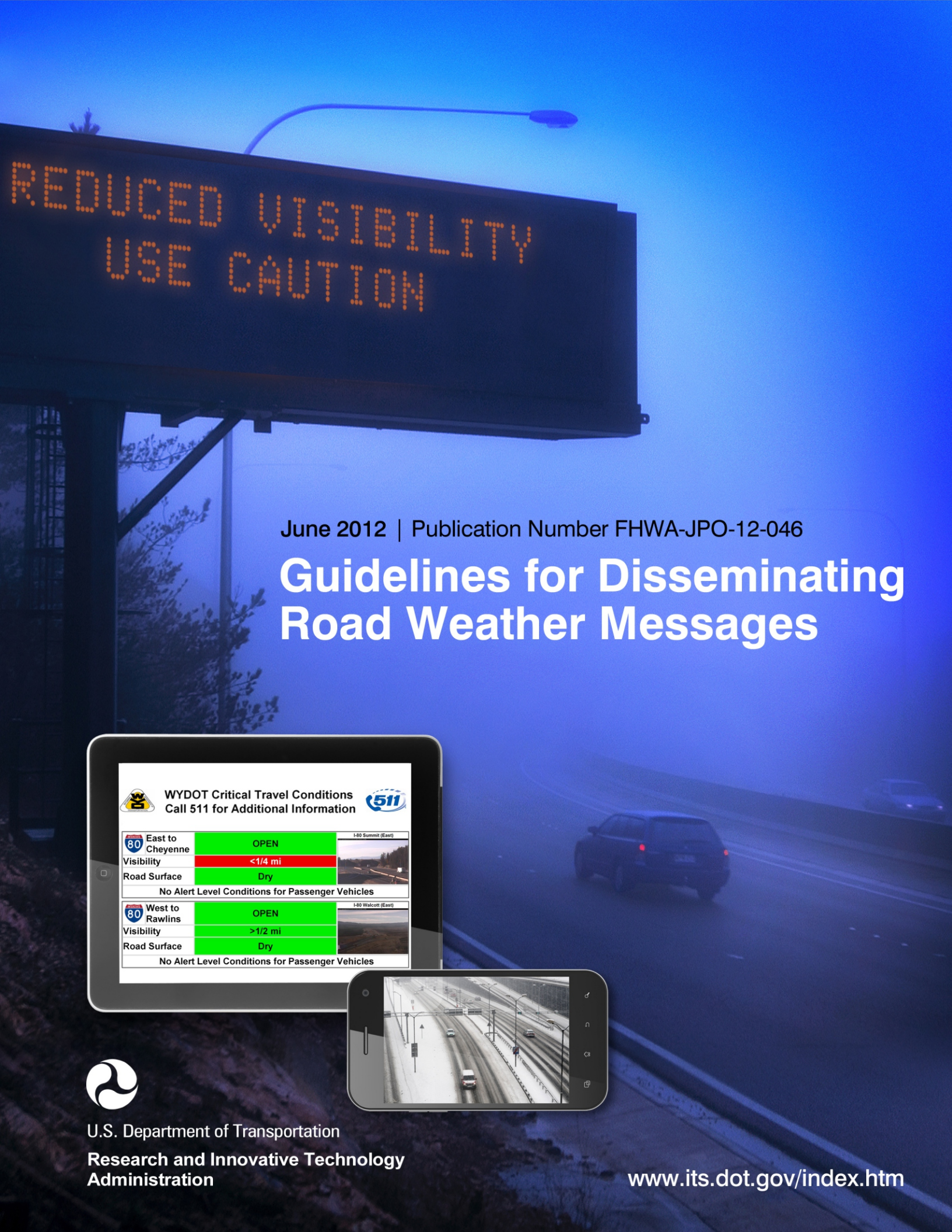



June 2012 | Publication Number FHWA-JPO-12-046

# Guidelines for Disseminating Road Weather Messages

U.S. Department of Transportation

**Research and Innovative Technology Administration**

www.its.dot.gov/index.htm

Cover Image Sources:

Wyoming DOT Website, retrieved May 13 , 2012, from http://map.wyoroad.info/hi.html
Minnesota DOT Website, retrieved April 25, 2012, from http://www.511mn.org/
Nevada DOT Website, retrieved May 3, 2012, from http://www.nevadadot.com/default.aspx

# Quality Assurance Statement

The U.S. Department of Transportation provides high-quality information to serve Government, industry, and the public in a manner that promotes public understanding. Standards and policies are used to ensure and maximize the quality, objectivity, utility, and integrity of its information. U.S. DOT periodically reviews quality issues and adjusts its programs and processes to ensure continuous quality improvement.

**Technical Report Documentation Page**

| 1. Report No. | 2. Government Accession No. | 3. Recipient's Catalog No. |
|---|---|---|
| FHWA-JPO-12-046 | | |

| 4. Title and Subtitle | 5. Report Date |
|---|---|
| Guidelines for Disseminating Road Weather Messages | June 2012 |
| | 6. Performing Organization Code |
| 7. Author(s) | 8. Performing Organization Report No. |
| Monica G. Lichty, Christian M. Richard, John L. Campbell, L. Paige Bacon | |
| 9. Performing Organization Name and Address | 10. Work Unit No. (TRAIS) |
| Battelle Seattle Research Center<br>1100 Dexter Avenue North, Suite 400<br>Seattle, WA 98109-3598 | 11. Contract or Grant No.<br>DTFH61-06-D-00007/ORDER T11001/WO BA07-089 |
| 12. Sponsoring Agency Name and Address | 13. Type of Report and Period Covered |
| U.S. Department of Transportation<br>Research and Innovative Technology Administration<br>Federal Highway Administration<br>1200 New Jersey Avenue, S.E.<br>Washington, DC 20590 | 14. Sponsoring Agency Code |

15. Supplementary Notes

Dr. Roemer Alfelor (COTR)

16. Abstract

The tremendous growth in the amount of available weather and road condition information—including devices that gather weather information, models and forecasting tools for predicting weather conditions, and electronic devices used by travelers—has led the Federal Highway Administration (FHWA) to develop effective and specific guidelines for communicating road weather information in a way that is consistent with what travelers need, want, and will use when making travel decisions.

This project, Testing and Evaluation of Preliminary Design Guidelines for Disseminating Road Weather Advisory and Control Information, builds upon the earlier Human Factors Analysis of Road Weather Advisory and Control Information project which was initiated to assist transportation officials in communicating both pre-trip and en-route road weather information effectively, consistently, and timely to meet the needs of travelers for different weather conditions and travel scenarios. This earlier project resulted in preliminary guidelines.

For the current effort, these preliminary guidelines were disseminated to a broad group of transportation and road weather officials for review and use. These reviewers included staff from private agencies and State Department of Transportation (DOT) staff working at Traffic Management Centers (TMCs). Evaluation of the guidelines followed through end user surveys, on-site interviews and discussions, and application of the preliminary guidelines to assess their suitability and effectiveness for traffic operations. Valuable feedback provided by these end users was used to modify the preliminary guidelines and develop the revised guidelines presented here.

| 17. Key Words | 18. Distribution Statement |
|---|---|
| Road Weather Messages, Traveler Advisory, Road Weather Condition Forecasts | No restrictions. This document is available to the public. |

| 19. Security Classif. (of this report) | 20. Security Classif. (of this page) | 21. No. of Pages | 22. Price |
|---|---|---|---|
| Unclassified | Unclassified | 122 | |

**Form DOT F 1700.7** (8-72) Reproduction of completed page authorized

# Acknowledgements

The authors of this report are very grateful for the assistance and advice provided throughout this project by the FHWA team overseeing the effort. Roemer Alfelor was the FHWA's Task Order Manager for the project and directly provided invaluable support and helpful guidance throughout the effort. Others at the FHWA who provided expertise and feedback on a number of key topics included: Roya Amjadi, Chris Monk, Thomas Granda, Brian Philips, Paul Pisano, and David Yang.

We would also like to acknowledge and thank all the representatives of the State Departments of Transportation (DOTs) and Transportation Management Centers (TMCs)who collaborated in support of the development and refinement of the Guidelines and generously gave of their time and expertise in reviewing the draft Guidelines, providing their constructive feedback, and meeting with members of the Guidelines team. While many individuals deserve recognition, we want to particularly acknowledge a few individuals and their organizations for helping organize their colleagues in the review and feedback process. We want to thank John Nelson and Joe Tucker of Colorado DOT; Rob Helt and Steve Tobias of the Colorado Springs TMC; Jason Sims and Nancy Powell of Kansas City SCOUT; Dave Rossbach and Theodore Valmas of Maryland CHART; Mark Leth and Ron Vessey of Washington State DOT and the WSDOT Supervisors from the six regional TMCs in Washington State; Vince Garcia and Kevin Cox of Wyoming Statewide TMC; Leon Osborne and his team at Meridian Environmental Technology, Inc.; and Peter Davies and Kristin Virshbo and their team at Castle Rock Corp. We have done our best to incorporate all the very helpful comments and suggestions for revising and improving the Guidelines received from all of these individuals.

In addition, Chris Cluett and Deepak Gopalakrishna of Battelle conducted much of the end-user evaluation discussed above and provided many helpful comments and suggestions on earlier versions of these guidelines.

# Table of Contents

**Chapter 1 Introduction ..... 1**

Background ..... 1

Purpose ..... 1

Benefits ..... 2

Organization of this Document ..... 2

How to Use these Guidelines ..... 2

Structured Guideline Format ..... 3

**Chapter 2 Dynamic Message Signs ..... 9**

Guideline 2-1. Structuring DMS Message Content ..... 10

Guideline 2-2. Determining DMS Message Length Limits ..... 12

Guideline 2-3. Dividing Information between Display Phases ..... 14

Guideline 2-4. Determining Phase Timing and other Dynamic Properties ..... 16

Guideline 2-5. Creating Acceptable DMS Abbreviations ..... 18

Guideline 2-6. Communicating Travel or Delay Times ..... 20

Guideline 2-7. Communicating Event Location ..... 22

Guideline 2-8. Communicating Degree of Urgency on DMSs ..... 24

Guideline 2-9. Communicating Degree of Certainty and Enhancing Message Credibility on DMSs ..... 26

**Chapter 3 Auditory Messages ..... 29**

Guideline 3-1. Auditory Message Content ..... 30

Guideline 3-2. Auditory Message Length ..... 32

Guideline 3-3. Auditory Message Delivery ..... 34

Guideline 3-4. Communicating Travel Times and Message Timestamps ..... 36

Guideline 3-5. Designing Auditory Diversion Directions ..... 38

Guideline 3-6. Communicating Degree of Urgency in Auditory Messages ..... 40

Guideline 3-7. Communicating Degree of Certainty and Enhancing Message Credibility for Auditory Messages ..... 42

**Chapter 4 Web-Based Messages ..... 45**
Guideline 4-1. Design of Tabular Information ..... 46
Guideline 4-2. Display of Text Paragraphs ..... 48
Guideline 4-3. Traffic Camera Displays ..... 50
Guideline 4-4. Designing General Map Displays ..... 52
Guideline 4-5. Designing Weather-Specific Map Displays ..... 54
Guideline 4-6. Use of Visual Icons ..... 56
Guideline 4-7. Color Selection ..... 58
Guideline 4-8. Display of Severe Weather Alerts ..... 60
Guideline 4-9. Linking to Road Weather Information ..... 62
Guideline 4-10. Website Use on Portable Electronic Devices (PED) ..... 64
Guideline 4-11. Communicating Degree of Urgency on Websites ..... 66
Guideline 4-12. Communicating Degree of Certainty and Enhancing Message Credibility on Websites ..... 68
**Chapter 5 Tutorials ..... 71**
Tutorial 5-1. Traveler Adjustments based on Road Weather Information ..... 72
Tutorial 5-2. When Travelers Use Road Weather Information ..... 74
Tutorial 5-3. How to Determine which Dissemination Methods Travelers will Use ..... 77
Tutorial 5-4. Safety/Mobility Implications of Road Weather Information ..... 80
Tutorial 5-5. Description of the Road Weather Message Design Tool ..... 84
Tutorial 5-6. Example Applications of the Road Weather Message Guidelines ..... 97
Tutorial 5-7. Road Weather Messaging for Personal Electronic Devices and Social Media ..... 100
**Chapter 6 Index ..... 105**
**Chapter 7 Glossary ..... 107**
**Chapter 8 References ..... 109**

## List of Tables

Table 1. Guideline look-up table. .....5
Table 2. Partial traveler responses to the most useful time to get weather information (from Richard et al., 2009). .....74
Table 3. Qualitative ratings describing the likely suitability of making a specific travel decision at various trip stages. .....75
Table 4. Dissemination method availability for different trip stages. .....77
Table 5. Potential traveler risks for the basic set of mobility impacts. .....82
Table 6. Questions associated with the key message design tool steps. .....86
Table 7. Definition and associated weather events for each weather impact. .....89
Table 8. Definition of the “suitability” category for dissemination methods in Table 10. .....92
Table 9. Step 1 – Safety/Mobility Impact Table – Identify safety/mobility impacts of concern (rows) for a weather event (columns). .....95
Table 10. Step 2 – Travel Decision Table – Identify travel decisions and suitable dissemination methods for each safety/mobility impact of concern. .....96
Table 11. WSDOT Twitter accounts. ..... 102

## List of Figures

Figure 1. Example guideline showing the structured presentation format and key information elements. .....4
Figure 2. Traveler adjustments based on weather information. .....73
Figure 3. Graph showing the rated importance of receiving weather information at different times relative to the start of a trip. .....76
Figure 4. Graph showing the rated importance of receiving weather information at different distances relative to the location of a weather event. .....76
Figure 5. Percent of travelers aware of each dissemination method.....78
Figure 6. Dissemination method preference by traveler type. .....79
Figure 7. Message design tool steps and questions for finding design recommendations shown with their associated look-up tables. .....87
Figure 8. Schematic diagram showing the relationship between the key tables and the inputs and outputs used in each step of the message design tool.....94
Figure 9. Example 1: Application of guidelines to DMS message. .....97
Figure 10. Example 2: Application of guidelines to website weather alert. .....98
Figure 11. Example 3: Application of guidelines to website information list. .....99
Figure 12. Texas DOT Austin Tweet. ..... 103

# Acronyms and Abbreviations

ATIS..... Advanced Traveler Information System
CMS ..... Changeable Message Sign
CVO..... Commercial Vehicle Operations
DMS .....Dynamic Message Sign
DOT.....Department of Transportation
FHWA.....Federal Highway Administration
GPS.....Global Positioning System
HAR.....Highway Advisory Radio
MUTCD .....Manual on Uniform Traffic Control Devices
PCMS.....Portable Changeable Message Sign
PDA..... Personal Digital Assistant
PED.....Portable Electronic Device
RSS..... Really Simple Syndication
RWIS..... Road Weather Information System
TCD.....Traffic Control Device
TMC..... Traffic Management Center
USDOT.....United States Department of Transportation
VMS..... Variable Message Sign

# Chapter 1 Introduction

## Background

The last decade has seen tremendous growth in the amount of available weather and road condition information, as well as the methods by which this information can be disseminated to travelers. This growth includes devices that gather weather information, models and forecasting tools for predicting weather conditions, and electronic devices used by travelers (National Research Council, 2004). However, simply transmitting this growing flood of data to travelers is not a viable strategy for helping them make effective use of this information. Rather, important consideration should be given to the content, format, and timing of available road weather information and making sure that it is consistent with what travelers need, want, and will use when making travel decisions.

Recognizing the need for effective and consistent procedures for communicating road weather information, the Federal Highway Administration (FHWA) began an effort in 2008 to help transportation professionals provide road weather messages to the traveling public that better support their information needs, travel decisions, and driving behaviors. The *Human Factors Analysis of Road Weather Advisory and Control Information* project was initiated to assist transportation officials in communicating both pre-trip and en-route road weather information effectively, consistently, and timely to meet the needs of travelers for different weather conditions and travel scenarios. The primary output of this effort was a preliminary guidelines report (Richard et al., 2010). The guidelines cover topics such as the content and wording of messages, message presentation and layout, and communication of information about urgency or certainty of road weather condition. They focused on three different types of dissemination methods: (1) short text/visual messages, (2) open format text/visual messages, and (3) auditory messages.

In 2010, the FHWA sponsored a follow-up project to evaluate and update the preliminary guidelines and using feedback from transportation practitioners. Specifically, the *Testing and Evaluation of Preliminary Design Guidelines for Disseminating Road Weather Advisory and Control Information* project included end user surveys, on-site interviews and discussions, and application of the preliminary guidelines to assess their suitability and effectiveness for traffic operations. The end users included staff from private agencies and State Department of Transportation (DOT) staff working at Traffic Management Centers (TMCs). Valuable feedback provided by these end users was used to modify the preliminary guidelines and develop the revised guidelines presented here.

## Purpose

This document is intended for use by individuals and organizations responsible for communicating road weather information to the traveling public. The purpose of this document is to provide guidance to help develop messages that support traveler information needs. This involves providing the information that travelers need to make safe and effective travel decisions, in a way that makes it easy for them to read and understand that information.

These guidelines are intended to augment—not replace—the guidance provided in the *Manual on Uniform Traffic Devices (MUTCD*) (FHWA, 2009) and other guidance documents relevant to the presentation of traveler information such as the *Changeable Message Sign Operation and Messaging*

*Handbook* (Dudek, 2004). The information provided here reflects best practices and principles for presenting road weather messages. These guidelines have the unique focus of providing the best available data on user performance and driver behavior relevant to the topic of road weather messages, and are intended to be used as a day-to-day resource and to support operator training.

## Benefits

This document provides transportation officials with valuable guidance on developing road weather messages that support traveler information needs before and during trips. The document covers a variety of message dissemination methods (e.g., dynamic message signs, auditory messages, and websites) and best practices from a number of transportation research studies. By providing information that travelers need to make safe and intelligent travel decisions during bad weather, in a way that is easy for them to read and understand, these travelers can choose to cancel, reroute, or change the timing or mode of their trips, thereby reducing crash risk and/or congestion, and increasing overall traveler safety and convenience.

The document is organized and formatted to be clear, relevant, and easy-to-use. Guidance for selecting dissemination methods and identifying specific characteristics of effective messaging is presented in a quick-reference format with numerous example messages that are easy to find and to apply. Background and additional information are provided in a set of tutorials located in Chapter 5.

## Organization of this Document

Beyond this introductory chapter, the document is divided into three parts: (1) guidelines, (2) tutorials, and (3) additional information. Specifically, Chapters 2 through 4 present the design guidelines associated with three distinct dissemination methods:

- Dynamic Message Signs (DMSs),
- Auditory messages including Highway Advisory Radio (HAR) and 511, and
- Websites

Chapter 5 contains tutorials that provide useful background or supplementary information about human factors issues that cut across multiple guidelines. They can be used separately if message designers want more detailed information about the issues covered. Otherwise, the guidelines and other sections link to relevant tutorials as a way to provide additional supporting information about key human factors issues.

Chapters 6 through 8 provide an index of key terms, a glossary, and a list of references used throughout this document.

## How to Use these Guidelines

The information presented in this document is provided to support more effective communication of road weather information to travelers. There are different ways that transportation agency staff and other end users can make use of this information; each approach is described below.

*Development and presentation of road weather messages*. The primary focus of this document is to provide guidelines on how to present known or existing road weather messages. The focus of the guidelines presented in Chapters 2-4 is on the content and format of individual messages. Message

developers can use this document as a reference to find design guidance about how to present their messages in a way that makes it easier for travelers to understand and use the road weather information. Example applications of the guidelines are included in Tutorial 5-6. Other possible uses of the guidelines include training new operators and supporting policy development.

*Finding additional information about traveler needs and preferences.* A set of tutorials that cover relevant human factors issues is also available in Chapter 5. These tutorials provide additional details about traveler behavior and use of weather information. Also covered are some of the safety implications of various dissemination methods.

*Developing new messages based on traveler information needs.* The fifth tutorial in Chapter 5 provides a message design tool that includes comprehensive guidance on the development of new road weather messages. It is intended as a tool that can be used when messages have to be created anew, and with the specific objective of supporting traveler information needs. This tool involves information about weather-related safety/mobility impacts, dissemination methods, key travel decisions, traveler information needs, and message layout and presentation options.

## Structured Guideline Format

The document uses a consistent format to present the road weather message design guidelines. Each guideline contains a series of subsections, drawn from a fixed set of elements, described in more detail below. Every guideline contains most of the same elements, with the exception of examples or discussion elements when there is no relevant information to supply. The key information is the design guidance available in the blue box on the first page of the guideline. The remaining fields typically provide supporting information (e.g., introduction to the topic, discussion of important issues). A sample guideline, with key information elements highlighted, is shown in Figure 1; a more detailed description of each element of the guidelines follows.

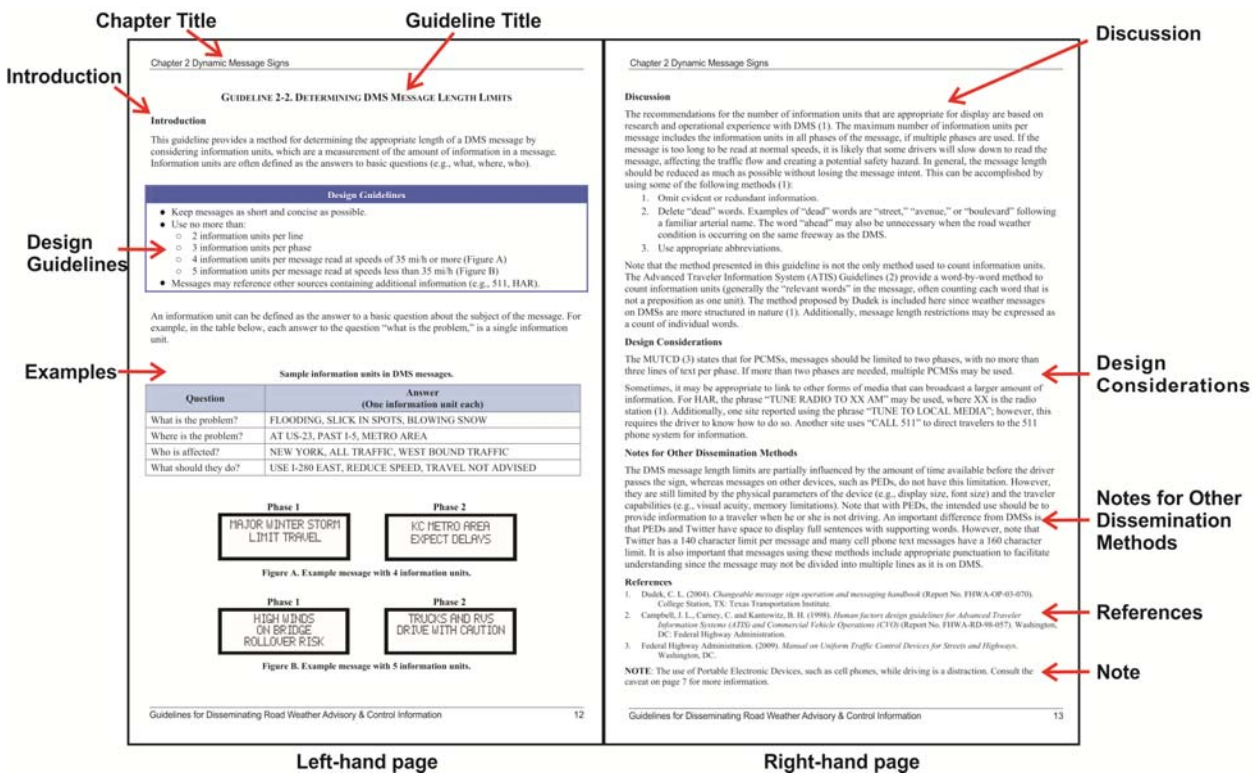



**Figure 1. Example guideline showing the structured presentation format and key information elements.**

***Title:*** The guideline title is indicated by centered, bold type at the top of the left-hand page.

***Introduction***: This subsection briefly defines the scope of the guideline and may provide additional information about how to apply the guideline or the origins of the guidance provided.

***Design Guideline***: This subsection presents the primary design recommendations for the specified topic. The guidelines are always presented prominently and enclosed in a blue box.

***Examples***: Where applicable, this subsection provides figures, tables, or graphics to augment the guidelines. This information demonstrates the principles described in the guidelines and/or provides a relevant messaging example from a transportation agency or research study.

***Discussion***: This subsection briefly summarizes the research used to create and support the guideline. It may also explain assumptions associated with the guidance or other relevant information. The discussion is presented primarily to help users understand the guideline and help them explain or justify the guideline to other members of their development teams.

***Design Considerations***: This subsection provides additional perspective on the design guidance, when available. The perspective is usually not research-based; rather, it is the result of interviews and surveys completed by TMC and DOT staff, input from private service providers, and human factors knowledge.

***Notes for Other Dissemination Methods***: This subsection, provided where applicable, gives information about how the design guidelines may apply to dissemination methods other than the one that is specifically referenced.

***References***: This subsection lists the References that were used to develop the guideline, cited in the text of the design guideline (e.g., included in the introduction, discussion, or design issues sections), and assigned a reference number. A complete reference section is provided in Chapter 8 of this document.

***Note***: This section provides any important notes or caveats regarding the use of the guideline information.

Table 1 provides a general overview of the design guidelines included in this document, which can also serve as a look-up table.

**Table 1. Guideline look-up table.**

| Guideline (Page #) | Content |
|---|---|
| **Chapter 2. Dynamic Message Signs** | |
| 2-1. Structuring DMS Message Content (10) | Discussion of common DMS message elements and specific content issues. |
| 2-2. Determining DMS Message Length Limits (12) | Information about determining the appropriate length of a DMS message by considering information units. |
| 2-3. Dividing Information between Display Phases (14) | Guidance on how to divide the information units in a message into phases. |
| 2-4. Determining Phase Timing and Other Dynamic Properties (16) | Information on the length of time to display message phases, the time between phases, and dynamic display methods. |
| 2-5. Creating Acceptable DMS Abbreviations (18) | Information on finding and creating abbreviations that travelers will understand. |
| 2-6. Communicating Travel or Delay Times (20) | Information on clear and succinct ways to describe trip impacts through travel or delay times. |
| 2-7. Communicating Event Location (22) | Information on communicating the location of a weather event in both urban and rural locations. |
| 2-8. Communicating Degree of Urgency on Dynamic Message Signs (24) | Information on communicating the priority, timing, and driving impacts of weather events using dynamic message signs. |
| 2-9. Communicating Degree of Certainty and Enhancing Message Credibility on Dynamic Message Signs (26) | Information on communicating the likelihood of road weather event predictions, conveying the associated impacts, and increasing traveler trust in road weather messages. |
| **Chapter 3. Auditory Messages** | |
| 3-1. Structuring Auditory Message Content (30) | Information on auditory message elements to include in 511 and HAR messages. |
| 3-2. Auditory Message Length (32) | Information on developing concise auditory messages. |
| 3-3. Auditory Message Delivery (34) | Guidance for operators who deliver auditory weather messages. |
| 3-4. Communicating Travel Times and Message Timestamps (36) | Discussion about communicating the travel time or delay length for a route and providing time-stamps to inform travelers how current the information is. |
| 3-5. Designing Auditory Diversion Directions (38) | Information on choosing auditory diversion message elements and determining the appropriate length for diversion directions. |
| 3-6. Communicating Degree of Urgency in Auditory Messages (40) | Information on communicating the priority, timing, and impacts of weather events through 511 or HAR. |
| 3-7. Communicating Degree of Certainty and Enhancing Message Credibility for Auditory Messages (42) | Information on communicating the likelihood of road weather event predictions, conveying the associated impacts, and increasing traveler trust in road weather messages. |

| Guideline (Page #) | Content |
|---|---|
| **Chapter 4. Web-Based Messages** | |
| 4-1. Design of Table Information (46) | Information on the design of tables or lists used to present mostly textual road condition information. |
| 4-2. Display of Text Paragraphs (48) | Discussion of display characteristics of text passages to maximize readability and comprehension. |
| 4-3. Traffic Camera Displays (50) | Information related to the use of camera images to convey road weather information. |
| 4-4. Designing General Map Displays (52) | Information on map characteristics that improve usability. |
| 4-5. Designing Weather-Specific Map Displays (54) | Discussion of elements of map displays that are specific to the provision of road weather information. |
| 4-6. Use of Visual Icons (56) | Information on selecting or designing icons and their labels. |
| 4-7. Color Selection (58) | Guidance for selecting colors for text and maps in web-based messages. |
| 4-8. Display of Severe Weather Alerts (60) | Specific advice for displaying severe weather alerts which are essential for travelers to receive. |
| 4-9. Linking to Road Weather Information (62) | Guidance about the internal and external links on the homepage through which travelers can access the road weather information. |
| 4-10. Website Use on Portable Electronic Devices (64) | Information on supporting website usage by travelers who use portable electronic devices to access internet weather websites. |
| 4-11. Communicating Degree of Urgency on Websites (66) | Information on communicating the priority, timing, and driving impacts of weather events through websites. |
| 4-12. Communicating Degree of Certainty and Enhancing Message Credibility on Websites (68) | Information on communicating the likelihood of road weather event predictions, conveying the associated impacts, and increasing traveler trust in road weather messages. |
| **Chapter 5. Tutorials** | |
| 5-1: Traveler Adjustments based on Road Weather Information (72) | Information on the adjustments that travelers may make in response to road weather information, and potential safety implications. |
| 5-2: When Travelers Use Road Weather Information (74) | Information on when travelers prefer to receive road weather information relative to the start of their trip, and the suitability of using various dissemination methods at different trip stages. |
| 5-3: How to Determine which Dissemination Methods Travelers will Use (77) | Information on the availability of various dissemination methods at different trip stages, in addition to information about traveler awareness of and preferences for specific dissemination methods. |
| 5-4: Safety Implications of Road Weather Information (80) | Information on how safety/mobility impacts for weather events can affect travelers' safety, crash risk, and convenience or schedules. |
| 5-5: Description of the Road Weather Message Design Tool (84) | Description of the road weather message design tool, which outlines a systematic approach for developing weather messages that incorporate traveler information needs, and appropriate formats for dissemination. |
| 5-6: Example Applications of the Road Weather Message Guidelines (97) | Examples of how the guidelines can be used to improve existing road weather messages. |
| 5-7: Road Weather Messaging for Personal Electronic Devices and Social Media (100) | Guidance for disseminating road weather messages on personal electronic devices. |

***IMPORTANT NOTE:*** There is an important caveat about providing short text message information that can be accessed over Portable Electronic Devices, such as cell phones. Trying to use these devices while driving is a distraction. An Executive Order prohibits text messaging while driving by Federal Employees using Government property or on official Government business (Executive Order No. 13,513, 2009). The United States Department of Transportation (USDOT) also recognizes distraction as a serious safety concern (http://www.distraction.gov/dot/). In addition, state laws pertaining to the use of certain Portable Electronic Devices while driving may apply. Consult applicable legislation and policy when designing information that could be used on these devices.

Exec. Order No. 13,513, 74 Fed. Reg. 51,225 (Oct. 1, 2009).

# Chapter 2 Dynamic Message Signs

## Introduction

This chapter provides information about the use of Dynamic Message Signs to communicate road weather information to travelers. DMSs have the ability to provide information to travelers en-route, at known locations, without requiring travelers to find the information on a website or using a phone number. For consistency, this chapter uses the term DMS to refer to the entire category of programmable signs, including Changeable Message Signs (CMSs) and Variable Message Signs (VMSs). The guidance provided in this chapter mainly applies to full-sized DMSs, but the general principles related to driver comprehension also apply to Portable Changeable Message Signs (PCMSs). Some topics provide information that is specific to PCMSs, in recognition that they have some particular design issues that differ from those for full-sized DMSs. In general, there is a substantial body of research related to DMSs, and the information provided in this chapter reflects this research.

**List of Guidelines** **Page**


Guideline 2-1. Structuring DMS Message Content ..... 10

Guideline 2-2. Determining DMS Message Length Limits ..... 12

Guideline 2-3. Dividing Information between Display Phases ..... 14

Guideline 2-4. Determining Phase Timing and other Dynamic Properties ..... 16

Guideline 2-5. Creating Acceptable DMS Abbreviations ..... 18

Guideline 2-6. Communicating Travel or Delay Times ..... 20

Guideline 2-7. Communicating Event Location ..... 22

Guideline 2-8. Communicating Degree of Urgency on Dynamic Message Signs ..... 24

Guideline 2-9. Communicating Degree of Certainty and Enhancing Message Credibility on Dynamic Message Signs ..... 26

## GUIDELINE 2-1. STRUCTURING DMS MESSAGE CONTENT

### Introduction

This guideline provides information about common DMS message elements and specific content issues.

**Design Guideline**

- The basic DMS message content is often determined using the acronym PLA, which stands for:
  - **P**roblem
  - **L**ocation
  - **A**ction
- Do not preface a message with a signal word such as: Danger, Warning, Caution.
- Avoid the use of symbols.

**Definitions and examples of the basic DMS message elements.**

| Message Element | Definition of Message Element | Example Element |
|---|---|---|
| **P**roblem | Provides information about the situation that the driver will encounter. | Flooding |
| **L**ocation | Describes the location or distance to the situation. | At US-23 |
| **A**ction | A recommendation to the driver in response to the problem and location information. | Use I-280 East |

Other message elements commonly used include those listed below:

- **Effect on Travel:** Informs the traveler of the severity of the situation by using delay or travel time and helps the traveler form expectations about their trip or decide to change their travel plans. Examples of this message element include: “Major Delay,” “# Min Delay.”
- **Audience for Action:** Used when the *Action* message element applies to a specific group of travelers rather than everyone passing the DMS. Examples of this message element include: “Eastbound Traffic,” “KC Metro Area.”
- **Good Reason for Following the Action:** Gives a traveler confidence that following the advice on the DMS will result in safer travel and/or significant savings in time. Examples of this message element include: “Best Route to I-5,” “Avoid # Min Delay.”

### Discussion

The PLA method is used by some TMCs to compose messages.* Each letter represents a message element. The P stands for Problem, which is the situation drivers will encounter. The L stands for Location and describes the location or distance to the situation. The A stands for Action, which is the recommendation to drivers. There are two caveats for this method. The first is that there can be other elements included in a message, such as a specific audience for the recommended action. The second is that, particularly in road weather messaging, there may not be a prescribed action element – the message may simply be descriptive of a condition. Alternatively, the action element may be a more general statement such as "Use Caution" or it may provide a different sort of recommendation like "Expect Delays."

Prefacing a message with a signal word (e.g., Danger, Warning, Caution) does not affect driver performance (1). Additionally, these words may not be interpreted as intended. Avoiding the use of such words can reduce reading time, conserve sign space, and prevent driver confusion. However, using the word caution as part of a recommended action (e.g. "Use Caution") is acceptable, though some TMCs reported that they prefer not to.* Note that it is one of the less prescriptive action elements used.

Message content in non-text formats needs to be considered with caution. In general, signs containing symbols are recognized better, faster, and from further away than corresponding text signs (1). They also do not require drivers to be literate. The meaning of symbols, however, is not always as well understood as text. Using DMSs to display television pictures of conditions or maps was not positively received by a majority of survey respondents (5). Additionally, message designers should defer to the MUTCD (6) for approved symbols, icons, and colors for DMSs.

### Notes for Other Dissemination Methods

Little to no research is available regarding structuring road weather message content for Portable Electronic Devices (PEDs) or Twitter applications. A brief review of available road-weather related Twitter messages shows that the PLA message format is often followed. The location element is particularly important as the traveler's location is unknown. Twitter currently does not natively support the use of pictures, and character-based symbols are not recommended. Also, symbols may not be part of the standard font used on some devices, rendering the information useless to travelers who access the message on those devices. More information on Twitter and PED applications is available in Tutorial 5-7.

The PLA method is also recommended for use on Portable Changeable Message Signs (PCMSs). PCMSs should convey the problem, location, and action, with each preferably shown on its own line (6).

### References


1. Proffitt, D. R., and Wade, M. M. (1998). *Creating effective variable message signs: Human factors issues.* (Report No. VTRC 98-CR31). Charlottesville: Virginia Transportation Research Council.
2. Wang, J.-H., Collyer, C. E., and Yang, C.-M. (2005). *Enhancing motorist understanding of variable message signs.* (Report No. FHWA-RIDOT-RTD-06-1). Providence: Rhode Island Department of Transportation.
3. Pedic, F., and Ezrakhovich, A. (1999). A literature review: The content characteristics of effective VMS. *Road & Transport Research, 8(2)*, 3-11.
4. Peeta, S., Ramos, J. L., and Pasupathy, R. (2000). Content of variable message signs and on-line driver behavior. *Transportation Research Record, 1725*, 102-108.
5. Benson, B. G. (1996). Motorist attitudes about content of variable-message signs. *Transportation Research Record, 1550*, 48-57.
6. Federal Highway Administration. (2009). Manual on Uniform Traffic Control Devices for Streets and Highways. Washington, DC.


**NOTE**: The use of Portable Electronic Devices, such as cell phones, while driving is a distraction. Consult the caveat on page 7 for more information.

*This information was provided as part of an evaluation of an earlier version of these guidelines.

## GUIDELINE 2-2. DETERMINING DMS MESSAGE LENGTH LIMITS

### Introduction

This guideline provides a method for determining the appropriate length of a DMS message by considering information units, which are a measurement of the amount of information in a message. Information units are often defined as the answers to basic questions (e.g., what, where, who).

**Design Guideline**

- Keep messages as short and concise as possible.
- Use no more than:
  - 2 information units per line
  - 3 information units per phase
  - 4 information units per message read at speeds of 35 mi/h or more (Figure A)
  - 5 information units per message read at speeds less than 35 mi/h (Figure B)
- Messages may reference other sources containing additional information (e.g., 511, HAR).

An information unit can be defined as the answer to a basic question about the subject of the message. For example, in the table below, each answer to the question "what is the problem," is a single information unit.

**Sample information units in DMS messages.**

| Question | Answer (One information unit each) |
|---|---|
| What is the problem? | FLOODING, SLICK IN SPOTS, BLOWING SNOW |
| Where is the problem? | AT US-23, PAST I-5, METRO AREA |
| Who is affected? | NEW YORK, ALL TRAFFIC, WEST BOUND TRAFFIC |
| What should they do? | USE I-280 EAST, REDUCE SPEED, TRAVEL NOT ADVISED |

**Phase 1**

**Phase 2**

**Figure A. Example message with 4 information units.**

**Phase 1**

**Phase 2**

**Figure B. Example message with 5 information units.**

### Discussion

The recommendations for the number of information units that are appropriate for display are based on research and operational experience with DMS (1). The maximum number of information units per message includes the information units in all phases of the message, if multiple phases are used. If the message is too long to be read at normal speeds, it is likely that some drivers will slow down to read the message, affecting the traffic flow and creating a potential safety hazard. In general, the message length should be reduced as much as possible without losing the message intent. This can be accomplished by using some of the following methods (1):

1. Omit evident or redundant information.
2. Delete "dead" words. Examples of "dead" words are "street," "avenue," or "boulevard" following a familiar arterial name. The word "ahead" may also be unnecessary when the road weather condition is occurring on the same freeway as the DMS.
3. Use appropriate abbreviations.

Note that the method presented in this guideline is not the only method used to count information units. The Advanced Traveler Information System (ATIS) Guidelines (2) provide a word-by-word method to count information units (generally the "relevant words" in the message, often counting each word that is not a preposition as one unit). The method proposed by Dudek is included here since weather messages on DMSs are more structured in nature (1). Additionally, message length restrictions may be expressed as a count of individual words.

### Design Considerations

The MUTCD (3) states that for PCMSs, messages should be limited to two phases, with no more than three lines of text per phase. If more than two phases are needed, multiple PCMSs may be used.

Sometimes, it may be appropriate to link to other forms of media that can broadcast a larger amount of information. For HAR, the phrase "TUNE RADIO TO XX AM" may be used, where XX is the radio station (1). Additionally, one site reported using the phrase "TUNE TO LOCAL MEDIA"; however, this requires the driver to know how to do so. Another site uses "CALL 511" to direct travelers to the 511 phone system for information.

### Notes for Other Dissemination Methods

The DMS message length limits are partially influenced by the amount of time available before the driver passes the sign, whereas messages on other devices, such as PEDs, do not have this limitation. However, they are still limited by the physical parameters of the device (e.g., display size, font size) and the traveler capabilities (e.g., visual acuity, memory limitations). Note that with PEDs, the intended use should be to provide information to a traveler when he or she is not driving. An important difference from DMSs is that PEDs and Twitter have space to display full sentences with supporting words. However, note that Twitter has a 140 character limit per message and many cell phone text messages have a 160 character limit. It is also important that messages using these methods include appropriate punctuation to facilitate understanding since the message may not be divided into multiple lines as it is on DMS.

### References

1. Dudek, C. L. (2004). *Changeable message sign operation and messaging handbook* (Report No. FHWA-OP-03-070). College Station, TX: Texas Transportation Institute.
2. Campbell, J. L., Carney, C. and Kantowitz, B. H. (1998). *Human factors design guidelines for Advanced Traveler Information Systems (ATIS) and Commercial Vehicle Operations (CVO)* (Report No. FHWA-RD-98-057). Washington, DC: Federal Highway Administration.
3. Federal Highway Administration. (2009). *Manual on Uniform Traffic Control Devices for Streets and Highways*. Washington, DC.

**NOTE**: The use of Portable Electronic Devices, such as cell phones, while driving is a distraction. Consult the caveat on page 7 for more information.

## GUIDELINE 2-3. DIVIDING INFORMATION BETWEEN DISPLAY PHASES

### Introduction

This guideline provides guidance on how to divide the information units in a message between phases. A phase is defined as the set of text that is displayed on a DMS at a single point in time, on a single screen.

**Design Guideline**

A. Use two phases maximum per message.
B. Each phase must be understandable by itself.
C. When dividing messages between two phases, compatible information units should be kept in the same phase.
D. One line should not contain parts of two information units, but may contain two whole information units.
E. Present different sets of information on each phase. Do not use alternating line messages (multiple phase messages in which only a subset of the lines change between phases).

**Examples of poor and improved message phasing, corresponding to each guideline listed above.**

| | Poor Message Phasing | Improved Message Phasing |
|---|---|---|
| **A** | FLOODING<br>AT US-23 NEW<br>YORK<br><br>USE<br>I-280 EAST<br><br>OR<br>OTHER ALTERNATE<br>ROUTES | FLOODING<br>AT US-23<br><br>NEW YORK<br>USE<br>I-280 EAST |
| **B** | NO LIGHT TRAILERS<br>WINTON TO GROTTO<br>STRONG WIND GUSTS<br><br>50+ MPH | NO LIGHT TRAILERS<br>WINTON TO GROTTO<br><br>STRONG WIND GUSTS<br>50+ MPH |
| **C** | DO NOT USE<br>CRUISE CONTROL<br><br>DURING SNOW<br>DRIVE WITH CAUTION | DO NOT USE<br>CRUISE CONTROL<br>DURING SNOW<br><br>DRIVE WITH CAUTION |
| **D** | REDUCED VISIBILITY<br>USE HEADLIGHTS USE<br>CAUTION | REDUCED VISIBILITY<br>USE HEADLIGHTS<br>USE CAUTION |
| **E** | BLOWING SNOW<br>METRO AREA<br>REDUCE SPEED<br><br>BLOWING SNOW<br>METRO AREA<br>TUNE TO 530 AM | BLOWING SNOW<br>METRO AREA<br><br>REDUCE SPEED<br>TUNE TO 530 AM |

### Discussion

Drivers have difficulty reading DMS messages that are on more than two phases (1). Since either phase 1 or phase 2 may be read first by a passing driver, each phase should make sense by itself. This is accomplished by keeping compatible information units in the same phase. Also, when drivers read the sign, displaying portions of two different information units on a single line is confusing and increases reading time (1).

In alternating-line messages, a portion of the message is held constant between the two phases (usually the first two lines) while the other portion is alternated between two pieces of information (usually the third line). Research on this method (2, 3) showed that although comprehension was not affected, reading times greatly increased.

### Design Considerations

Most TMCs reported that they try to avoid using two phases when at all possible.* However, for complex or lengthier messages, it may be necessary. Tips for reducing message length are included in the Discussion subsection of Guideline 2-2.

### Notes for Other Dissemination Methods

The MUTCD (4) states that for PCMSs, no more than two phases should be presented, with a maximum of three lines of text per phase. Each phase should be able to be understood alone. Also, if multiple PCMSs are visible to drivers at the same time, only one of the visible PCMSs should display a multiple phase message.

Most other short text messaging applications do not divide their messages into display phases as is done on DMS signs. However, if a short text message is sent to a PED, such as a cell phone, and if the message is too long, it may be automatically divided into multiple messages. Although some messaging does not have a limit, text messages are often limited to 160 characters (depending on the character set, or language used). If it can be anticipated that a single message is going to be split by the traveler's device, it may be prudent to split the message beforehand and send it in two separate transmissions. By this method, the sender can control where the break in the message will occur. If the message is split into two, it is important that the traveler links the two messages so that the full message will be understood. It may be necessary to repeat the audience or problem to ensure that the two messages are associated with one another.

### References

1. Dudek, C. L. (2004). *Changeable message sign operation and messaging handbook* (Report No. FHWA-OP-03-070). College Station, TX: Texas Transportation Institute.
2. Dudek, C. L., and Ullman, G. L. (2002). Flashing messages, flashing lines, and alternating one line on changeable message signs. *Transportation Research Record, 1803*, 94-101.
3. Dudek, C. L., Schrock, S. D., and Ullman, G. L. (2005). *Impacts of using dynamic features to display messages on changeable message signs* (Report No. FHWA-HOP-05-069). Washington, DC: Federal Highway Administration.
4. Federal Highway Administration. (2009). Manual on Uniform Traffic Control Devices for Streets and Highways. Washington, DC.

**NOTE**: The use of Portable Electronic Devices, such as cell phones, while driving is a distraction. Consult the caveat on page 7 for more information.

*This information was provided as part of an evaluation of an earlier version of these guidelines.

## GUIDELINE 2-4. DETERMINING PHASE TIMING AND OTHER DYNAMIC PROPERTIES

### Introduction

This guideline provides information on the length of time to display message phases and the amount of time between phases. Additional information is provided on dynamic methods used to transition between portions of messages, or attract driver attention.

**Design Guideline**

| Topic | Definition | Guideline | Rationale/Source |
|---|---|---|---|
| Phase Display Time | The amount of time to display each phase of a two-phase message. | Use 2 seconds per information unit OR 1 second per 4-8 character word (excluding prepositions), whichever is longest. | Research and field experience (1). |
| Blank Time between Phases | The amount of time that a display is left completely blank between message phases. | Insert a 300 ms blank screen between message phases 1 and 2. | Increased word and number comprehension (2). |

### Discussion

The amount of time that a single phase should be displayed is determined by the amount of content in that phase. Dudek (1) summarizes that 1 second is needed per 4-8 character word, excluding prepositions, or 2 seconds per information unit, whichever is longest. For information about defining information units, see Guideline 2-2. Also, inserting a 300 ms blank screen between phase 1 and phase 2 of a PCMS message was found to improve comprehension (2). This is possibly because a refractory period helps information processing between screens. However, it is possible that drivers, who see a blank between phases 1 and 2 but not between phases 2 and 1, would reverse the order of the phases and have trouble understanding the message. Dudek (1) recommends that blank time and/or asterisks be displayed between cycles of a message that contains 3 or more phases (on one-word or one-line signs). Since these signs are more limited in the amount of information that they can display at one time, the phases may not make sense independently, and drivers who read later phases before phase 1 may not understand the message. Thus, giving an indication of the end of the message cycle gives drivers an idea of the phase order.

### Design Considerations

The following table describes a few methods for dynamically displaying information on DMSs. Due to disagreeing research results, negative effects, or a lack of positive effects, they are not recommended.

**Dynamic messaging strategies not recommended for use on DMSs.**

| Method | Definition | Rationale/Source |
|---|---|---|
| Flashing Messages | One phase messages which flash the entire message | Disagreement in research results (3, 4) |
| | One phase messages which contain one flashing or blinking line | Increased reading time and reduced comprehension (3, 4) |
| Looming | Increasing text or symbol size over time | No positive effect (2) |

There are many ways in which all or portions of messages can be flashed or moved in an attempt to draw driver attention. Flashing one phase of a message caused differing results in the laboratory and simulator (3, 4), and thus is not recommended. Flashing one line (most often the last line) of a message negatively affected comprehension levels and reading times (3, 4) and is also not recommended. In a study by Greenhouse (2), looming: did not help any group of drivers comprehend messages, functioned as a driver distraction, and had a negative effect on intelligibility.

### Notes for Other Dissemination Methods

The MUTCD (5) recommends that for two-phase PCMS messages, each phase should be displayed for a minimum of 2 seconds. Additionally, the total message (the sum of both phase display times) should be displayed for a maximum of 8 seconds.

### References

1. Dudek, C. L. (1992). *Guidelines on the use and operation of changeable message signs* (Report No. FHWA-TX-92-1232-9). College Station: Texas Transportation Institute.
2. Greenhouse, D. (2007). *Optimizing comprehension of Changeable Message Signs (CMS)* (Report No. UCB-ITS-PRR-2007-24). Berkeley: University of California Partners for Advanced Transit and Highways (PATH).
3. Dudek, C. L., and Ullman, G. L. (2002). Flashing messages, flashing lines, and alternating one line on changeable message signs. *Transportation Research Record, 1803*, 94-101.
4. Dudek, C. L., Schrock, S. D., and Ullman, G. L. (2005). *Impacts of using dynamic features to display messages on changeable message signs* (Report No. FHWA-HOP-05-069). Washington, DC: Federal Highway Administration.
5. Federal Highway Administration. (2009). Manual on Uniform Traffic Control Devices for Streets and Highways. Washington, DC.

**NOTE**: The use of Portable Electronic Devices, such as cell phones, while driving is a distraction. Consult the caveat on page 7 for more information.

## GUIDELINE 2-5. CREATING ACCEPTABLE DMS ABBREVIATIONS

### Introduction

This guideline provides information about finding and creating abbreviations that drivers will understand.

**Design Guideline**

- Avoid using abbreviations whenever possible.
- If abbreviations are necessary, use approved abbreviations from Section 1A.15 of the MUTCD (1).
- If the MUTCD does not include the desired abbreviation, create truncated abbreviations by removing letters from the end of a word until it is the desired length.

**Select abbreviations from the MUTCD (from 1, except where noted).**

| Word | Abbreviation | Word | Abbreviation | Word | Abbreviation |
|---|---|---|---|---|---|
| Afternoon/ Evening | PM | Miles Per Hour | MPH | South | S |
| Alternate | ALT | Morning/ Late Night | AM | Southbound | S-BND* |
| AM Radio | AM | Mount | MT | Speed | SPD* |
| East | E | Mountain | MTN | Telephone | PHONE |
| Eastbound | E-BND* | National | NATL | Temporary | TEMP |
| Feet | FT | Night | NITE** | Thru** | - (hyphen) |
| FM Radio | FM | Normal | NORM* | Traffic | TRAF* |
| Information | INFO | North | N | Travelers | TRAVLRS* |
| Left | LFT* | Northbound | N-BND* | Vehicles | VEH, VEHS* |
| Tires With Lugs | LUGS* | Service | SERV* | Warning | WARN* |
| Maintenance | MAINT* | Shoulder | SHLDR* | West | W |
| Mile(s) | MI | Slippery | SLIP* | Westbound | W-BND* |

*Only recommended for use on PCMSs.
**From Reference 2.

In addition, common abbreviations such as the days of the week and types of streets (e.g., boulevard) are included in the MUTCD. Except for what is provided in the table above, or when needed to avoid confusion, additional punctuation is not necessary when using these abbreviations (1).

Some abbreviations are only recommended for use with a prompt word, which is a word that directly precedes or follows the abbreviation in the message. A selection of these abbreviations from the MUTCD is shown in the table below. The MUTCD also includes a table of unacceptable abbreviations (Table 1A-3), which should not be used since they are easily misinterpreted by drivers.

**Abbreviations that should be used with prompt words (MUTCD, 1).**

| Word | Abbreviation | Prompt Word that Should Precede the Abbreviation |
|---|---|---|
| Ahead | AHD | Fog |
| Blocked | BLKD | Lane |
| Bridge | BR | [Name]* |
| Exit | EX | Next |
| Lane | LN | [Roadway Name]*, Right, Left, Center |
| Pavement | PVMT | Wet |
| Right | RT | Keep, Next, Lane** |
| Route | RT, RTE | Best |

*May be used on Traffic Control Devices (TCDs) other than PCMSs, when used with a prompt word.
**The prompt word "Lane" should follow the abbreviation, if used.

### Discussion

Abbreviations may be necessary to convey information to the level of specificity desired, when considering fixed display size and message length recommendations. The use of abbreviations, however, is discouraged because they were found to decrease message comprehension (3) and increase reading times (4). In a study of sonar operators, they preferred truncated abbreviations over conventional (created by experts) or contraction (vowel removed) abbreviations (4). Truncated abbreviations proved to have faster response times and improved decoding times with increasing trials. A hyphen may be used in place of the word "thru" when used between an inclusive range of days (e.g., TUE-THURS, to include Tuesday and Thursday; 2). The MUTCD (1) also recommends that the same abbreviation be used throughout a single jurisdiction.

### Notes for Other Dissemination Methods

When using abbreviations in road weather messages on social media, it is important to remember that the reader has less context when reading the message since they may not be driving on the affected roadway. Additionally, in text or Twitter messages, all of the words are run together in one long phrase or series of sentences. There is no structure similar to that provided by the line breaks on a DMS. Therefore, the context of the abbreviation within the message is important. Another consideration is the use of casual abbreviations that save space such as "bsafe" instead of "be safe" or "b4" instead of "before." Though space limitations are stringent in social messaging, casual abbreviations may make the message appear less professional or less serious to the traveler. Also, travelers who are unfamiliar with the abbreviation may have difficulty understanding the message.

### References

1. Federal Highway Administration (FHWA). (2009). *Manual on Uniform Traffic Control Devices (MUTCD)* Washington, DC.
2. Dudek, C. L. (2004). *Changeable message sign operation and messaging handbook* (Report No. FHWA-OP-03-070). College Station, TX: Texas Transportation Institute.
3. Greenhouse, D. (2007). *Optimizing comprehension of Changeable Message Signs (CMS)* (Report No. UCB-ITS-PRR-2007-24). Berkeley: University of California Partners for Advanced Transit and Highways (PATH).
4. Proffitt, D. R., and Wade, M. M. (1998). *Creating effective variable message signs: Human factors issues* (Report No. VTRC 98-CR31). Charlottesville: Virginia Transportation Research Council.

**NOTE**: The use of Portable Electronic Devices, such as cell phones, while driving is a distraction. Consult the caveat on page 7 for more information.

## GUIDELINE 2-6. COMMUNICATING TRAVEL OR DELAY TIMES

### Introduction

This guideline provides information about clear and succinct ways to describe trip impacts through travel or delay times.

**Design Guideline**

| Type of Information | Guidelines |
|---|---|
| Travel times | Travel times can be displayed in multiple formats:<br>• "# MIN AT 8:20"<br>• "#-## MINUTES"<br>• "## MINUTES" |
| Delay times | Delay times should be relative to the drivers' normal travel times. |

One of the approaches to displaying travel times, as expressed in the guideline above, is to include a time-stamp for when the travel time was calculated (1).

Another approach is to show a range of estimated travel times (1).

Several TMCs were found to display a list of travel times on a single DMS, for multiple locations.* This specific format is not discussed in the available research, but an adapted example from the Colorado DOT is shown in the figure below.

*This information was provided as part of an evaluation of an earlier version of these guidelines.

### Discussion

Dudek (1) found that displaying recent historic travel times is not a significant issue if differences in the expected and actual times are not significant. In a study of travel time phrasing, he also found that two different signs: "TRAVEL TIME TO DOWNTOWN 20 MINUTES" and "TRAVEL TIME TO DOWNTOWN AT 7:20 A.M. 20 MINUTES" caused no significantly different time expectations for drivers. Also, only 10% of drivers expected their travel time to be exactly 20 minutes.

Credibility is a major factor when providing travel times. Travel times are easy for drivers to verify when they reach their destination, potentially proving the message to be incorrect. When travel times cannot be predicted and historical travel times are used, it should be ensured that they are reasonably accurate. Additionally, a couple of TMCs in Texas are using the formats presented to convey the time that the travel time was estimated, or ranges of travel times in an attempt to increase credibility.* Some TMCs reported that delay times are not often shared since they are difficult to calculate.*

### Design Considerations

Typically, road weather information is only provided on DMSs for ongoing events/conditions. However, there may be situations where future conditions need to be presented to the traveler. For example, information about forecast conditions or long-term road closures due to weather might be displayed on a DMS. The table below provides guidance on clear and succinct ways to describe date information related to travel impacts due to weather events.

**Guidance for displaying date information on DMS signs.**

| Date Range | Guidelines |
|---|---|
| Dates in the next 7 days | • Use days of the week rather than calendar dates (e.g. Tue – Thurs).<br>• Do not use the phrase "For 1 Week" because the start and end dates are ambiguous.<br>• "Weekend" may be used if the event begins on Saturday morning and ends on Sunday evening. |
| Dates not in the next 7 days | • Use a 3-letter month abbreviation rather than a numerical month representation (i.e. Apr 21 rather than 4/21).<br>• Only state the month once if both dates in a range are in the same month (i.e. Apr 21 – 23 rather than Apr 21 – Apr 23).<br>• Don't include day, date, AND time information. |

Research has shown that drivers have difficulty converting calendar dates to appropriate days of the week (1). It is often desirable to present closure or other information more than one week in advance; however, that requires the inclusion of numeric date information in the message. In a laptop study examining date formats, it was found that regardless of the format that was used to present the date, only approximately 75% of drivers could tell if the event would impact their current or future travel (2).

### Notes for Other Dissemination Methods

The guidelines included on the previous page most directly apply to DMS messaging due to the length limits for messages displayed on DMS signs. However, the general concepts related to driver expectations and driver comprehension of the different phrases apply to all dissemination methods.

### References

1. Dudek, C. L. (2004). *Changeable message sign operation and messaging handbook* (Report No. FHWA-OP-03-070). College Station: Texas Transportation Institute.
2. Ullman, G.L., Ullman, B.R., and Dudek, C.L. (2007). Evaluation of alternative dates for advance notification on portable changeable message signs in work zones. *Transportation Research Record, 2015*, 36-40.

**NOTE**: The use of Portable Electronic Devices, such as cell phones, while driving is a distraction. Consult the caveat on page 7 for more information.

*This information was provided as part of an evaluation of an earlier version of these guidelines.

## GUIDELINE 2-7. COMMUNICATING EVENT LOCATION

### Introduction

This guideline provides information about how to communicate the location of a weather event in both urban and rural locations.

**Design Guideline**

| Road Density | How to Reference |
|---|---|
| Cross-roads are close together | By street names, exit names, exit numbers, landmarks, or distance from the DMS |
| Cross-roads are far apart (e.g. rural areas) | By distance from the DMS |

**Examples of geographic descriptors used to communicate event location.**

| Category | Examples |
|---|---|
| Common descriptors used by TMCs | • 1 MILE<br>• # MILES<br>• AT [highway name, exit ramp number, etc.]<br>• NEAR [highway name, exit ramp number, etc.] |
| Other descriptors to consider | • BEFORE [highway name, exit ramp number, etc.]<br>• PAST [highway name, exit ramp number, etc.] |

### Discussion

The reference points used to convey geographic information should vary by the density of the cross-roads. If the cross-roads are close together, drivers will be able to use the road names, exit names, exit numbers, or landmarks to understand geographic areas. If the cross-roads are far apart, providing road names may not provide sufficient granularity for event locations. The distance from the DMS provides drivers with precise location information, using a reference to their current location.

Another element that impacts driver understanding is their familiarity with the geographic area. If the drivers are unfamiliar with the area, the road names and landmarks will likely be unfamiliar and thus will provide no useful information. In these cases, the distance from the DMS or exit numbers can be easily understood in reference to their current position.

When expressing exit information, “This Exit” instead of “Next Exit” was preferred to refer to the upcoming exit (2).

### Design Considerations

There are innate challenges with expressing event locations for road weather information. Weather often impacts broad areas of a region that may not be easy to define succinctly. However, it may be necessary to describe areas for related reasons, for example, defining an area where truck drivers must carry chains due to road weather conditions.

In general, drivers appreciate and prefer more specific information when it is available. For example, one study found through questionnaires that messages with more specific diversion routes and locations (e.g., “Major Delays to Boston, Use Route I-295”) were preferred to less specific messages (e.g., “Major Delays, Use other Routes”; 2). Another study reported that drivers are more likely to correctly interpret a message when it includes a specific diversion task instead of a generic diversion task (3). Drivers are also more willing to divert if given the incident location, expected delay, and best detour strategy rather than just a subset of that information (4). Survey data shows that precise location information was preferred, so that drivers could make informed decisions about exiting/re-entering the roadway (5). All of these benefits, however, are counterbalanced by the space available on the sign, the information available to the TMC, and message length limits. In the case of road weather events, they are often widespread, so it is not always appropriate to divert drivers to a specific detour route. Additionally, there may not be enough information about the conditions of the surrounding roadways to give a specific detour route.

### Notes for Other Dissemination Methods

If the message is read from a PED instead of a DMS, fixed reference points such as street names, exit names, exit numbers, or landmarks will need to be used since the traveler’s exact location will not be known.

### References

1. Dudek, C. L. (2004). Changeable message sign operation and messaging handbook. (Report No. FHWA-OP-03-070). College Station, TX: Texas Transportation Institute.
2. Benson, B. G. (1996). Motorist attitudes about content of variable-message signs. *Transportation Research Record, 1550*, 48-57.

**NOTE**: The use of Portable Electronic Devices, such as cell phones, while driving is a distraction. Consult the caveat on page 7 for more information.

## GUIDELINE 2-8. COMMUNICATING DEGREE OF URGENCY ON DMSS

### Introduction

This guideline provides general design principles and specific message content that communicate the priority, timing, and driving impacts of weather events using dynamic message signs.

**Design Guideline**

| Road Weather Message Characteristic | Guidelines |
|---|---|
| Message Style (1) | • Use **command** style messages when the situation is urgent and an immediate control action is required by the driver. Examples of command style messages include: “slow down” or “move to the right lane.”<br>• Use **notification** style messages when an immediate control action is not required, or the situation is not urgent. Examples of notification style messages include: “ice ahead,” “use alternate route,” or “storm warning.” |
| Color | • Use green to communicate clear or normal situations/conditions/routes (low urgency).<br>• Use yellow to communicate caution, warning, slow moving areas of traffic or roadway locations moderately compromised by weather events (medium urgency).<br>• Use red to communicate danger, emergencies, extremely slow traffic conditions, or roadway locations either made impassable or highly dangerous due to weather events (high urgency). |
| Icons or Symbols (2) | • To communicate high urgency:<br>  o Use red lettering or red background.<br>  o Increase line weight of the icon’s border.<br>  o Increase relative size of the high urgency icon.<br>• If text labels are used:<br>  o Increase font size of text labels to identify icons of greater urgency.<br>  o Increase white space around text labels.<br>• If possible and appropriate, show the consequence of not responding appropriately. |

## Discussion

Communicating the appropriate degree of urgency to travelers is important because travelers use the cues to urgency contained within a message to make travel decisions regarding: if they should travel, when they should travel, if a mode choice change is in order, or if a planned route should be changed. Urgency can be communicated in numerous ways, including the use of specific words, phrases, colors, location on a visual display, location within a message, and the modality used to present the message. Importantly, the many different aspects of a particular weather message dissemination method (i.e., DMS vs. website vs. 511) can be used together to effectively communicate the appropriate degree of urgency to travelers.

The priority of a message is a function of how quickly a response must be made by the driver, as well as the consequences of failing to make the proper response (1). A high-priority message requires a fast response (0-5 minutes) and has serious consequences, such as a crash with possible injuries or fatalities. For example, a weather-related roadway condition—such as an upcoming road that is washed-out due to a flash flood. A lower priority message has no response needed for at least 5 minutes and has no immediate consequences. An example of a lower priority message is a forecast for rain on the next day.

The guidelines above provide principles for communicating urgency on DMSs through color and icons/symbols. At this time, most equipment used to present messages on DMSs is monochromatic and does not use icons or symbols; therefore, those portions of the guideline above may have limited applicability to many DOTs and TMCs. Additionally, message designers should defer to the MUTCD (3) for approved symbols, icons, and colors. Newer DMS technologies, however, can present multiple colors and have sufficient resolution and configurability to present icons/symbols; we expect these portions of this guideline to have greater applicability across DOTs and TMCs in the future.

## References

1. Campbell, J. L., Carney, C., and Kantowitz, B. H. (1998). *Human factors design guidelines for Advanced Traveler Information Systems (ATIS) and Commercial Vehicle Operations (CVO)* (FHWA-RD-98-057). Washington, DC: Federal Highway Administration.
2. Campbell, J. L., Richman, J.B., Carney, C., and Lee, J.D. (2004). *In-vehicle display icons and other information elements. Volume I: Guidelines* (FHWA-RD-03-065). McLean, VA: Federal Highway Administration (see also http://www.tfhrc.gov/safety/pubs/03065/index.htm).
3. Federal Highway Administration (FHWA). (2009). *Manual on Uniform Traffic Control Devices (MUTCD)* Washington, DC.

**NOTE:** The use of Portable Electronic Devices, such as cell phones, while driving is a distraction. Consult the caveat on page 7 for more information.

## GUIDELINE 2-9. COMMUNICATING DEGREE OF CERTAINTY AND ENHANCING MESSAGE CREDIBILITY ON DMSS

### Introduction

Communicating the degree of certainty in a road weather message refers to general design principles and specific message content that communicate the likelihood of road weather event predictions and the impacts of these events to travelers. Enhancing message credibility requires general design principles that can be used to increase the trust that travelers place in the road weather messages, thereby increasing their confidence in—and the value of—the messages.

**Design Guideline**

Ways to communicate the degree of certainty:

- Provide a percentage (e.g., 30%, 50% 100%) corresponding to the likelihood of a road weather event.
- Provide a qualitative description (e.g., "certain", "possible", "a chance") corresponding to the likelihood of a road weather event.
- Provide additional details about the weather event—or its driving impact—to improve the *specificity* of the prediction and increase the certainty communicated by the message. These details can include information about the location, timing, or impacts of a road weather event.

In this regard, "*specificity*" can refer to:

- Where a road weather event will occur or impact driving (specificity of location).
- When the road weather event or driving impact will occur (specificity of timing).
- The consequences of a road weather event on driving conditions (specificity of impacts).
- Secondary impacts of a road weather event, such as power outages, school closures, etc.

The value of road weather information is only as great as the trust that a traveler can place in the accuracy of the information. Goals for the accuracy of road weather information are (adapted from Reference 1):

- Across a typical trip, road weather information should be at least 70% accurate.
- 100% accuracy yields the best driver performance, but information above 70% accuracy should yield acceptable levels of trust.

In the context of presenting DMS messages, Dudek (2) lists the following message characteristics that should be avoided because they can damage the credibility of a message:

- Information is inaccurate or not current and can be easily checked by travelers and disproved.
- Information is irrelevant to most travelers.
- Information is obvious, and thus redundant to travelers' visual inspection.
- Information is repetitive, i.e., the same information is presented over a long period of time.
- Information is trivial with regard to the driving task.
- Information is poorly presented and thus difficult to comprehend or confusing.

Message credibility is also enhanced when messages are *updated appropriately* and *removed promptly* as conditions change.

## Discussion

Communicating the appropriate degree of certainty about road weather messages to travelers is important because travelers use the "cues to certainty" that are contained within a message to make travel decisions such as: if they should travel, when they should travel, if a mode choice change is in order, or if a planned route should be changed. As seen above, certainty can be communicated in numerous ways, including the likelihood of an event, as well as the specificity with which a road weather event or driving impact is communicated.

A key concept related to certainty is the *accuracy* of information presented to travelers. Accuracy was a key topic in Campbell et al. (3), which noted: *"accuracy refers to the correctness, usually expressed as a percentage, of traffic information presented to motorists. In this context, accuracy is considered to be a binary concept; i.e., the information is either accurate or inaccurate. Although accuracy is most often discussed with respect to congestion levels associated with various routing options, it may also refer to total travel time estimates, estimates of time delays due to congestion, and presentation of accident information."* This is equally true of road weather information: accuracy leads to credibility, credibility leads to trust, and trusted information is more likely to be used by travelers than information that is *not* trusted. Thus, information that is more accurate is simply more valuable to travelers.

The goal of 70% accuracy in the guidelines was adapted from a study that measured driver's trust in a simulated in-vehicle Advanced Traveler Information System (ATIS) at different levels of system accuracy (1). Results showed that while 100 percent accurate information yields the best driver performance and subjective ratings of the system's usefulness, information that was 70 percent accurate remained both acceptable and useful. Similar impacts on driver attitudes about inaccurate presentation of hazard information were found by Jonsson, Nass, Harris, and Takayama (4).

Dudek (2) also stresses the importance of displaying accurate information to travelers. He further states that if messages are not trusted by travelers, eventually they will be ignored. If travelers ignore the messages, any advantages that would have been provided by the messages are negated.

One issue to consider when presenting road weather information to travelers is that there may be trade-offs between the accuracy of the messages provided to travelers and the timeliness of such information. For example, information accuracy may be increased by using multiple, independent sources of raw weather data to derive predictions of the likelihood of a weather event or of weather-related impacts on driving. However, such increases in accuracy may increase the time between the onset of the weather event, and the presentation of relevant messages through a given dissemination method.

## References

1. Kantowitz, B. H., Hanowski, R. J., and Kantowitz, S. C. (1996). *Development of human factors guidelines for advanced traveler information systems and commercial vehicle operations: The effects of inaccurate traffic information on driver acceptance of in-vehicle information systems* (FHWA-RD-96-145). Washington, DC: Federal Highway Administration.
2. Dudek, C. L. (2004). *Changeable message sign operation and messaging handbook* (Report No. FHWA-OP-03-070). College Station: Texas Transportation Institute.
3. Campbell, J. L., Carney, C., and Kantowitz, B. H. (1998). *Human factors design guidelines for Advanced Traveler Information Systems (ATIS) and Commercial Vehicle Operations (CVO)* (FHWA-RD-98-057). Washington, DC: Federal Highway Administration.
4. Jonsson, M., Nass, C., Harris, H., and Takayama, L. (2005). Influence of hazard system accuracy on driving performance. *Proceedings of the 12th World Congress on Intelligent Transport Systems.*

**NOTE:** The use of Portable Electronic Devices, such as cell phones, while driving is a distraction. Consult the caveat on page 7 for more information.

# Chapter 3 Auditory Messages

## Introduction

This chapter provides information about the use of auditory dissemination methods, such as HAR and 511, to communicate road weather information to travelers. HAR and 511 have the ability to provide information to travelers at a range of locations relative to available DMSs or the availability of Internet connections. Although both HAR and 511 involve auditory communication that travelers listen to, they each function differently and have unique design requirements; these include different methods for accessing information and 511's use of menus and direct interaction with travelers. It should be noted that some of the guidelines in this chapter were developed based on early research conducted with these systems, which is not as comprehensive and up-to-date as the research available for the DMS chapter. Nevertheless, the information related to aspects of driver comprehension remains applicable.

**List of Guidelines** **Page**


Guideline 3-1. Auditory Message Content ..... 30

Guideline 3-2. Auditory Message Length ..... 32

Guideline 3-3. Auditory Message Delivery ..... 34

Guideline 3-4. Communicating Travel Times and Message Timestamps ..... 36

Guideline 3-5. Designing Auditory Diversion Directions ..... 38

Guideline 3-6. Communicating Degree of Urgency in Auditory Messages ..... 40

Guideline 3-7. Communicating Degree of Certainty and Enhancing Message Credibility for Auditory Messages ..... 42

## GUIDELINE 3-1. AUDITORY MESSAGE CONTENT

### Introduction

This guideline provides information about auditory message elements to include in 511 and HAR messages. The following message elements need not be presented in the order given.

**Design Guideline**

| Message Elements | Examples (adapted from References 1, 2 or from TMCs) |
|---|---|
| Introductory Statement | • *"This is WPQB 669 Providence, The Rhode Island Department of Transportation's Highway Advisory Radio System, broadcasting on 1630 AM"*<br>• *"This message is current as of 8:36 PM, Friday, April 13, 2012"*<br>• *"Attention Eastbound Interstate 10 Traffic"* |
| Problem Statement | • *"Snowfall and high winds have caused drifting snow and limited visibility"*<br>• *"There are strong and gusty crosswinds"* |
| Good Reason for Following the Advice | • *"To avoid a major delay"*<br>• *"To avoid 20 minutes delay"*<br>• *"To save 15 minutes"*<br>• *"To avoid heavy congestion"* |
| Location Statement | Use navigation references such as:<br>• Road segments<br>• Cities / towns<br>• Mileposts<br>• Major intersections / interchanges<br>• Exits<br>• Landmarks<br>• Rest areas |
| Action Statement | • *"Use headlights"*<br>• *"Look out for slush on the roadway"*<br>• *"Be prepared to stop"* |

**Example message from WSDOT showing various message elements.**

*At 9:19am, March 29, 2012, Stevens Pass, US-2.*
*Conditions: Snowing. Compact snow and ice on the roadway.*
*Advanced notice for avalanche control work planned for Stevens Pass from milepost 58, near Scenic to milepost 64, near the summit between 11 am and 3 pm.*
*Motorists should expect 20 minute delays and be prepared to stop.*
*Restrictions: Traction tires advised, oversized vehicles prohibited.*

### Discussion

*Introductory Statement*: The introductory statement can provide a variety of information, including the agency name and a time/day stamp (3). The message may start by addressing a particular traveler group, using the word "Attention" followed by the destination group (identified by direction of travel and name of facility) and the word "Traffic". Using the word "Attention" is only suitable for HAR messages since 511 users are likely to have already navigated a 511 menu before reaching this information.

*Problem Statement*: The problem statement describes the incident to the driver. If the severity is described, be brief. Drivers are more concerned about what they should do than the severity of the problem (1). Follow the problem statement with information that the driver does not need to remember (such as a good reason for following the advice, or a phrase such as "you are advised to" before providing the action statement), so that they have time to think about the problem before hearing more information that is imperative for them to recall (e.g., diversion directions (1)).

*Good Reason for Following the Advice*: This statement provides a more direct incentive for following the recommended action, beyond that implied by words such as "Flooding" or "Icy Roads".

*Location Statement*: The roadway segment that the road weather information applies to should be given to let drivers know if the weather will affect their travels and how to avoid it if necessary. Non-local drivers would benefit from a location presented in terms of major highways or landmarks. It is important to provide a stationary reference for the weather information since travelers will be in a variety of locations. However, in 511 systems, travelers usually select their location using the menu. TMCs emphasized that providing geographic references that can be understood by travelers is essential for 511 messaging.* Also, for fast information dissemination, the specific location may not be available to provide.

*Action Statement*: The 511 Deployment Coalition recommends that the weather and environmental conditions provided be actionable by travelers (4). Some TMCs reported that particularly in road weather messaging, there may not be a prescribed action – the message may simply be descriptive of a condition. Alternatively, the action may be a more general statement such as "Use Caution" or it may provide a different sort of recommendation like "Expect Delays."

### Design Considerations

Delay information is sometimes difficult to calculate. Instead of a specific delay time, agencies sometimes use "minor delay" or "major delay". A major delay implies a delay of at least 20 minutes to drivers (1).

Auditory icons are "familiar environmental sounds that intuitively convey information about the object or action that they represent" (5). Auditory icons in the context of road weather information include thunder claps, raindrops, etc. Auditory icons are generally not recommended for use in the presentation of road weather information. They convey little useful information and are also at risk for being perceived by drivers as a nuisance. Transportation agencies surveyed indicated that they do not use auditory icons in their messaging, therefore the unfamiliar sounds may evoke different interpretations by different travelers.

### References

1. Huchingson, R.D., Dudek, C. L., and Dorsey, W. (1982). *Highway advisory radio message development guide* (Report No. FHWA/RD-82/059). Washington, DC: Federal Highway Administration.
2. 511 Deployment Coalition. (2005). *Implementation and operational guidelines for 511 services* (Version 3.0). Retrieved November 30, 2009 from http://ops.fhwa.dot.gov/511/resources/publications/511guide_ver3/511guid3.pdf.
3. I-95 Northeast Consultants and The Scientex Corporation. (1995). *VMS/HAR operations guidelines and recommended practices. Quick reference guide* (Report No. I-5 CC 95-094). I-95 Corridor Coalition. Retrieved May 14, 2012 from http://ntl.bts.gov/lib/jpodocs/repts_te/2807.pdf.
4. 511 Deployment Coalition. (2003). *Deployment Assistance Report #6: Weather and Environmental Content on 511 Services.* Washington, DC.
5. Campbell, J. L., Richman, J. B., Carney, C., and Lee, J. D. (2004). *In-vehicle display icons and other information elements. Volume 1: Guidelines* (Report No. FHWA-RD-03-065). McLean, VA: Federal Highway Administration.

*This information was provided as part of an evaluation of an earlier version of these guidelines.

## GUIDELINE 3-2. AUDITORY MESSAGE LENGTH

### Introduction

This guideline provides information on developing concise auditory messages. Depending on the type of information being presented, different message lengths are acceptable.

**Design Guideline**

- Be as succinct as possible.
- Use concise messages rather than conversational messages.
- Avoid interesting but unnecessary information.
- If the message is long, place the critical information near the beginning.

Below are examples of a concise message and a corresponding conversational message (adapted from Reference 1).

**Concise Message**

*Attention southbound Interstate 5 traffic.*
*There is flooding between Washington State Route 599 and Washington State Route 518.*
*Expect congestion and delays ahead.*

**Conversational Message**

*This is your Washington Highway Advisory Radio coming to you from traffic control headquarters, 1660 kilohertz on your dial.*
*Attention all traffic headed south on Interstate 5.*
*You are advised that there is flooding between Washington State Route 599 and Washington State Route 518 just north of the Seattle-Tacoma International Airport.*
*This flooding is causing traffic congestion and will result in some delay in your travel time on Interstate 5.*
*Be alert for slowing vehicles.*
*Please drive safely and thank you for listening to the Washington Highway Advisory Radio system for timely traffic reports.*

### Discussion

There is a trade-off between providing essential information to drivers and maintaining a reasonable message length. Drivers prefer short auditory messages to conversational messages (1). Conversational messages may broadcast additional unnecessary information such as a statement thanking the driver for listening or use many more words to get the same information across. Long messages may be necessary in some situations, but they should convey more critical information than the shorter messages and remain concise.

In short, messages should be as concise as possible while still conveying the necessary information. Interesting information that is unnecessary to the driver should be avoided (1). If the message is long, the most critical information should be placed at the beginning of the message. This will allow travelers who only want the most critical information to hang up and avoid tying up the 511 line. Another consideration is that the longer the message is, the more time drivers will spend attending to a secondary task (i.e., listening to the message) that is unrelated to driving.

### Design Considerations

The message length as referenced in this guideline refers to the length of the actual message text. When the message is delivered, if it is done by a live recording, the time taken to speak the words will vary by operator.

One private service provider emphasized that from their experience, travelers want to minimize the time spent on the 511 phone system. They would like to get the information that they need quickly and then get off of the call. This provides further argument for keeping messages as concise as possible. Additionally, system limitations and costs also argue for efficient messaging.

### References

1. Huchingson, R.D., Dudek, C. L., and Dorsey, W. (1982). *Highway advisory radio message development guide* (Report No. FHWA/RD-82/059). Washington, DC: Federal Highway Administration.

## GUIDELINE 3-3. AUDITORY MESSAGE DELIVERY

### Introduction

This guideline provides guidance for human operators who deliver auditory weather messages. Some of the following guidelines apply only to messages that are recorded by human operators, but many also apply to messages that are created by an automated system.

**Design Guideline**

- Message Delivery:
  - Choose a male or female announcer with an average to low-pitched voice.
  - Deliver the message in a calm, matter of fact, dignified manner.
  - Use vocal inflexions to avoid speaking in a monotone.
  - Stress information that the driver needs to recall such as street names and turn directions.
  - Enunciate proper names carefully.
  - Use sentences instead of isolated words.
- Delivery Timing and Rate:
  - Pause 1 second after each statement (e.g. attention statement, problem statement) except in the following situations:
    - Pause ½ second after the phrase “To Avoid Major Delay” if used.
    - Pause 2 seconds if repeating the message, before and after the statement “I Repeat.”
    - Pause only ½ second between street names if the message is read without turn directions (see Guideline 3-5).
  - Deliver the message at approximately 175 words per minute.
  - Play a 3-5 second non-verbal sound between cycles.

## Discussion

Huchingson, Dudek, and Dorsey (1) provide guidance for message delivery. The message should sound official. The information that the driver needs to recall should be well understood. The speed of the message delivery is also important. Any speed below 110 words per minute sounds dragged out while speeds over 200 words per minute may not be understood by some drivers (1).

Most of the guidance presented applies to HAR rather than 511 messages. For example, it is not necessary to get travelers' attention when they are listening to a 511 message since they called into the system. Additionally, they may be given the option to repeat by the phone system rather than forced to listen to the same message. In 511 systems, many of the messages are automated or prerecorded. These guidelines may not apply to those messages, but provide some guidance for the initial design of those messages.

A cycle is a single repetition of the entire auditory message. Huchingson et al. (1) recommend that a 3-5 second sound plays between cycles of a message, if the message is automatically repeated by the system. It is important for drivers to know when the message has ended and is starting again at the beginning. Also, if they start listening between message cycles, the sound lets them know that they are tuned to the correct station. The sound can be an alert, such as a pulsating beep, or a combination of unique tones (1).

The order of the information in an auditory message is also important. The information that is the most important should be presented at the beginning or end of the message since that position makes it easier to recall (2).

## References

1. Huchingson, R.D., Dudek, C. L., and Dorsey, W. (1982). *Highway advisory radio message development guide* (Report No. FHWA/RD-82/059). Washington, DC: Federal Highway Administration.
2. Campbell, J. L., Carney, C. and Kantowitz, B. H. (1998). *Human factors design guidelines for Advanced Traveler Information Systems (ATIS) and Commercial Vehicle Operations (CVO)* (Report No. FHWA-RD-98-057). Washington, DC: Federal Highway Administration.

## GUIDELINE 3-4. COMMUNICATING TRAVEL TIMES AND MESSAGE TIMESTAMPS

### Introduction

This guideline discusses communicating the travel time or delay length for a route and also providing time-stamps to inform the driver how current the information is.

**Design Guideline**

- Time-stamps
  - Providing a time-stamp for current information lets drivers know when it was entered into the system.
  - Providing a time-stamp for long-term information can confuse drivers.
  - The time-stamp should use the time that the message was updated, not the time that the incident occurred.
- Travel time information can be presented in two ways:
  - Absolute time: "segment travel time is 24 minutes"
    - Should never be less than the travel time at the speed limit
    - Multi-segment or corridor travel times are acceptable in urban areas
  - Delay beyond normal conditions: "segment travel time is delayed 5 minutes"

**Travel time message example from Ohio HAR.**

*This is station WQOQ916, Richfield Ohio, operating on 1610 AM, by the Ohio Department of Transportation. This is the Buckeye Traffic travel time information system. This message is current as of 8:36 PM, Friday, April 13, 2012.*
*For I-77 Northbound, from I-271 to I-480, the distance is 12 miles and the travel time is 12 minutes.*
*For I-271 Northbound, from I-77 to I-480, the distance is 16 miles and the travel time is 15 minutes.*
*For I-77 Southbound, from I-271 to SR-21, the distance is 8 miles and the travel time is 8 minutes.*
*For I-271 Southbound, from I-77 to I-71, the distance is 10 miles and the travel time is 10 minutes.*

**Delay message example from Washington 511.**

*At 9:19am, March 29, 2012, Stevens Pass, US-2.*
*Conditions: Snowing. Compact snow and ice on the roadway.*
*Advanced notice for avalanche control work planned for Stevens Pass from milepost 58, near Scenic to milepost 64, near the summit between 11 am and 3 pm.*
*Motorists should expect 20 minute delays and be prepared to stop.*
*Restrictions: Traction tires advised, oversized vehicles prohibited.*

### Discussion

Providing time and/or date information gives drivers a sense of the accuracy and reliability of the information (1). However, if a time-stamp is given for an event that is long-term and not changing, an old time-stamp may give the impression that the information is out of date and inaccurate even if it is not. Thus, it is important that time-stamps remain current, especially if the information is presented for a longer period of time (e.g., for an extended road closure). The time-stamp should use the time that the message was updated so that drivers will know how current the information is and if the incident is likely still ongoing.

Travel time information can be useful if an estimate can be made with reasonable accuracy. The travel time can be presented as an absolute travel time or a delay time. If it is presented as a delay, the time given should be the amount of time that is expected to be spent beyond the normal travel time.

Credibility is a major factor when providing travel times. Travel times are easy for drivers to verify when they reach their destination, potentially proving the message to be incorrect. When travel times cannot be predicted and historical travel times are used, it should be ensured that they are reasonably accurate.

### Design Considerations

Timing of a road weather event is notoriously difficult to predict. Although this guideline does not provide any specific provisions for road weather information, travel times are commonly affected by road weather events. Additionally, especially with the ever-changing nature of road weather, it is important to give a message timestamp to allow drivers to determine how current the information is.

### References

1. 511 Deployment Coalition. (2005). *Implementation and operational guidelines for 511 services* (Version 3.0). Retrieved November 30, 2009 from http://ops.fhwa.dot.gov/511/resources/publications/511guide_ver3/511guid3.pdf.

## GUIDELINE 3-5. DESIGNING AUDITORY DIVERSION DIRECTIONS

### Introduction

This guideline provides information on choosing auditory diversion message elements and determining the appropriate length for diversion directions.

**Design Guideline**

- Message Content:
  - Use freeway exit numbers if they are available.
  - Use route describers and specific directions for unfamiliar drivers.
  - Familiar drivers do not need turn directions (e.g. left, right).
  - Do not include the number of traffic signals as a route describer if one or more are inoperative or flashing.
- Message Length:
  - Diversion information should be a maximum of 8 information units.
    - An information unit in auditory diversion messages is defined as a roadway name or turning movement.
  - Repeat the turning directions and street names if they are included in a diversion message, using internal or external redundancy.

An information unit for an auditory diversion message is defined as either a turning movement or a roadway name. Note that an implied turning direction also counts as an information unit. There are two methods used to provide redundancy in diversion route messages, shown in the figure below (adapted from Reference 1). Each of the information units in the figure is colored and has a superscript denoting an arbitrary information unit number to help identify where units are repeated within the message.

**Method #1**: Internal Redundancy: each information unit containing a street name is repeated in the following line of the message.

Exit at Fredericksburg[1] and take the following route:

Turn right[2] on Fredericksburg[1]

And continue to Wurzbach[3]

Turn left[4] on Wurzbach[3]

And then continue to Evers[5]

Turn left[6] again on Evers[5]

And proceed back to Interstate 410 West[7]

**Method #2**: External Redundancy: the entire diversion route is repeated.

*Information Units #1-7:*

Exit at Fredericksburg[1] and take the following route:

Turn right[2] on Fredericksburg[1]

Turn left[4] on Wurzbach[3]

Turn left[6] again on Evers[5]

And proceed back to Interstate 410 West[7]

***Repeated** Information Units #1-7:*

I repeat,

Exit at Fredericksburg[1] and take the following route:

Turn right[2] on Fredericksburg[1]

Turn left[4] on Wurzbach[3]

Turn left[6] again on Evers[5]

And proceed back to Interstate 410 West[7]

### Discussion

When providing diversion information, unfamiliar drivers benefit from landmarks in the route information (1). These can include service stations, restaurants, water towers, traffic lights and other prominent landmarks. However, if one or more of the traffic lights along the route are flashing or out of service, the number of traffic lights should not be used. Unfamiliar drivers also need specific instructions on how to avoid an incident rather than to be left to find their way. It is helpful to tell the driver if a turn is at the first signal or to provide the correct travel lane for a turn if the signs are small (1). Other optional elements in diversion messages include the length of the detour and the additional time required by the detour (if known). If 85% or more of the drivers are familiar drivers, turn directions may be omitted to save time and space. For example, instead of stating: "Turn right on Fredericksburg and go to the fourth stoplight, Wurzbach," for familiar drivers the message could simply state: "Fredericksburg to Wurzbach."

Huchingson et al. (1) reported that 90% of unfamiliar drivers can follow a diversion route containing 6-8 information units with no errors. When drivers return to their initial roadway, it is not necessary to tell them which direction to turn since they will know which direction they were originally headed. It is recommended that routes requiring ten or more information units be avoided. If such a complex route is necessary, drivers should be directed to exit the roadway by the message and then guided through the diversion route by trailblazers.

Huchingson et al. (1) also recommend the repetition of street names either within the message (Approach #1) or after the message (Approach #2) since they are often difficult to hear with other ambient driving noise. The repetition guidance mainly applies to HAR messages since 511 listeners may be given the option to repeat by saying "repeat" at the end of the message, rather than automatically being played a repetition of the message.

### Design Considerations

TMC operators reported that they do not often provide auditory diversion information to this level of specificity, particularly on HAR.* An alternate to providing this level of information is to state "Call 511," "Take an Alternate Route," "Follow Posted Detours," or "Follow Posted Signs" if they are indeed posted. Additionally, in weather events, interstates are often the best roads to travel since weather impacts broad portions of a region. However, this guideline could be useful for long-term disruptions, closures, or major events. Agencies also noted that the phrases "We Suggest" or "Travelers are Recommended" can be included in the diversion information.

When diverting drivers to a particular route, it is important to monitor the congestion levels on the diversion route. If enough drivers follow the diversion route given by the message, that route may become as congested as the main route. A third route may even need to be identified to handle the traffic flow.

Another consideration when posting a diversion route or route closure is providing drivers with enough information to make a decision as to their preferred action. In areas without many alternate routes (e.g., a mountain pass), diversion routes may be very long or even not available. Depending on the length of time that the diversion is expected to be active, drivers may choose to wait out the closure rather than take a long diversion (or vice versa). In this scenario, provided a projected length of time that the diversion is expected to be in place may be helpful to drivers when planning their course of action.

### Notes for Other Dissemination Methods

At least one TMC mentioned that they provide diversion directions using Twitter.*

### References

1. Huchingson, R.D., Dudek, C. L., and Dorsey, W. (1982). *Highway advisory radio message development guide* (Report No. FHWA/RD-82/059). Washington, DC: Federal Highway Administration.

*This information was provided as part of an evaluation of an earlier version of these guidelines.

## GUIDELINE 3-6. COMMUNICATING DEGREE OF URGENCY IN AUDITORY MESSAGES

### Introduction

This guideline provides general design principles and specific message content that communicate the priority, timing, and driving impacts of weather events through dissemination methods such as 511 or HAR.

**Design Guideline**

| Road Weather Message Characteristic | Guidelines |
|---|---|
| Specific words that can be used | • Words that communicate moderate urgency include: caution, warning, or hazard.<br>• Words that communicate high urgency include: severe, emergency, life-threatening, deadly. |
| Order of presentation within a message | • Present the most important/urgent information at either the beginning or end of the message in order to improve driver recall of the message (1). |
| Use of repeated messages | • Provide a means for repeating urgent messages—this is especially helpful for older drivers (1). |
| Use of time-stamps | • When providing time-stamps, the time data should reflect the time that the information was updated, not the time that the incident occurred (2). |

## Discussion

Communicating the appropriate degree of urgency to travelers is important because travelers use the cues to urgency that are contained within a message to make decisions regarding if they should travel, when they should travel, if a mode choice change is in order, or if a planned route should be changed. Urgency can be communicated in numerous ways, including words, phrases, colors, location on a visual display, location within a message, and the modality used to present the message. Importantly, the many different aspects of a particular weather message dissemination method (i.e., DMS vs. website vs. 511) can be used together to effectively communicate the appropriate degree of urgency to travelers.

The priority of a message is a function of how quickly a response must be made by the driver, as well as the consequences of failing to make the proper response (2). A high-priority message requires a fast response (0-5 minutes) and has serious consequences, such as a crash with possible injuries or fatalities. For example, a weather-related roadway condition—such as an upcoming road that is washed-out due to a flash flood. A lower priority message has no response needed for at least 5 minutes and has no immediate consequences. An example of a lower priority message is a forecast for rain on the next day.

## References

1. Campbell, J. L., Carney, C., and Kantowitz, B. H. (1998). *Human factors design guidelines for Advanced Traveler Information Systems (ATIS) and Commercial Vehicle Operations (CVO)* (FHWA-RD-98-057). Washington, DC: Federal Highway Administration.
2. 511 Deployment Coalition. (2005). *Implementation and operational guidelines for 511 services (Version 3.0)*. Retrieved November 30, 2009 from http://ops.fhwa.dot.gov/511/resources/publications/511guide_ver3/511guid3.pdf.

## GUIDELINE 3-7. COMMUNICATING DEGREE OF CERTAINTY AND ENHANCING MESSAGE CREDIBILITY FOR AUDITORY MESSAGES

### Introduction

Communicating the degree of certainty in a road weather message refers to general design principles and specific message content that communicate the likelihood of road weather events predictions and the impacts of these events to travelers. The Guidelines below should be used to communicate the degree of certainty in road weather messages presented through HAR or 511.

**Design Guideline**

Ways to communicate the degree of certainty:

- Provide a percentage (e.g., 30%, 50% 100%) corresponding to the likelihood of a road weather event.
- Provide a qualitative description (e.g., "certain", "possible", "a chance") corresponding to the likelihood of a road weather event.
- Provide additional details about the weather event—or its driving impact—to improve the *specificity* of the prediction and increase the certainty communicated by the message. These details can include information about the location, timing, or impacts of a road weather event.

In this regard, "*specificity*" can refer to:

- Where a road weather event will occur or impact driving (specificity of location).
- When the road weather event or driving impact will occur (specificity of timing).
- The consequences of a road weather event on driving conditions (specificity of impacts).
- Secondary impacts of a road weather event, such as power outages, school closures, etc.

The value of road weather information is only as great as the trust that a traveler can place in the accuracy of the information. Goals for the accuracy of road weather information (adapted from Reference 1):

- Across a typical trip, road weather information should be at least 70% accurate.
- 100% accuracy yields the best driver performance, but information above 70% accuracy should yield acceptable levels of trust.

In the context of presenting DMS messages, Dudek (2) lists the following message characteristics that should be avoided because they can damage the credibility of a message:

- Information is inaccurate or not current and can be easily checked by travelers and disproved.
- Information is irrelevant to most travelers.
- Information is obvious, and thus redundant to travelers' visual inspection.
- Information is repetitive, i.e., the same information is presented over a long period of time.
- Information is trivial with regard to the driving task.
- Information is poorly presented and thus difficult to comprehend or confusing.

Message credibility is also enhanced when messages are updated appropriately and removed promptly as conditions change.

## Discussion

Communicating the appropriate degree of certainty about road weather messages to travelers is important because travelers use the "cues to certainty" that are contained within a message to make travel decisions such as: if they should travel, when they should travel, if a mode choice change is in order, or if a planned route should be changed. As seen above, certainty can be communicated in numerous ways, including the likelihood of an event, as well as the specificity with which a road weather event or driving impact is communicated.

A key concept related to certainty is the *accuracy* of information presented to travelers. Accuracy was a key topic in Campbell et al. (3), which noted: *"accuracy refers to the correctness, usually expressed as a percentage, of traffic information presented to motorists. In this context, accuracy is considered to be a binary concept; i.e., the information is either accurate or inaccurate. Although accuracy is most often discussed with respect to congestion levels associated with various routing options, it may also refer to total travel time estimates, estimates of time delays due to congestion, and presentation of accident information."* This is equally true of road weather information: accuracy leads to credibility, credibility leads to trust, and trusted information is more likely to be used by travelers than information that is *not* trusted. Thus, information that is more accurate is simply more valuable to travelers.

The goal of 70% accuracy in the guidelines was adapted from a study that measured driver's trust in a simulated in-vehicle Advanced Traveler Information System (ATIS) at different levels of system accuracy. Results showed that while 100 percent accurate information yields the best driver performance and subjective ratings of the system's usefulness, information that was 70 percent accurate remained both acceptable and useful. Similar impacts on driver attitudes about inaccurate presentation of hazard information were found by Jonsson, Nass, Harris, and Takayama (4).

Dudek (2) also stresses the importance of displaying accurate information to travelers. He further states that if messages are not trusted by travelers, eventually they will be ignored. If travelers ignore the messages, any advantages that would have been provided by the messages are negated.

One issue to consider when presenting road weather information to travelers is that there may be trade-offs between the accuracy of the messages provided to travelers and the timeliness of such information. For example, information accuracy may be increased by using multiple, independent sources of raw weather data to derive predictions of the likelihood of a weather event or of weather-related impacts on driving. However, such increases in accuracy may increase the time between the onset of the weather event, and the presentation of relevant messages through a given dissemination method.

## References

1. Kantowitz, B. H., Hanowski, R. J., and Kantowitz, S. C. (1996). *Development of human factors guidelines for advanced traveler information systems and commercial vehicle operations: The effects of inaccurate traffic information on driver acceptance of in-vehicle information systems* (FHWA-RD-96-145). Washington, DC: Federal Highway Administration.
2. Dudek, C. L. (2004). *Changeable message sign operation and messaging handbook.* (Report No. FHWA-OP-03-070). College Station: Texas Transportation Institute.
3. Campbell, J. L., Carney, C., and Kantowitz, B. H. (1998). *Human factors design guidelines for Advanced Traveler Information Systems (ATIS) and Commercial Vehicle Operations (CVO)* (FHWA-RD-98-057). Washington, DC: Federal Highway Administration.
4. Jonsson, M., Nass, C., Harris, H., and Takayama, L. (2005). Influence of hazard system accuracy on driving performance. *Proceedings of the 12th World Congress on Intelligent Transport Systems.*

# Chapter 4 Web-Based Messages

## Introduction

This chapter provides information about the use of web-based information, such as that provided by State DOT websites[1], to communicate road weather information to travelers. This dissemination method has the ability to supply users with content-rich graphical information (e.g., maps, cameras) as well as easy customization of the information that they view. It should be noted that there is little existing research related to web-based, road weather communication. There is a great deal of relevant research related to Internet communication in general, however, and this chapter incorporates established user-interface design principles into the guidelines. Some of the guidance developed in this chapter is based on the results of a "Best Practice" analysis of all available State DOT travel websites. Accordingly, this chapter uses many graphical examples taken from State DOT websites to illustrate some of the key design recommendations and concepts provided by the design guidelines.

**List of Guidelines** **Page**


Guideline 4-1. Design of Tabular Information ..... 46

Guideline 4-2. Display of Text Paragraphs ..... 48

Guideline 4-3. Traffic Camera Displays ..... 50

Guideline 4-4. Designing General Map Displays ..... 52

Guideline 4-5. Designing Weather-Specific Map Displays ..... 54

Guideline 4-6. Use of Visual Icons ..... 56

Guideline 4-7. Color Selection ..... 58

Guideline 4-8. Display of Severe Weather Alerts ..... 60

Guideline 4-9. Linking to Road Weather Information ..... 62

Guideline 4-10. Website Use on Portable Electronic Devices ..... 64

Guideline 4-11. Communicating Degree of Urgency on Websites ..... 66

Guideline 4-12. Communicating Degree of Certainty and Enhancing Message Credibility on Websites ..... 68


[1] The number of states using kiosks to disseminate road weather information, and the exact implementation of these kiosks are unknown; however, much of the guidance in this chapter likely applies to information displayed on kiosks.

## GUIDELINE 4-1. DESIGN OF TABULAR INFORMATION

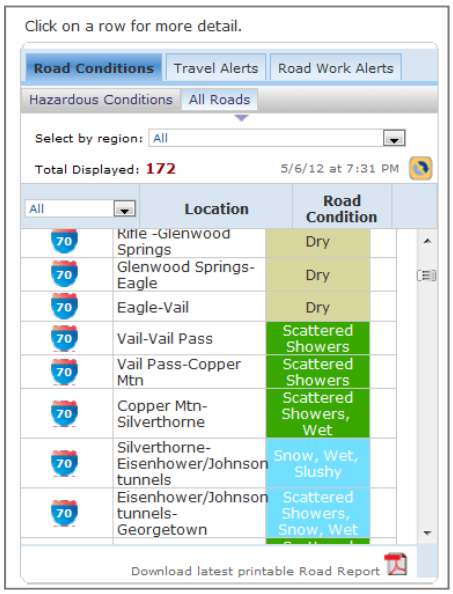
### Introduction

This guideline provides information about the design of tables or lists used to present mostly textual road condition information. These recommendations are based upon the best or most common practices identified in a survey of state weather websites. On 34 of the 51 weather sites surveyed, textual road condition information was presented in addition to a visual representation on a map.

**Design Guideline**

- Order table or list items alphabetically or numerically.
- Provide a sort feature to allow travelers to find the information by route or region.
- If displaying a lot of text for many locations, display the short form by default and allow travelers to click for more information.
- Use multiple columns to display different types of information rather than multiple lines within the same row.
- Provide a time-stamp.

**Example table containing road condition information.**




Source: Colorado DOT ITS Traveler Website, retrieved May 6, 2012 from http://www.cotrip.org/roadConditions.htm

### Discussion

When presenting a list or table of road weather information, the elements should be ordered in a way that will be easily understood by travelers. The most common ways of accomplishing this are alphabetical and numerical ordering by the first column. If information is being presented for an entire state, let the travelers narrow down which entries are displayed by selecting a route or region of interest. Most commonly, websites allow travelers to select a route name or area of the map for which they want a listing of road weather information. If long text fields such as weather reports are going to be displayed, reduce the field to a shorter form (such as in the road condition column above) and allow travelers to click if they want more information. Organize the information in multiple columns, rather than multiple lines in a single row, to allow travelers to scan the first column for the information that they need.

## Design Considerations

Wyoming DOT (WYDOT) used these guidelines to revise the format of the road weather information on their website. The before- and after-images are shown in the figures below.

**Format of WYDOT road condition information before the website rebuild.**

**WYDOT road conditions as of Mar. 21, 2012 07:43am**

**Conditions for the Jackson area are as follows:**

**Dry:**
US 189/191 between Bondurant and Hoback Jct
...Falling rock advisory in effect.
US 26/89/191 between Jackson and the S Boundary of Grand Teton Nat'l Park
US 26/89/189/191 between Hoback Jct and Jackson
WY 22 between Jackson and Wilson
WY 390 between WY 22 and Teton Village

**Dry with Snowfall:**
US 26/89/191 between the S Boundary of Grand Teton Nat'l Park and Moose

**Slick with Snowfall:**
US 89/191/287 between Moran Jct and Flagg Ranch
US 26/89/191 between Moose and Moran Jct
US 26/287 between Moran Jct and the E Boundary of Grand Teton Nat'l Park

Source: Personal communication with Chris Cluett and WYDOT, dated March 21, 2012.

**Format of WYDOT road condition information after the website rebuild.**

**Conditions for the Jackson area are as follows:**

| Regional Comments | |
|---|---|
| **Southwest Wyoming:** | US 191 is CLOSED to commercial vehicles over 40,000 GVWR between Rock Springs and UT. This will continue until April 01, 2012. |

| Route | Location | Conditions | Advisories | Last Report Time | Cameras | Sensors |
|---|---|---|---|---|---|---|
| US 189/191 | Between Bondurant and Hoback Jct | Dry | Falling Rock | Mar 21, 2012 07:43 am | | |
| US 26/89 | Between Alpine Jct and Hoback Jct | Slick in Spots | Falling Rock | Mar 21, 2012 07:43 am | | |
| | Between Hoback Jct and Jackson | Dry | None | Mar 21, 2012 07:43 am | | |
| | Between Jackson and the S Boundary of Grand Teton Nat'l Park | Dry | None | Mar 21, 2012 07:43 am | | |
| | Between the S Boundary of Grand Teton Nat'l Park and Moose | Dry with Snowfall | None | Mar 21, 2012 07:43 am | | |
| | Between Moose and Moran Jct | Slick with Snowfall | None | Mar 21, 2012 07:43 am | | |
| | Between Moran Jct and the E Boundary of Grand Teton Nat'l Park | Slick with Snowfall | None | Mar 21, 2012 07:43 am | | |
| US 89/191/287 | Between Moran Jct and Flagg Ranch | Slick with Snowfall | None | Mar 21, 2012 07:43 am | | |
| WY 22 | Between Jackson and Wilson | Dry | None | Mar 21, 2012 07:43 am | | |
| | Between Wilson and the Idaho State Line | Wet, Slick in Spots | No Trailer Traffic | Mar 21, 2012 07:43 am | | |
| WY 390 | Between WY 22 and Teton Village | Dry | None | Mar 21, 2012 07:43 am | | |

*Chain Law - Level 1 Definition
**Chain Law - Level 2 Definition

| Impact Levels | Description / Recommended Action |
|---|---|
| Low | Minimal impacts expected, use general caution. |
| Moderate | Some impacts expected, use extra caution. Stay alert for changing weather conditions. |
| High | Dangerous impacts expected, use extreme caution, delay travel or consider alternate route. If travel is necessary, slow down and allow extra time. |
| CLOSED | Per W.S. 24-1-109, motorists traveling on a closed road without permission from WYDOT or WHP may be subject to a fine of up to $750 and/or up to 30 days imprisonment. |
| All travelers are encouraged to check present conditions and forecasts before departing. | |

Source: Personal communication with Chris Cluett and WYDOT, dated March 21, 2012.

## GUIDELINE 4-2. DISPLAY OF TEXT PARAGRAPHS

### Introduction

This guideline discusses display characteristics of text passages to maximize readability and comprehension.

**Design Guideline**

| Text Feature | Guidelines (from 1, except where noted) |
|---|---|
| Text Display | • Display text in sentence case rather than all upper case.<br>• Text should be in a clear and simple font. Avoid fonts with excessive flourishes or embellishments. (2)<br>• For simple, continuous online text, display at least 4 lines at one time.<br>• If space is limited, display a few long lines of text rather than many short lines.<br>• Display text in wide columns of at least 50 characters per line.<br>• Highlight critical text, if necessary, using color or another notation, rather than capitalization.<br>• Separate paragraphs by at least one blank line.<br>• Use left justification and consistent word spacing. |
| Punctuation | • Try to avoid breaking words using hyphenation.<br>• Use conventional punctuation (i.e. periods at the end of sentences, etc.) |
| Sentence Phrasing | • Use clear wording and short, simple sentences.<br>• Put the main topic near the beginning of the sentence.<br>• Use distinct words (e.g. will not or not complete) rather than combined forms (e.g. won't or incomplete).<br>• Use the active voice instead of the passive voice.<br>• Maintain the order of a sequence of events in the sentence in which they are described. |
| Lists | • Use a single-column list when conveying a series of items.<br>• Order list items logically (order the items alphabetically if no logic exists).<br>• Use Arabic numerals (i.e., 1, 2, 3) rather than Roman numerals (i.e., I, II, III).<br>• If a list is too long to be displayed on one page, consider a hierarchical structure to break it into shorter lists. |

**Examples of acceptable and unacceptable fonts for web display (2).**

**Acceptable Fonts:**

**Unacceptable Fonts:**

### Discussion

Displaying 4 lines of continuous text is acceptable when the text is simple. However, if the text is complex or requires the reader to refer to previously displayed lines, more lines are necessary. Text that is displayed in wide columns is read significantly faster than text that is displayed in narrow columns. Also, text displayed in mixed upper and lower case (i.e., capitalizing only the start of a sentence, proper nouns, and acronyms) is read more easily than text in all capital letters. If the display cannot accommodate lower case descenders (the parts of some letters that drop below the baseline of the font, such as in the letters "p" and "g"), upper case letters should be used. Most fonts that are clear and simple will be legible if other parameters such as character size and contrast are sufficient (2). If a passage of text is critical and needs to be highlighted, use color or another notation rather than capitalization to preserve legibility. It is easier for travelers to read text with consistent spacing between words. This benefit outweighs any benefit provided by using uneven spacing to have a flush right margin. Similarly, it is better to eliminate hyphenation and have a ragged right margin. To support traveler understanding, it is important to use simple wording and short sentences. Using distinct wording helps travelers understand the sense of a message, especially when it involves negation. Using separate words is not a problem for open format text messages since length is less of a concern. Additionally, it is clearer when a sequence of events (such as a diversion route) is written in the same order in which the traveler is expected to complete the actions.

When describing a series of items, travelers scan the items faster and more accurately when they are in a list format. Each item should start on a new line and the list should remain in a single column if space allows (except when comparison between items makes multiple columns practical). If an entry takes up multiple lines in a list, indicate that the lines belong together using blank space between items, indenting the lines after the initial line, or marking the first line of each item using a symbol or number.

### Design Considerations

Text segments are displayed in many locations on road weather websites. They may include, for example, descriptions of weather incidents, severe weather alerts, or mountain pass condition reports.

### References

1. Smith, S.L., and Mosier, J.N. (1986). *Guidelines for designing user interface software* (Report No. ESD-TR-86-278). Bedford, MA: The Mitre Corporation.
2. Campbell, J. L., Carney, C. and Kantowitz, B. H. (1998). *Human factors design guidelines for Advanced Traveler Information Systems (ATIS) and Commercial Vehicle Operations (CVO)* (Report No. FHWA-RD-98-057). Washington, DC: Federal Highway Administration.

## GUIDELINE 4-3. TRAFFIC CAMERA DISPLAYS

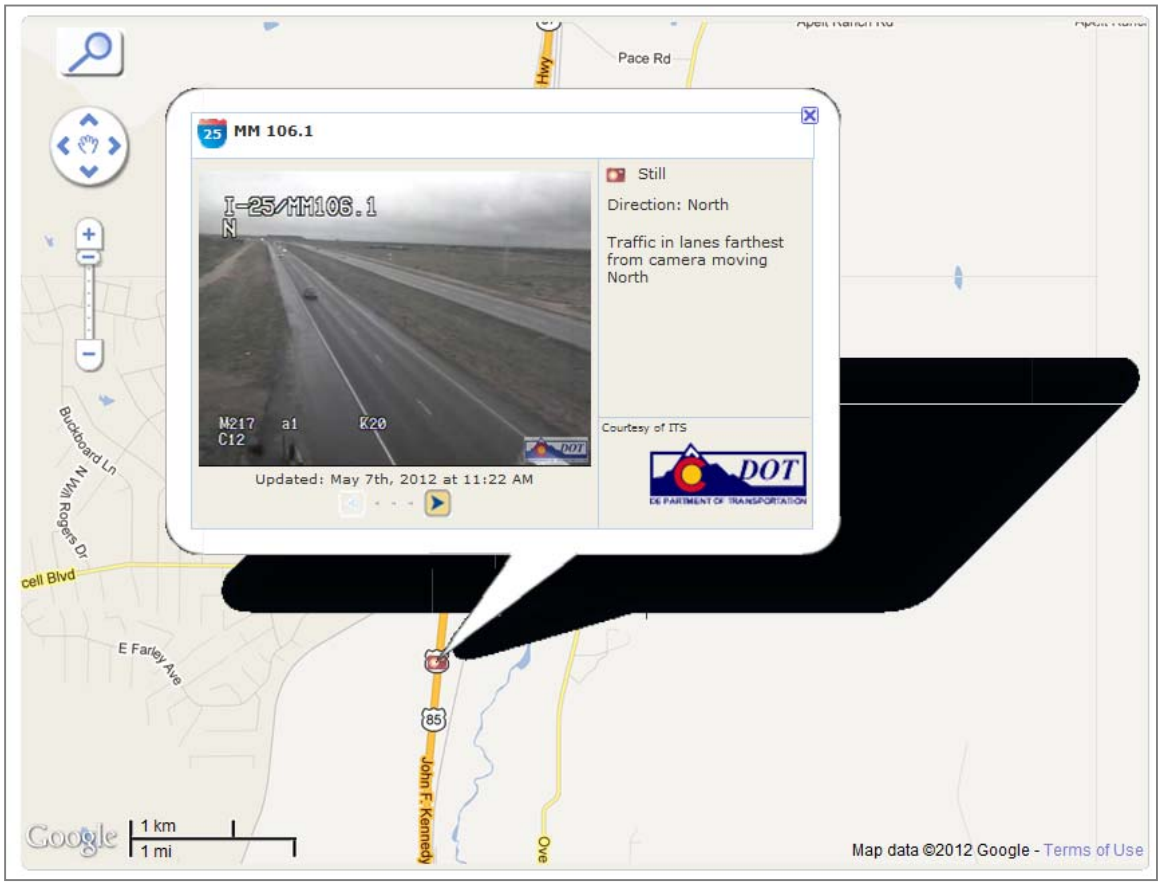
### Introduction

This guideline provides information related to the use of camera images to convey road weather information. These recommendations are based upon the best or most common practices identified in a survey of state weather websites. Live cameras or periodically updated static images are used on 41 of the 51 weather websites surveyed to show traffic congestion levels and road conditions.

**Design Guideline**

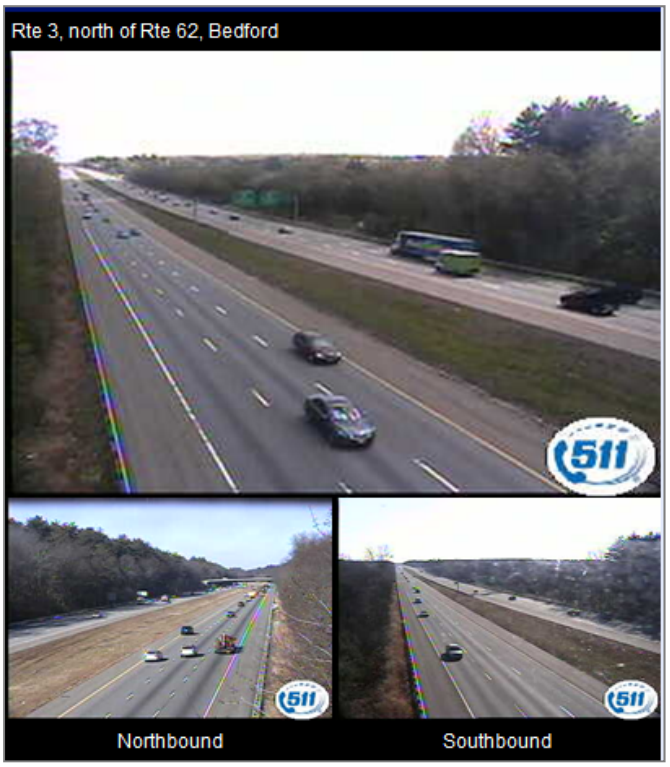
- Provide a timestamp to show how current the display is.
- Provide an indication of how often the video updates if the feed is not continuously streaming.
- Provide precise location information including the direction that the traffic on the camera (or nearest to the camera) is flowing.
- Show the roadway so that travelers can get an idea of the pavement and traffic conditions.
- Consider allowing travelers to pause the video if appropriate.

**Still camera image with timestamp and directional information.**




Source: Colorado DOT ITS Traveler Website, retrieved May 7, 2012, from http://www.cotrip.org/device.htm

**Three camera images to show directional information (top image updates periodically; the user is expected to match one of the lower images with the upper image to identify directionality).**




Source: Massachusetts DOT Website, retrieved May 7, 2012, from http://www1.eot.state.ma.us/

## Discussion

Camera images are generally presented in a separate window, sidebar, or pop-out from the map display. Live cameras either update continuously or at discrete intervals. The majority (34 out of 41) of the websites surveyed that included a camera display also provided a timestamp for their camera information. It is very important that the date and time are prominently displayed on or near the picture so that the traveler knows if the information is current. If the camera breaks or freezes, the date and time will inform the traveler that the picture is old, preserving credibility. If the picture is updated at discrete times, an indication of how often the picture is updated prevents travelers from checking back too often and perhaps becoming frustrated. For continuously updating camera feeds, a consideration should be made to allow the traveler to pause the camera. This may help travelers whose computer systems run slowly. Additionally, if travelers are looking closely at the image to see details, it will be easier for them to focus if the picture is not constantly updating.

Precise camera location information including direction is provided by 26 out of 41 websites. Even if landmarks are visible in the frame, at nighttime it may be difficult to tell which direction the camera is facing and which road it is on. The direction that the camera is facing is provided through comparative directional photographs (3 websites), or an explicit statement of the side of the road where the camera is located (23 websites). Providing directional information is especially critical for pan-tilt-zoom cameras which change shooting directions. Also, the roadway should be prominently shown in the frame so that travelers can see what the pavement and traffic conditions are like.

## GUIDELINE 4-4. DESIGNING GENERAL MAP DISPLAYS

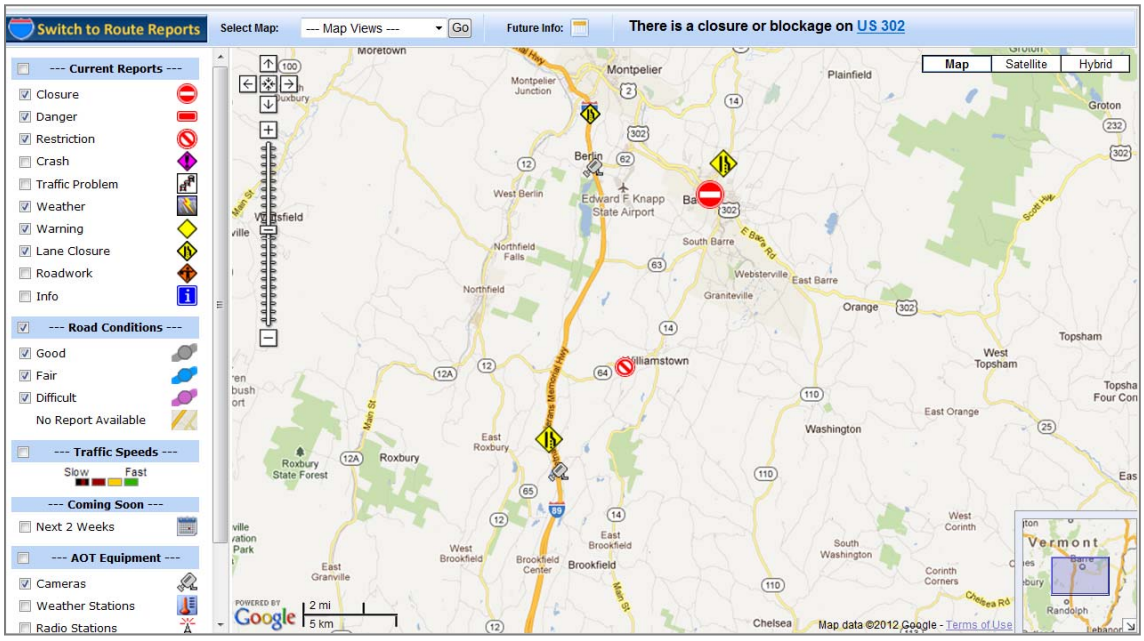
### Introduction

This guideline provides information on general map characteristics that improve usability.

**Design Guideline**

| Map Feature | Guidelines |
|---|---|
| Orientation | • Use a consistent orientation for every map. |
| Labels | • Label significant map features directly on the display.<br>• Position map labels in consistent locations for different features. |
| Movement | • When a traveler pans over a map to show a particular area, provide a graphic to show their position within the larger map.<br>• If using linked maps, ensure that they overlap slightly. |
| Event Data | • Use graphic elements to display non-geographic data over a geographic area.<br>• Use additional graphic elements to indicate changes in mapped data as necessary.<br>• Provide stable map elements for changing data in automatically updated displays.<br>• If the data categories for the traveler's task cannot be predicted at a particular point, let them select the categories that they want displayed. |
| Distance Measurements | • Provide computerized aids if distance judgments are necessary (e.g. a movable grid, concentric range rings, or a movable scaled ruler). |

**Example map display with North/South orientation, position display, and category selection.**




Source: Vermont Agency of Transportation Website, retrieved May 7, 2012, from http://511.vermont.gov/main.jsf

## Discussion

***Labels:*** The significant features on the maps should be labeled if it can be done without cluttering the display. If the labels cannot be incorporated directly onto the map, they may be shown outside the map area and linked using a coding method. Another alternative is to allow travelers to click on a geographic label and then highlight the corresponding location on the map, or vice versa. Map labels should be placed in consistent locations for similar map features (e.g. town names always directly above the town symbol).

***Movement:*** When the map area that is displayed is larger than can fit in a frame, travelers can have the option to pan the display (to move continuously over the map without any predefined boundaries), or click links to predefined areas. If the travelers can pan the display, they should be provided with a graphic (i.e. a miniature display of the entire map in a corner of the display and a rectangle imposed on top) to show the area that they are viewing. This helps the traveler stay oriented within the entire display and provides information as to which direction to move in order to see another section. If the travelers are provided with links to different map sections, it is important that the sections provide some overlap with each other in case the area that the traveler wants to see is at a boundary between sections.

***Event data:*** If non-geographic data are being displayed over a geographic area (such as the amount of rainfall in different regions), it is easier to visually compare the values if they are coded using graphic elements rather than alphanumeric characters. Alphanumeric characters may also add visual clutter when used with the existing map labels. If changes in data, such as weather front movements, are to be shown on a static display, additional graphic elements are needed to show directional movement. These can include arrows, or directional symbols (such as triangles pointing in the direction of the movement) added to contour lines. It is sometimes recommended that these directional symbols be 1-2 times as large as the alphanumeric characters and spaced at 5-10 times their own width. If the data are changing and the displays are automatically updated, some stable elements are needed as a frame of reference. These elements can include coordinates or geographic elements. If the changing elements cover background elements, the background should return when the changing data move away. If the data the traveler wants displayed cannot be predicted, let travelers select the categories that will be displayed. Travelers should be given a reminder of available categories and be able to easily select them. However, this does introduce the risk that travelers will select too many or incorrect categories, making their task more difficult.

## References

1. Smith, S.L., and Mosier, J.N. (1986). *Guidelines for designing user interface software*. (Report No. ESD-TR-86-278). Bedford, MA: The Mitre Corporation.

## GUIDELINE 4-5. DESIGNING WEATHER-SPECIFIC MAP DISPLAYS

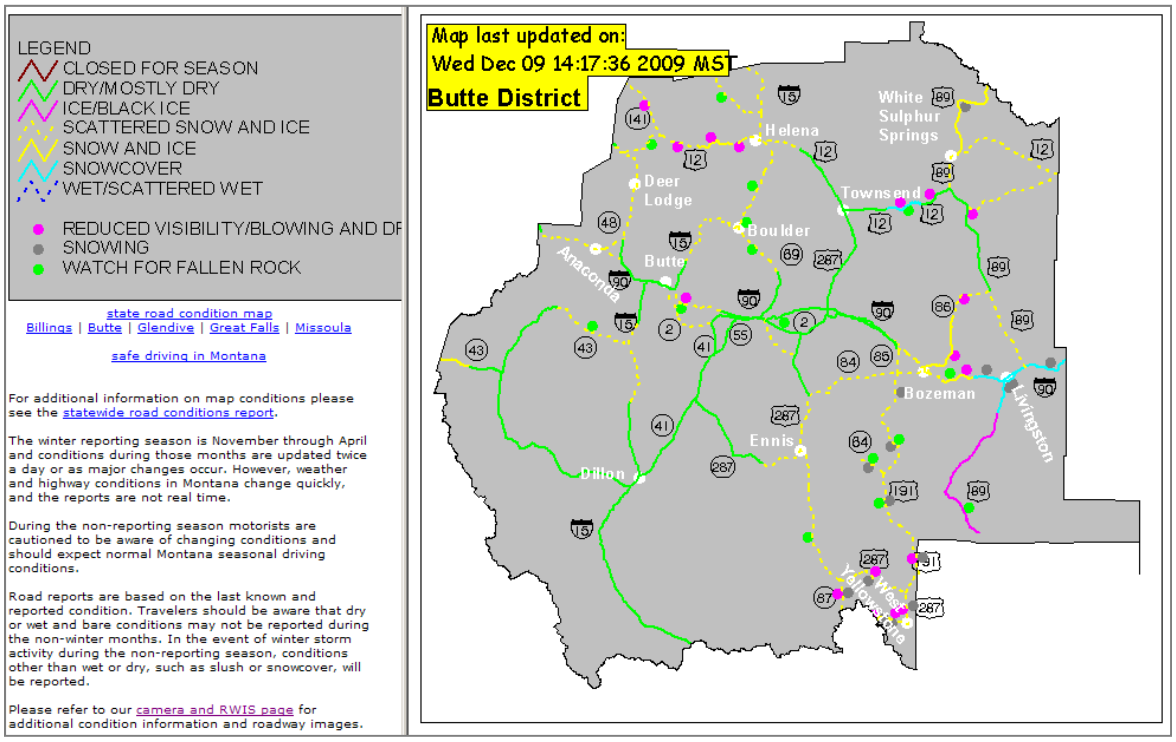
### Introduction

This guideline discusses elements of map displays that are specific to the provision of road weather information. These recommendations are based upon the best or most common practices identified in a survey of state weather websites. Of the 51 websites examined in the weather survey in this report, 45 used a map to convey some weather information.

**Design Guideline**

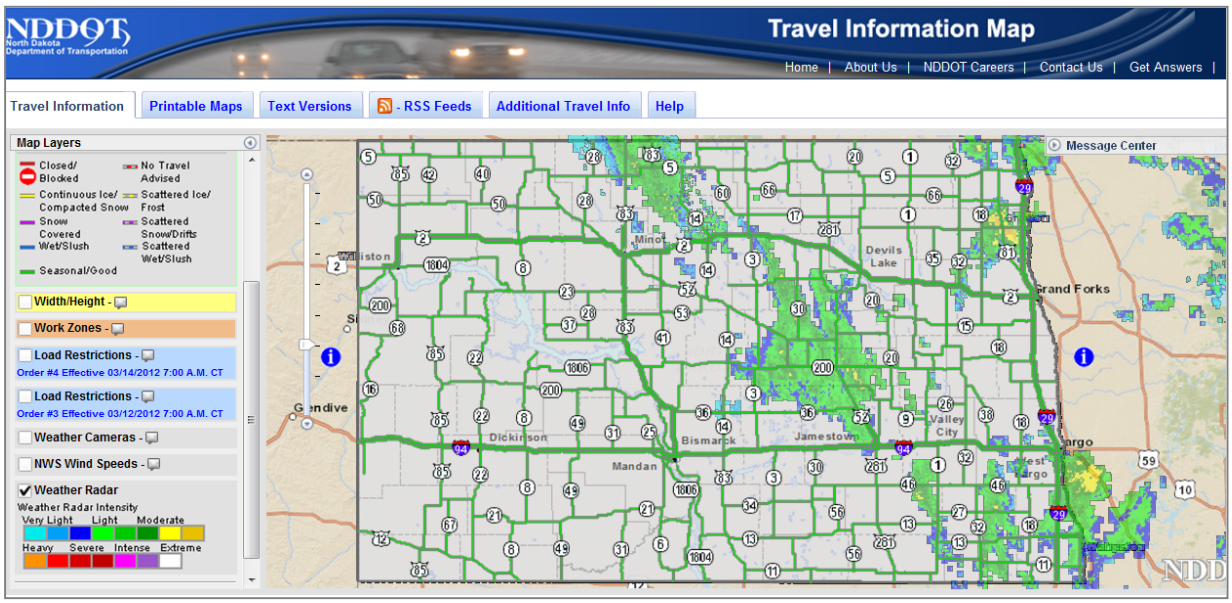
- Load with a view of the entire state or coverage area and allow zooming to route or street views.
- Icons can be used to show locations of weather-related conditions, closures, weather information sensors, etc.
- Choose icons that are weather-related (commonly clouds, thunderclouds, or suns).
- Many map legends allow travelers to select which events they want to view, reducing visual clutter.
- Color coded roadways frequently show weather-related road conditions or traffic levels (not both at the same time).
- Include a timestamp to show when the map was last updated, or when each weather event was updated if they are listed individually.
- If the map can show more than 4 or 5 weather elements at one time, use a dedicated weather map that does not show non-road weather information, such as traffic conditions.

**Example of color coding and line-style coding to show road conditions.**




Source: Montana DOT Website, retrieved December 9, 2009, from http://www.mdt.mt.gov/travinfo/map/butmap_frame.html

**Example of a weather radar display on a travel information site.**




Source: North Dakota DOT Website, retrieved April 13, 2012, from http://www.safetravelusa.com/nddot/

## Discussion

Of the 45 websites surveyed that include weather maps, 42 load with a view of the entire state and allow travelers to zoom in to their area of interest. The maps that load with a regional view force travelers who are interested in other views to zoom out and then zoom in to another area. However, travelers who are on a website that only provides regional coverage will likely expect that region to be the only one that appears. The icons that are weather-related are easier to associate with weather conditions, especially when a variety of information is being presented on the same map.

If there is a lot of information presented, it can help travelers reduce visual clutter if they can select the icons that they want displayed, or to have a separate weather map altogether. Color-coded roadways were used by 39 states to show road conditions or traffic levels. If road conditions and traffic levels are both shown using color-coded roadways, travelers should not be able to select both to be shown at the same time.

Finally, a timestamp was only displayed with the map in 15 instances; however, it is important to let travelers know how current the displayed information is. If the program crashes or freezes, an old timestamp will help preserve the credibility of a map that may be displaying out-of-date information, especially if the map states that it is “current.” A timestamp for the entire map may be confusing if the individual elements are updated at various times. If each event has a separate textual description, it may be more appropriate to include the timestamp there since each event may be updated individually.

## GUIDELINE 4-6. USE OF VISUAL ICONS

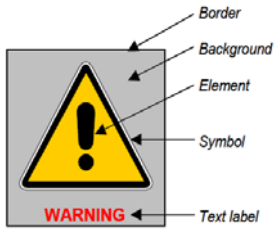
### Introduction

This guideline provides information on selecting or designing icons and their labels.

**Design Guideline**

| Icon Property | Guidelines (1) |
|---|---|
| Border | • Use a border to show the icon area. |
| Background | • Don't cover more than half of the available area with objects.<br>• Avoid patterns in the background.<br>• Put the image clearly in front of the background.<br>• Place objects in the center and the background around the periphery.<br>• Use unsaturated, cool colors for the background, and saturated, warm colors for the foreground image.<br>• Keep the background static; if anything blinks or moves, the viewer perceives it as a foreground image.<br>• Limit the background image to a simple rendition of a recognizable, concrete object. |
| Element | • Use commonly accepted or standardized elements when possible. |
| Symbol | • Use circles to present prohibition or mandatory information.<br>• Use triangles or diamonds to present warning or cautionary information.<br>• Use squares or rectangles to present general information, instructions, or safe condition information. |
| Text Label | • Use only when necessary, especially when the icon is concept-related or arbitrary.<br>• Limit to two or three words. |

**Components of an Icon (1)**




**Examples of Weather-Related Icons (1)**
**(originally from www.intellicast.com, not intended for use)**

| Sunny | Windy | Partly Cloudy | Cloudy | Rain | Snow |
|---|---|---|---|---|---|

Some road weather website maps link to information that is being broadcast on other dissemination methods (e.g., DMS, HAR). The icons in the table on the following page are examples of what is used to show that information from another dissemination method is available for a particular location. On the websites, each icon was also shown in a legend to provide an explanation of its meaning.

**Icons to show information from other dissemination methods.**

| Icon | | Notes |
|---|---|---|
| **DMS** | | Some of the DMS icons have two styles: one for when the sign is active (left), and another for when it is not (right). Also, some allowed the traveler to mouse-over or click for text. |
| Source: Adapted April 23, 2012, from http://www.cotrip.org/device.htm | Source: Adapted April 23, 2012, from http://map.wyoroad.info/hi.html | |
| **HAR** | | HAR icons denote locations where travelers can click to hear the auditory broadcast or read a text transcription. |
| Source: Adapted April 23, 2012, from http://www.buckeyetraffic.org/ | Source: Adapted April 23, 2012, from http://511.vermont.gov/main.jsf | |
| **Still Camera** | **Video Camera** | Camera icons show either still images (left) or streaming video (right). |
| Source: Adapted April 23, 2012, from http://www.cotrip.org/roadConditions.htm | Source: Adapted April 23, 2012, from http://www.cotrip.org/roadConditions.htm | |

### Discussion

Icon borders and backgrounds are useful to clearly show the travelers which elements are part of the icon. They help define the icon area, show travelers where to click if they are part of a control, and make the icon stand out from surrounding text. However, if the icon is going to be placed over another display such as a map, borders and backgrounds may increase visual clutter and cover other display elements unnecessarily. This could be prevented by removing the border and background. The example weather-related icons in this guideline have thick symbol borders, which would likely provide sufficient contrast against map elements without an additional background or colored border around the entire icon.

### Design Considerations

The weather icons in this guideline are atmospheric weather icons rather than road weather icons. Weather-related road conditions are often represented on website maps by using color-coded roadways. This type of shading is discussed in Guideline 4-7.

The plethora of available and desirable informational icons can contribute to a cluttered map display. Many website maps allow the travelers to select which types of icons they are interested in (e.g., cameras, DMSs, surface conditions), cutting down on the number of icons on a particular display. Other websites have multiple, separate maps, to allow travelers to choose the map that contains the information they desire (e.g., cameras, signs, weather stations). Also, allowing the traveler to zoom can help spread out some of the icons, making icon selection easier.

### References

1. Campbell, J. L., Richman, J. B., Carney, C., and Lee, J. D. (2004). *In-vehicle display icons and other information elements. Volume 1: Guidelines.* (Report No. FHWA-RD-03-065). McLean, VA: Federal Highway Administration.

**NOTE**: The use of Portable Electronic Devices, such as cell phones, while driving is a distraction. Consult the caveat on page 7 for more information.

## GUIDELINE 4-7. COLOR SELECTION

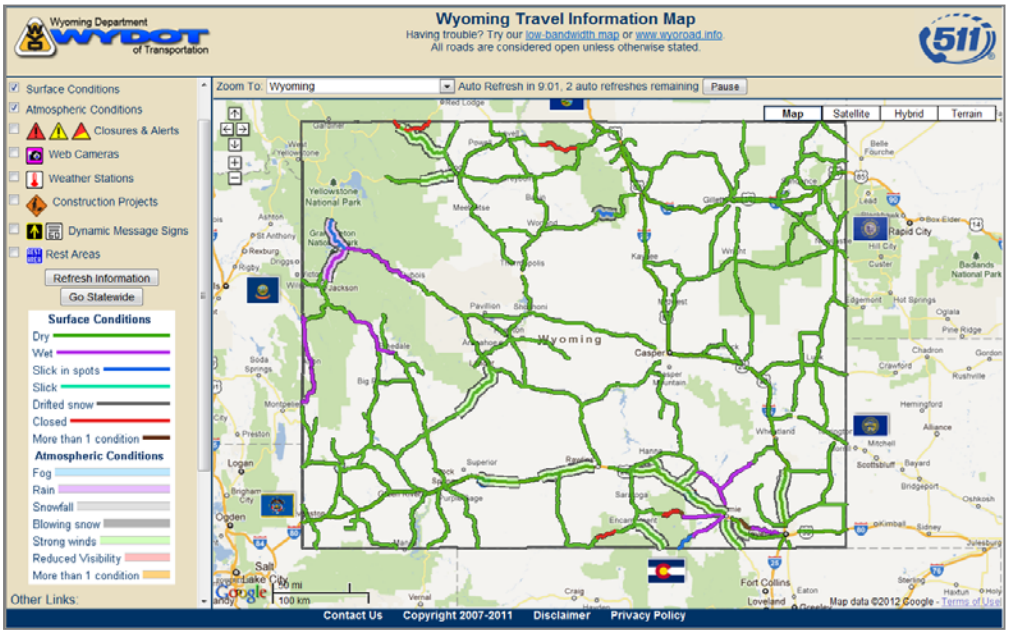
### Introduction

This guideline provides guidance for selecting colors for both text and maps in web-based messages.

**Design Guideline**

- Keep the number of colors used to code information to a minimum (use 4-7 colors maximum).
- Follow population expectations for color usage:
  - Red: stop, warning, hazard
  - Yellow: caution, wait
  - Green: proceed, OK
- Use color consistently on every display in the system (e.g., every page on a website).
- Increase object size as the number of colors used increases.
- Keep roads that are not color coded the same color that they would normally be on a paper map.
- Use thicker roads when they are color coded.
- Use compatible color combinations for colors that are presented at the same time. Avoid: red/green, green/blue, blue/yellow, and red/blue pairs unless the goal is to make different parts of the screen appear in different planes.
- Coding map features:
  - Map areas may be coded using texture patterns, color, or tonal codes (different shades of the same color).
  - Use tonal codes rather than different colors when travelers must make relative judgments (e.g., elevations).
  - Order the code values so that the darkest and lightest shades are the most extreme coded values.
  - Highlight areas of extra significance that require traveler attention (e.g., severe storms).

**Example of the use of roadway color coding.**




Source: Wyoming DOT Website, retrieved May 13, 2012, from http://map.wyoroad.info/hi.html

### Discussion

Most of the guidance in the guideline above is from the Guidelines for Advanced Traveler Information System Displays (1). When using color coding, it is important to keep the number of colors used to a minimum and follow traveler expectations as much as possible. Research has shown that for casual travelers, a maximum of 4 colors is appropriate, while for experienced travelers, a maximum of 7 colors is appropriate. Green et al. (3) suggest that color coded roads be thicker than regular roads since it is easier to identify the color of a larger area and the coding values of the roadway may not be the same in each direction.

Coding maps helps to define areas of interest. It may be practical to limit coding to the single most significant variable for the purpose of clarity. When coding areas that require the traveler to perceive relative differences for a single dimension (e.g., elevation changes), use tonal codes. Travelers can order different tones along a continuum, but there is no natural way to order different colors. Before using tonal codes, it should be checked if the electronic displays can provide the variation in colors necessary. The tonal codes should be assigned so that the darkest and lightest shades represent the most extreme values represented (e.g., highest and lowest elevations). This ordering will help travelers remember and understand the categories.

In order to meet the needs of travelers with color-blindness, the use of alternative means to represent different conditions, roadways, etc., should be explored. These alternative means could include shading, cross-hatching, or other patterns that do not rely on color.

### Design Considerations

Approximately eight percent of the population, mostly males, does not have normal color vision. Therefore, when critical information must be presented to travelers, color coding should be redundant with other coding (e.g., shape coding; (1)). It may be difficult in a map presentation to redundantly code information. Therefore, it may be necessary to have another presentation of the same information, such as a textual presentation in a table, or the ability for the traveler to mouse-over a road and have the condition appear in text format.

There is no strong agreement among states with regard to a standardized color scheme for presenting road weather information on a map display (4). Reference 4 does suggest a standardized color scheme for roadways on maps; however, more research is needed to determine which colors are well understood by the traveling public.

### References

1. Campbell, J. L., Carney, C. and Kantowitz, B. H. (1998). *Human factors design guidelines for Advanced Traveler Information Systems (ATIS) and Commercial Vehicle Operations (CVO)* (Report No. FHWA-RD-98-057). Washington, DC: Federal Highway Administration.
2. Smith, S.L., and Mosier, J.N. (1986). *Guidelines for designing user interface software*. (Report No. ESD-TR-86-278). Bedford, MA: The Mitre Corporation.
3. Green, P., Levison, W., Paelke, G., and Serafin, C. (1993). *Suggested human factors design guidelines for driver information systems*. (Report No. FHWA-RD-94-087). McLean, VA.
4. Boselly, S. E. (2000). *Identification and documentation of weather and road condition dissemination devices and data formats* (Mn/DOT Agreement No. 79575, prepared for the Aurora Program). Chesterfield, MO: Weather Solutions Group.

**NOTE**: The use of Portable Electronic Devices, such as cell phones, while driving is a distraction. Consult the caveat on page 7 for more information.

## GUIDELINE 4-8. DISPLAY OF SEVERE WEATHER ALERTS

### Introduction

This guideline provides specific advice for displaying severe weather alerts, which are warnings that are essential for travelers to receive. Severe weather alerts are sometimes given unique formatting and positioning on a webpage to attract traveler attention. These recommendations are based upon the best or most common practices identified in a survey of state weather websites.

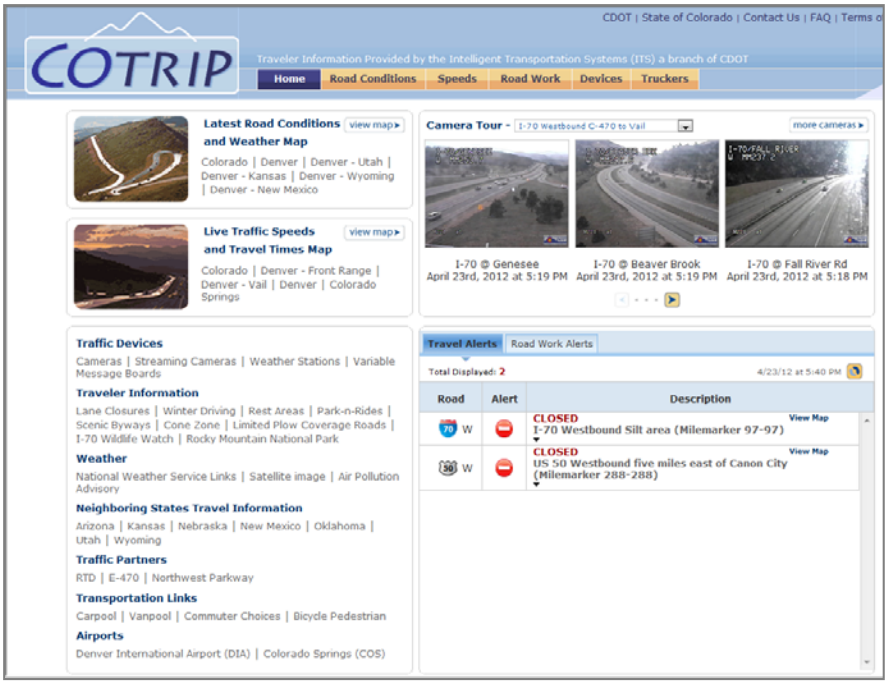
**Design Guideline**

- Use a bright color, such as red, to draw attention.
- Place the alerts in a prominent location on the page.
- Display the alerts on a main page, not in a downloadable file or separate link.
- Have an assigned location for displaying alerts.
- Use concise wording to convey essential event information, and link to additional information as necessary.

**Example of a brightly-colored closure posting.**

Source: New Mexico DOT Website, retrieved 2010 from http://splash.nmroads.com/

**Example of prominently located travel alerts.**




Source: Colorado DOT ITS Traveler Website, retrieved April 23, 2012 from http://www.cotrip.org

## Discussion

Of the 51 websites examined in the weather survey, 24 provided weather alerts separately from the regular weather-related information. The idea behind a weather alert is that the information is so essential to travelers that it is important that they read it. The weather alerts should be attention-grabbing. The examples above all use red text for the section headers or titles, which is a color often used to communicate hazard information (1). Each example site has a dedicated area for displaying the weather alerts, so travelers know where to expect the information to be. Additionally, the information is prominently displayed on a main page for the road weather information, a place where travelers who are looking for road weather information are likely to go. Due to their urgency, weather alerts should not be listed in a file that travelers must download, or in a separate link. Also, alerts should be worded concisely so that they may be read quickly to obtain pertinent information. If the traveler decides that the alert applies to them, they should be able to access any additional information via a link to a separate page.

## Design Considerations

Another observed method for displaying travel alerts was scrolling text above the road conditions map that linked to a full report. This method would likely work best for an area with a small set of roads. If a larger set of roads were reported on, travelers may get annoyed by the banner or may not stay on the page long enough to see the alerts that are relevant to their trip.

## References

1. Campbell, J. L., Carney, C. and Kantowitz, B. H. (1998). *Human factors design guidelines for Advanced Traveler Information Systems (ATIS) and Commercial Vehicle Operations (CVO)* (Report No. FHWA-RD-98-057). Washington, DC: Federal Highway Administration.

**NOTE**: The use of Portable Electronic Devices, such as cell phones, while driving is a distraction. Consult the caveat on page 7 for more information.

## GUIDELINE 4-9. LINKING TO ROAD WEATHER INFORMATION

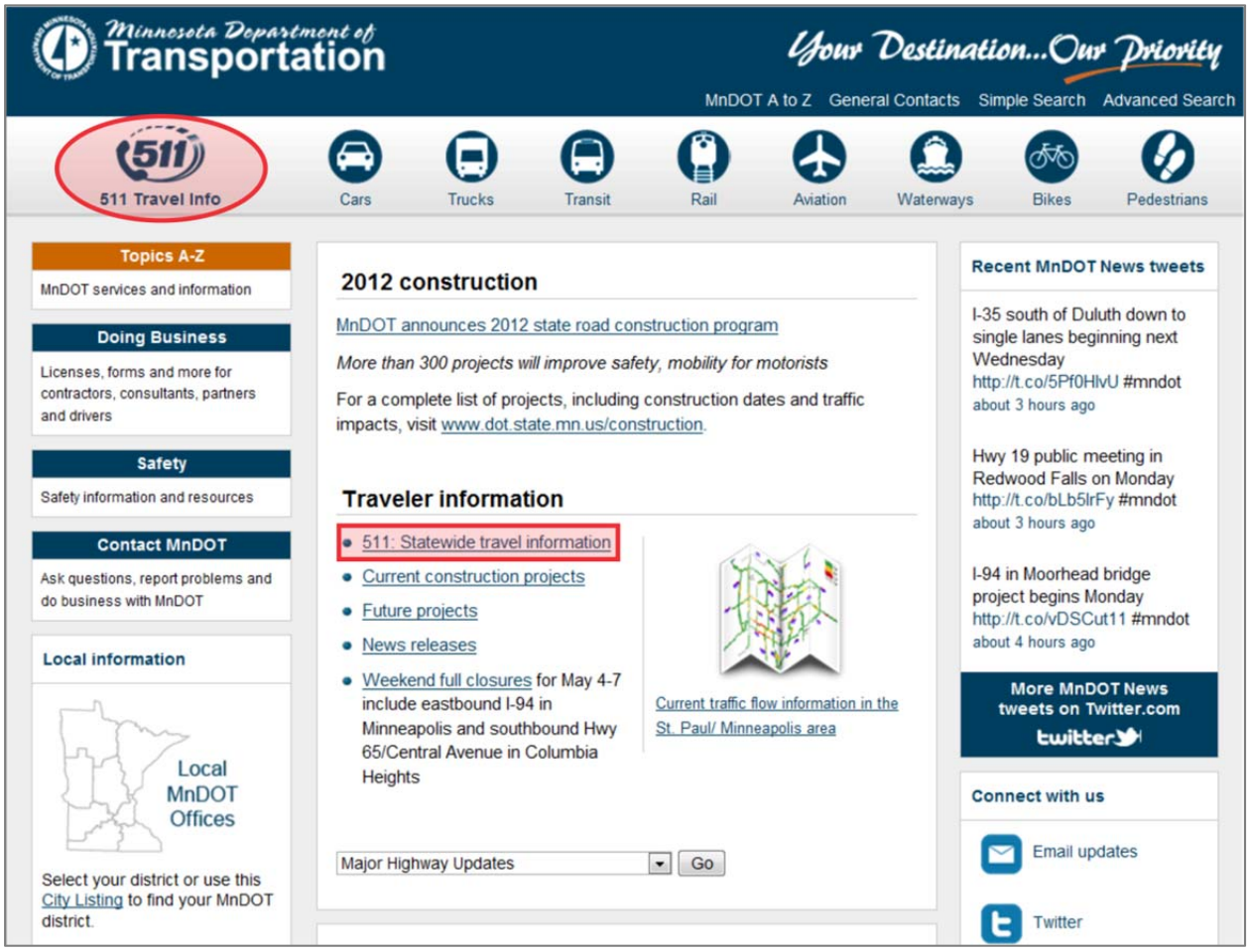
### Introduction

This guideline provides guidance related to the internal and external links that are provided on the homepage through which travelers can access road weather information. These recommendations are based upon the best or most common practices identified in a survey of state weather websites.

**Design Guideline**

- Link to the road weather information directly from the transportation agency homepage.
- Use a single link rather than a string of links.
- Maintain the functionality of the links.
- Choose link titles that are associated with road condition information (e.g., "road conditions" or "traveler information").

**Example links to 511 travel information from the DOT homepage.**

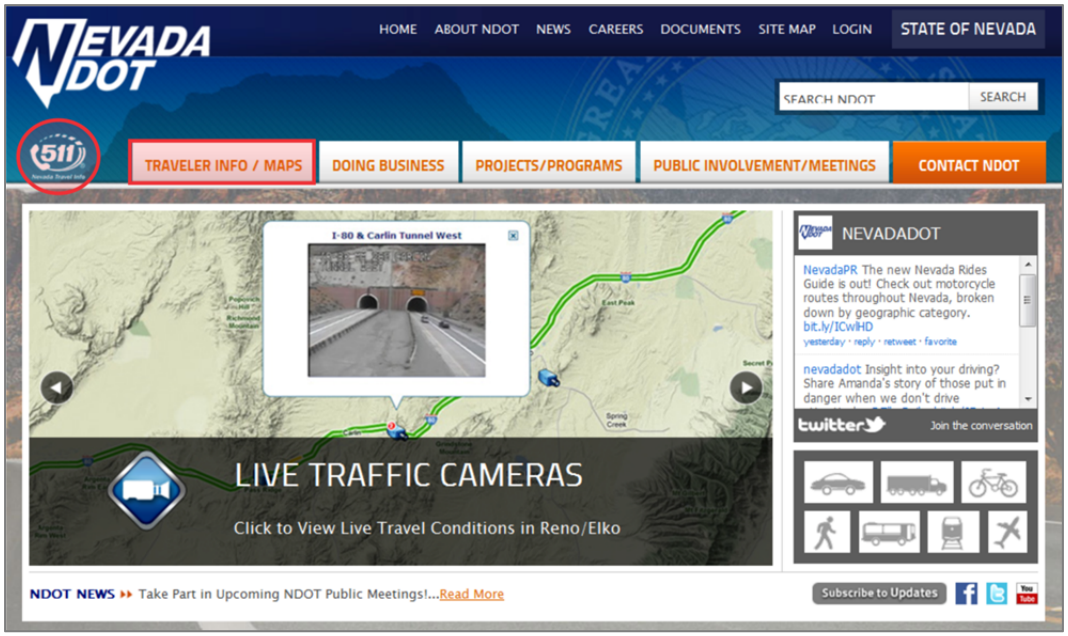



Source: Minnesota DOT Website, retrieved May 3, 2012, from http://dot.state.mn.us/

**Example travel information links section on DOT homepage.**

Source: Iowa DOT Website, retrieved May 3, 2012, from http://www.iowadot.gov/

**Example traveler information menu item on DOT homepage.**




Source: Nevada DOT Website, retrieved May 3, 2012, from http://www.nevadadot.com/default.aspx

## Discussion

A main goal of linking to road weather information directly from the homepage is to reduce the *information access cost*. The information access cost is defined by the number of pages and links that the traveler must search through to find the information that they need. Travelers save time if they can find the information with one click, using a single link rather than a string of multiple links. Multiple homepage links that lead to the same page should be avoided since they only increase the visual clutter on the page. Additionally, the links should be functional and lead to the information that the traveler expects. Link titles such as “road conditions” or “traveler information” are more likely to be associated with road weather information than words like “highways” or “miscellaneous.”

## GUIDELINE 4-10. WEBSITE USE ON PORTABLE ELECTRONIC DEVICES (PED)

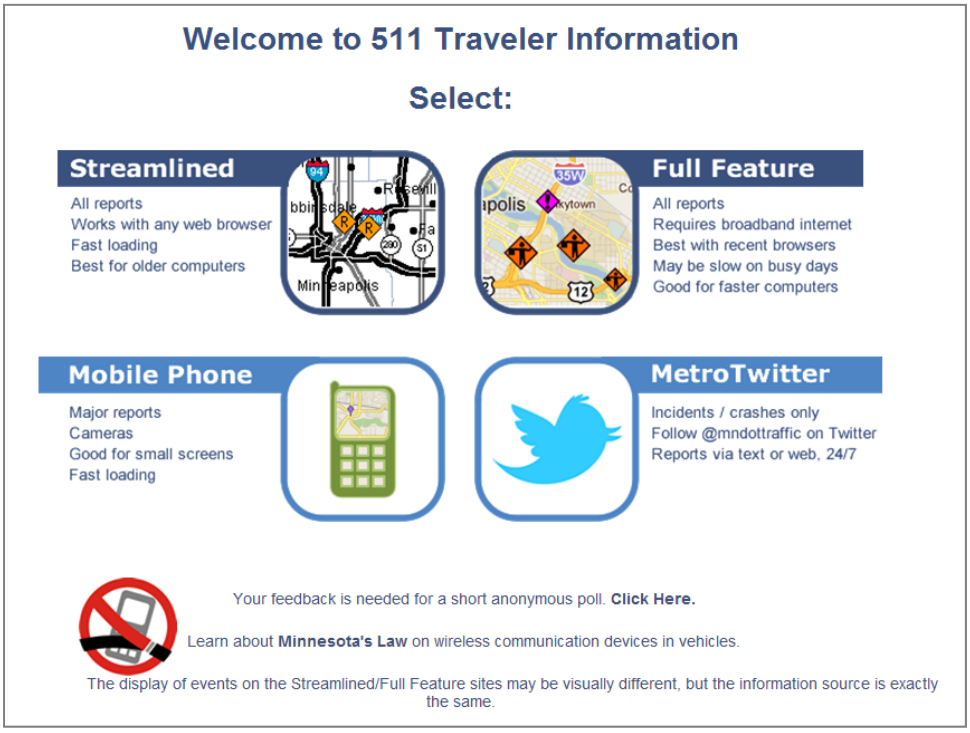
### Introduction

This guideline provides information about supporting website usage by travelers who use portable electronic devices to access internet weather websites. These recommendations are based upon the best or most common practices identified in a survey of state weather websites.

**Design Guideline**

- Provide a way for travelers to select an appropriate version for their device.
- Provide a short, text-only version for devices with smaller screens.
- Support subscriptions to weather alerts for PEDs.

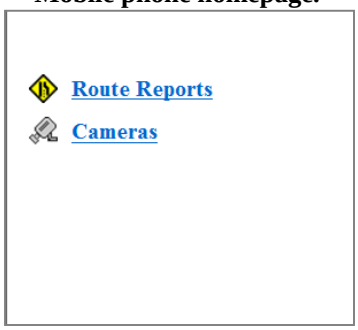
**Example selection screen for mobile devices.**



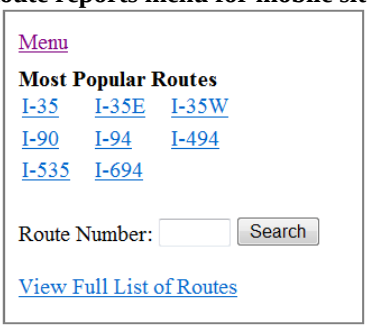

Source: Minnesota DOT Website, retrieved April 25, 2012, from http://www.511mn.org/

Selecting the 'Mobile Phone' option from the screen above brings the traveler to the menu pages shown on the following page. The mobile phone homepage provides options for the traveler to see Route Reports or Cameras. Selecting 'Route Reports' on this menu screen brings up a list of popular routes for which reports are available and the option for the traveler to search by route number. Selecting 'Cameras' on the mobile phone homepage brings up a list of cameras and the option for the traveler to search by route.

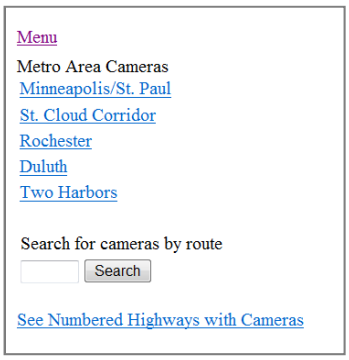
**Mobile phone homepage.**




**Route reports menu for mobile site.**




**Cameras menu for mobile site.**




Source: Minnesota DOT Website, retrieved April 25, 2012, from http://www.511mn.org/

**Example of a service for travelers to subscribe to weather alerts.**

Source: Oklahoma Department of Emergency Management Website, retrieved in 2010 from http://www.ok.gov/notifications/index/php

## Discussion

Only 12 out of 51 websites surveyed support portable electronic devices such as cell phones. Although many of these devices can load the same websites as computers, due to their screen size and bandwidth limitations, it is impractical to do so. Loading weather sites with lots of content and maps takes a lot of bandwidth for a smaller device and may take a long time. By providing a way for travelers to select their version, the content of the site can be tailored to their needs.

On devices with smaller screens, viewing detail on a map is impractical. By providing a text-only version with short text, travelers can avoid awkward text wrapping, slow-loading maps, and the complex navigation of much larger sites. A few sites also supported subscriptions for weather alerts, sent to PEDs.

**NOTE**: The use of Portable Electronic Devices, such as cell phones, while driving is a distraction. Consult the caveat on page 7 for more information.

## GUIDELINE 4-11. COMMUNICATING DEGREE OF URGENCY ON WEBSITES

### Introduction

This guideline provides general design principles and specific message content that communicate the priority, timing, and driving impacts of weather events through websites.

**Design Guideline**

| Road Weather Message Characteristic | Guidelines |
|---|---|
| Words/text | • Words that communicate moderate urgency include: caution, warning, or hazard.<br>• Words that communicate high urgency include: severe, emergency, life-threatening, or deadly. |
| Colors | • Use green to communicate clear, or normal conditions/routes (low urgency).<br>• Use yellow to communicate caution, warning, slow moving areas of traffic, or roadway locations moderately compromised by weather events (medium urgency).<br>• Use red to communicate danger, emergencies, extremely slow traffic conditions, or roadway locations either made impassable or highly dangerous due to weather events (high urgency). |
| Icons or symbols (1) | • To communicate high urgency:<br>  o Use red lettering or red background.<br>  o Increase line weight of the icon's border.<br>  o Increase relative size of the high urgency icon.<br>• If text labels are used:<br>  o Increase font size of text labels to identify icons of greater urgency.<br>  o Increase white space around text labels.<br>• If possible and appropriate, show the consequence of not responding appropriately. |
| Order of presentation | • Present the information in the order of importance or relevance to the driver.<br>• Present the most important information at either the beginning or the end of the message because it is easiest to recall (2). |
| When menus or multiple web pages are used | • Provide a means for travelers to "go back" into the menu structure and repeat or retrieve urgent information (3). |

## Discussion

Communicating the appropriate degree of urgency to travelers is important because travelers use the cues to urgency that are contained within a message to make travel decisions regarding if they should travel, when they should travel, if a mode choice change is in order, or if a planned route should be changed. Urgency can be communicated in numerous ways, including words, phrases, colors, location on a visual display, location within a message, and the modality used to present the message. Importantly, the many different aspects of a particular weather message dissemination method (i.e., DMS vs. website vs. 511) can be used together to effectively communicate the appropriate degree of urgency to travelers.

The priority of a message is a function of how quickly a response must be made by the driver, as well as the consequences of failing to make the proper response (2). A high-priority message requires a fast response (0-5 minutes) and has serious consequences, such as a crash with possible injuries or fatalities. For example, a weather-related roadway condition—such as an upcoming road that is washed-out due to a flash flood. A lower priority message has no response needed for at least 5 minutes and has no immediate consequences. An example of a lower priority message is a forecast for rain on the next day.

## References

1. Campbell, J. L., Richman, J.B., Carney, C., and Lee, J.D. (2004). *In-vehicle display icons and other information elements. Volume I: Guidelines* (FHWA-RD-03-065). McLean, VA: Federal Highway Administration (see also http://www.tfhrc.gov/safety/pubs/03065/index.htm).
2. Campbell, J. L., Carney, C., and Kantowitz, B. H. (1998). *Human factors design guidelines for Advanced Traveler Information Systems (ATIS) and Commercial Vehicle Operations (CVO)* (FHWA-RD-98-057). Washington, DC: Federal Highway Administration.
3. 511 Deployment Coalition. (2005). *Implementation and operational guidelines for 511 services (Version 3.0).* Retrieved November 30, 2009 from http://ops.fhwa.dot.gov/511/resources/publications/511guide_ver3/511guid3.pdf.

**NOTE:** The use of Portable Electronic Devices, such as cell phones, while driving is a distraction. Consult the caveat on page 7 for more information.

## GUIDELINE 4-12. COMMUNICATING DEGREE OF CERTAINTY AND ENHANCING MESSAGE CREDIBILITY ON WEBSITES

### Introduction

Communicating the degree of certainty in a road weather message refers to general design principles and specific message content that communicate the likelihood of road weather event predictions and the impacts of these events to travelers. The Guidelines below should be used to communicate the degree of certainty in road weather messages presented through websites.

**Design Guideline**

Ways to communicate the degree of certainty:

- Provide a percentage (e.g., 30%, 50% 100%) corresponding to the likelihood of a road weather event.
- Provide a qualitative description (e.g., "certain", "possible", "a chance") corresponding to the likelihood of a road weather event.
- Provide additional details about the weather event—or its driving impact—to improve the *specificity* of the prediction and increase the certainty communicated by the message. These details can include information about the location, timing, or impacts of a road weather event.

In this regard, "*specificity*" can refer to:

- Where a road weather event will occur or impact driving (specificity of location).
- When the road weather event or driving impact will occur (specificity of timing).
- The consequences of a road weather event on driving conditions (specificity of impacts).
- Secondary impacts of a road weather event, such as power outages, school closures, etc.

The value of road weather information is only as great as the trust that a traveler can place in the accuracy of the information. Goals for the accuracy of road weather information (adapted from Reference 1):

- Across a typical trip, road weather information should be at least 70% accurate.
- 100% accuracy yields the best driver performance, but information above 70% accuracy should yield acceptable levels of trust.

In the context of presenting DMS messages, Dudek (2) lists the following message characteristics that should be avoided because they can damage the credibility of a message:

- Information is inaccurate or not current and can be easily checked by travelers and disproved.
- Information is irrelevant to most travelers.
- Information is obvious, and thus redundant to travelers' visual inspection.
- Information is repetitive, i.e., the same information is presented over a long period of time.
- Information is trivial with regard to the driving task.
- Information is poorly presented and thus difficult to comprehend or confusing.

Message credibility is also enhanced when messages are *updated appropriately* and *removed promptly* as conditions change.

## Discussion

Communicating the appropriate degree of certainty about road weather messages to travelers is important because travelers use the "cues to certainty" that are contained within a message to make travel decisions such as: if they should travel, when they should travel, if a mode choice change is in order, or if a planned route should be changed. As seen above, certainty can be communicated in numerous ways, including the likelihood of an event, as well as the specificity with which a road weather event or driving impact is communicated.

A key concept related to certainty is the *accuracy* of information presented to travelers. Accuracy was a key topic in Campbell et al. (3), who noted: *"accuracy refers to the correctness, usually expressed as a percentage, of traffic information presented to motorists. In this context, accuracy is considered to be a binary concept; i.e., the information is either accurate or inaccurate. Although accuracy is most often discussed with respect to congestion levels associated with various routing options, it may also refer to total travel time estimates, estimates of time delays due to congestion, and presentation of accident information."* This is equally true of road weather information: accuracy leads to credibility, credibility leads to trust, and trusted information is more likely to be used by travelers than information that is *not* trusted. Thus, information that is more accurate is simply more valuable to travelers.

The goal of 70% accuracy in the guidelines was adapted from a study that measured driver's trust in a simulated in-vehicle Advanced Traveler Information System (ATIS) at different levels of system accuracy. Results showed that while 100 percent accurate information yields the best driver performance and subjective ratings of the system's usefulness, information that was 70 percent accurate remained both acceptable and useful. Similar impacts on driver attitudes about inaccurate presentation of hazard information were found by Jonsson, Nass, Harris, and Takayama (4).

Dudek (2) also stresses the importance of displaying accurate information to travelers. He further states that if messages are not trusted by travelers, eventually they will be ignored. If travelers ignore the messages, any advantages that would have been provided by the messages are negated.

One issue to consider when presenting road weather information to travelers is that there may be trade-offs between the accuracy of the messages provided to travelers and the timeliness of such information. For example, information accuracy may be increased by using multiple, independent sources of raw weather data to derive predictions of the likelihood of a weather event or of weather-related impacts on driving. However, such increases in accuracy may increase the time between the onset of the weather event, and the presentation of relevant messages through a given dissemination method.

## References

1. Kantowitz, B. H., Hanowski, R. J., and Kantowitz, S. C. (1996). *Development of human factors guidelines for advanced traveler information systems and commercial vehicle operations: The effects of inaccurate traffic information on driver acceptance of in-vehicle information systems* (FHWA-RD-96-145). Washington, DC: Federal Highway Administration.
2. Dudek, C. L. (2004). *Changeable message sign operation and messaging handbook.* (Report No. FHWA-OP-03-070). College Station: Texas Transportation Institute.
3. Campbell, J. L., Carney, C., and Kantowitz, B. H. (1998). *Human factors design guidelines for Advanced Traveler Information Systems (ATIS) and Commercial Vehicle Operations (CVO)* (FHWA-RD-98-057). Washington, DC: Federal Highway Administration.
4. Jonsson, M., Nass, C., Harris, H., and Takayama, L. (2005). Influence of hazard system accuracy on driving performance. *Proceedings of the 12th World Congress on Intelligent Transport Systems.*

**NOTE:** The use of Portable Electronic Devices, such as cell phones, while driving is a distraction. Consult the caveat on page 7 for more information.

# Chapter 5 Tutorials

## Introduction

This chapter provides information, in the form of tutorials, to supplement the guidelines contained in the previous chapters. These tutorials fall into three broadly organized groups. The first group provides more specific information about travelers, including: traveler behaviors (Tutorial 5-1), their use of road weather information (Tutorials 5-2 and 5-3), and ways by which they are impacted by road weather (Tutorial 5-4). The second group of tutorials provides supplemental information for message designers, including: a tool for designing new road weather messages (Tutorial 5-5), and example applications of the guidelines included in the document to improve existing messages (Tutorial 5-6). The third group is most specific, and provides general guidance for messaging on personal electronic devices and using social media (Tutorial 5-7).

**List of Tutorials** **Page**


Tutorial 5-1. Traveler Adjustments based on Road Weather Information..... 72

Tutorial 5-2. When Travelers Use Road Weather Information..... 74

Tutorial 5-3. How to Determine which Dissemination Methods Travelers will Use ..... 77

Tutorial 5-4. Safety Implications of Road Weather Information..... 80

Tutorial 5-5. Description of the Road Weather Message Design Tool..... 84

Tutorial 5-6. Example Applications of the Road Weather Message Guidelines ..... 97

Tutorial 5-7. Road Weather Messaging for Personal Electronic Devices and Social Media ..... 100

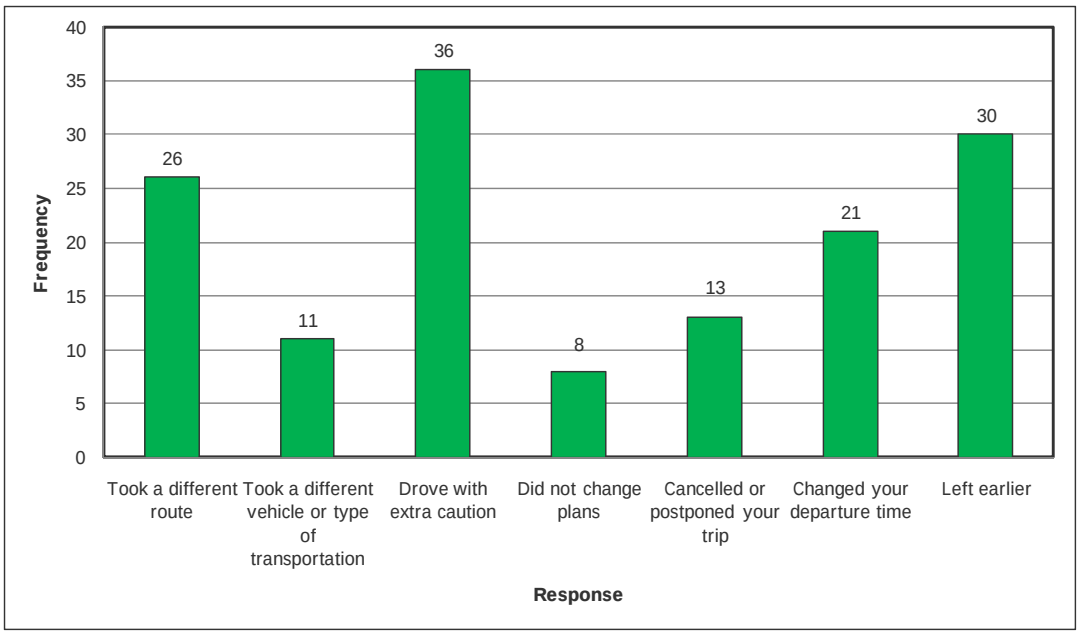
## TUTORIAL 5-1. TRAVELER ADJUSTMENTS BASED ON ROAD WEATHER INFORMATION

**Summary:** This tutorial provides information about the adjustments that travelers may make in response to road weather information, in addition to the potential safety implications of these adjustments.

### Types of Adjustments that Travelers Make

There are many adjustments travelers can make in response to road weather information. Most of the information related to this topic is from studies involving traveler adjustments in response to traffic information, which is likely associated with a different set of travel adjustment factors overall. However, some elements, such as expected delays and route changes may be associated with comparable travel decisions related to weather events. In one study of traveler decision making, 40% of travelers were willing to change both departure time and route (35% of these respondents report changing trip based on weather information, vs. 89% for congestion, 86% for traffic reports, 44% for time pressure; Haselkorn & Barfield, 1990). Also, 21% were willing to change their route, 16% were willing to make time, mode, or route changes prior to leaving home, while 23% were unwilling to change departure time. In another study, 60% of travelers reported changing their route or departure time based on radio traffic reports (Khattak, Schofer, & Koppelman, 1992). Finally, a study using travel diaries reported that 37% of trips for which traveler information was consulted resulted in some change in travel behavior (which represented 1% of total trips recorded; Peirce & Lappin, 2003). The most typical changes involved changes in departure time (13%) or route (11%), with only 1% of travelers changing mode.

The brief traveler questionnaire conducted in an earlier phase of this project (Richard et al., 2009) provided some information specific to weather-related adjustments. The findings are somewhat different from those found in previous studies because these responses were directly tied to a severe weather event that respondents encountered the past year, so they had a specific reason to consult weather information. Consequently, the overall percentage of travelers changing their plans is greater than in previous studies (see Figure 2 below). Respondents reported changing their travel plans and behaviors in several different ways, with the most common responses being “Drove with more caution” (50%), “Left earlier” (42%), and “Took a different route” (36%). Note that multiple responses were possible, so some travelers may have made more than one of these adjustments during their travel. Overall, travelers seem quite willing to change their plans based on the weather information, a finding which is underscored by the fact that only 11% of respondents reported not changing their travel plans at all.




Source: From questionnaire data reported in Richard et al., 2009.

**Figure 2. Traveler adjustments based on weather information.**

## Safety Implications of the Adjustments

It is not possible to examine the safety implications of the adjustments in a way that is tied directly into the types of adjustments travelers make, since there was no related follow up information provided by the surveys covered. However, indirect information is given by the types of weather conditions that require information dissemination to preserve driver safety. In particular, there appear to be just a few general ways in which weather events and corresponding mobility impacts can affect safety. The first is that a traveler can end up at a location that jeopardizes personal safety, such as on a flooded road or where they are at risk of being stranded in harsh conditions (e.g., in a blizzard). The other safety implications relate to increased crash risk stemming from low visibility or low traction conditions.

We did not find data that addressed whether travel adjustments improve or reduce personal safety related to conditions such as being stranded, etc. However, the results of the questionnaire from this earlier project indicate that some travelers did make decisions that could have general personal safety benefits in certain situations (e.g., canceling their trip during heavy snow), but without more specific information it is difficult to quantify this benefit. Questionnaire results also provide a slightly better answer regarding driver behavioral adjustments to increased crash risk conditions. In particular, for the subset of 50 respondents who identified “slippery conditions” as a weather impact of concern in a previous question, 60% of these respondents indicated that they “drove with extra caution.” This finding clearly suggests that the travelers surveyed do use weather information to make safer travel decisions in certain crash-risk situations.

## TUTORIAL 5-2. WHEN TRAVELERS USE ROAD WEATHER INFORMATION

**Summary:** This tutorial provides additional information about when travelers prefer to receive road weather information relative to the start of their trip, and how suitable various dissemination methods are for providing information at different trip stages.

Several sources partially address the question of when travelers use weather information. In particular, one survey conducted in The Netherlands found that 15% of motorists sought weather condition information prior to departing (Emmerink, Nijkamp, Rietvald, & Van Ommeren, 1996). This study also found that motorists between the ages of 46-60, in addition to vacation and business travelers, were the most likely to seek out weather condition information prior to leaving. Another study reported the percentage of respondents rating information access as very or extremely important by trip stage, which included 52.3% of travelers having this opinion for before starting their trip, 47.8% for en-route, and 27.7% for stopped on-route (Patten, Pribyl, & Goulias, 2003). In contrast, another road weather survey found that travelers' preferred information access point depended on the type of traveler (Martin et al., 2000). More specifically, commuters and recreational travelers preferred getting information less than 1 hour before leaving and en-route; "travelers" preferred information at all intervals, with 1-2 days prior and en-route being the most common, and truckers preferred receiving information from up to 3 hours before departing to en-route.

Traveler questionnaire responses reported in Richard et al. (2009) also provided some timing information. Table 2 below shows the percentage of respondents that reported that obtaining weather information at various points during their trip was either "Very Useful" or "Mostly Useful." In addition to this, the second row provides the same information for just the "Very Useful" response option. Prior to departing and on the road appear to be the most popular times to receive weather information, which is comparable to the findings from Martin et al. (2000).

**Table 2. Partial traveler responses to the most useful time to get weather information (from Richard et al., 2009).**

| | During Trip Planning | Prior to Leaving | At a Stopping Point | While Driving |
|---|---|---|---|---|
| Mostly Useful or Very Useful | 63% | 78% | 57% | 70% |
| Very Useful | 37% | 52% | 30% | 39% |

One limitation of the survey findings from Richard et al. (2009) is that they lack details about the specific travel decisions travelers are making at various trip stages. This is useful information because trip stage limits the use of some dissemination methods (e.g., internet websites are not typically available while driving), which has implications for how various dissemination methods should be used to communicate certain types of information to travelers. In order to obtain a more detailed picture of how acceptable certain travel decision outcomes might be if they were made at specific stages during a trip, we evaluated each combination of travel decision and trip stage based on suitability of making a specific travel decision at that point (see Table 3). We used a three-level classification scheme to characterize the "suitability" of a decision outcome based on the following categories:

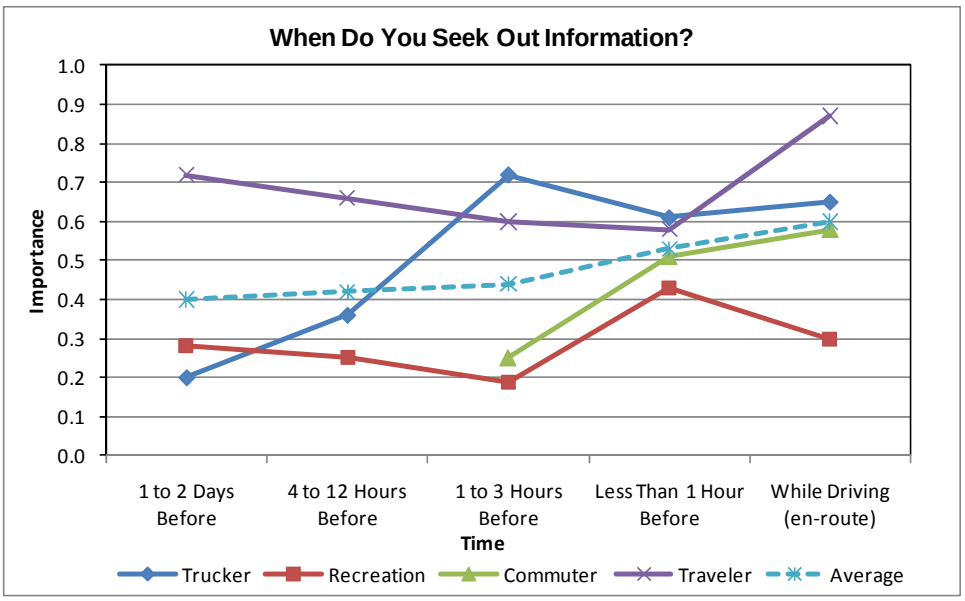
- ***Suitable*:** Travelers are still in a position to make a decision at this stage if they obtain relevant road weather information (even if it is not under optimal conditions: e.g., compensating for travel delays en-route may be more challenging than doing so during trip planning).

- ***Possibly too soon*:** Weather information is obtained before a decision must be made, but it may come so early that there is a chance of forgetting the information by the time it is needed. For example, if drivers are warned about icy roads prior to leaving, they can still make use of this information; however, its effectiveness as a warning depends on how well drivers remember it, which can be unreliable.
- ***Too late*:** The information is obtained once it is no longer possible to make this decision or if there is likely to be a high cost of doing so (e.g., canceling hotel reservations).

**Table 3. Qualitative ratings describing the likely suitability of making a specific travel decision at various trip stages.**

| | During Trip Planning | Prior to Leaving | At a Stopping Point | While Driving |
|---|---|---|---|---|
| Take alternative route? | Suitable | Suitable | Suitable | Suitable |
| Expect delays? | Suitable | Suitable | Suitable | Suitable |
| Drive with caution? | Possibly Too Soon | Possibly Too Soon | Suitable | Suitable |
| Delay departure? | Suitable | Suitable | Too Late | Too Late |
| Cancel Trip? | Suitable | Suitable or Too Late for Major Trips | Suitable or Too Late for Major Trips | Too Late |
| Change Mode? | Suitable or Possibly Too Soon | Suitable | Too Late | Too Late |
| Make special preparations? | Suitable or Possibly Too Soon | Suitable | Too Late | Too Late |

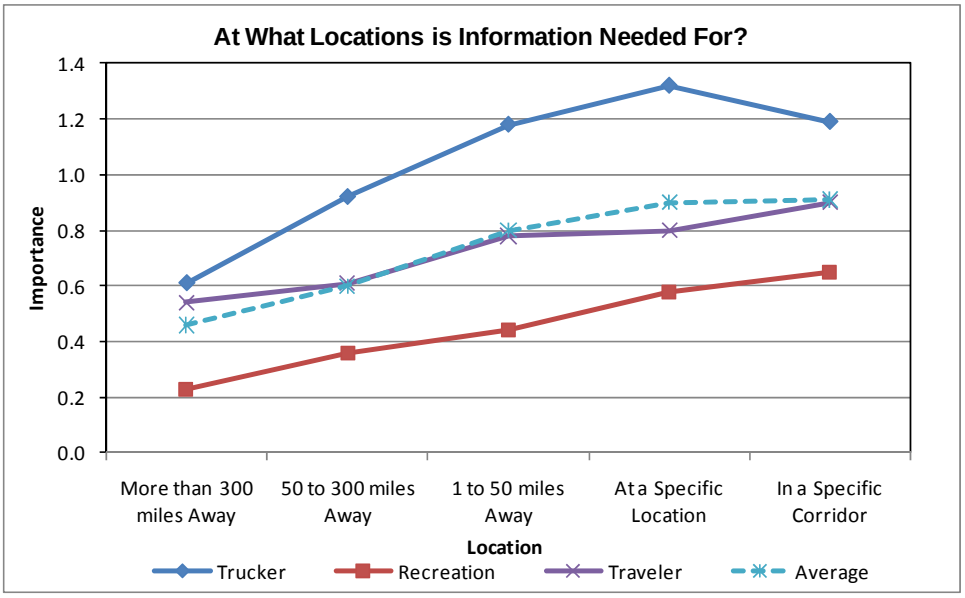
More specific information regarding the timing of traveler information needs relative to the onset of the weather event could not be found. However, one traveler survey did ask about the timing of information needs relative to the start of the trip (Martin et al., 2000). The results of this survey (shown in Figure 3 below) suggest that the importance of receiving weather information over time relative to the trip start varied as a function of traveler type. In particular, most drivers viewed receiving information less than 1 hour prior to leaving and while en-route as being the most important, but truckers rated 1-3 hours before as the most important, and the “traveler” group rated 1-2 days before as among the most important times. These differences are likely related to the types of travel adjustments that different types of travelers need to make. One caveat of these findings is that technology use patterns and availability of travel information on various dissemination methods have changed significantly since then (Martin et al., 2000).




Source: Recreated from Martin et al., 2000.

**Figure 3. Graph showing the rated importance of receiving weather information at different times relative to the start of a trip.**

This study also asked about the timing of the information relative to the location of the event. In general, the highest responses were obtained for locations within 50 miles of a weather event or within a specific travel corridor (see Figure 4).




Source: Recreated from Martin et al., 2000.

**Figure 4. Graph showing the rated importance of receiving weather information at different distances relative to the location of a weather event.**

## TUTORIAL 5-3. HOW TO DETERMINE WHICH DISSEMINATION METHODS TRAVELERS WILL USE

**Summary:** This tutorial provides information about the availability of various dissemination methods at different trip stages, in addition to information about traveler awareness of, and preferences for, specific dissemination methods.

### Availability of Dissemination Methods

There does not seem to be any specific data about dissemination method availability or traveler access to disseminations methods during their travel. However, it was possible to analytically determine when most dissemination methods would likely be available to travelers based on how each technology functions. We categorized the dissemination methods in one of four ways based on its likely availability during four basic trip stages. The categories included:

- ***Available*:** There are no obvious barriers to using this dissemination method.
- ***Available at Certain Locations*:** The dissemination method could be available at this stage, but this is unlikely to be true everywhere (e.g., some common stop-over such as restaurants may have TV or wireless internet access, but others such as rest areas likely do not).
- ***Not Available*:** It is impossible or impractical to access this dissemination method at this trip stage.
- ***Potential distraction:*** The dissemination method can be accessed during this stage, however, doing so could potentially pose a safety-related distraction-risk to drivers. Information from human factors analytical activities (Richard et al., 2009), was used to identify distraction risks.

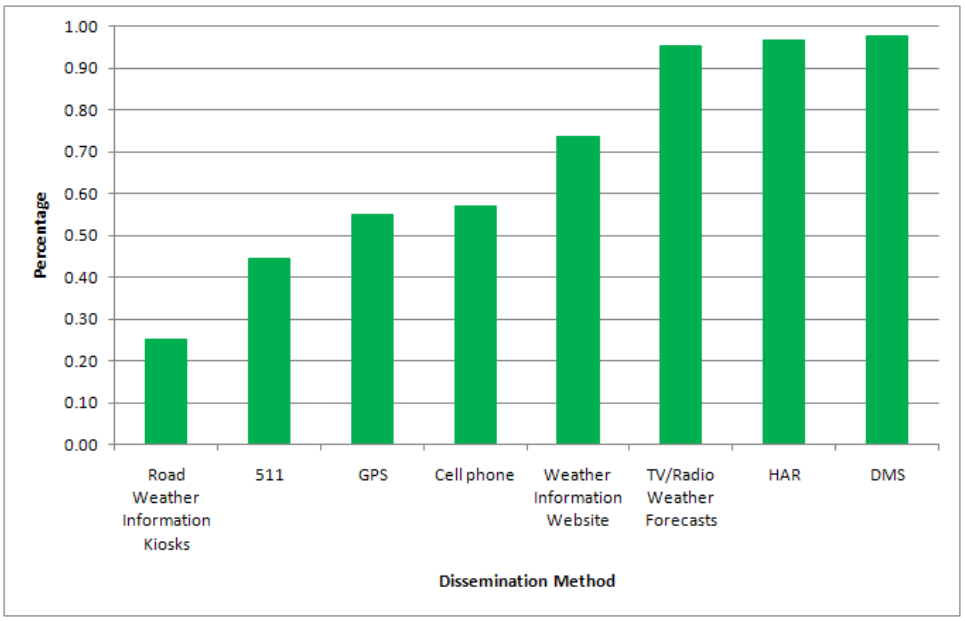
A summary of when most dissemination methods would likely be available to travelers is provided below in Table 4.

**Table 4. Dissemination method availability for different trip stages.**

| Dissemination Method | During Trip Planning | Prior to Leaving | At a Stopping Point | While Driving |
|---|---|---|---|---|
| *Road Weather Information Kiosks* | Not Available | Not Available | Available at Certain Locations | Not Available |
| *511* | Available | Available | Available | Potential Distraction |
| *Global Positioning System (GPS)/PEDs* | Available | Available | Available | Potential Distraction |
| *Cell phone/Text Messaging* | Available | Available | Available | Potential Distraction |
| *Weather Information Website* | Available | Available | Available at Certain Locations | Not Available |
| *Commercial Radio Weather Forecasts* | Available | Available | Available | Available |
| *TV Weather Forecasts* | Available | Available | Available at Certain Locations | Not Available |
| *HAR* | Not Available | Not Available | Available at Certain Locations | Available |
| *DMS* | Not Available | Not Available | Not Available | Available |

### Traveler Awareness of Different Dissemination Methods

Another factor affecting the dissemination methods used by travelers is their awareness of the different methods. If the travelers are unaware of a method, they will not have the option of using it. In Richard et al. (2009), travelers were asked which dissemination methods they were aware of. The results are included in Figure 5 below.




Source: From Richard et al., 2009.

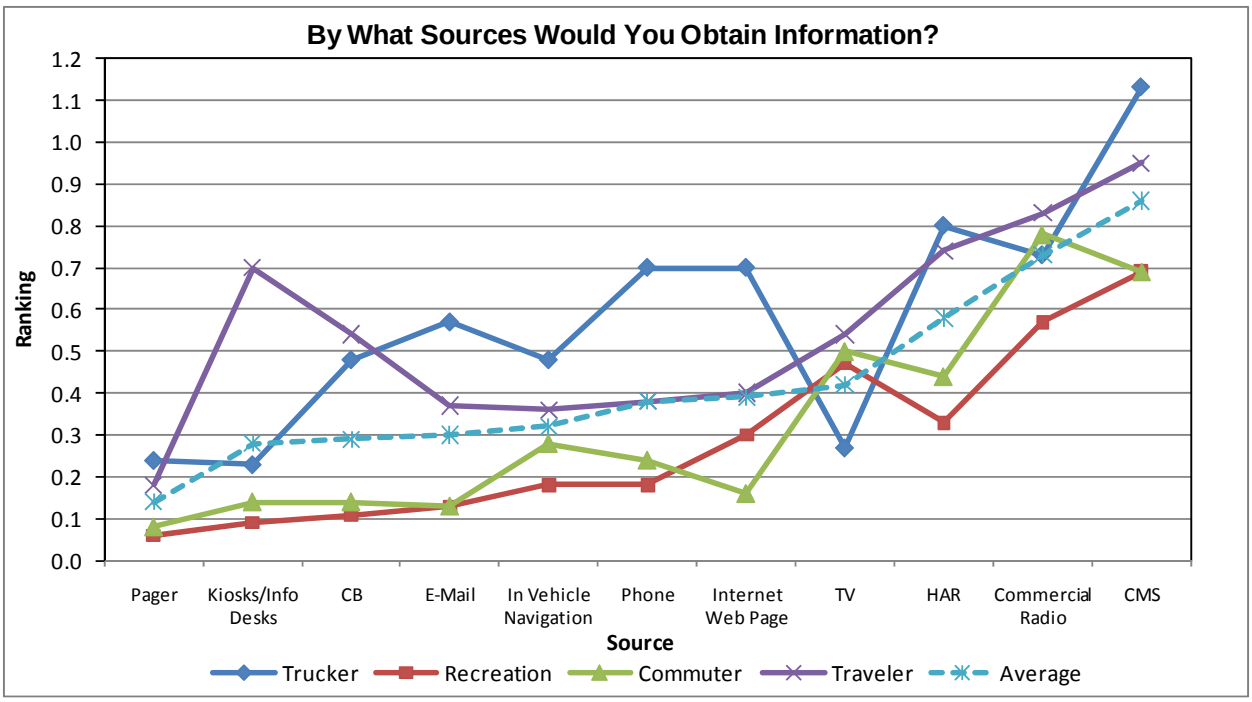
**Figure 5. Percent of travelers aware of each dissemination method.**

It should be noted that this questionnaire was conducted in Washington State and that traveler awareness could be partially a function of the availability of the dissemination methods in that area. However, some strong trends are likely to apply across geographic groups. TV/Radio weather forecasts, HAR, and DMS are all well-known methods, whereas kiosks are much less commonly known.

### Traveler Preferences for Different Dissemination Methods

Overall, the limited existing research information makes it difficult to understand traveler preferences with a high degree of confidence. A few reports provided some specific findings related to dissemination preferences of select groups, such as business travelers were more likely to change their routes than commuters based on DMS traffic information (Emmerink, et al., 1996; see also Peirce & Lappin, 2003).

One research study examined this issue comprehensively; however, the results are from year 2000, and technology use patterns and availability of travel information on various dissemination methods have changed significantly since then (Martin et al., 2000). Results from Martin et al. are shown in Figure 6 below. Nevertheless, the general pattern, especially for more established dissemination methods, such as DMS/CMS (Changeable Message Sign), HAR, commercial radio/TV and perhaps kiosks, may still hold. With the exception of travelers' preference for kiosks and truckers' limited use of TV, preference patterns are similar across traveler types. The other dissemination methods in which differences are observed, such as phone and web, likely have different usage patterns since the survey was conducted.




Source: Recreated from Martin et al., 2000.

**Figure 6. Dissemination method preference by traveler type.**

## TUTORIAL 5-4. SAFETY/MOBILITY IMPLICATIONS OF ROAD WEATHER INFORMATION

**Summary:** This tutorial provides additional information about how safety/mobility impacts for certain weather events can affect drivers' personal safety, crash risk, and convenience or schedules. Safety/mobility impacts are generally characterized along these dimensions, which can be useful for prioritizing the importance of specific messages.

An important use for road weather information is to preserve traveler safety. Crash data analyses provide a partial indication of which conditions require information. For example, it is clear that certain weather impacts, such as low traction and low visibility play a major role in crashes and fatalities (e.g., Maze, Agarwal, & Burchett, 2005; Pisano, Goodwin, & Rossetti, 2008). Other evidence also suggests that speed reductions are associated with increased crash risk arising from greater speed variability on a roadway (e.g., Hauer, 1971); however, there is some controversy regarding the interpretation of these results (e.g., Davis, 2002). We did not find data showing how weather-related lane obstructions and "reduced traffic capacity" were directly related to crash risk. However, it is not unreasonable to expect that these impacts may increase crash risk in some way, although the relationship may also be less direct (e.g., other related factors such as low traction contribute) or these types of events less common in general.

Crash data do not provide a complete description of the safety impacts and other major ways in which road weather information can help travelers avoid personal safety risks and other undesirable conditions, such as significant unexpected schedule disruptions. In order to obtain a more complete picture of traveler impacts, we used a systematic approach to characterize the general level of risk potentially associated with each mobility impact with regard to personal safety, crash risk, and schedule/convenience impacts. This information can be useful for prioritizing weather impacts. Also, by adding in information about schedule/convenience impacts, it makes it possible to provide an additional basis for prioritizing certain impacts that do not have associated safety consequences. Note that no attempt was made to align the risks from each dimension along the same "severity" scale; however, the personal safety and crash risk consequences are clearly more severe than any of the convenience impacts.

The results of this analysis are presented in Table 5 below. Two severity levels were used for each dimension, a major or direct risk (solid circle) or a minor/potential risk (empty circle), the latter case representing impacts that are less severe or less likely to occur. Note that for some weather impacts, the associated type of risk was inherent in the definition of the mobility impact (e.g., disruption to transit schedules by definition involves major schedule impacts to travelers dependent on transit). The severity categories were defined as follows:

- **Personal Safety Risks**
  - *Direct Risk to Personal Safety* (●): Safety/mobility impacts could endanger travelers if they are not prepared or disregard warnings (e.g., becoming stranded on the road during a snow storm).
  - *Potential Risk to Personal Safety* (○): Safety/mobility impacts could endanger travelers if they are not prepared or disregard warnings, but the connection is more dependent on situational factors which may be uncommon (i.e., if a road is closed because of a hazard, such as avalanches or rock slides).
  - *No Impact Indicated* (–): The safety/mobility impact likely has no obvious impact on personal safety.
- **Crash Risks**
  - *Direct Crash Risk* (●): Crash data suggest a likely causal relationship between these factors.

  - *Potential Crash Risk* (○): Crash data are less clear regarding a causal relationship, or this type of crash risk is relatively uncommon.
  - *No Impact Indicated* (–): The safety/mobility impact likely has no obvious impact on crash risk.

- **Convenience/Schedule Impacts**
  - *Major Convenience / Schedule Impacts* (●): Indicates that one of the primary impacts will not necessarily be a safety risk, but travelers may suffer some other consequences in terms of meeting their schedules or being inconvenienced in some way, that might otherwise have been avoidable had they received appropriate information.
  - *Minor Convenience / Schedule Impacts* (○): Traveler schedules or convenience could be affected, but other factors (e.g., low traffic volumes from other travelers staying away) may mitigate these impacts.
  - *No Impact Indicated* (–): The mobility impact would not be expected to cause unreasonable impacts on traveler schedule and convenience.

**Table 5. Potential traveler risks for the basic set of mobility impacts.**

Information about corresponding weather events and specific impacts on travelers is included in the table to provide additional context when evaluating risks.

| Safety/Mobility Impact | Associated Conditions | Impact on Travelers | Personal Safety Risk | Crash Risk | Convenience / Schedule Impacts |
|---|---|---|---|---|---|
| Total Road Closure | Blizzard conditions, White-out conditions, Moderate to heavy snow, Sleet or freezing rain, Flooding, Thunderstorms, High winds | Requires detour onto alternate routes or delaying travel. | ○ | – | ● |
| Reduced traction | Blizzard conditions, White-out conditions, Blowing snow, Bridge or road frost, Flurries or light snow, Moderate to heavy snow, Sleet or freezing rain, Moderate to heavy rain | Drivers should be more cautious in the affected area. | – | ● | ○ |
| Low visibility | Blizzard conditions, White-out conditions, Blowing snow, Flurries or light snow, Moderate to heavy snow, Sleet or freezing rain, Moderate to heavy rain, Smoke/mist/fog | Drivers should be more cautious in the affected area. | – | ● | ○ |
| Lane Obstruction/ Reduced capacity | Blizzard conditions, White-out conditions, Blowing snow, Flurries or light snow, Moderate to heavy snow, Sleet or freezing rain, Moderate to heavy rain, Drizzle or light rain, Flooding, Thunderstorms, High winds, Smoke/mist/fog | Likely to cause moderate to high levels of traffic congestion in the immediate area. Debris on roadway, lanes unavailable because of snow obstruction/ clearing or partial flooding. Also, vehicles pulling over to side of road, washed out roadways or pavement damage. | – | ○ | ● |
| Congestion/ Reduced speed | Blizzard conditions, White-out conditions, Blowing snow, Bridge or road frost, Flurries or light snow, Moderate to heavy snow, Sleet or freezing rain, Moderate to heavy rain, Flooding, Smoke/mist/fog | Greater speed variability in traffic and loss of roadway capacity. | – | ○ | ○ |
| Traffic Control Device (TCD) Malfunction | Blizzard conditions, White-out conditions, Moderate to heavy snow, Sleet or freezing rain, Thunderstorms, High winds | Traffic signals are non-operational leading to increased congestion. | – | – | ● |

| Safety/Mobility Impact | Associated Conditions | Impact on Travelers | Personal Safety Risk | Crash Risk | Convenience / Schedule Impacts |
|---|---|---|---|---|---|
| Unsteady Driving/ High Winds | High Winds | Drivers (particularly those of larger vehicles/trucks, RVs) should be more cautious in the affected areas. | – | ● | – |
| Flooding/ Water Ponding | Moderate to heavy rain, Flooding, Thunderstorms | Drivers are at risk of being stuck or stranded mid-travel. Potential road closures. Drivers should be more cautious in the immediate area. | ● | ○ | ● |
| Maintenance Vehicles on Road | Blizzard conditions, Blowing snow, Bridge or road frost, Extreme cold, Flurries or light snow, Moderate to heavy snow, Sleet or freezing rain, Flooding, Extreme heat | Drivers should be more cautious in the affected area. Maintenance vehicles on the road may reduce roadway capacity, leading to increased congestion. | – | ○ | ○ |
| Transit, Bus Delays/ Stoppage | Blizzard conditions, White-out conditions, Blowing snow, Bridge or road frost, Extreme cold, Flurries or light snow, Moderate to heavy snow, Sleet or freezing rain, Moderate to heavy rain, Flooding, Thunderstorms, High winds, Smoke/mist/fog | Travel by transit has a higher time cost. | – | – | ● |
| Sun Glare | Extreme heat, Fair weather | Drivers should be more cautious in the affected area. | – | ○ | – |
| Extreme Temperatures | Extreme cold, Extreme heat | Drivers should prepare for conditions by bringing along appropriate gear/supplies. | ● | – | – |

## TUTORIAL 5-5. DESCRIPTION OF THE ROAD WEATHER MESSAGE DESIGN TOOL

**Summary:** This tutorial describes the road weather message design tool, which outlines a systematic approach for developing relevant weather messages that incorporate driver information needs, as well as appropriate formats for disseminating them.

One of the key objectives of the FHWA message guidelines project was to recommend relevant standards for communicating road weather information to travelers. As described in previous chapters, a message design tool that takes into account specific traveler information needs and driving behaviors was identified as a suitable method for meeting this objective.

The rationale for this approach is straightforward: a message design tool is the most efficient way to integrate the large number of different possible combinations of weather events, safety and mobility impacts, traveler decisions and behaviors, and dissemination methods into specific recommendations for road weather messages. In particular, the "problem space" associated with these various combinations is so large that providing specific guidance for each combination would result in a product that would be unwieldy and—ultimately—of little use to state DOT staff and other end users. For example, a winter storm can have many different impacts on travel (e.g., road closures, reduced capacity, low traction, low visibility, etc.), and different types of travelers will be concerned about these impacts in different ways (e.g., concerns about being late, concerns about getting stranded, etc.) and they will have different options with regard to dealing with their concerns (e.g., staying home, changing route, departing earlier, etc.). This situation is further complicated by the fact that travelers have several options for obtaining information (e.g., TV/radio, DMSs, HAR, etc.), and the suitability and availability of these dissemination methods also varies based on the traveler's situation, such as trip stage, etc. Finally, the message design recommendations are themselves closely tied to the types of dissemination selected, because the dissemination methods differ in terms of format (e.g., short text, auditory, graphics, etc.) and how much information can be provided.

Thus, a key challenge throughout the conceptualization and planning of the message design recommendations was how to navigate the complex relationship between all these factors in way that is not burdensome and confusing to the end user, who just wants recommendations for how best to communicate road weather messages to travelers. Based on some initial work, it was clear that a message design tool would be necessary to make navigating the large number of message design issues tractable and more efficient.

The following sections provide a detailed overview of how the message design tool works. This discussion includes the rationale for the tool, in addition to a more detailed explanation of how to use it.

*Rationale*: When a weather event occurs, it will have some impact on the travel network which in turn may impact the travelers (we refer to these as *Safety and Mobility Impacts*). For example, heavy rains could lead to flooding on some roads, and the closure of some road segments. Travelers originally intending to use the closed roads will now have to change their plans since their original route is no longer available. Moreover, these situations become more complicated because the decisions that travelers make—and how they obtain their information—depend on a variety of factors including driver characteristics, type of trip, the stage of their trip, etc. For example, a traveler seeking road weather information before departing has several options regarding where they seek information (e.g., home internet, TV, 511, etc.) and several options regarding their response (e.g., plan a different route, delay their departure, cancel their trip, etc.). In contrast, a traveler already on the road will be limited to a different set of available dissemination methods (e.g., DMS, HAR, 511, etc.), and travel options (e.g., take a detour, but not easily cancel or postpone travel). Finally, when travelers get around to seeking out road weather information, how the information is presented can also effect whether or not travelers can

make use of it. For example, if a message is difficult to understand, read, or hear, then travelers will be less likely to use that information to make good travel decisions. In summary, an approach to providing effective road weather information to travelers should contain three key elements:

1. Information that supports the key travel decisions they need to make
2. Information that is provided to travelers using dissemination methods that are available and suitable for them to use based on their travel situation, and
3. Message content that is easily understood, and displayed in a manner that can be clearly read, heard, etc.

The message design tool provides guidance related to the above three topics for a given set of weather events and corresponding safety/mobility impacts. The design tool works in four steps plus one optional step, and is comprised of seven questions that help specify: (1) the relevant message content, (2) suitable dissemination methods, and (3) design recommendations for developing messages that address the weather event and safety/mobility impacts of concern. The basic steps and questions are described in Table 6 below.

**Table 6. Questions associated with the key message design tool steps.**

| Question | Description |
|---|---|
| ***Step 1: Identify safety/mobility impacts based on the weather event*** | |
| What is the weather event? | Identifies key safety/mobility impacts, and provides contextual information for message content and details about the weather event in general (e.g., timeframe, location, etc.). |
| What are the safety/mobility impacts of greatest concern? | Used to identify the travelers' key travel decisions, which correspond to their key information needs. |
| ***Step 2: Identify likely travel decisions and suitable dissemination methods*** | |
| What are the key trip decisions and behavior changes that travelers would likely make in response to the safety/mobility Impacts? | Travelers will seek out information based on what travel plan changes they have to make (i.e., their travel decision). This information is related to the weather message content. |
| What dissemination methods are most suitable given the traveler's situation? | Used to identify the dissemination methods that are most likely to be suitable/available to travelers, based on their travel situation. |
| What are the specific traveler information needs? | Can be used to identify information that should be included in the road weather messages to support traveler decision making. This step is optional and only required if additional guidance is needed regarding what the message should say. |
| ***Step 3: Lookup relevant design recommendations*** | |
| For the specified dissemination methods, which human factors design recommendations apply to the message content and presentation format? | A "look-up table" is used to identify message design guidelines that are specific to the identified dissemination methods. |
| ***Step 4: Apply design recommendation information*** | |
| What are the specific design recommendations? | This is the key message design recommendation. This guidance provides information about how to communicate a message that is easy to read/hear and understand given the presentation constraints inherent in specific dissemination methods. |

The seven questions are structured around four separate tables that mostly follow a linear progression plus a separate section that will contain the actual design recommendations (see Figure 7). The first table (Step 1) helps identify the key safety/mobility impacts associated with the weather event. Once the primary safety/mobility impacts of concern have been selected, the second table (Step 2) identifies the key travel decisions and suitable dissemination methods associated with the mobility impact. Finally, the last table (Step 3) provides a "roadmap" to the specific message design recommendations available for the message content and presentation based on the parameters selected in the previous tables. The specific design recommendations (Step 4) are contained in separate chapters.

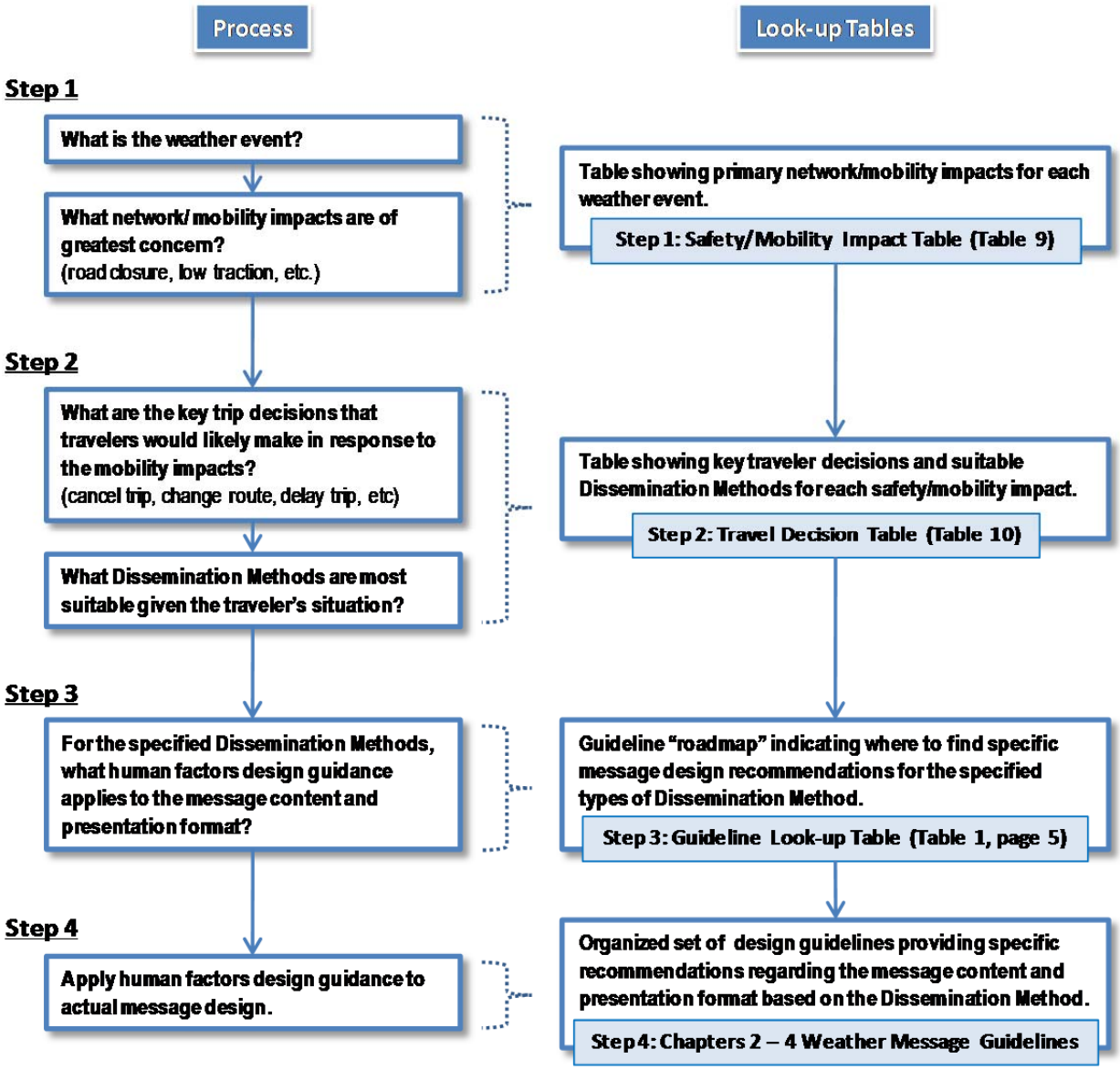



**Figure 7. Message design tool steps and questions for finding design recommendations shown with their associated look-up tables.**

It is not necessary to start at Step 1 in this process; the tool is designed to provide flexibility to an end user for extracting information. In some cases, the weather impacts may already be specified or dictated by existing DOT communication policies. In these cases, end users could begin at Step 2 if they require information about likely travel decisions and suitable dissemination methods. Alternatively, they could go right to Step 3 to find specific message design guidance from the "road-map" table, if they already know what message they must communicate and which set of dissemination methods must be used.

Each of the steps listed above, along with its corresponding rationale, is described in more detail in the following sections.

### Step 1: Identify safety/mobility impacts based on the weather event

The first step of the process involves identifying the road safety/mobility impacts that are of greatest concern for the weather event in question.

***Question 1: What is the weather event?***

The weather event is the primary starting point in this process. It essentially provides a high-level way to organize the associated road weather concerns. For example, a single weather event could be associated with several different impacts on the road network (e.g., blowing snow, slippery roads, road closures, etc. during winter storms). In addition, certain secondary information is tied more generally to the weather event, such as its timeframe, geographic extent, the likelihood of it affecting a certain region, etc. The message design recommendations will also provide separate guidance for incorporating this secondary information in road weather messages if this information is important, and can be accommodated by a specific dissemination method.

***Question 2: What are the safety/mobility impacts of greatest concern?***

These impacts reflect the specific ways in which the road network or general traveler safety and mobility are affected by the weather event, such as closure of road segments, capacity reductions, etc. It is useful to specify the effects of a weather event in terms of these impacts because they determine what decisions travelers ultimately have to make with regard to their travel plans or behavior (e.g., driving more cautiously).

Likely weather event and safety/mobility impact combinations are shown in Table 9 (cells that are not shaded blue). To make this table easier to use, combinations that are unlikely to occur are shaded blue. The reason for doing this was to highlight combinations where the safety/mobility impact was a direct consequence of the weather event, rather than just being associated or indirectly linked with the event. However, it should be noted that there is no specific reason to avoid selecting a blue-shaded combination if it makes sense to do so based on conditions. Note that most weather events have multiple associated safety/mobility impacts. Tutorial 4 provides additional guidance for prioritizing these impacts based upon personal safety risks, crash risks, and convenience/schedule impacts for the traveler.

These safety/mobility impacts are primarily based on those used to develop Traffic Management strategies for addressing various weather events as defined in the FHWA ConOps report on “Weather-Responsive Traffic Management: Concept of Operations” (Cambridge Systematics, 2003). However, some weather impacts were added to cover additional traveler concerns that were not included in the original document (e.g., stranding conditions), and others were changed based on feedback from the FHWA. The full list of weather impacts used in scenario development is provided in Table 7 below.

**Table 7. Definition and associated weather events for each weather impact.**

| Safety/Mobility Impact | Associated Conditions | Impact on Travelers |
|---|---|---|
| Total Road Closure | Blizzard conditions, White-out conditions, Moderate to heavy snow, Sleet or freezing rain, Flooding, Thunderstorms, High winds | Requires detour onto alternate routes or delaying travel. |
| Reduced traction | Blizzard conditions, White-out conditions, Blowing snow, Bridge or road frost, Flurries or light snow, Moderate to heavy snow, Sleet or freezing rain, Moderate to heavy rain | Drivers should be more cautious in the affected area. |
| Low visibility | Blizzard conditions, White-out conditions, Blowing snow, Flurries or light snow, Moderate to heavy snow, Sleet or freezing rain, Moderate to heavy rain, Smoke/mist/fog | Drivers should be more cautious in the affected area. |
| Lane Obstruction/ Reduced capacity | Blizzard conditions, White-out conditions, Blowing snow, Flurries or light snow, Moderate to heavy snow, Sleet or freezing rain, Moderate to heavy rain, Drizzle or light rain, Flooding, Thunderstorms, High winds, Smoke/mist/fog | Likely to cause moderate to high levels of traffic congestion in the immediate area. Debris on roadway, lanes unavailable because of snow obstruction/clearing or partial flooding. Also, vehicles pulling over to side of the road, washed out roadways or pavement damage. |
| Congestion/ Reduced speed | Blizzard conditions, White-out conditions, Blowing snow, Bridge or road frost, Flurries or light snow, Moderate to heavy snow, Sleet or freezing rain, Moderate to heavy rain, Flooding, Smoke/mist/fog | Greater speed variability in traffic and loss of roadway capacity. |
| TCD Malfunction | Blizzard conditions, White-out conditions, Moderate to heavy snow, Sleet or freezing rain, Thunderstorms, High winds | Traffic signals are non-operational leading to increased congestion. |
| Unsteady Driving/ High Winds | High winds | Drivers (particularly those of larger vehicles/trucks, RVs) should be more cautious in the affected areas. |
| Flooding/ Water Ponding | Moderate to heavy rain, Flooding, Thunderstorms | Drivers are at risk of being stuck or stranded mid-travel. Potential road closures. Drivers should be more cautious in the immediate area. |
| Maintenance Vehicles on Road | Blizzard conditions, Blowing snow, Bridge or road frost, Extreme cold, Flurries or light snow, Moderate to heavy snow, Sleet or freezing rain, Flooding, Extreme heat | Drivers should be more cautious in the affected area. Maintenance vehicles on the road may reduce roadway capacity, leading to increased congestion. |
| Transit, Bus Delays/ Stoppage | Blizzard conditions, White-out conditions, Blowing snow, Bridge or road frost, Extreme cold, Flurries or light snow, Moderate to heavy snow, Sleet or freezing rain, Moderate to heavy rain, Flooding, Thunderstorms, High winds, Smoke/mist/fog | Travel by transit has a higher time cost. |
| Sun Glare | Extreme heat, Fair weather | Drivers should be more cautious in the affected area. |
| Extreme Temperatures | Extreme cold, Extreme heat | Drivers should prepare for conditions by bringing along appropriate gear/supplies. |

### Step 2: Identify likely travel decisions and suitable dissemination methods

Based on the key safety/mobility impact identified, the next step is to identify the key decision that travelers would likely want to make based on the weather impacts. In addition, it is also necessary to identify suitable dissemination methods based on these situational factors.

***Question 3: What are the key trip decisions and behavior changes that travelers would likely make in response to the safety/mobility impacts?***

Travel decisions reflect the changes that travelers may need to make to their travel plans based on how those plans are affected by the weather event. The information needed to properly support these travel decisions makes up the travelers' basic information needs. For example, if travelers find out that the highway they were intending to take later in the trip is closed, the primary information that they need to know is what alternative routes are available or should be taken. For travelers currently on the road, finding an alternative route is the most important trip modification; however, for travelers who have yet to depart on their trip, they may also benefit from knowing if they should expect delays or from knowing information that allows them to consider cancelling their trip altogether.

The goal in making this type of information readily available, or notifying drivers directly (e.g., in the case of visibility or traction problems) is to help drivers avoid making poor travel decisions. In particular, if a road weather message clearly communicates the information that travelers are seeking, it will be helpful to them and they will be able to make more informed decisions about changes to their travel plans or behavior. However, if a message cannot provide the needed information, then travelers will either ignore the message or be required to look elsewhere for the information they need. A related factor is the willingness of travelers to make certain travel decisions (additional detail regarding this issue is available in Tutorial 1).

A list of primary travel decisions that travelers might make in response to safety/mobility impacts includes:

- Should they expect and plan for delays?
- Should they use an alternative route?
- Should they change travel modes (e.g., drive vs. take transit)?
- Should they drive with greater caution?
- Should they change their driving behavior because of hazardous conditions?
- Should they make special safety-related preparations (e.g., pack special supplies, bring tire chains, etc.)?
- Should they cancel their trip?

The Travel Decision Table (Table 10 in Step 2) maps out the relationship between these travel decisions and each safety/mobility impact described in the previous step. Two categories are used to describe the relationship between a travel decision and mobility impact. The term "likely" is used to indicate a likely or primary travel decision that needs to be made in response to a safety/mobility impact. The term "possible" is used to indicate a travel decision that could be applicable, but does not represent a key decision. It may be a convenience to travelers, but not a priority, to make information available for "likely" travel decisions. One important caveat associated with Table 10 is that the likelihood assignments (e.g., "likely", "possible") are currently based on expert judgment and have not been empirically validated (see the Task 4 Report for further discussion (Richard et al., 2009)).

***Question 4: What dissemination methods are most suitable given the traveler's situation?***

The dissemination methods represent the primary methods for providing road weather information to travelers. These methods also complicate the process of communicating to travelers because they vary substantially with regard to what type of and how much information can be provided. Furthermore, travelers will have access to different dissemination methods at different points during their travel planning and during their trip.

One consideration is that the suitability of specific dissemination methods will vary depending on the travel situation. For example, some methods can provide information directly when it is needed, such as route closure and detour information accessed from the internet while a traveler is selecting his or her route, or information on a DMS that alerts drivers of icy road conditions just ahead. In contrast, other situations can involve the use of dissemination methods when they are less suitable, such as when they provide relevant information, but not when it is needed. For example, drivers can be informed about icy roads the day before their trip or just prior to departing; however, since they will not be able to use that information until later in their trip, there is a good possibility that this warning information will be forgotten. In this case, the dissemination methods used to communicate information this way are ineffective. Tutorial 2 discusses the suitability of making specific travel decisions at various trip stages.

Another way in which a dissemination method may be less suitable is if using it has safety implications. For example, using a PED to obtain road condition information while driving could pose a driver distraction hazard. Consequently, other dissemination methods should also be available to provide information, so that drivers are not required to use potentially unsafe means to obtain road weather information.

Finally, some dissemination methods are unsuitable for providing certain types of road weather information because of when travelers receive the information. An example of this is using *only* DMS or HAR to communicate information related to delaying or canceling travel. Since travelers would not obtain this information until they were already on the road, they obviously could not use this information to make the appropriate travel decisions during the planning of their trips. Tutorial 3 discusses the availability of various dissemination methods at different trip stages as well as traveler awareness and preferences for different dissemination methods.

The key point is that not all dissemination methods are useful for presenting certain types of road weather information; however, the suitability of each method also depends on the trip stage and other aspects of the travel situation. The Travel Decision Table (Table 10 in Step 2), provides a way to identify the most suitable dissemination methods for particular travel decisions. The definitions regarding the suitability of dissemination methods are based on limited categorizations at this point, due to limited existing research information. Table 8 below summarizes the three categories.

An additional note is that the category of "text messaging" was included as a dissemination option in this table. To clarify, the text messaging option would represent any technology that sends a brief message to travelers via a portable electronic device. This could also include newer communication formats, such as "Twitter" that involve a similar short message sent to subscribers. The key descriptive feature in these approaches is that information is sent to the traveler, which means that the timing of information communication is predominately outside of the traveler's control. In contrast, the category of PED is used to represent a collection of portable devices that travelers can use to actively acquire information when they want it. In this case, the timing information communication is fully under the traveler's control (note that technologies such as "Twitter" contain elements of both, since travelers can choose when to check for new messages). Another important point that should be noted is that "pushing" messages on travelers while they are driving may pose a safety hazard, and several jurisdictions are considering passing or enacting laws against using text messaging while driving.

**Table 8. Definition of the "suitability" category for dissemination methods in Table 10.**

| Category | Definition |
|---|---|
| *Suitable* | Dissemination method typically makes road weather information available when: (1) drivers actually need it to make decisions, and (2) they can safely access the information. |
| *Suboptimal* | Dissemination method typically makes road weather information available when: (1) well before when travelers need it to make decisions, which makes it easier to forget, and/or (2) accessing the information may be a safety concern (e.g., driver distraction). |
| *Unsuitable* | Dissemination method makes information available when most travelers will be unable to access it when they have to make the relevant travel decision. |

***Question 5: What are the specific traveler information needs?***

When deciding what to do when faced with certain safety/mobility impacts, most travelers will try to make the best decision they can (or at least try to avoid making bad decisions) based on the available information. In most cases, travelers will be depending almost entirely on information from road weather messages, with the exception of what information they can get from their immediate surroundings. Therefore, a prerequisite for helping travelers make sound travel decisions is making sure that they get information that applies to their decision and covers as many relevant aspects as possible.

The information from the recommendations available in this step is applicable to the main content of the message. This information is most useful if there is uncertainty about what a message should communicate such as when developing new messages. Another use is in deciding how to prioritize message information. In particular, the key difficulty in designing messages is often identifying what information elements have to be left out of a message because of limitations associated with the dissemination method (e.g., limited resolution or space on a display).

**Step 3: Lookup relevant design recommendations**

The purpose of Step 3 is simply to point an end user or message designer to the relevant design recommendation information, once they have identified the specific dissemination methods, and other weather event information (e.g., timeframe) that they want to communicate.

***Question 6: For the specified dissemination methods, which human factors design guidelines apply to the message content and presentation format?***

The look-up table in Step 3 provides a way to find message design guidelines that apply to the identified dissemination methods. The idea is that an end user would use the relevant dissemination method class to look up the page numbers of the applicable design guidelines shown in the table cell. The specific content of the message should be consistent with the associated travel decisions.

Note that in order to reduce the complexity of the table, dissemination methods were grouped by the base format, such as short text messages (e.g., DMS), open visual formats (e.g., web-pages), and auditory messages (e.g., HAR, 511). Although specific design recommendations may not be identical for dissemination methods within a class, they are similar enough that the basic design principles should still apply across methods. Clear exceptions are noted in the discussion section of applicable guidelines.

### Step 4: Apply design recommendation information

***Question 7: What are the specific design recommendations?***

The design guidelines contained in Chapters 2 – 4 of this document represent the primary information provided by the design tool. They include recommendations regarding the content and display format/layout of weather message information tailored for certain types of dissemination methods. These recommendations are based on the best available information; however, because there is a lack of data specific to road weather information, much of this guidance has been extrapolated from more general human factors design principles. Nevertheless, the objective was to provide as specific of recommendations as possible to promote the design of road weather messages that support sound traveler decision-making during weather disruptions. Additionally, these guidelines provide recommendations for presenting that information in a way that is easy to read/hear and understand for the selected dissemination methods and the situational constraints that travelers may face when obtaining that information (e.g., reading distance requirements for DMS).

### Complete Process for Finding Relevant Message Design Recommendations

The complete process for finding design information is shown in Figure 8 below and the corresponding look-up tables for each step follow the table. It essentially involves 4 main steps and one optional step. These include:

1. Use Table 9 to identify primary safety/mobility impacts of concern for the impending weather event.
2. For the selected safety/mobility impacts, look up the *likely* and *possible* travel decisions in Table 10, and the dissemination methods that are identified as being *suitable/acceptable* for reaching travelers.
3. Use the Table 1 guideline look-up table as a “road map” to find message design recommendations based on the identified types of dissemination methods.
4. Refer to the specific design recommendations in Chapters 2-4 for “design tips” that promote clear and effective understanding of road weather messages.

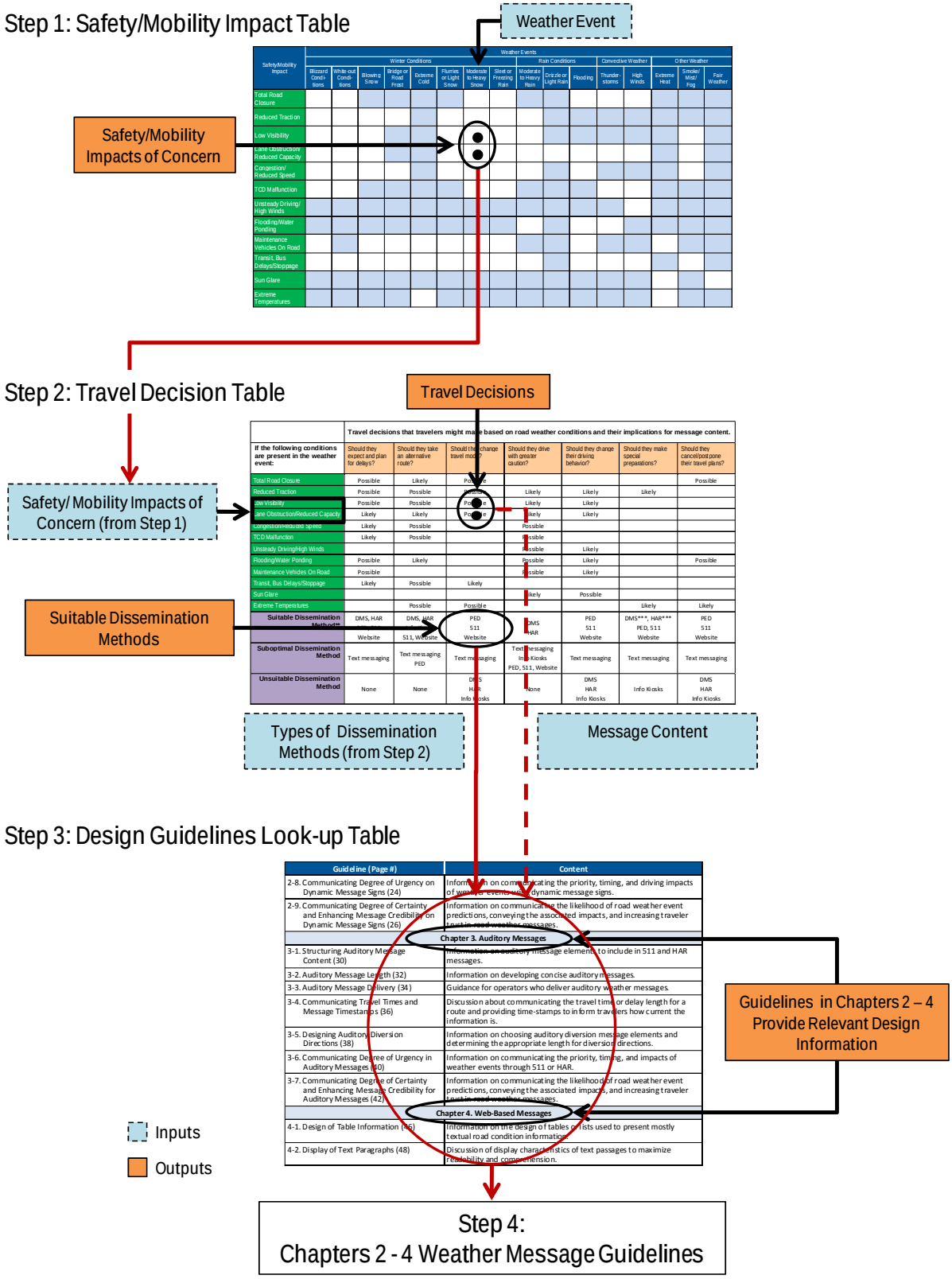



**Figure 8. Schematic diagram showing the relationship between the key tables and the inputs and outputs used in each step of the message design tool.**

**Table 9. Step 1 – Safety/Mobility Impact Table – Identify safety/mobility impacts of concern (rows) for a weather event (columns).**

| Safety/Mobility Impact | Weather Events | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Winter Conditions | | | | | | | | Rain Conditions | | | Convective Weather | | Other Weather | | |
| | Blizzard Condi-tions | White-out Condi-tions | Blowing Snow | Bridge or Road Frost | Extreme Cold | Flurries or Light Snow | Moderate to Heavy Snow | Sleet or Freezing Rain | Moderate to Heavy Rain | Drizzle or Light Rain | Flooding | Thunder-storms | High Winds | Extreme Heat | Smoke/ Mist/ Fog | Fair Weather |
| Total Road Closure | | | | | | | | | | | | | | | | |
| Reduced Traction | | | | | | | | | | | | | | | | |
| Low Visibility | | | | | | | | | | | | | | | | |
| Lane Obstruction/ Reduced Capacity | | | | | | | | | | | | | | | | |
| Congestion/ Reduced Speed | | | | | | | | | | | | | | | | |
| TCD Malfunction | | | | | | | | | | | | | | | | |
| Unsteady Driving/ High Winds | | | | | | | | | | | | | | | | |
| Flooding/Water Ponding | | | | | | | | | | | | | | | | |
| Maintenance Vehicles On Road | | | | | | | | | | | | | | | | |
| Transit, Bus Delays/Stoppage | | | | | | | | | | | | | | | | |
| Sun Glare | | | | | | | | | | | | | | | | |
| Extreme Temperatures | | | | | | | | | | | | | | | | |

*Note: The shaded cells represent Weather Event and Mobility Impact combinations that are unlikely to occur. This is done to make this table easier to use, however, there is no specific reason to preclude selecting a shaded combination if it makes sense to do so based on conditions.*

**Next go to Step 2**: Match Safety/Mobility Impacts of concern (row headers) with corresponding impacts in Table 10 (Traveler Information Table).

**Table 10. Step 2 – Travel Decision Table – Identify travel decisions and suitable dissemination methods for each safety/mobility impact of concern.**

| | **Travel decisions that travelers might make based on road weather conditions and their implications for message content.** | | | | | | |
|---|---|---|---|---|---|---|---|
| **If the following conditions are present in the weather event:** | Should they expect and plan for delays? | Should they take an alternative route? | Should they change travel mode? | Should they drive with greater caution? | Should they change their driving behavior? | Should they make special preparations? | Should they cancel/postpone their travel plans? |
| Total Road Closure | Possible | Likely | Possible | | | | Possible |
| Reduced Traction | Possible | Possible | Possible | Likely | Likely | Likely | |
| Low Visibility | Possible | Possible | Possible | Likely | Likely | | |
| Lane Obstruction/Reduced Capacity | Likely | Likely | Possible | Likely | Likely | | |
| Congestion/Reduced Speed | Likely | Possible | | Possible | | | |
| TCD Malfunction | Likely | Possible | | Possible | | | |
| Unsteady Driving/High Winds | | | | Possible | Likely | | |
| Flooding/Water Ponding | Possible | Likely | | Possible | Likely | | Possible |
| Maintenance Vehicles On Road | Possible | | | Possible | Likely | | |
| Transit, Bus Delays/Stoppage | Likely | Possible | Likely | | | | |
| Sun Glare | | | | Likely | Possible | | |
| Extreme Temperatures | | Possible | Possible | | | Likely | Likely |
| **Suitable Dissemination Method**** | DMS, HAR<br>PED, 511<br>Website | DMS, HAR<br>Info Kiosks<br>511, Website | PED<br>511<br>Website | DMS<br>HAR | PED<br>511<br>Website | DMS***, HAR***<br>PED, 511<br>Website | PED<br>511<br>Website |
| **Suboptimal Dissemination Method** | Text messaging | Text messaging<br>PED | Text messaging | Text messaging<br>Info Kiosks<br>PED, 511, Website | Text messaging | Text messaging | Text messaging |
| **Unsuitable Dissemination Method** | None | None | DMS<br>HAR<br>Info Kiosks | None | DMS<br>HAR<br>Info Kiosks | Info Kiosks | DMS<br>HAR<br>Info Kiosks |

* Note: Could be likely, but it depends on the severity of the conditions.
** Note: Commercial TV/Radio are excluded because the presentation of information is outside of the control of transportation professionals.
***Note: DMS and HAR work for preparations such as putting on chains, but not for preparations where the traveler needs to bring items from home.

**Next go to Step 3**: Use Look-up Table 1 to find design recommendations related to selected travel decisions and suitable dissemination methods.

## TUTORIAL 5-6. EXAMPLE APPLICATIONS OF THE ROAD WEATHER MESSAGE GUIDELINES

**Summary:** This tutorial provides examples of how the guidelines can be used to improve existing road weather messages.

### Improvements of Existing Weather Messages

The process outlined in Tutorial 5-5 provides a comprehensive method to design new weather messages. It is sometimes the case, however, that a weather message already exists for the current situation. In those instances, the weather message guidelines can be used to refine the format, presentation, and wording of the existing message. Below are three examples of weather messages that were found on state DOT or 511 websites. Each example includes an improved message that was written using the weather message guidelines.

| Message that Can be Improved | Improved Message |
|---|---|
| Phase 1:<br>WEATHER ALERT<br>INTERMITTENT RAIN<br>REDUCE SPEED<br>Phase 2:<br>WEATHER ALERT<br>INTERMITTENT RAIN<br>USE HEADLIGHTS | Phase 1 (singular phase message):<br>PERIODIC RAIN<br>REDUCE SPEED<br>USE HEADLIGHTS |

**Figure 9. Example 1: Application of guidelines to DMS message.**

The message that can be improved consists of two phases, with an alternating third line. Using the guidelines included in this document, the message was improved to solve the following problems.

1. The phrase “weather alert” does not provide any useful information to the driver. It may be that the intention of providing this information was to inform drivers that a DMS, which was generally used for non-weather-related displays, is being used to provide weather information in this special case. However, drivers already know that DMS are used for alerts and the weather-specific nature of the message can be easily be seen by reading the first few words of the message. Thus, this line is self-evident and can be eliminated. (Guideline 2-2)

2. The word “intermittent” is unnecessarily long and may not be understood by some drivers. A shorter word like “periodic” captures the nature of the event and uses fewer characters; although, it may not be the best word since it is still relatively uncommon. An alternative is to delete the word “intermittent” entirely; however, leaving the word in the message may preserve DMS credibility since the rain is sporadic and may not be occurring when the driver passes the sign. (Guideline 2-2 and Guideline 2-9)

3. The location information element was not included in the original message, potentially due to the transitory nature of the rain and the implied location on the same road, “ahead.” For DMS, if the

location line is omitted or included on the first line, the two action lines can be displayed on the same phase. This eliminates the alternating third line, which was found to increase reading time. For PED messages it would be useful to provide location information since the exact location of the traveler is unknown. In this situation, a route name with cross-roads can be used to define a geographic extent (e.g. "periodic rain on I-5 between exit 166 and exit 192"). (Guideline 2-4 and Guideline 2-7)

**Message that Can be Improved**

**DUE TO A ROCK SLIDE, I-40 IS CLOSED IN BOTH DIRECTIONS BETWEEN EXIT 20 (U.S. 276), 24 MILES WEST OF ASHEVILLE, IN NORTH CAROLINA AND EXIT 421 ( I-81 INTERCHANGE), EAST OF KNOXVILLE IN TENNESSEE**

*Travelers can still reach Western North Carolina.*

Both directions of I-40 are closed between Exit 20, West of Asheville in North Carolina, and Exit 421 (I-81 Interchange) East of Knoxville in Tennessee due to a rock slide at mile marker 2.6 on I-40 in North Carolina. The road is not expected to reopen for several months.

Official Detour: Motorists traveling on I-40 West are advised to take Exit 53B, I-240 West. Follow I-240 West to Exit 4A, I-26 West. Follow I-26 West (a North Carolina Scenic Highway) to I-81 South. Take I-81 South and follow back to I-40, Mile Marker 421, in Tennessee. This route is 53 miles longer than I-40.

Motorists can access Asheville via I-40 from the east and I-26 to the north and south. Exits 20 and 27 on I-40 provide access to popular destinations west of Asheville. In Tennessee, Exits 432 through 451 are open to local traffic.

For a map of detour routes and the affected road closure, please click HERE

**US-321 CLOSED IN CALDWELL COUNTY, NORTH OF LENOIR**

Due to the threat of a rock slide, US-321 is closed between Kirby Mountain Road and Waterfalls Road in Caldwell County, North of Lenoir. The road may be closed for 3 or 4 days.

Motorists are advised to follow the signed detour in place.

**Improved Message**

| Current Alerts | |
|---|---|
| **I-40** | Closed in both directions between Exit 20 (U.S. 276) in North Carolina and Exit 421(I-81 Interchange) in Tennessee due to a rock slide.<br>Click here for more information. |
| **US-321** | Closed in both directions between Kirby Mountain Road and Waterfalls Road due to the threat of a rock slide.<br>Click here for more information. |

**Figure 10. Example 2: Application of guidelines to website weather alert.**

There are a number of qualities that make the first message a good alert message according to Guideline 18. It uses a red border to draw attention and is prominently located at the top of the page. However, there are also a number of characteristics that could be improved using the guidance in Guideline 4-2 for text.

1. The first alert for I-40 is overly wordy. The amount of information provided overshadows the following alert for US-321. The improved message provides a link to the bulk of the detailed information contained in the message. (Guideline 4-8)

2. The text displayed in red, bold, uppercase, underlined font is difficult to read. Text in mixed case is easier to read. Additionally, the red box draws attention sufficiently so that the remainder of the formatting is unnecessary. (Guideline 4-2)

3. Left justification of the text also makes the message easier to read. (Guideline 4-2)

**Message that Needs Improvement**

**US 36 - PARTLY COVERED**
From Route Z (Shelby Co.) to Route 24 (Ralls Co.).
Condition last updated at 12:51 PM on 09-DEC-09.

**US 36 - PARTLY COVERED**
From Route 24 (Ralls Co.) to Route 61 (Marion Co.).
Condition last updated at 12:51 PM on 09-DEC-09.

**US 40 - CLEAR**
From I-70 (St. Charles Co.) to I-270 (St. Louis Co.).
Condition last updated at 07:38 PM on 08-DEC-09.

**US 412 - CLEAR**
From Arkansas Line to Route 25 (Dunklin Co.).
Condition last updated at 02:09 PM on 09-DEC-09.

**US 412 - CLEAR**
From Route 25 (Dunklin Co.) to I-55 (Pemiscot Co.).
Condition last updated at 02:09 PM on 09-DEC-09.

**US 50 - CLEAR**
From I-470 (Jackson Co.) to Route F (Jackson Co.).
Condition last updated at 02:38 PM on 09-DEC-09.

**US 50 - CLEAR**
From Route F (Jackson Co.) to Route 13 (Johnson Co.).
Condition last updated at 02:38 PM on 09-DEC-09.

**Improved Message**

| Route | Location | Road Condition | Last Update |
|---|---|---|---|
| 36 | Route Z (Shelby Co.) to Route 24 (Ralls Co.) | Partly Covered | 12:51 PM 12/9/09 |
| 36 | Route 24 (Ralls Co.) to Route 61 (Marion Co.) | Partly Covered | 12:51 PM 12/9/09 |
| 40 | I-170 (St. Charles Co.) to I-270 (St. Louis Co.) | Clear | 7:38 PM 12/8/09 |
| 50 | I-470 (Jackson Co.) to Route F (Jackson Co.) | Clear | 2:38 PM 12/9/09 |
| 50 | Route F (Jackson Co.) to Route 13 (Johnson Co.) | Clear | 2:38 PM 12/9/09 |
| 412 | Arkansas Line to Route 25 (Dunklin Co.) | Clear | 2:09 PM 12/9/09 |
| 412 | Route 25 (Dunklin Co.) to I-55 (Pemiscot Co.) | Clear | 2:09 PM 12/9/09 |

**Figure 11. Example 3: Application of guidelines to website information list.**

Guideline 4-1 included in this document was used to improve the presentation of the tabular road weather information.

1. The original table listed the events partially, but not consistently by route name. The improved format lists the routes numerically so that the desired route information is easy to find. Additionally, a sort or select feature could allow the traveler to display only the information related to their route. (Guideline 4-1)

2. The original table was difficult to scan for information related to a particular route due to the text density and the information presentation in rows below a header. When the information is separated into multiple columns based upon the type, the table is easy to scan for information by route or severity. Additionally, some of the supported text can be eliminated. (Guideline 4-1)

# TUTORIAL 5-7. ROAD WEATHER MESSAGING FOR PERSONAL ELECTRONIC DEVICES AND SOCIAL MEDIA

**Summary:** This tutorial provides guidance for disseminating road weather messages on personal electronic devices (e.g., cell phones) or via social media (e.g., Twitter).

## Introduction

As mobile technologies and social media expand in the marketplace, it becomes increasingly easy for travelers to get updated information that is: (1) relevant to their particular trip, (2) delivered when they need it, and (3) available in virtually any location. These advantages are currently apparent through weather messaging via social media platforms like Twitter and Facebook, and sending messages to cell phones. This tutorial provides some guidance related to messaging using these platforms. A list of the dissemination methods included in this tutorial is below:

- **Twitter:** Twitter is a service that is used to communicate brief messages. These messages are called "Tweets" and they are limited to 140 characters. Users can "follow" other users, meaning that they are subscribed to that user's Twitter messages. All of the messages that a user is subscribed to will appear in a list on their homepage or in a mobile application.
- **Facebook:** Facebook is a social networking application where users can connect with people, businesses, and organizations. Like Twitter, users can follow other users. Users can post brief status updates that will appear on their followers' newsfeeds (like a homepage).
- **Text Messages:** Text messages are short messages sent between fixed or mobile devices over a cellular network, often between cell phones. Some DOTs allow users to subscribe to text alerts that are sent to their mobile phones regarding particular events, such as road weather.

All of these types of messages will be broadly covered as "mobile messages" in this tutorial.[2] Although some of the messaging methods are primarily web-based, there are many applications that allow users to access a similar interface on a mobile device. This tutorial discusses some basic messaging guidance related to content, length, format, phasing, and tone. It also provides some dissemination method-specific guidance.

## Message Content

A brief review of available road-weather related Tweets shows that, similar to DMS and auditory messaging, the 'Problem-Location-Action' (PLA) message format is often followed. A brief review of each element is included below (related to Guidelines 2-1 & 3-1).

### *Problem*

The problem element provides information about the situation that drivers will encounter. It is more important to clearly state the problem than to provide lengthy information about the severity of the problem.

[2] Little to no research is currently available on road weather messaging for mobile applications, so most of the guidance included in this tutorial is based on that provided for other dissemination methods (e.g., DMS), human factors expertise, and best practices gathered from currently available messages. Due to this lack of research, the mobile messaging methods will be discussed together and in general terms. Additionally, selections of the guidance included in this tutorial can be found in the "Notes for Other Dissemination Methods" sections of related guidelines.

### *Location*

The location element describes the location of the situation. This element is particularly important for social media since it is impossible to know where the user is when they are reading the messages. Fixed reference points such as street names, exit names, exit numbers, or landmarks will need to be used. Additionally, the reference points should be familiar to all travelers, though it may be more likely that travelers reading a DOT Twitter feed will be frequent travelers who know the local area well.

### *Action*

The action element provides a recommendation to the driver in response to the problem and location information. Some TMCs noted that it is not always possible to provide an action recommendation since weather messages may be more descriptive than prescriptive.* The recommended action may be more likely to be a general note, such as “Use Caution”, or more specifically, “Use Headlights.”

### *Other Content Elements*

As described in the DMS and Auditory messaging guidelines, other content elements may be used when appropriate. However, due to the tight length restrictions on mobile messaging, they may not fit within the length restrictions.

Currently, including other media with a message is not recommended. It is impossible to know which devices users will use to access the messages. If their device cannot display, for example, an image or symbol, they may receive a garbled string of text instead. Twitter currently does not support the use of pictures, and character-based symbols are not recommended.

## Message Length

Limitations on message length vary by dissemination method, but each generally has its own restriction. Twitter has a 140 character limit per message and many cell phone text messages have a 160 character limit. Unlike messages displayed on DMS, the time available to read messages on devices such as PEDs is not limited by the amount of time that the driver has before they physically pass the sign. They are still limited, however, by the physical parameters of the device (such as display size and font size) and the traveler capabilities (such as visual acuity and memory limitations). Multiple TMCs were observed to link to a website or write “call 511” in tweets to point travelers to additional information. Also, note that with social media messaging, the intended use should be to provide information to a traveler when he or she is not driving.

## Message Format

Mobile messages have space to display full sentences or phrases with supporting words (e.g., “if”, “and”). These words can improve message comprehension and allow for more complex statements to be communicated. It is also important for these dissemination methods to include conventional punctuation to facilitate understanding (i.e., periods at the end of sentences). In general, the message, like other text, should use clear wording and short, simple sentences. To improve legibility, text should be displayed in mixed case (upper and lower) rather than a single case. Where possible, the messages should use the active voice rather than the passive voice.

When using abbreviations in mobile road weather messages, it is important to remember that the reader has less context when reading the message since they may not be driving on the affected roadway. Additionally, in mobile messages, all of the words are run together in one long phrase or series of sentences; there is no structure similar to that provided by the line breaks on a DMS. Therefore, the context of the abbreviation within the message is important.

*This information was provided as part of an evaluation of an earlier version of these guidelines.

### Message Phasing

Most other mobile messaging applications do not divide their messages into display phases as is done on DMS signs. However, if a mobile message is sent to a PED, such as a cell phone, if the message is too long, it may be automatically divided into multiple messages. Although some messaging does not have a limit, text messages are often limited to 160 characters (depending on the character set, or language used). If it can be anticipated that a single message is going to be divided into multiple messages by the user's device, it may be prudent to divide the message beforehand and send it in two separate transmissions. By this method, the sender can control where the break in the message will occur. If the message is divided into two transmissions, it is important that the user mentally links the two transmitted messages so that the full message will be understood. It may be necessary to repeat the audience or problem in the second message to ensure that the two messages are associated with one another.

### Message Tone

Similar to the guidance provided for auditory messaging, the tone of mobile messages should remain professional. Humor in messages is risky; it has the possibility of obscuring the message intent and it may offend some travelers.

Another consideration is the use of casual abbreviations that save space such as "bsafe" instead of "be safe" or "b4" instead of "before." Though space limitations are stringent in social messaging, casual abbreviations may make the message appear less professional or serious to the reader. Also, users who are unfamiliar with the abbreviation may have difficulty understanding the message.

### Twitter-specific Considerations

There are specific considerations for messaging using Twitter. When using Twitter, users are allowed to choose their own usernames. Some DOTs primarily use a single Twitter username, while others have multiple user names that allow them to post messages specific to a geographic area, project, or interest group., Users can subscribe to and receive messages for only the items that are relevant to them. For example, Texas DOT posts using many usernames for various regions of the state as well as different projects that are ongoing. Washington State DOT posts under the usernames shown in Table 11 below:

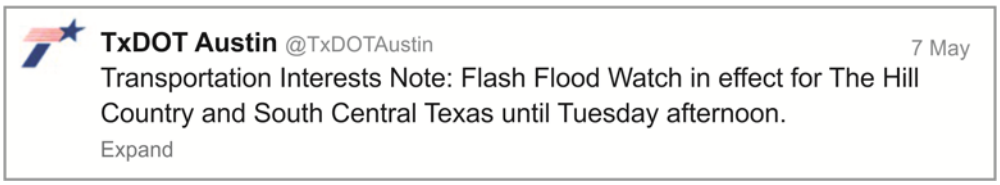
**Table 11. WSDOT Twitter accounts.**
**(Retrieved May 14, 2012, from http://www.wsdot.wa.gov/inform/twitter)**

| Username | Content Focus |
|---|---|
| wsdot | General news and miscellaneous items |
| wsdot_traffic | Puget sound traffic reports |
| wsdot_passes | Mountain pass reports |
| wsdot_tacoma | Tacoma traffic |
| goodtogowsdot | Good To Go! tolling information |
| snoqualmiepass | I-90 Construction updates |
| wsferries | Ferry alerts and updates |

An advantage of Twitter that one TMC mentioned is that it allows for a two-way conversation between the TMC and travelers.* Travelers can reply to the TMC's tweets or direct tweets at a TMC using the symbol "@" and the TMC's username.

Another feature of Twitter is that keywords in messages can be marked using hash tags, or the "#" symbol. Users can place the hash tag before a word or phrase (without spaces) in a message. This method allows these phrases to show up more easily in Twitter Search. Additionally, clicking on a hash tag will show all of the other tweets with that hash tag.

Below is a sample Tweet from the Texas DOT's Austin username:




Source: Adapted from https://twitter.com/#!/TxDOTAustin, retrieved May 14, 2012

**Figure 12. Texas DOT Austin Tweet.**

*This information was provided as part of an evaluation of an earlier version of these guidelines.

# Chapter 6 Index

*Accuracy*
26, 27, 37, 42, 43, 68, 69

*Cell/Mobile Phone Messaging*
7, 13, 15, 65, 77, 100-102

*Changeable Message Sign (CMS)*
see Dynamic Message Sign

*Comprehension*
6, 9, 15-17,19, 21, 29, 48, 101

*Dynamic Message Sign (DMS)*
2, 5, 9-27 (Chapter 2), 41, 42, 56, 57, 67, 68, 77, 78, 84, 91, 92, 93, 96, 97, 100-102

*Executive Order No. 13,513*
7

*Human Factors*
2, 3, 4, 77, 86, 92, 93

*Information Units*
5, 12-16, 38, 39

*Kiosk (Information Kiosks)*
45, 77, 78, 96

*Message Content*
10, 11, 24, 26, 30, 38, 40, 42, 66, 68, 85, 86, 92, 96, 100

*Message Design*
3, 6, 84-88, 92-94

*Message Length*
5, 12, 13, 15, 19, 23, 32, 33, 101

*Message Style*
Command style, 24
Notification style, 24

*Portable Electronic Device (PED)*
6, 7, 11, 13, 15, 23, 64, 65, 77, 91, 96, 98, 101, 102

*Phases (for message signs)*
5, 12-17, 97, 98, 102

*Symbol*
10, 11, 17, 24, 25, 49, 53, 56, 57, 66, 101-103

*Urgency*
5, 6, 24, 25, 40, 41, 61, 66, 67

*Variable Message Sign (VMS)*
see Dynamic Message Sign

# Chapter 7 Glossary

| | |
|---|---|
| *Accuracy* | The correctness, usually expressed as a percentage, of traffic information presented to motorists. In this context, accuracy is considered to be a binary concept; i.e., the information is either accurate or inaccurate. Although accuracy is most often discussed with respect to congestion levels associated with various routing options, it may also refer to total travel time estimates, estimates of time delays due to congestion, and presentation of accident information. |
| *Changeable Message Sign (CMS)* | Changeable Message Signs (CMS) are electronic, programmable traffic control devices, placed above or near the roadway, which can display any combination of characters to present messages to motorists. Also referred to as Variable Message Signs (VMSs) or Dynamic Message Signs (DMSs). For a full definition, see Dynamic Message Signs. |
| *Command Style Message* | A message style typically used to communicate urgent information to a driver when an immediate control action is required. |
| *Comprehension* | The degree to which an observer understands the presented information. |
| *Dynamic Message Sign (DMS)* | Dynamic Message Signs (DMS) are electronic, programmable traffic control devices, placed above or near the roadway, which can display any combination of characters to present messages to motorists. These electronic signs may contain words, numbers or symbols. The messages can be changed on-command remotely from a traffic control center or sometimes on-site. Messages are typically displayed when a response or decision is needed by motorists. These signs are either permanently installed above or on the side of a roadway, or portable devices attached to a trailer or mounted directly on a truck and driven to a desired location. Also referred to as Changeable Message Signs (CMSs) or Variable Message Signs (VMSs). |
| *Executive Order No. 13,513* | Executive Order that prohibits text messaging while driving by Federal Employees using Government property or, on official Government business. |
| *Human Factors* | A scientific discipline that tries to enhance the relationship between devices and systems and the people who are meant to use them through the application of extensive, well-documented, and fully appropriate behavioral data which describes and analyzes the capabilities and limitations of human beings. |
| *Information Units* | A measure of the amount of information presented in terms of facts used to make a decision. |
| *Kiosk (Information Kiosks)* | Interactive information displays available at stop-over locations, such as some rest areas. |

| | |
|---|---|
| *Message Content* | For DMS messages, message content refers to the specific text used in messages. Message content for auditory messages refers to the specific words and phrasing of an auditory message. |
| *Message Design* | Design parameters of messages that impact the legibility of text placed in the message, including legend color, font size, and font style. |
| *Message Length* | For short text/visual messages, the number of words or characters in a message, excluding prepositions. For auditory messages, it is either the number of syllables, words, or sentences necessary for presenting auditory information to the driver. |
| *Message Style* | The use of command vs. notification style messages. Examples of command style messages include: “slow down” or “move to the right lane” Examples of notification style messages include “ice ahead” “use alternate route”, or “storm warning”. |
| *Notification Style Message* | A message style typically used to communicate non-urgent information that the driver can respond to when it is safe or convenient to do so (i.e., when the vehicle is stopped). |
| *Portable Changeable Message Sign (PCMS)* | Portable Changeable Message Signs (PCMSs) are dispatched by highway agencies to warn drivers of incidents such as crashes in areas where permanent DMSs are not available or near enough to use as a preventative measure for reducing secondary accidents. Portable signs are smaller than permanent signs and are often used in highway work zones, when major crashes or natural disasters occur, for special events (e.g., sport events), and for other temporary changes in normal traffic patterns. The messages displayed on the signs can be programmed locally on the unit's control panel, or units equipped with a cellular modem can be programmed remotely via computer or phone. |
| *Portable Electronic Device (PED)* | Represents any portable device (e.g., Personal Digital Assistants (PDAs) and cell phones) that drivers can use to actively seek out web-based information (includes wireless or web-connected global positioning system (GPS) navigation systems). |
| *Phases (for message signs)* | For short text messages, it is the text that is displayed at a single point in time on a message sign. For auditory messages it is a single repetition of an entire auditory message. |
| *Symbol* | Pictorial sign or message elements that convey information without relying on driver literacy. |
| *Variable Message Sign (VMS)* | Variable Message Signs (VMS) are electronic, programmable traffic control devices, placed above or near the roadway, which can display any combination of characters to present messages to motorists. Also referred to as Changeable Message Signs (CMSs) or Dynamic Message Signs (DMSs). For a full definition, see Dynamic Message Signs. |

# Chapter 8 References


511 Deployment Coalition. (2003). *511 America's Travel Information Number. Deployment assistance report #6: Weather and environmental content on 511 services*. Retrieved May 8, 2012 from http://www.deploy511.org/docs/511-dar6weatherenviroservices.pdf.

511 Deployment Coalition. (2005). *Implementation and operational guidelines for 511 services* (Version 3.0). Retrieved November 30, 2009 from http://ops.fhwa.dot.gov/511/resources/publications/511guide_ver3/511guid3.pdf.

Benson, B. G. (1996). Motorist attitudes about content of variable-message signs. *Transportation Research Record, 1550*, 48-57.

Boselly, S. E. (2000). *Identification and documentation of weather and road condition dissemination devices and data formats* (Mn/DOT Agreement No. 79575, prepared for the Aurora Program). Chesterfield, MO: Weather Solutions Group. Retrieved May 8, 2012 from http://www.aurora-program.org/pdf/standardinforpt.pdf.

Cambridge Systematics. (2003). *Weather-responsive traffic management. Concept of operations* (Draft, prepared for the Federal Highway Administration). Chevy Chase, MD. Retrieved September 9, 2008 from http://ops.fhwa.dot.gov/weather/resources/publications/fhwa/wxrespontrafmgconops.pdf

Campbell, J. L., Carney, C. and Kantowitz, B. H. (1998). *Human factors design guidelines for Advanced Traveler Information Systems (ATIS) and Commercial Vehicle Operations (CVO)* (Report No. FHWA-RD-98-057). Washington, DC: Federal Highway Administration.

Campbell, J. L., Richman, J. B., Carney, C., and Lee, J. D. (2004). *In-vehicle display icons and other information elements. Volume 1: Guidelines* (Report No. FHWA-RD-03-065). McLean, VA: Federal Highway Administration. Retrieved October 6, 2009, from http://www.tfhrc.gov/safety/pubs/03065/03065.pdf.

Cluett, C., Gopalakrishna, D., Lichty, M. G., Bacon, L. P., Campbell, J. L. and Richard, C. M. (2012). *Testing and evaluation of preliminary design guidelines for disseminating road weather advisory & control information. Task 4: Test and evaluation of the preliminary guidelines.* Seattle, WA: Battelle Seattle Research Center.

Davis, G.A. (2002). Is the claim that 'variance kills' an ecological fallacy? *Accident Analysis and Prevention, 34*(3), 343-346.

Dudek, C. L. (1992). *Guidelines on the use and operation of changeable message signs*. (Report No. FHWA-TX-92-1232-9). College Station: Texas Transportation Institute.

Dudek, C. L. (2004). *Changeable message sign operation and messaging handbook* (Report No. FHWA-OP-03-070). College Station, TX: Texas Transportation Institute.

Dudek, C. L., and Ullman, G. L. (2002). Flashing messages, flashing lines, and alternating one line on changeable message signs. *Transportation Research Record, 1803*, 94-101

Dudek, C. L., Schrock, S. D., and Ullman, G. L. (2005). *Impacts of using dynamic features to display messages on changeable message signs* (Report No. FHWA-HOP-05-069). Washington, DC: Federal Highway Administration.

Emmerink, R., Nijkamp, P., Rietveld, P., and Van Ommeren, J. N. (1996). Variable message signs and radio traffic information: An integrated empirical analysis of drivers' route choice behavior. *Transportation Research A, 30*(2), 135-153.

Federal Highway Administration (FHWA). (2009). *Manual on Uniform Traffic Control Devices (MUTCD)*. Washington, DC.

Green, P., Levison, W., Paelke, G., and Serafin, C. (1993). *Suggested human factors design guidelines for driver information systems* (Report No. FHWA-RD-94-087). McLean, VA. Retrieved December 4, 2009 from http://www.umich.edu/~driving/guidelines/UMTRI_Guidelines.pdf.

Greenhouse, D. (2007). *Optimizing comprehension of Changeable Message Signs (CMS)* (Report No. UCB-ITS-PRR-2007-24). Berkeley: University of California Partners for Advanced Transit and Highways (PATH).

Haselkorn, M. P., & Barfield, W. (1990). *Improving motorist information systems: towards a user-based motorist information system for the Puget Sound area*. Olympia: Washington State Department of Transportation.

Hauer, E. (1971). Accidents, overtaking and speed control. *Accident Analysis and Prevention, 3*(1).

Huchingson, R.D., Dudek, C. L., and Dorsey, W. (1982). *Highway advisory radio message development guide* (Report No. FHWA/RD-82/059). Washington, DC: Federal Highway Administration.

I-95 Northeast Consultants and The Scientex Corporation. (1995). *VMS/HAR operations guidelines and recommended practices. Quick reference guide* (Report No. I-5 CC 95-094). I-95 Corridor Coalition. Retrieved May 14, 2012 from http://ntl.bts.gov/lib/jpodocs/repts_te/2807.pdf.

Jonsson, M., Nass, C., Harris, H., and Takayama, L. (2005). Influence of hazard system accuracy on driving performance. *Proceedings of the 12th World Congress on Intelligent Transport Systems*.

Kantowitz, B. H., Hanowski, R. J., and Kantowitz, S. C. (1996). *Development of human factors guidelines for advanced traveler information systems and commercial vehicle operations: The effects of inaccurate traffic information on driver acceptance of in-vehicle information systems* (FHWA-RD-96-145). Washington, DC: Federal Highway Administration.

Khattak, A. J., Schofer, J. L., and Koppelman, F. S. (1992). Factors influencing commuters' en route diversion behavior in response to delay. *Transportation Research Record, 1318*, 125-136.

Martin, P. T., Perrin, J., Hansen, B., Meldrum, D. and Quitana, I. (2000). *Utah RWIS traveler information evaluation* (UTRAC #99.4-5). Salt Lake City: University of Utah.

Maze, T. H., Agarwal, M., and Burchett, G. (2005). *Whether weather matters to traffic demand, traffic safety, and traffic flows* (From the Integration of Road Weather Information with Traffic Data Aurora project). Ames: Iowa State University Center for Transportation Research and Education.

National Research Council. (2004). *Where the weather meets the road: A research agenda for improving road weather services*. Washington, DC: National Academies Press.

Patten, M. L., Pribyl, O., and Goulias, K. G. (2003). *Evaluation of the Pennsylvania turnpike's Advanced Traveler Information System (ATIS) project, Phase III* (Report No. PTI 2004-01). University Park: Pennsylvania Transportation Institute.

Pedic, F., and Ezrakhovich, A. (1999). A literature review: The content characteristics of effective VMS. *Road & Transport Research, 8(2)*, 3-11.

Peeta, S., Ramos, J. L., and Pasupathy, R. (2000). Content of variable message signs and on-line driver behavior. *Transportation Research Record, 1725*, 102-108.

U.S. Department of Transportation
ITS Joint Program Office-HOIT
1200 New Jersey Avenue, SE
Washington, DC 20590

Toll-Free "Help Line" 866-367-7487
www.its.dot.gov

FHWA-JPO-12-046

U.S. Department of Transportation
Research and Innovative Technology Administration

Peirce, S. and Lappin, J. (2003). *Acquisition of traveler information and its effects on travel choices: Evidence from a Seattle-area travel diary survey*. Retrieved March 21, 2008 from http://www.itsdocs.fhwa.dot.gov/JPODOCS//REPTS_TE/13813.html.

Pisano, P. A., Goodwin, L. C., and Rossetti, M. A. (2008). U.S. highway crashes in adverse road weather conditions. *Proceedings of the American Meteorological Society 88th Annual Meeting*. Retrieved September 23, 2009 from http://ams.confex.com/ams/88Annual/techprogram/session_20929.htm

Proffitt, D. R., and Wade, M. M. (1998). *Creating effective variable message signs: Human factors issues.* (Report No. VTRC 98-CR31). Charlottesville: Virginia Transportation Research Council.

Richard, C. M., Campbell, Lichty, M. G., Cluett, C., Osborne, L., and Balke, K. (2009). *Human factors analysis of road weather advisory and control information. Draft Task 4 Report. Develop research plan and conduct human factors study on road weather information* (Prepared for the Federal Highway Administration's FHWA's Office of Transportation Operations, DTFH61-06-D-00007). Seattle, WA: Battelle Center for Human Performance and Safety.

Richard, C. M., Campbell, J. L., Lichty, M. G., Cluett, C., Osborne, L., and Balke, K. (2010). *Human factors analysis of road weather advisory and control information. Final Report.* (Report No. FHWA-JPO-10-053). Washington DC: Federal Highway Administration. Available May 8, 2012 at http://ntl.bts.gov/lib/33000/33000/33047/index.htm.

Smith, S.L., and Mosier, J.N. (1986). *Guidelines for designing user interface software*. (Report No. ESD-TR-86-278). Bedford, MA: The Mitre Corporation. Retrieved December 3, 2009, from http://hcibib.org/sam/index.html#top

Ullman, G.L., Ullman, B.R., and Dudek, C.L. (2007). Evaluation of alternative dates for advance notification on portable changeable message signs in work zones. *Transportation Research Record, 2015*, 36-40.

Wang, J.-H., Collyer, C. E., and Yang, C.-M. (2005). *Enhancing motorist understanding of variable message signs.* (Report No. FHWA-RIDOT-RTD-06-1). Providence: Rhode Island Department of Transportation.