Guidelines for Communicating Winter Conditions and Other Weather Information to Road Users

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ABSTRACT

The US DOT Federal Highway Administration (FHWA) Road Weather Management Program began an effort in 2008 to help transportation agencies provide road weather messages to the traveling public that support their information needs, travel decisions, and driving behaviors. A research study was initiated to identify the requirements of road users for road weather information and to assist transportation officials in communicating both pre-trip and en-route road weather information in an effective, consistent, and timely manner for various weather conditions, including winter events, and travel scenarios. Preliminary guidelines were produced to support the design, development and communication of road weather messages using various dissemination methods including dynamic message signs, auditory messages and web-based messages. Guidance on communicating messages using social media was also provided. 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. The guidelines help road managers and operators provide 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.

In 2010, the FHWA initiated a follow-up project to evaluate and refine the preliminary guidelines using feedback from transportation practitioners. The 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 that will be discussed here.

This paper describes the contents of the messaging guidelines, how it was developed, tested, evaluated and modified from the preliminary version, its uses, and the benefits of adopting it for communicating winter conditions and other road weather information to the road users.

1.0 INTRODUCTION

The last decade has seen tremendous growth in both the amount of available weather information, as well as the methods by which this information can be disseminated to travelers. This growth includes weather gathering devices (sensors, satellites), models and forecasting tools for predicting weather conditions, and electronic devices used by drivers (e.g., Internet, in- vehicle devices, roadway signage). These changes are well-documented in the 2004 National Research Council Report '*Where the Weather Meets the Road: A Research Agenda for Improving Road Weather Services' [1]*. However, increases in both the type and amount or road weather information do not automatically lead to better driving decisions by drivers. Specifically, unless the content, format, and timing of road weather information is consistent with what travelers need, want, and will use, and are receiving from other sources (e.g. National Weather Service), then such information may not be useful and—in certain situations— may even lead to reduced mobility, as well as unsafe driving behaviors.

However, very little information is known about the human factors issues that directly impact how travelers seek out and use road weather information, and what trip decisions this information should support. FHWA conducted several activities to bring together available information from other related domains, such as traveler information systems (*[2], [3])* and commuter decision-making (*[4], [5])*, in addition to supplementing this information with analytical activities, such as developing travel scenarios and collecting brief questionnaire data to obtain information to fill in key knowledge gaps.

Another important element in communicating road weather information to travelers is the method used to provide this information. There is a variety of different dissemination methods available, such as television, commercial radio, personal electronic devices PEDs, weather websites, Highway Advisory Radio (HAR), and Dynamic Message Signs (DMS), among others. Some important questions involve how communication of road weather information is constrained by the technological capabilities of these dissemination methods, and what is their availability at different points during a traveler's trip (e.g., prior to leaving, en-route, etc.)?

To address these knowledge gaps, the FHWA's RWMP initiated a two-phased effort to: (1) evaluate the current state of the practice in weather-responsive traffic advisory and control strategies, (2) develop preliminary guidelines to improve those practices, and (3) use detailed evaluation feedback from State Department of Transportation (DOT) staff working at Traffic Management Centers (TMCs) and private agencies to refine and revise the preliminary guidelines. The two phases of the project are summarized in Figure 1.

The guidelines are intended to augment, not replace, the guidance provided in the *Manual on Uniform Traffic Devices (MUTCD) [6]* and other guidance documents relevant to the

presentation of traveler information such as the *Changeable Message Sign Operation and Messaging Handbook [7].*
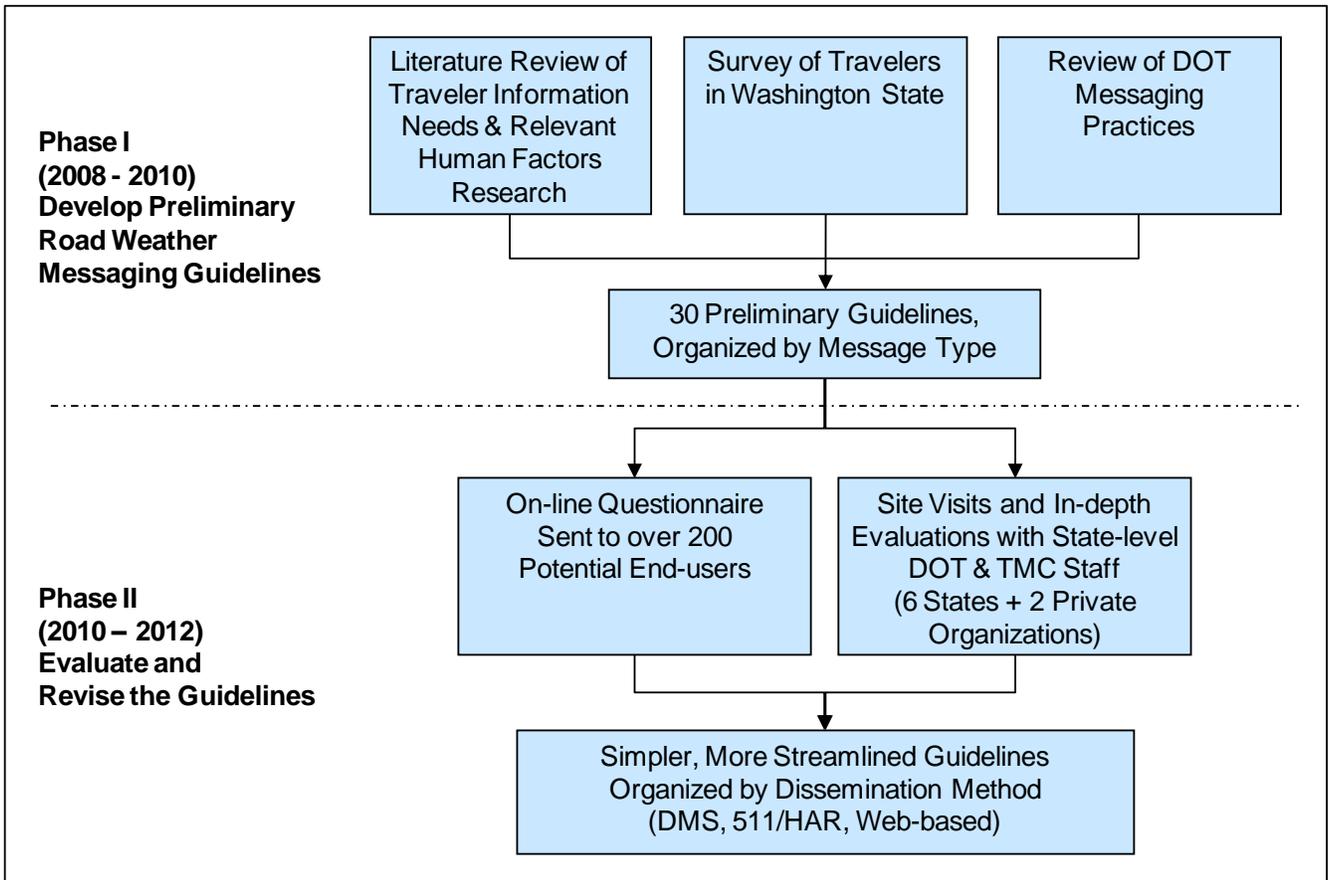
Figure 1 - Overview of the Two Projects that led to the Guidelines for Disseminating Road Weather Advisory and Control Information.

2.0 RESEARCH METHODS

2.1 Development of the Preliminary Guidelines

An important component of determining road weather information requirements for travelers was to obtain detailed information about road weather messages and dissemination strategies currently in use or documented in the research literature. In the first phase of this research effort, detailed reviews were conducted to determine:

- *Weather Messages*: Existing weather advisory and control messages used by state transportation agencies and other providers of weather information

- *Dissemination Strategies*: Messages that are posted on the road as well as messages that are disseminated through traveler information systems such as kiosks, websites, in-vehicle navigation systems, dynamic message signs (DMSs), Highway Advisory Radio (HAR), cellular phones, 511, and other road weather information portals.
- *State DOT Practices*: To characterize road-weather information currently available on state DOT websites, we visited all 50 state DOT websites (in addition to District of Columbia website) and cataloged general information about their contents.

- *Best Practices from the Literature*: A detailed review of key human factors literature on display design and presentation of traveler information was also conducted.

The general approach to providing guidance on recommended weather messages and dissemination methods was to provide end-users with a decision/design tool, organized around key driver behaviors, that also reflects key weather events and available dissemination options.

The general form of the decision/design tool is shown in Figure 2. End-users work through a short series of questions to identify the weather event and corresponding mobility impacts and traveler decisions that the weather message should support. Based on these inputs, dissemination methods and specific guidance for designing weather messages are provided.
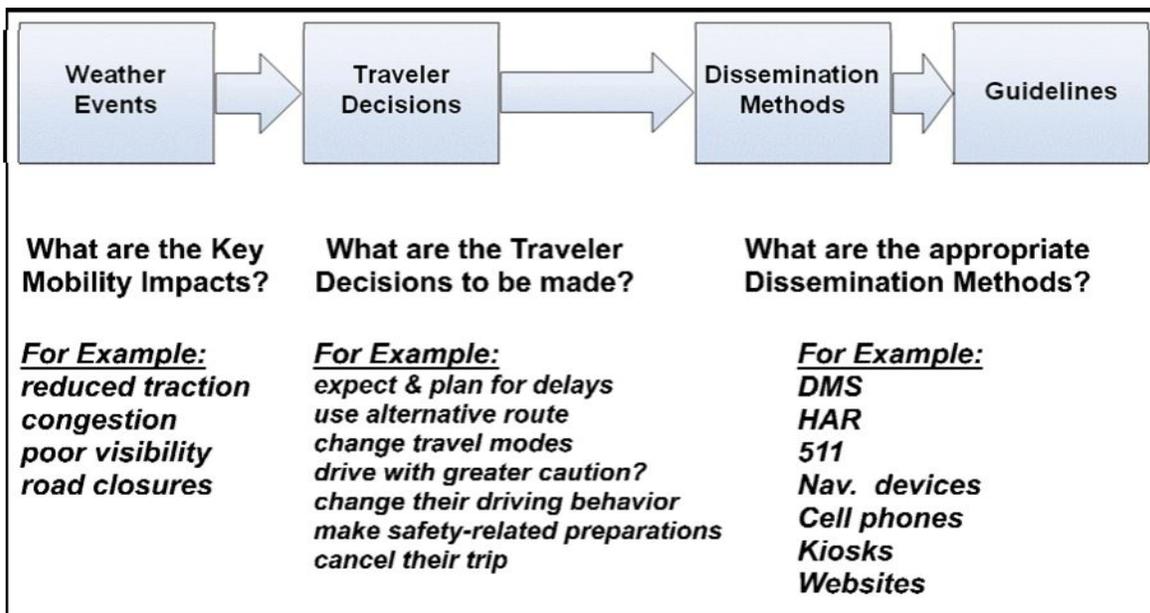

Figure 2 - Structure and sequence associated with the decision/design tool for road weather messages in the preliminary guidelines.

These activities resulted in a preliminary set of guidelines for presenting road weather messages, published in 2010 *[8].*

2.2 Evaluation of the Preliminary Guidelines

The preliminary guidelines were then evaluated in a follow-up project. The evaluations were conducted by numerous individuals who provided feedback through an on-line questionnaire, and through more in-depth reviews and evaluations provided by the following organizations/agencies: Kansas City (KC) Scout, MO; Wyoming Statewide TMC(WYDOT); Colorado Springs, CO TMC (CSTMC); Colorado DOT, CO (CDOT); Washington State DOT (WSDOT) and six Northwest Regional TMCs; Maryland (MD) Coordinated Highway Action Response Team (CHART); Meridian Environmental Technology, Inc.; and Castle Rock, Inc.

The evaluations focused on assessing the content, format, organization and general usefulness of the preliminary guidelines, in the context of how road weather messages are conceived, developed and delivered from the perspectives of the individual end users and organizations/agencies. The end users spent considerable time actually using the guidelines and generating detailed feedback and, through a series of data collection activities, provided numerous high-level suggestions for improving the guidelines as a whole, as well as suggestions for revising individual guidelines. An overview of the evaluation activities is shown below in Figure 3.
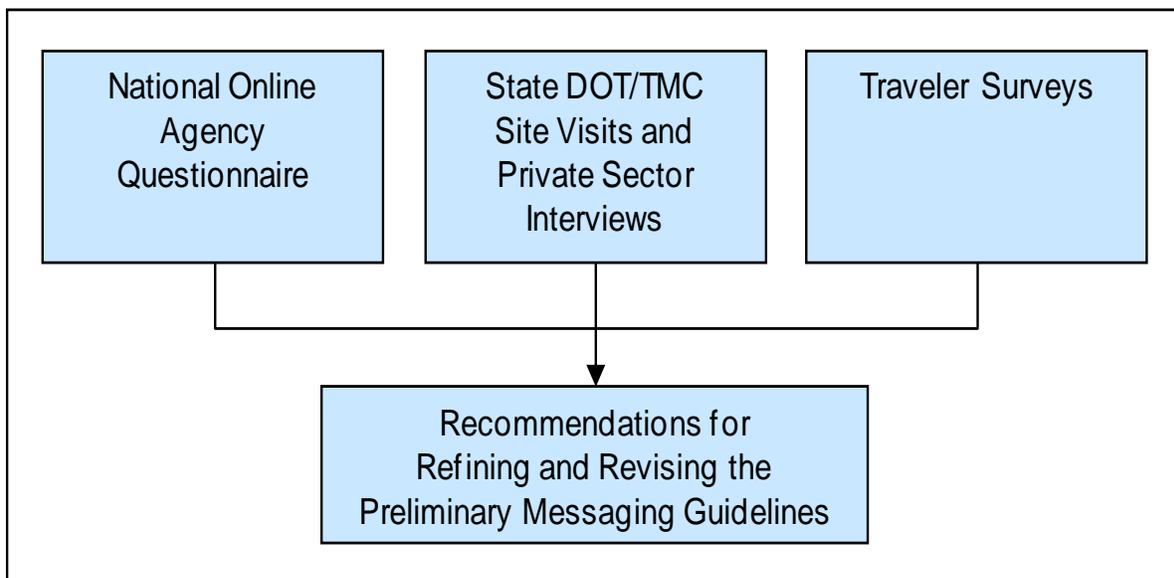
Figure 3 - Overview of Evaluation Activities.

3.0 EVALUATION RESULTS – USES AND BENEFITS OF GUIDELINES

The agencies that were visited said the messaging guidelines are useful in helping them improve how they frame and communicate road weather information. They are also seen as being helpful in meeting a need to achieve greater consistency across jurisdictions in

messaging for travelers, across all the dissemination methods. They offered the following general observations:

- The guidelines offer a useful tool for training operators, both experienced and new personnel.
- The format of the individual guidelines was viewed as extremely useful, with the discussions providing helpful information to the agencies, although too detailed for real-time use by operators.
- They do not expect the guidelines document to sit on an operator's desk as a reference document. Rather, they want operators to learn and internalize the principles incorporated in the guidelines and use them when considering their messaging decisions.

The evaluation also yielded various recommendations on the organization, focus, content and details of the guidelines. Virtually all recommendations were adopted and incorporated into the final Guidelines for Disseminating Road Weather Advisory and Control Information *[9]*. The end user evaluation provided a guidelines document that is clearer, more focused on road weather, more relevant to how messages are developed, easier to use and, ultimately, more valuable to the road weather community. The new structure of the guidelines document is as follows:

- Chapter 1 provides an introduction to the document.

- Chapters 2 through 4 present the design guidelines associated with three distinct dissemination methods:
    - Dynamic Message Signs (DMSs),
    - Auditory messages (HAR and 511), and
    - Web-based messages
- Chapter 5 contains tutorials that provide useful background or supplementary information about human factors issues that cut across multiple guidelines.

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

The revised guidelines include 28 detailed guidelines for road weather advisory and control information reflecting relevant literature and best practices for topics such as:
- Message content, length, and structure
- Design of fonts, colors, icons, and alerts
- Display of map, weather, and traffic information
- How to communicate timeframe, urgency, likelihood

The final document uses a consistent format to present individual road weather message design guidelines. Each guideline contains a series of subsections, drawn from a generally fixed set of elements; 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 4.
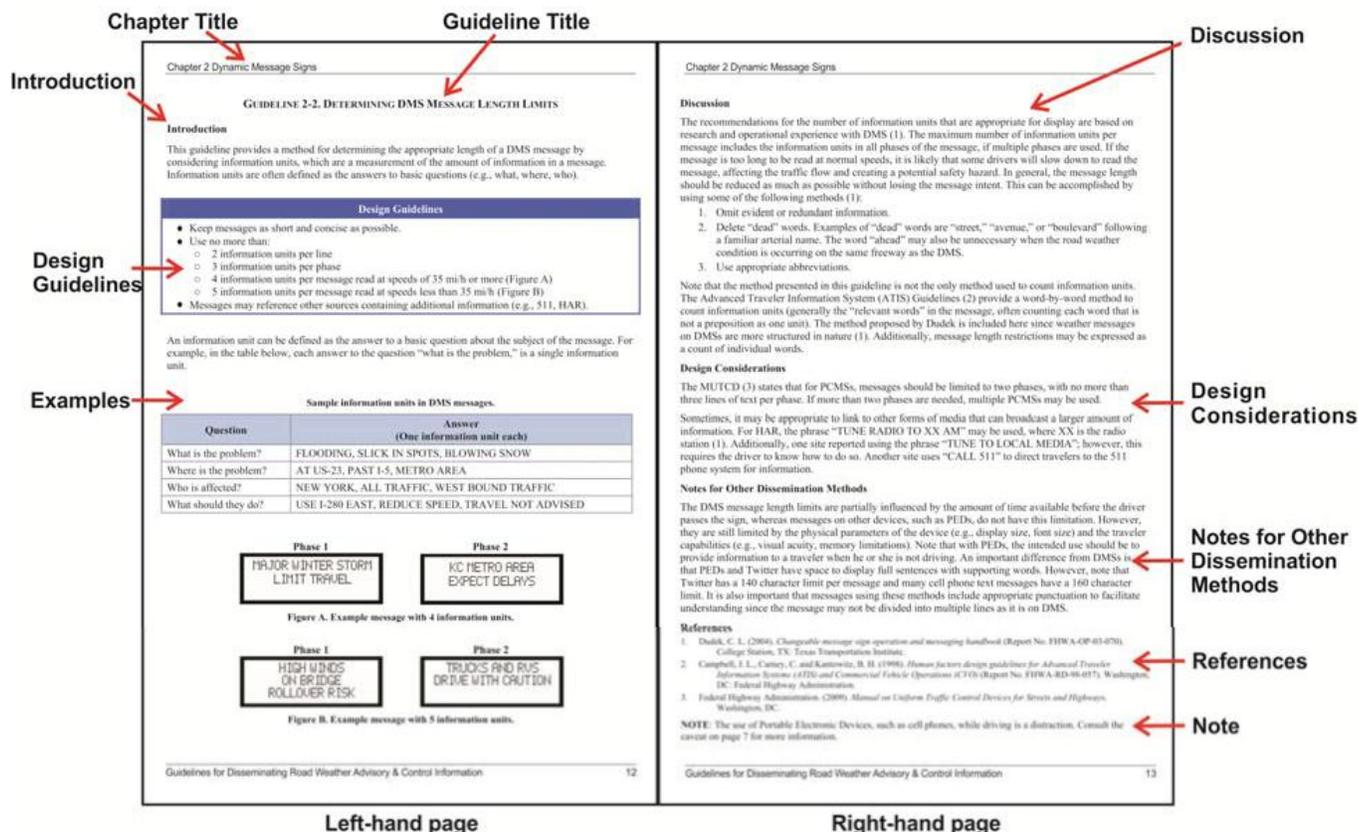
Figure 4 - Example guideline showing the structured presentation format and key information elements.

Overall, the *Guidelines for Disseminating Road Weather Advisory and Control Information* have great potential for improving the presentation and timing of road weather advisory and control information for travelers, including:

- Effective and timely dissemination of road weather information by individual transportation agencies and others.
- Weather messages that are more: useful, understandable, accurate, and specific.
- Informed pre-trip decisions by travelers regarding routes, modes, and departure times.
- En-route decisions by travelers that are more likely to reflect actual conditions and lead to safer driving behaviors.
- A more consistent approach to the content and delivery of road weather information across cities, states, and regions.

4.0 APPLICATION FOR WINTER ROAD CONDITIONS – KANSAS CITY

Several telephone interviews were held with Kansas City (KC) Scout Traffic Management Center (TMC) in 2011 to discuss their current road weather messaging and plans for the winter of 2011-2012. KC Scout began developing their own winter weather messaging sets beginning in the spring of 2011, based on the preliminary guidelines that were released at

that time. KC Scout is a bi-state TMC representing Missouri and Kansas DOTs in providing traffic management for the metropolitan Kansas City area. They also implement unique Missouri DOT (MoDOT) and Kansas DOT (KDOT) messaging plans along the I-70 corridor between Colorado and St. Louis. MoDOT and KDOT met in mid-September 2011 to finalize decisions regarding severe weather message sets, and the guidelines were used in support of that decision process. KDOT operates a 511 phone service but MoDOT does not offer 511 and instead relies upon continuous live-operator customer service to answer caller's questions (1-888-ASK-MODOT). They are seeking a license to operate a HAR system. The guidelines' recommendations were forwarded by KC Scout to MoDOT's corporate website department that develops a travel map for the state. Scout looks to this website to extract information on state road closures due to weather. KDOT's website information is particularly wordy. KC Scout believes that these three systems can benefit from handling information and messaging consistently based on following the guidelines, and the guidelines can serve as a justification for making needed changes.

KC Scout stores their standard preset weather messages in libraries. Scout auto-posts recommended messages for DMS on their Advanced Traffic Management System (ATMS), and TMC operators can accept or modify these messages. KDOT and MoDOT manually select and post their road weather messages. KDOT's messages are sent to legal for review before they are accepted into a message library, due to liability concerns. They also do ad hoc messaging. They planned to use the guidelines to update their message libraries, and reviewed their snow messages used in prior years for possible inclusion into the message library. They used the guidelines to help with this review, along with legal and operational reviews. At KC Scout road weather messaging is integrated in the ATMS with other event and traffic information, and the system will provide a recommended message plan. The TMC operator can simply accept the recommended message or change the message as they see fit, though KC Scout wants to minimize operator discretion.

It was agreed with KC Scout that the testing and evaluation of the guidelines would primarily focus on the use of the guidelines in crafting their DMS road weather messages. Scout has used the preliminary guidelines and developed new messaging for weather-related conditions on their DMS signs. These messages were used for the first time during the winter of 2011-2012. Table 1 lists the messages that were developed by Scout and approved for use:

As a result of the site visit discussions, KC Scout considered making few other changes to the above messages. These include:

- Creating a new message for black ice

- Creating a message for tornado warnings

- Including fog extent (miles) in the message relating to fog

- Changing the cruise control message to match MODOT's messages

In addition to the DMS information, KC Scout also planned to improve their Twitter feed for weather-related messaging.

KC Scout tracks the message usage and obtains feedback on effectiveness, where possible, from users. Their system archives messages posted for each event and is well-suited to tracking usage of DMS messages. They also post the survey on their website to collect qualitative user perception data during the winter months.

Table 1 - Kansas City Scout winter road weather DMS messages.

GIVE SNOW PLOWS ROOM TO WORK USE CAUTION	BLOWING SNOW REDUCED VISBILITY TRAVEL NOT ADVISED	REDUCED VISIBILITY USE HEADLIGHTS USE CAUTION
SNOW PLOWING IN EFFECT EXPECT DELAYS	SEVERE THUNDERSTORM WARNING TUNE TO LOCAL MEDIA	WATER OVER ROADWAY [LANE SPECIFIED]
HIGH WIND ADVISORY USE CAUTION	FOG CONDITIONS REDUCED VISIBILITY USE CAUTION	DO NOT USE CRUISE CONTROL DURING [RAIN/SNOW/ICE]
EXTREME WEATHER USE CAUTION ON BRIDGES AND RAMPS	EXTREME WEATHER CONDITIONS TRAVEL NOT ADVISED	MAJOR WINTER STORM EXPECT DELAYS LIMIT TRAVEL

5.0 CONCLUSIONS

Three primary conclusions emerged from the work in this project. These are described below:

1. The responses to the messaging guidelines from the road weather community indicate that the guideline is a valuable tool that provides useful information to message designers. Overall, the positive feedback obtained from the site visits and online questionnaire generally demonstrates that the road weather guidelines are a helpful and valued resource. Some TMCs had started using the preliminary guidelines to design or refine their messages even before the guidelines were finalized, reflecting their need for such guidance., The refined guidelines are useful to experienced operators who are tasked with creating ad hoc messages to fit unique road weather situations especially during winter events. Also, the ability of the guidelines to encourage consistency among messages between operating agencies was touted by the end users as a real benefit to their messaging efforts.

2. From a methodological perspective, the surveys, site visits, and interviews used in this project were valuable approaches for obtaining feedback on the guidelines from the selected state DOTs, TMCs and private service providers. The end user community was able and willing to provide feedback through these structured processes, and the surveys, site visits, and interviews conducted in the project provided a rich and helpful set of recommendations for modifying the preliminary guidelines developed in 2010. Critical feedback included suggestions for crafting the guidelines to be more responsive to road weather conditions and restructuring the presentation of the guidelines to be more consistent with how they were expected to be used in practice.

3. Also, given a lack of specific research focused on road weather messaging, the feedback from the evaluation of the preliminary guidelines was essential for helping refine the guidelines that were based primarily on non-road weather traffic research to make them more appropriate for road weather conditions including winter travel. State DOT and TMC users of the guidelines found the research foundation for the preliminary guidelines to be highly credible and confirming of their existing practices.

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