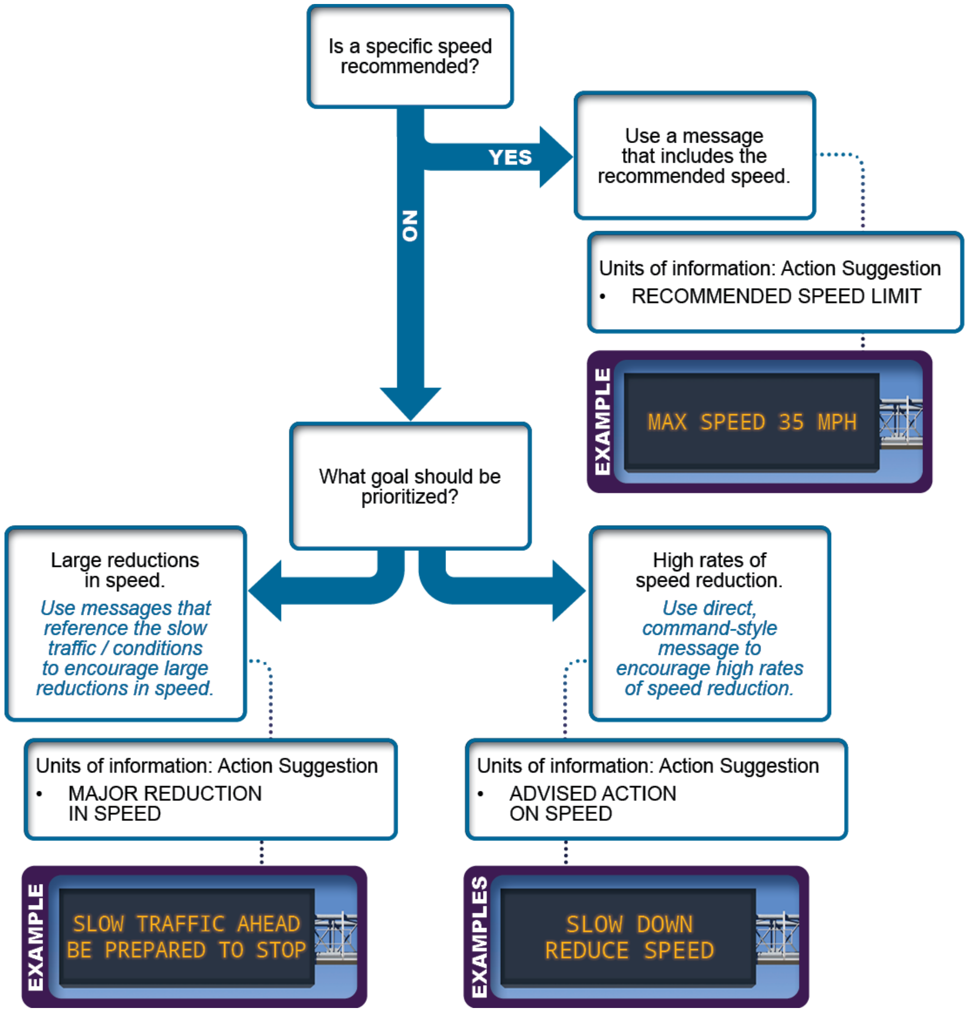
CMS operators suggesting a specific alternate route have to ensure that the suggested route can accommodate diverting drivers, since encouraging drivers to take the alternate route will benefit the roadway system only as long as the capacity of the alternate route is not exceeded (Luoma et al. 2000; Chaurand, Bossart, and Delhomme 2015). Concern that diverting traffic may exceed the capacity of specific alternate routes prevents many CMS operators from suggesting specific roadways on CMSs (Schroeder and Demetsky 2010; Finley, Gates, and Dudek 2001; Barjenbruch et al. 2016).

Diversion rates are difficult to estimate because they are influenced by a number of factors such as personal driver factors like age, gender, personality, and familiarity with the road network, as well as external variables such as time of day, weather conditions, and visible congestion levels (Wardman, Bonsall, and Shires, 1997; Peng, Guequierre, and Blakeman 2004; Harder, Bloomfield, and Chihak 2003; Ardeshiri, Jeihani, and Peeta 2015; Jeihani and Ardeshiri 2013). Research on CMS messaging is likely to be more informative in determinations of the relative effectiveness of different types of messages than it is in provisions of specific estimates of the percentage of drivers who will divert in response to a message.

Reduce Speed

Introduction

During a nonrecurring event, reductions in speed can help drivers better negotiate dangerous conditions, help prevent end-of-queue collisions, and help alleviate traffic congestion. With regard to specific messages that encourage speed reduction, there appears to be an inverse relationship between the amount by which drivers believe they should reduce their speed after seeing a message and the number of drivers who state they would reduce their speed in response to that message. Thus, CMS operators may need to determine whether they would prefer high-compliance frequencies or large drops in speed. Figure 11 shows the decision tree used for determining speed reduction messages. The decision tree is used for developing only a single unit of information for speed reduction as part of a more complete CMS message. A single unit of information for speed reduction is not intended for display alone on the CMS, and separate units of information for speed reduction are not intended for display together in the same message.



Source FHWA.

Figure 11. Diagram. Decision tree for determining reduce speed.

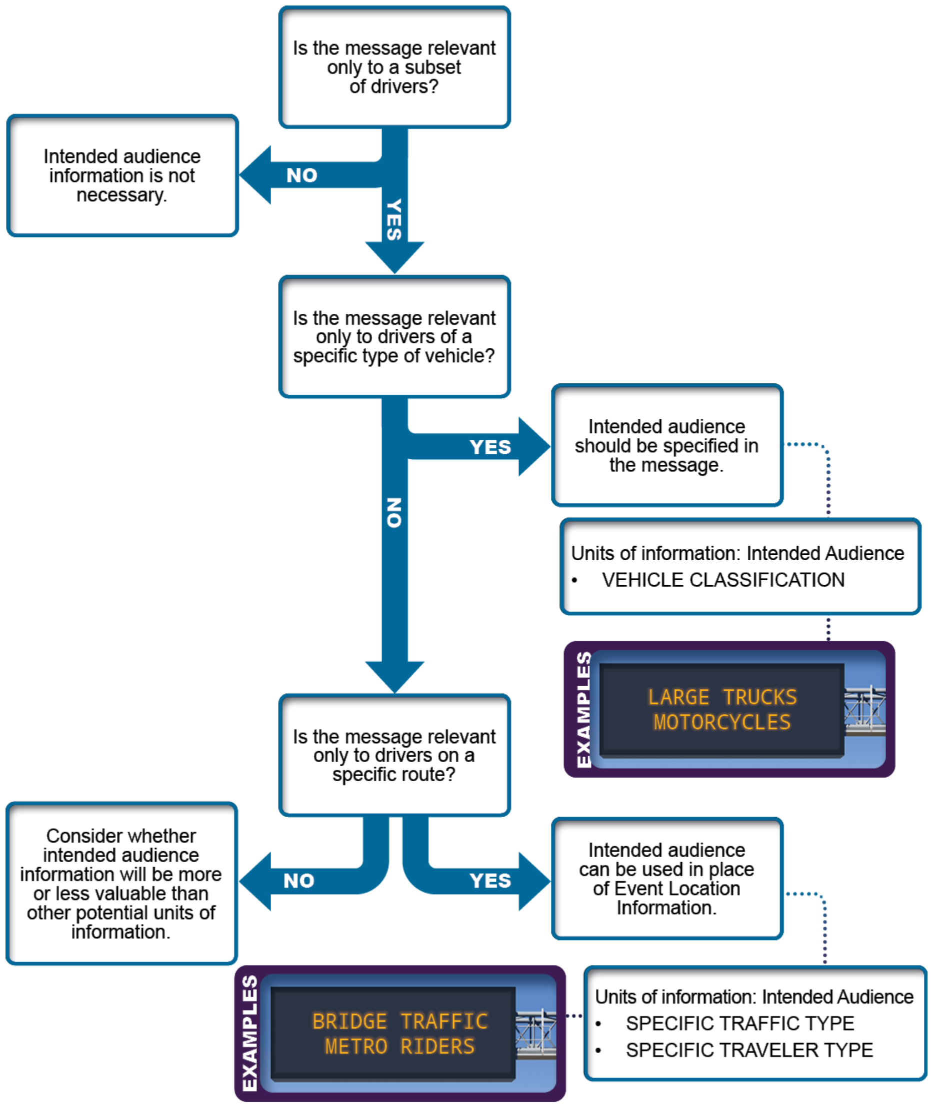
Discussion

Reductions in speed have resulted in response to various CMS messages, including those that warn against potential hazardous conditions on the road ahead (Luoma et al. 2000; Alm and Nilsson 2000). CMS operators may also use messages that directly mention driver and traffic speed to encourage speed reductions (Weaver, Balk, and Arnold 2019; Garber and Patel 1995; Chaurand, Bossart, and Delhomme 2015). A number of different phrases may be used for encouraging drivers to reduce their speed during a nonrecurring event (e.g., SLOW, SLOW DOWN, REDUCE SPEED, PREPARE TO STOP, SLOW TRAFFIC AHEAD, ADVISE SPEED XX, and MAX SPEED XX) (Luoma et al. 2000; Alm and Nilsson 2000). Research has noted that using a direct command message (e.g., SLOW DOWN) can be an effective method for eliciting a change in speed and is more effective than relying on drivers to infer that a speed reduction is required based on a description of, for instance, a potentially hazardous weather event (Weaver, Balk, and Arnold 2019). However, when Weaver, Arnold, and Jannat (2024, anticipated) asked drivers how much to slow down in response to different types of weather messages, these same command messages were perceived as requiring the smallest reductions in speed. In contrast, messages that referred to slow or stopped traffic (e.g., SLOW TRAFFIC AHEAD) were associated with lower frequencies of expected speed reduction but also perceived as requiring a greater reduction in driving speed. The reason for this contrast is likely based on the extent to which a message elicits a change in route. Previous work has found that CMS messages that included the suggested action SLOW DOWN led to reduced diversion ratings (Weaver, Balk, and Arnold 2019). If drivers typically perform only one action in response to a CMS message, then when encountering a message about a nonrecurring event, drivers may choose either to slow down or to change routes but are unlikely to do both. Thus, messages that are perceived as requiring more dramatic drops in speed were less likely to result in a slowing and more likely to result in a route change.

INTENDED AUDIENCE

Introduction

Often, the information on a CMS may apply to all drivers on a particular roadway. Other times, the information may be intended for a specific segment of road users. When a message applies to a particular group of road users, the operator has an option to specify targeted users directly. Figure 12 shows the decision tree used for determining an intended audience. The decision tree is used for developing only a single unit of information for an intended audience as part of a more complete CMS message. A single unit of information for an intended audience is not intended for display alone on the CMS, and separate units of information for an intended audience are not intended for display together in the same message.



Source FHWA.

Figure 12. Diagram. Decision tree for determining intended audience.

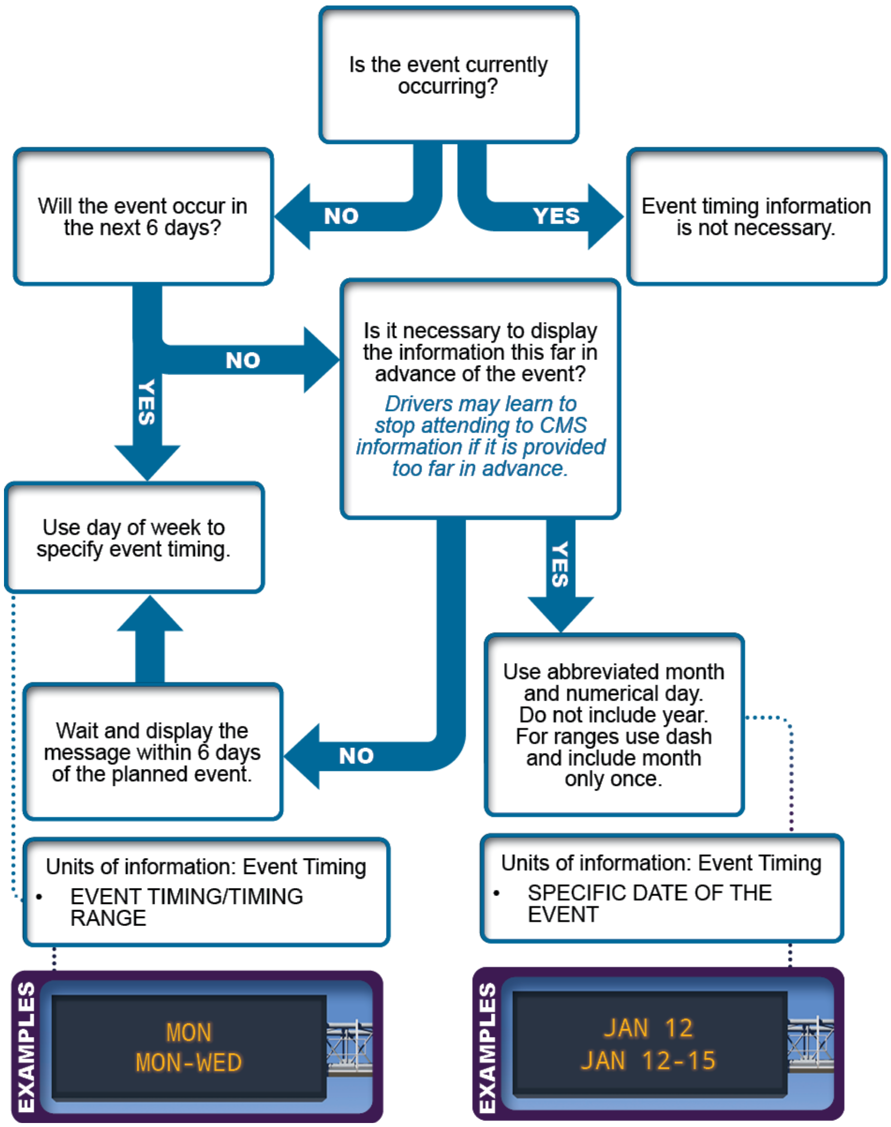
Discussion

Dudek and Ullman suggest that when a message applies to a particular group of road users, the audience be specified in the CMS message (e.g., BRIDGE TRAFFIC) (Ullman, Ullman, and Dudek 2007). Weaver, Arnold, and Jannat (2024, forthcoming) assessed whether messages that specify an intended audience are more effective than messages that include only location information. They found that participants were slightly better at identifying the intended audience of a message that directly contained intended-audience information than the intended audience of a message that did not. However, that knowledge did not have a significant effect on participants' response to each message. The results suggest that location information may be a sufficient substitute for intended-audience information in some circumstances, but intended-audience information may be more appropriate in situations in which the potential target audience of the message is unclear.

EVENT TIME

Introduction

CMSs are typically used for giving drivers information about events that are currently happening on a roadway. They may also be used for informing drivers about events that are expected to affect traffic in the near future. Figure 13 shows the decision tree used for determining event time. The decision tree is used for developing only a single unit of information for event time as part of a more complete CMS message. A single unit of information for event time is not intended for display alone on the CMS, and separate units of information for event time are not intended for display together in the same message.



Source FHWA.

Figure 13. Diagram. Decision tree for determining event time.

Discussion

Drivers assume that CMS messages are about current conditions on the roadway (Ullman, Ullman, and Dudek 2007). Providing time stamps for current events is not necessary (Benson 1996). However, when a CMS provides information about a future event, event timing information is needed to inform drivers of when the event will occur. Days of the week work best to specify the future event time. Drivers have difficulty calculating how many days in the future an event will be occurring when they are provided with only date information relative to when days of the week are provided. If the future event will take place only during specified hours, a message can also include event time (e.g., 10 a.m.–6 p.m.). However, drivers have limited ability to remember time information displayed on CMSs (Ullman, Ullman, and Dudek 2007).

Drivers would not be able to differentiate between this Monday and next Monday based on day-of-the-week information alone, so days of the week can announce to drivers only events planned in the next 6 d. If an event is planned for more than 6 d in the future, it may be too early to create a CMS message about that event. It is important to use CMSs in ways that promote drivers' trust and attention. If drivers frequently view messages they do not deem relevant to their current driving situation, their trust in and use of CMSs will degrade (Chatterjee et al. 2002). Limiting the length of time that information about a future event is displayed on a CMS can prevent drivers from becoming overloaded with uninformative messaging and can reduce CMS energy and maintenance costs (Finley, Gates, and Dudek 2001).

If providing information about an event more than 6 d in the future is deemed necessary, then dates can display that information. Month names (e.g., APR 21) lead to greater message recall than numbers (e.g., 4/21) and are easier to recognize relative to the current date (Ullman, Ullman, and Dudek 2007). When a message refers to a range of dates, a dash provides a compact alternative to the word "THRU" that is easy for drivers to understand. Including the name of the month twice (e.g., APR 21–APR 25) does not improve recall or comprehension compared with giving the month only once (e.g., APR 21–25), and drivers prefer this format.

CHAPTER 3. WORKSHEET AND EXAMPLES

This chapter is designed to help CMS operators learn how to use this systematic approach to construct CMS messages for nonrecurring events. Table 2 displays a worksheet that can help CMS operators construct CMS messages. The chapter first outlines the components of this worksheet and then provides two examples of how to use the worksheet to construct a CMS message for different nonrecurring events.

Table 2. Message Construction Worksheet

Message goal:____

Unit of Information	Priority (H, M, L, NA)	Message Phrase	Include	Order	Notes
Event type					
Effect of event					
Event location					
Suggested action					
Intended audience					
Event time					

Final CMS Message

Phrase One	Phrase Two

H = high, L = low, M = medium, NA = not applicable.

CMS MESSAGE CONSTRUCTION WORKSHEET

A full-size version of the worksheet appears in the appendix. The worksheet is designed for a CMS operator to complete as they move through the decision trees in chapter 2. The components of the worksheet are outlined in the next sections.

Message Goal

Before beginning to construct a CMS message, it is important to determine-the goal of the message. The message goal helps inform message construction because the CMS operator is identifying and selecting phrases that would be the most effective in accomplishing the goal.

Units of Information

Several different units of information have potential for inclusion in a CMS message. The worksheet lists the six units of information described in chapter 2 (table 2). The worksheet also includes a few blank lines where the CMS operator can insert additional or replicated units of information as necessary.

Priority

The number of units of information operators may place on a CMS typically exceeds the actual capacity limits of the CMS. Therefore, prioritizing the specific and most helpful units of information for drivers so as to best enable the message to meet the message goal is important. To aid in that process, the priority column of the worksheet offers four priority ratings for selection based on the perceived importance of that unit of information (table 2). *High* denotes units of information that are deemed critical. *Moderate* denotes a unit of information relevant to the current nonrecurring event but less critical than those with high priority. *Low* denotes a unit of information that is relevant to the current situation but less valuable to drivers. Finally, *NA* denotes a phrase that is not relevant to the current situation. When NA is selected for a unit of information, that unit will not be included in the message, and the remaining items in that row of the worksheet do not need to be completed.

Message Phrase

The message phrase column in table 2 provides an area where the CMS operator can write out a specific phrase to use on the CMS if that unit of information is included in the final message. Chapter 2 offers several examples of phrases that may be effective in communicating information to drivers. The CMS operator can consider the information and examples in the decision trees in chapter 2 during phrase selection. Further, because consistency in CMS phrasing is important to message-processing ease, a CMS operator gains advantage by maintaining a list of phrases used for specific types of events and by using those phrases consistently through time.

Phrases To Include

Once all of the potential phrases for a CMS have been constructed, the CMS operator then determines the number of units of information to include in the final CMS message. For one-phrase messages, no more than three units of information are to be displayed. For two-phrase messages, no more than four or five units of information are to be displayed, depending on the speed limit of the road where the message will be presented. If the number of units of information added to the worksheet exceeds these limits, the CMS operator can use the priority column to mark the specific units to include in the message.

Phrase Order

The final step in the message construction process is to determine the order of presentation of the units of information. A slightly modified version of the PLA method may be helpful for determining message order. Each phrase of the message must be understandable on its own, and the driver's ability to understand the message must not be influenced by the order in which the messages are seen (FHWA 2009).

Event/Effect of Event

The first line of a CMS message should indicate the problem that drivers will face on the roadway. In many cases, the problem will be stated in the unit of information that corresponds to event type. However, in other cases, the effect of event may be a better fit for that role. For example, if the effect of event ROAD CLOSED is included in a message, the phrase should appear on the first line of the CMS, and event information is not required. When both event type and effect of event are included in the same message, event information should appear before effect of event.

Location

The second line of the CMS is for conveying location information. Location information tells drivers where an event is occurring on the roadway. Location information is not to appear on the first line of the CMS but instead is to be located directly beneath the unit of information to which the location is applicable (e.g., ROADWORK/IN 5 MILES).

Suggested Action

When a suggested action is included in a CMS message, its phrase should appear on the last line of the CMS. The preceding line(s) of the message should have provided a reason to perform the action, and positioning an action suggestion last encourages drivers to proceed with executing the suggested action.

Intended Audience

Intended-audience information targets a specific subset of drivers who are instructed to perform a suggested action. Thus, intended-audience information is to appear before the action selection. In some cases, a CMS operator may wish to include event or effect-of-event information before the intended-audience information because doing so gives context to applicable drivers and may help motivate the intended action. In other cases, the intended audience may appear on the first line of the message.

Event Time

Event time is similar to location information in that it is to appear directly below the event or effect of event to which the displayed date(s) is(are) applicable.

Notes

The final column of the worksheet provides a space where the CMS operator can write notes regarding the factors that motivate the decisions made during each step of the process (table 2). Notes that operators make while selecting one particular phrase can help inform the other phrases. For example, while selecting the priority phrase, an operator may wish to note why each unit of information is more or less applicable to the current nonrecurring event or roadway. That information can then help the operator decide which units of information to include.

Final Message

The bottom portion of the worksheet has a section for writing out the final version of the CMS message (table 2). Room for both one-phrase and two-phrase messages is provided.

EXAMPLES

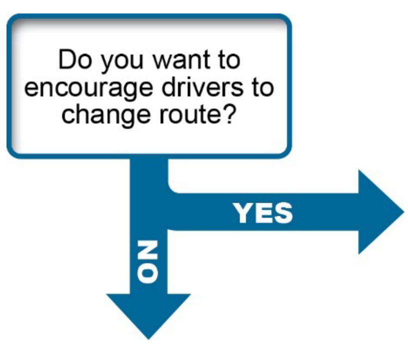
This section provides two examples of how to use the worksheet in combination with chapter 2 to construct messages for different nonrecurring events. The first example is a detailed description of how the questions within each of the relevant decision trees motivate completion of the CMS Message Construction Worksheet for a crash event. The second, more concise examples focus on the decision that led to completion of the worksheet for a roadwork event.

Detailed Example: Crash Event

In this example, a CMS operator has received verification of a crash that is delaying traffic on a four-lane divided highway. The vehicles involved in the crash have been relocated to the side of the road so that no lanes of traffic are currently blocked. However, traffic is still moving at slow speeds in the area and causing significant travel time delays. The following are the steps the operator could use to construct an appropriate message for this nonrecurring event.

Message Goal

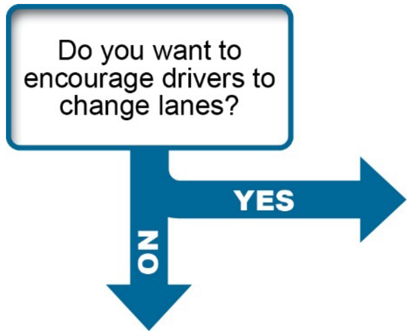
First, the operator determines the goal of the CMS message. The operator uses the decision tree in the section on event type in chapter 2 to help with that goal. The first question in that decision tree is displayed in figure 14.



Source: FHWA.

Figure 14. Diagram. First question in the decision tree for event type.

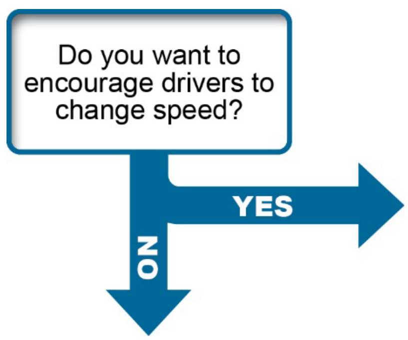
Commuters use this roadway to pass through a relatively rural area that does not include a large number of alternate routes. Few drivers could be encouraged to change routes. The operator follows the NO branch of the tree to the second question (figure 15).



Source: FHWA.

Figure 15. Diagram. Second question in the decision tree for event type.

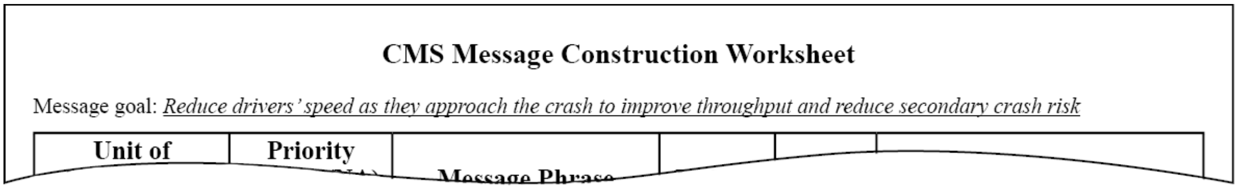
The crashed vehicles have been moved to the shoulder, and no lanes are currently blocked. There is no need to encourage drivers to change lanes. The operator follows the NO branch of the tree to the third question (figure 16).



Source: FHWA.

Figure 16. Diagram. Third question in the decision tree for event type.

The road is congested with slow-moving traffic near the location of the crash. If drivers begin reducing their speed before reaching the slowed-down traffic, throughput could be improved. Gradual speed reductions could also reduce the risk of secondary crashes that may occur when drivers traveling at high speeds reach the slower moving vehicles. Based on the potential safety benefit of reducing speeds, the operator concludes that the goal of this message is to encourage speed reductions. The operator uses that conclusion to follow the message goal portion of the CMS Message Construction Worksheet (figure 17; see also table 2). The CMS operator will use that goal when filling in the remainder of the worksheet (table 2).

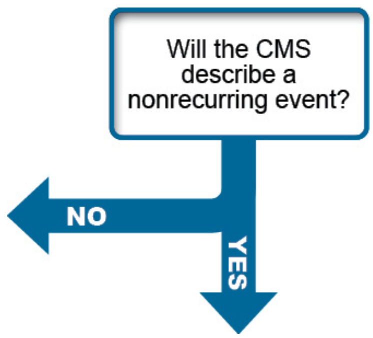


Source: FHWA.

Figure 17. Illustration. Completed message goal within the CMS Message Construction Worksheet.

Event Type

Now the CMS operator is ready to fill in the remainder of the CMS message construction worksheet by starting with the first unit of information, event type (table 2). The operator moves to the decision tree in the event-type section to help determine which phrase to use for this event. The first question from the decision tree in that section is displayed in figure 18.



Source: FHWA.

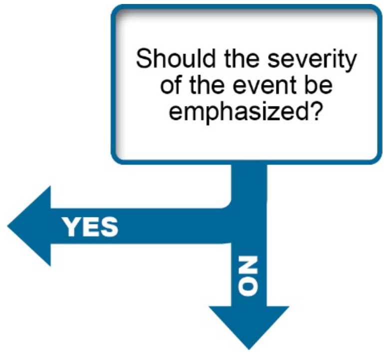
Figure 18. Diagram. First question in the decision tree for event type.

The CMS will describe a crash, which is a nonrecurring event. The CMS operator moves down the YES branch of the tree to the second question (figure 19).

Source: FHWA.

Figure 19. Diagram. Second question in the decision tree for event type.

This crash was not caused by weather conditions. The operator follows the NO branch of the tree to the third question (figure 20).



Source: FHWA.

Figure 20. Diagram. Third question in the decision tree for event type.

The CMS operator would like to keep traffic moving in the area as much as possible. Emphasizing the severity of the crash could be counterproductive to that effort, since it may make drivers more likely to engage in rubbernecking. The operator follows the NO branch of the tree to the end point of the figure, which instructs the operator to describe the event by using a concise word or phrase. For this nonrecurring event, the single word CRASH is the most concise way of describing the event. The operator adds that message phrase to the worksheet (table 2). Knowing that a crash has occurred is not important to the goal of this message, but it does provide drivers with an explanation for the congestion and delays they are likely to encounter and could motivate them to change their behavior. The operator adds this reasoning to the notes section and rates the priority of event type as moderately important on the CMS Message Construction Worksheet (figure 21).

CMS Message Construction Worksheet

Message goal: *Reduce drivers' speed as they approach the crash to improve throughput and reduce secondary crash risk*

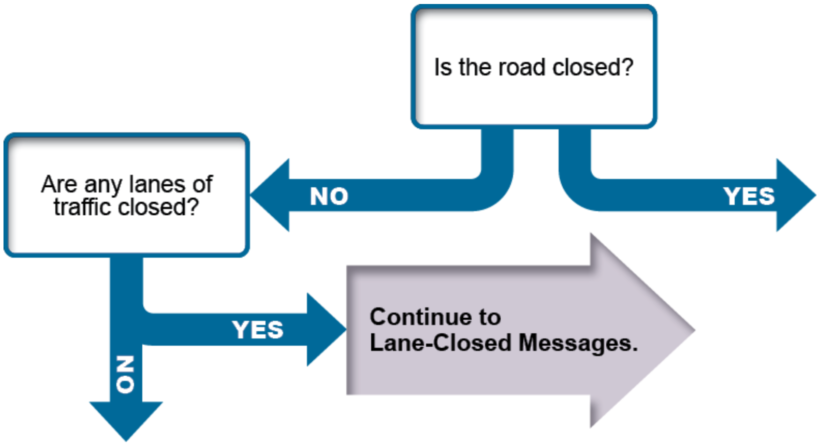
Unit of Information	Priority (H/M/L/NA)	Message Phrase	Include	Order	Notes
Event type	*Moderate*	*CRASH*			*Event info could give drivers a reason to slow down*

Source: FHWA.

Figure 21. Illustration. Completed event-type section of the CMS Message Construction Worksheet.

Effect of Event

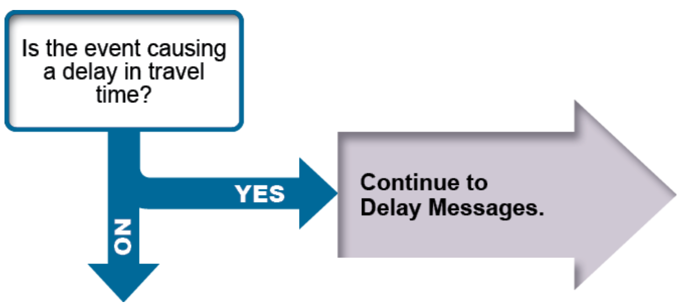
The next unit of information is effect of event, which is described in chapter 2. The first two questions in that decision tree are displayed in figure 22.



Source: FHWA.

Figure 22. Diagram. First and second questions in the decision tree for effect of event.

The first and second questions in this decision tree have straightforward answers. The road in question is not closed and all of the traffic lanes are open. The operator proceeds down the NO branches of the tree to the third question (figure 23).



Source: FHWA.

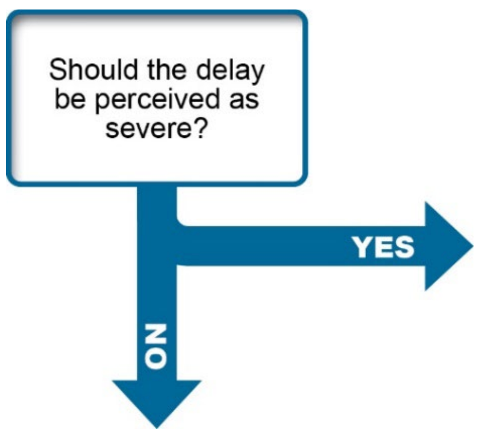
Figure 23. Diagram. Third question in the decision tree for effect of event.

The crash is causing a delay in travel time. The operator follows the YES branch of the tree, which instructs the operator to turn to the subsection on delay messages in chapter 2. The first question in the delay message decision tree is displayed in figure 24.

Source: FHWA.

Figure 24. Diagram. First question in the decision tree for delay messages.

Traffic speed around the nonrecurring event has been somewhat variable, so that it would be difficult to determine the precise length of the delay. The CMS operator follows the NO branch of the tree to the second question (figure 25).



Source: FHWA.

Figure 25. Diagram. Second question in the decision tree for delay messages.

Traffic is traveling at low speeds, but for a relatively short distance. Thus, the total delay would not be categorized as extremely severe. The operator chooses to select a delay message that describes a delay of moderate severity and rates the priority for effect of event as moderate (figure 26).

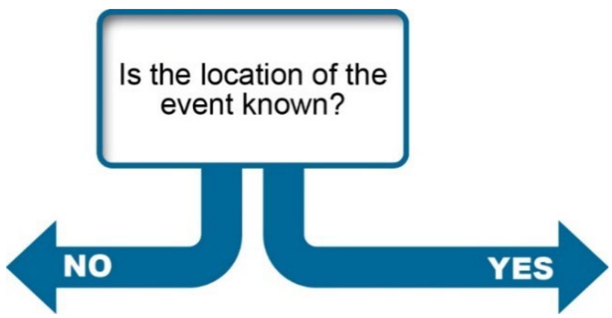
Unit of Information	Priority (H/M/L/NA)	Message Phrase	Include	Order	Notes
Event type	*Moderate*	*CRASH*			*Event info could give drivers a reason to slow down*
Effect of event	*Moderate*	*EXPECT DELAY*			

Source: FHWA.

Figure 26. Illustration. Completed effect-of-event section of the CMS Message Construction Worksheet.

Event Location

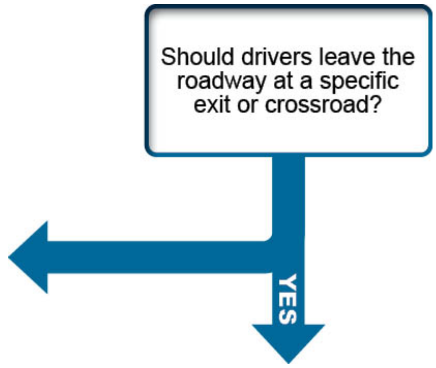
The next unit of information is event location, which is described in chapter 2. The first question in this decision tree is shown in figure 27.



Source: FHWA.

Figure 27. Diagram. First question in the decision tree for event location.

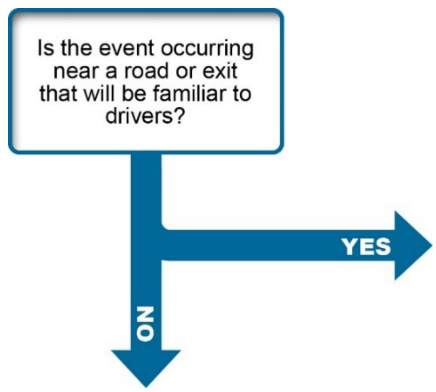
The crash location is known to be about 4 mi downstream from the event. The CMS operator proceeds down the YES branch of the decision tree to the second question (figure 28).



Source: FHWA.

Figure 28. Diagram. Second question in the decision tree for event location.

No applicable alternate routes are available, so drivers should not be instructed to leave the roadway. The operator proceeds down the NO branch of the decision tree to the third question (figure 29).



Source: FHWA.

Figure 29. Diagram. Third question in the decision tree for event location.

The crash did not occur near a specific road or exit, so the CMS operator proceeds down the NO branch of the decision tree, where the operator is then told to approximate the distance between the CMS and the event to construct an event location phrase. The operator adds the phrase to the worksheet (table 2). The operator would like drivers to begin slowing before they reach the actual event and recognizes that having event location information could aid drivers in realizing that the event is not far away. The operator rates the priority of event location as high (figure 30).

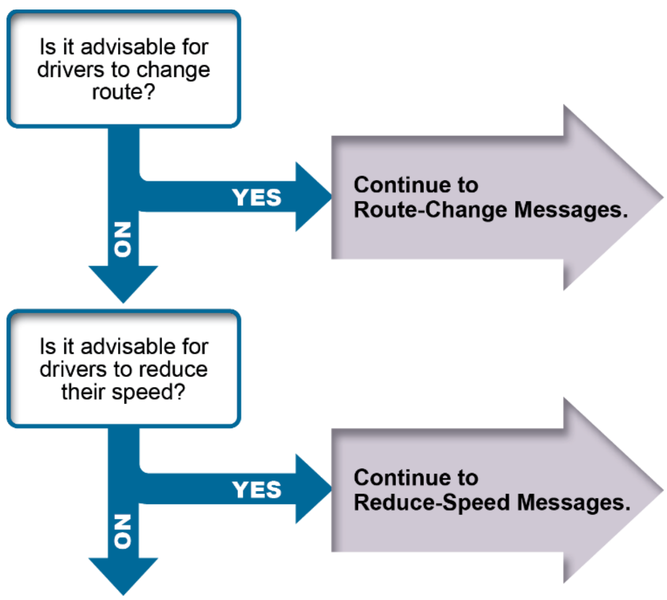
Unit of Information	Priority (H/M/L/NA)	Message Phrase	Include	Order	Notes
Event type	*Moderate*	*CRASH*			*Event info could give drivers a reason to slow down*
Effect of event	*Moderate*	*EXPECT DELAY*			
Event location	*High*	*IN 4 MILES*			

Source: FHWA.

Figure 30. Illustration. Completed event location section of the CMS Message Construction Worksheet.

Suggested Action

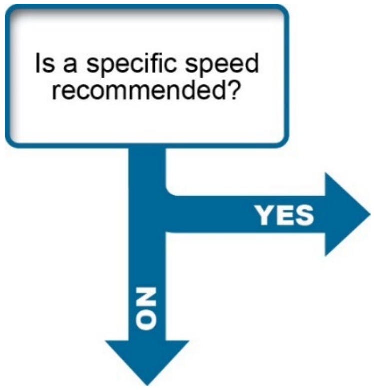
The next unit of information—suggested action—is located in chapter 2. Figure 31 displays the first two questions in the suggested-action decision tree.



Source: FHWA.

Figure 31. Diagram. First and second questions in the decision tree for suggested action.

The first question—Is it advisable for drivers to change route?—is not applicable to this event, so the CMS operator proceeds down the NO branch to the second question. Since reducing drivers' speed in advance of the crash is the goal of this CMS message, the operator follows the YES branch of the tree to the speed reduction messages subsection in chapter 2. The first question of that decision tree is displayed in figure 32.



Source: FHWA.

Figure 32. Diagram. First question in the decision tree for speed reduction.

The goal is for drivers to reduce their speed, but a new, specific target speed is not provided. The CMS operator proceeds down the NO branch of the decision tree to question two (figure 33).

Source: FHWA.

Figure 33. Diagram. First question in the decision tree for speed reduction.

Now the operator must make a decision about whether to use a message that prioritizes the rate of slowing or the reduction in required speed. Due to the low speed of traffic directly surrounding the crash relative to the posted speed limit, the operator thinks large reductions in speed are to be prioritized. The operator chooses the left branch of the decision tree, which encourages choosing a message phrase that references the slow traffic caused by the nonrecurring event. The operator selects the phrase SLOW TRAFFIC AHEAD. Since this unit of information matches the message goal, the operator rates its priority as high (figure 34).

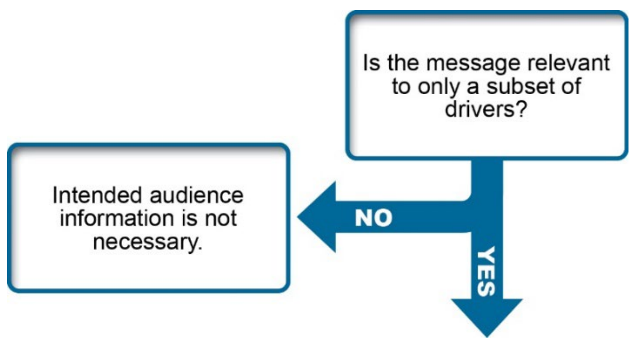
Unit of Information	Priority (H/M/L/NA)	Message Phrase	Include	Order	Notes
Event type	*Moderate*	*CRASH*			*Event info could give drivers a reason to slow down*
Effect of event	*Moderate*	*EXPECT DELAY*			
Event location	*High*	*IN 4 MILES*			
Suggested action	*High*	*SLOW TRAFFIC AHEAD*			*This is the goal of the message*
Intended audience	*NA*				

Source: FHWA.

Figure 34. Illustration. Completed suggested action section of the CMS Message Construction Worksheet.

Intended Audience

The next unit of information is intended audience, which is described in chapter 2. The first question in that decision tree is displayed in figure 35.



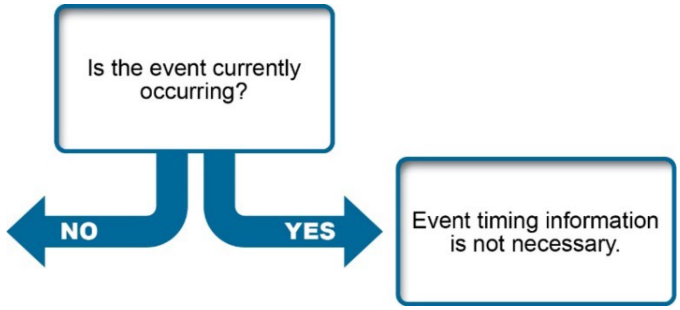
Source: FHWA.

Figure 35. Diagram. First questions in the decision tree for intended audience.

Since the current message will apply to all drivers on the roadway, the CMS operator proceeds down the NO branch of the decision tree, which indicates that intended-audience information is not needed. The operator transfers that information to the worksheet (table 2).

Event Time

The final unit of information is event time, discussed in chapter 2. Figure 36 displays the first question in that decision tree.



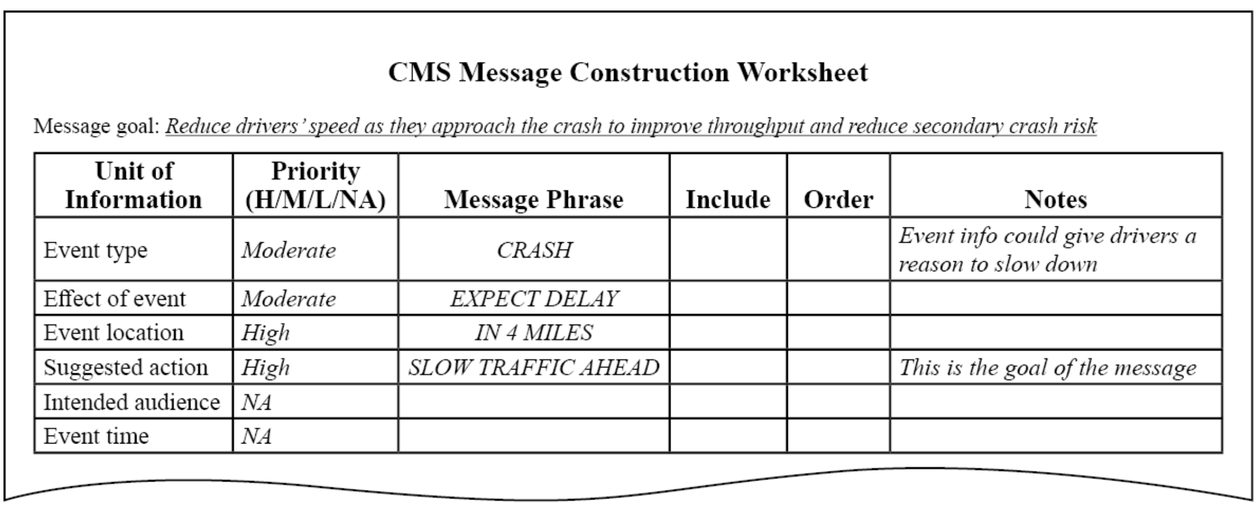
Source: FHWA.

Figure 36. Diagram. First questions in the decision tree for event time.

The event is currently occurring on the roadway. Determining that event timing is not necessary for this CMS message, the operator marks this unit of information as NA on the worksheet (table 2).

Phrases To Include

After working through the decision trees in chapter 2, the CMS operator is ready to determine which of the selected phrases to include in the final CMS message. Figure 37 shows the information that has been filled in on the worksheet so far (table 2).



CMS Message Construction Worksheet

Message goal: *Reduce drivers' speed as they approach the crash to improve throughput and reduce secondary crash risk*

Unit of Information	Priority (H/M/L/NA)	Message Phrase	Include	Order	Notes
Event type	*Moderate*	*CRASH*			*Event info could give drivers a reason to slow down*
Effect of event	*Moderate*	*EXPECT DELAY*			
Event location	*High*	*IN 4 MILES*			
Suggested action	*High*	*SLOW TRAFFIC AHEAD*			*This is the goal of the message*
Intended audience	*NA*				
Event time	*NA*				

Source: FHWA.

Figure 37. Illustration. Almost complete CMS Message Construction Worksheet.

The potential message now contains four components, two of which have high priority. The CMS operator could include all components in a two-phrase message but also has the option to remove one or more of the components to create a one-phrase message. The operator would like to include both of the components that are rated as high priority, so the operator places an X in the include box for both event location and suggested action. The operator is now faced with deciding whether to include event type—CRASH—or effect of event—EXPECT DELAY—in the current message. In this instance, the suggested-action message phrase—SLOW TRAFFIC AHEAD—conveys information that is relatively similar to that conveyed by the effect-of-event information—EXPECT DELAY—so the operator chooses to exclude this phrase. The operator's previous note is a reminder that providing event-type information may give drivers a reason to slow down, so the operator chooses to include this phrase in the final message.

Ordering the Selected Phrases

The three components in this message correspond to classic PLA ordering, with event displayed on the first line, event location on the second, and suggested action on the third. The operator numbers these items as one, two, and three, respectively.

The final step is to fill in the completed message at the bottom of the worksheet (table 2). The completed worksheet is displayed in table 3.

Table 3. Completed CMS Message Construction Worksheet.

Message goal: _Reduce drivers' speed as they approach the crash to improve throughout and reduce secondary crash risk_

Unit of Information	Priority (H/M/L/NA)	Message Phrase	Include	Order	Notes
Event type	Moderate	CRASH	X	1	Event info could give drivers a reason to slow down
Effect of event	Moderate	EXPECT DELAY			
Event location	High	IN 4 MILES	X	2	
Suggested action	High	SLOW TRAFFIC AHEAD	X	3	This is the goal of the message
Intended audience	NA	—	—	—	—
Event time	NA	—	—	—	—

Final CMS Message

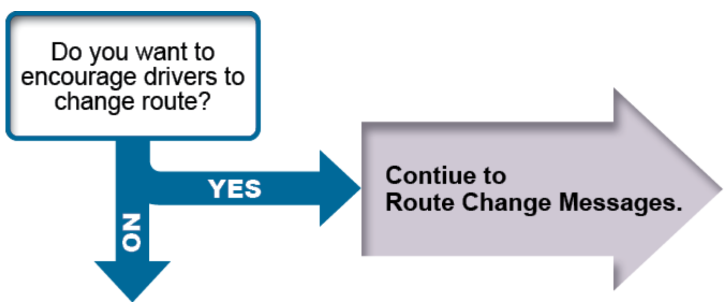
Phrase One	Phrase Two
CRASH	
IN 4 MILES	
SLOW TRAFFIC AHEAD	

Example 2: Roadwork

Pavement resurfacing is scheduled for a major four-lane undivided arterial roadway. The roadwork requires a lane closure. That lane reduction is expected to reduce the capacity of the roadway significantly. The next section gives a more concise example of the steps used for constructing a CMS message for this event by using the decision trees and worksheet in this systematic approach.

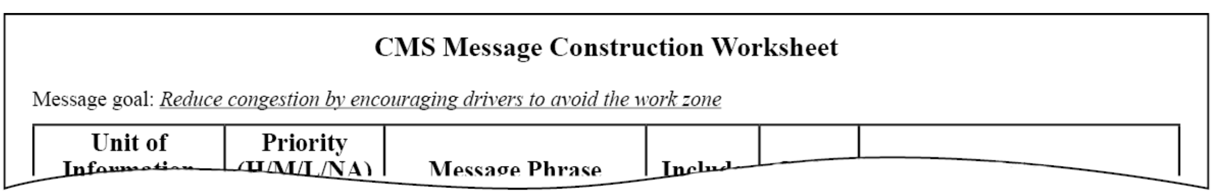
Message Goal

Figure 38 displays the decision tree path used for constructing the message goal. In this case, the operator wants to encourage drivers to change routes. The roadwork is expected to reduce the capacity of the busy arterial. The road in question is part of a dense road network. Diverting traffic from the main arterial to neighboring roadways could reduce the congestion that would otherwise be expected to result from the reduced capacity caused by the nonrecurring event. “Reduce congestion by encouraging drivers to avoid the work zone” is identified as the goal of the message (figure 39).



Source: FHWA.

Figure 38. Diagram. Path followed within the message goal decision tree for the roadwork example event.

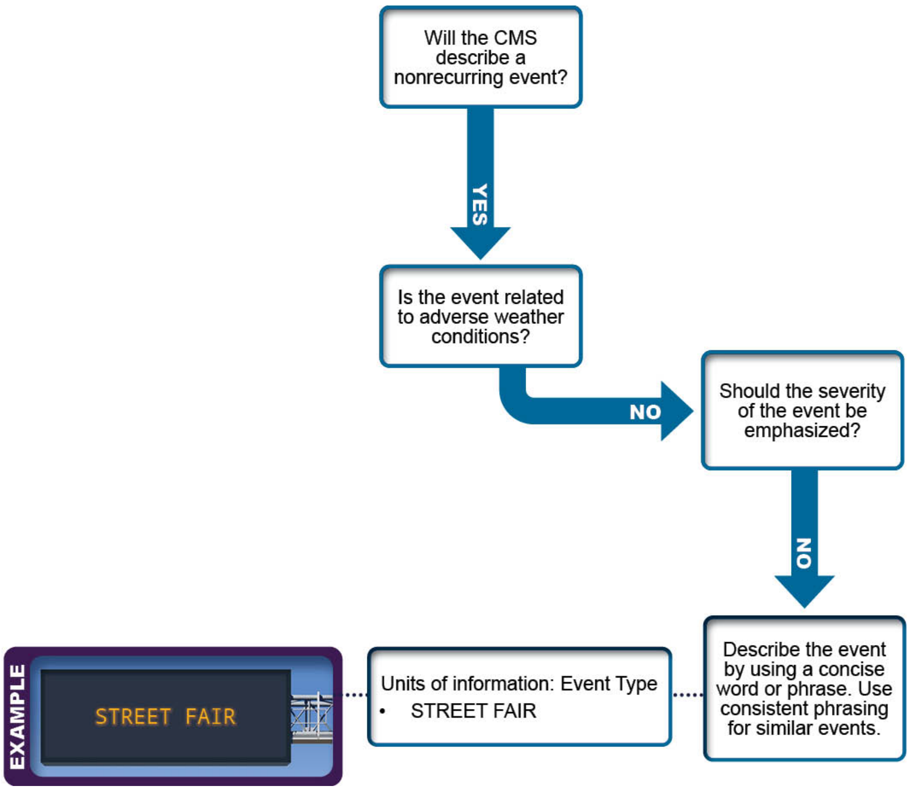


Source: FHWA.

Figure 39. Illustration. Completed message goal section of the CMS Message Construction Worksheet for the roadwork event.

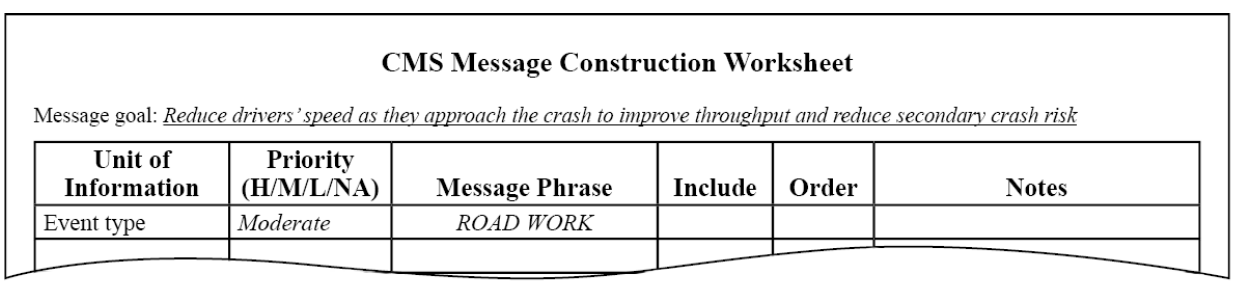
Event Type

Figure 40 displays the decision tree path used for selecting the event-type phrase. The CMS is intended to describe a nonrecurring event. The event ROADWORK is not related to weather, and there is no need to emphasize the severity of the event. The concise phrase ROADWORK is selected to describe the event. Event type is rated as having moderate priority, since knowing that roadwork is present on the roadway could encourage drivers to select a different route. This information is added to the worksheet as displayed in figure 41.



Source: FHWA.

Figure 40. Diagram. Path followed within the event-type decision tree for the roadwork example event.



CMS Message Construction Worksheet

Message goal: *Reduce drivers' speed as they approach the crash to improve throughput and reduce secondary crash risk*

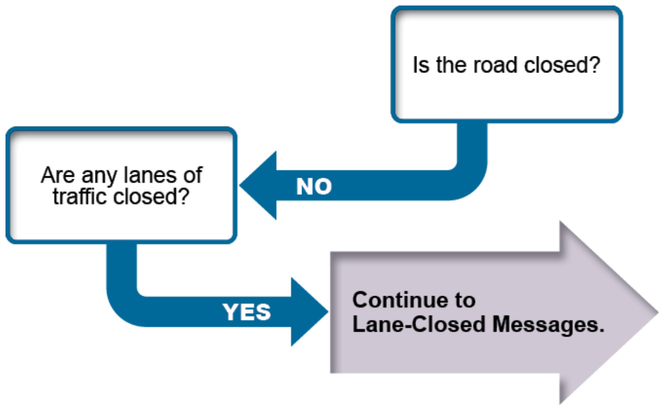
Unit of Information	Priority (H/M/L/NA)	Message Phrase	Include	Order	Notes
Event type	*Moderate*	*ROAD WORK*			

Source: FHWA.

Figure 41. Illustration. Completed event-type section of the CMS Message Construction Worksheet for the roadwork event.

Effect of Event

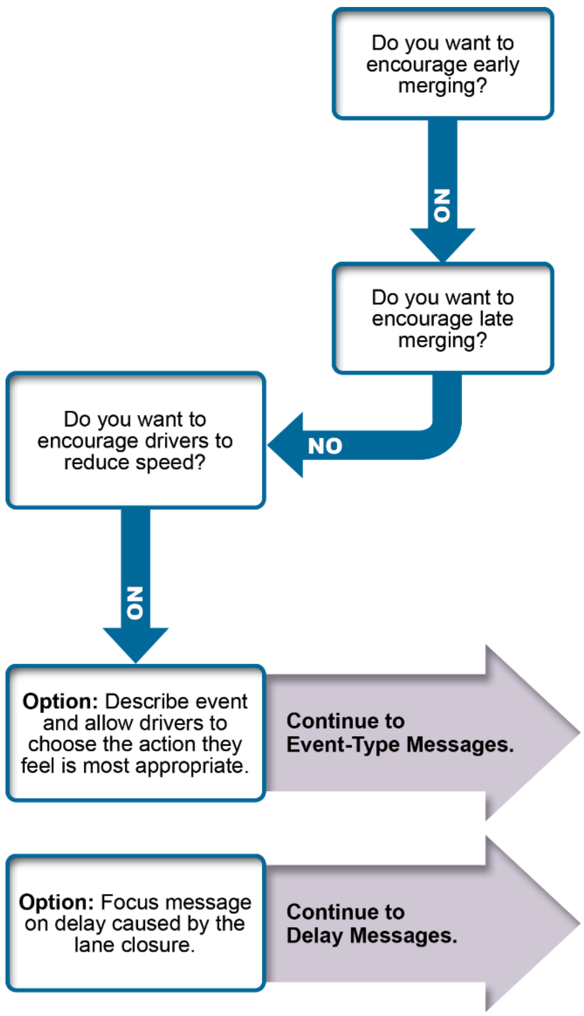
Figure 42 displays the decision tree path for the effect of event. The road is not closed, but some lanes of traffic are closed. The operator continues to the section on lane closed messages as informed by the decision tree.



Source: FHWA.

Figure 42. Diagram. Path followed within the effect of event decision tree for the roadwork example event.

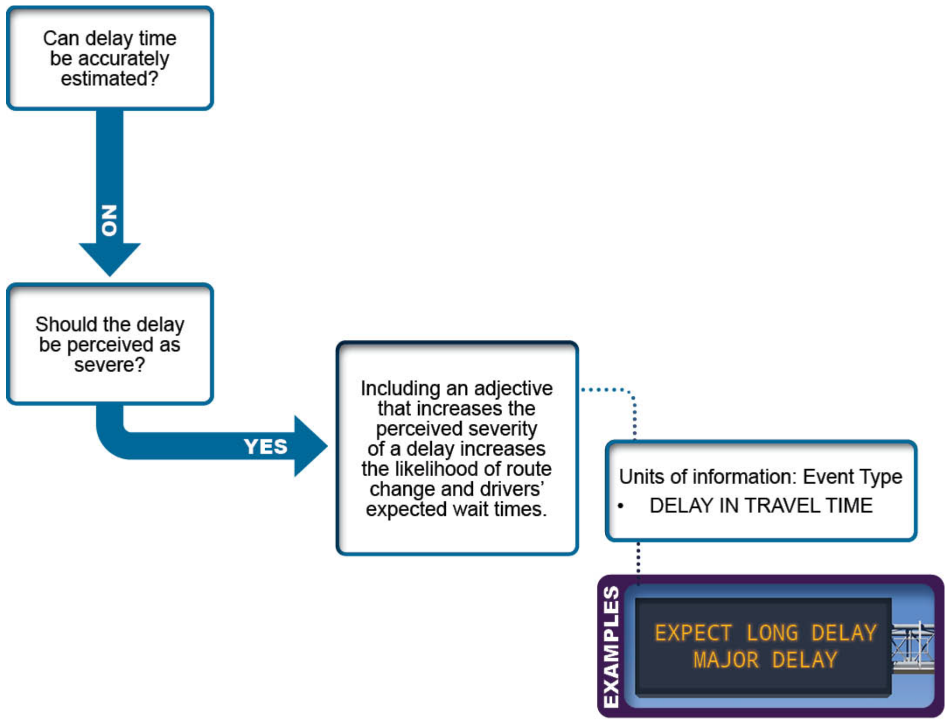
When selecting the effect of event, operators' most obvious choice is a message that describes a lane closure, but as noted in the discussion portion of chapter 2, messages specifying the direction of a lane closure can reduce diversion rates because drivers focus on changing lanes rather than changing route. To reduce diversion, the operator notes the potential for a lane closure message on the effect-of-event line of the worksheet and then uses the lane closure decision tree to explore other message options. Figure 43 shows the decision tree path the operator follows within the lane-closed decision tree. Since encouraging drivers to both merge early and merge late could reduce diversion rates, the operator follows the NO branch of each of these questions. A reduction in speed is also not desired. These factors leave the operator with the option to describe the event. The operator has already done so in the event type portion of the worksheet. The next option is to focus the message on the delay caused by the lane closure. As noted in chapter 2, delay messages have the potential to increase diversion rates, so the operator moves to the delay message section.



Source: FHWA.

Figure 43. Diagram. Path followed within the lane closure decision tree for the roadwork example event.

Figure 44 displays the operator's path through the delay messages decision tree. In this case, the exact delay time is not easy to estimate, but it is expected to be severe. The operator chooses to add an adjective to the delay message to emphasize the severity of the delay and help encourage route diversion. Since route diversion is the goal of this message, effect of event is assigned high priority (figure 45).



Source: FHWA.

Figure 44. Diagram. Path followed within the delay message decision tree for the roadwork example event.

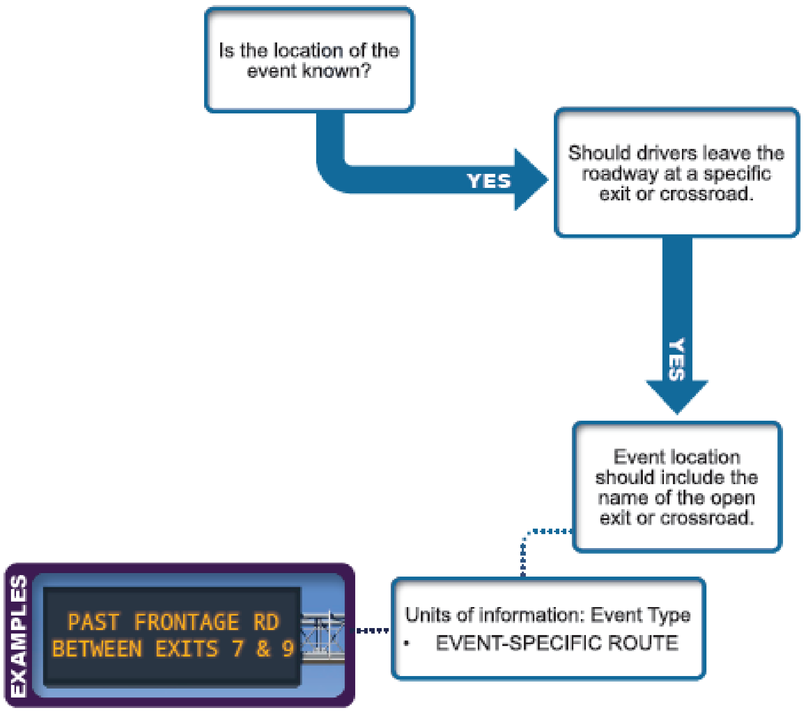
Unit of Information	Priority (H/M/L/NA)	Message Phrase	Include	Order	Notes
Event type	*Moderate*	*ROADWORK*			
Effect of event	*High*	*MAJOR DELAY*			*A lane close message may discourage diversions*

Source: FHWA.

Figure 45. Illustration. Completed effect-of-event section of the CMS Message Construction Worksheet for the roadwork event.

Event Location

Figure 46 displays the operator's path through the event location decision tree. In this case, the event location is known. The roadwork is occurring from 4th Street to 9th Street. Drivers should leave the roadway at specific roads to avoid the event. The operator includes the names of the roads in the message.



Source: FHWA.

Figure 46. Diagram. Path followed within the event location decision tree for the roadwork example event.

The roadwork begins just before 4th Street and continues through 9th Street. Chapter 2 section Event Location discussed that drivers assume they can use the streets named on a CMS sign to avoid the event. Thus, the operator constructs an event location message to include two open streets. Drivers could use the street just upstream of 4th Street (i.e., 3rd Street) and the street just downstream of 9th Street (i.e., 10th Street) to avoid the event. Knowing where the event is located can help drivers avoid the event, so the event location message's priority is labeled as high. This information is added to the event location line of the worksheet (figure 47).

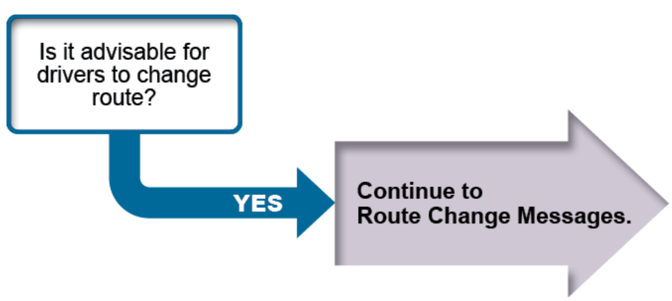
Unit of Information	Priority (H/M/L/NA)	Message Phrase	Include	Order	Notes
Event type	*Moderate*	*ROADWORK*			
Effect of event	*High*	*MAJOR DELAY*			*A lane close message may discourage diversions*
Event location	*High*	*3RD STREET – 10TH STREET*			

Source: FHWA.

Figure 47. Illustration. Completed event location section of the CMS Message Construction Worksheet for the roadwork event.

Suggested Action

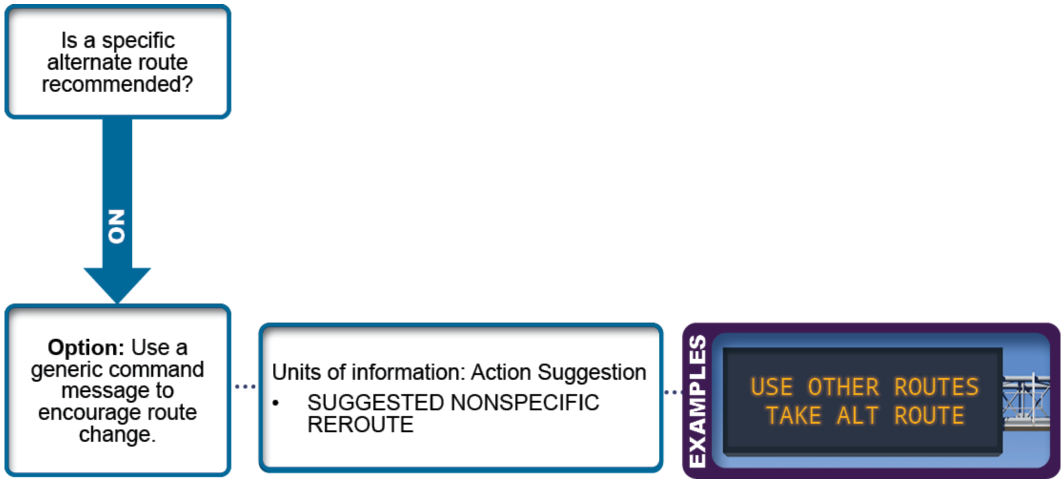
Figure 48 displays the operator's route through the suggested-action decision tree. The goal of this message is to encourage drivers to change routes, so the operator follows the decision tree to the route change message section.



Source: FHWA.

Figure 48. Diagram. Path followed within the suggested-action location decision tree for the roadwork example event.

The operator's path through the alternate route decision tree is displayed in figure 49. Since no single route could support all diverting drivers, a generic route diversion message is selected for this unit of information. Diverting drivers is the goal of this message, so this unit of information is rated as having high priority within the worksheet (figure 50).



Source: FHWA.

Figure 49. Diagram. Path followed within the alternate route location decision tree for the roadwork example event.

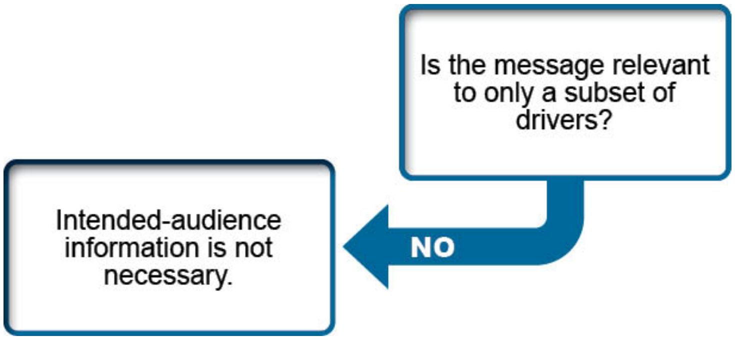
Unit of Information	Priority (H/M/L/NA)	Message Phrase	Include	Order	Notes
Event type	*Moderate*	*ROADWORK*			
Effect of event	*High*	*MAJOR DELAY*			*A lane close message may discourage diversions*
Event location	*High*	*3RD STREET – 10TH STREET*			
Suggested action	*High*	*USE OTHER ROUTES*			

Source: FHWA.

Figure 50. Illustration. Completed suggestion action section of the CMS Message Construction Worksheet for the roadwork event.

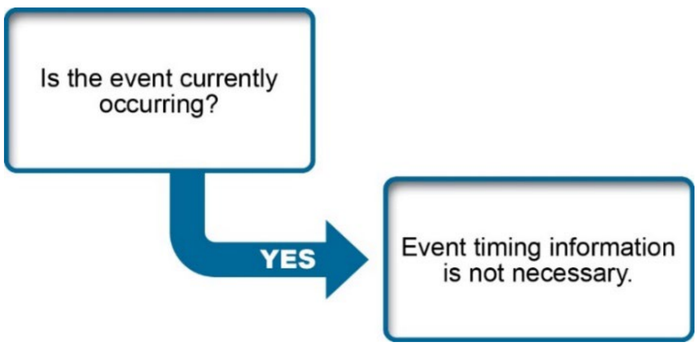
Intended Audience and Event Time

Figure 51 and figure 52 display the paths through the intended-audience and event-time decision trees for this event. The message is relevant to all drivers, so intended-audience information is not needed for this event. Additionally, the message will be on display while the event is occurring, so event timing information is also not required.



Source: FHWA.

Figure 51. Diagram. Path followed within the intended-audience decision tree for the roadwork example event.



Source: FHWA.

Figure 52. Diagram. Path followed within the event time decision tree for the roadwork example event.

Completing the Worksheet

Any combination of the four message phrases selected during the message construction process could be effective in helping meet the message goal of encouraging drivers to avoid the nonrecurring event. In this case, the decision is to use a two-phrase message that combines all four of the phrases. As noted in chapter 1, both phrases are to be able to stand on their own, since some drivers may see only one phrase of the message. The sign communicates by separating the event type and the effect-of-event information and placing each on the first line of a phrase. The remaining phrases are paired to create the final CMS message, which reads: ROADWORK/3RD ST–10TH ST, MAJOR DELAY/USE OTHER ROUTES. Table 4 displays the competed CMS message construction worksheet for this event.

Table 4. The completed CMS Message Construction Worksheet for the roadwork event.

Message goal: *Reduce congestion by encouraging drivers to avoid the work zone.*

Unit of Information	Priority (H/M/L/NA)	Message Phrase	Include	Order	Notes
Event type	Moderate	ROADWORK	X	1	
Effect of event	High	MAJOR DELAY	X	3	A lane-closed message may discourage diversions
Event location	High	3RD STREET–10TH STREET	X	2	
Suggested action	High	USE OTHER ROUTES	X	4	
Intended audience	NA	—	—	—	—
Event time	NA	—	—	—	—

Final CMS Message

Phrase One	Phrase Two
ROADWORK	MAJOR DELAY
3RD STREET–10TH STREET	USE OTHER ROUTES

APPENDIX. CMS MESSAGE CONSTRUCTION WORKSHEET

Table 5. CMS Message Construction Worksheet.

Message goal: ____

Unit of Information	Priority (H/M/L/NA)	Message Phrase	Include	Order	Notes
Event type					
Effect of event					
Event location					
Suggested action					
Intended audience					
Event time					

Final CMS Message

Phrase One	Phrase Two

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