Comprehensive Testing of Imminent Threat Public Messages for Mobile Devices

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COMPREHENSIVE TESTING OF IMMINENT THREAT PUBLIC MESSGES FOR MOBILE DEVICES

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Executive Summary

This project sought to determine the *optimized message contents* of imminent threat wireless emergency alert (WEA) messages delivered over mobile communication devices. This report presents findings for *first alert* WEA messages from two research phases with U.S. adults: (1) eight experiments, seven focus groups, and 50 think-out-loud interviews, and (2) a survey of an actual *"real world"* severe flood in Boulder, CO. It also integrates findings from across study methods and provides *actionable guidance and considerations for optimized message contents* of imminent one-hour-to-impact threat alerts delivered over mobile communication devices.

Primary conclusions from the research performed to date are:

1. **Short alert and warning messages are unique and unlike any others:** The optimized order of their contents is unique; their limited length constrains public understanding of the message source; people are less able to understand if the message is meant for them; the key content elements of guidance (describing what to do and how to do it) and hazard (describing why they should do it) cannot be adequately communicated; and short messages cannot overcome people's pre-event hazard-specific perceptions. Hence, to be effective at motivating public protective action taking, the short messages in use today rely on information provided by others.

2. **There are pathways forward to optimize today's wireless emergency alert messages:** An alternative order of message contents could be put into practice; message sources of a particular kind could be selected; and a public education and marketing campaign about the WEA system could be conducted.

3. **The project's findings provide concrete insights to help imagine optimized wireless emergency alert and warning messages that could exist in the future.** These messages would not rely on information provided by others, but would instead be sufficient to motivate public protective action taking on their own. In addition to putting into practice an alternative order of message contents, selecting message sources of a particular kind, and conducting a public education and marketing campaign about the WEA system, the optimized messages of the future could also include high information maps, indicate more precisely by what time people should begin taking recommended protective actions, and allow for longer message lengths.

Key findings from the research reported here suggest that:

1. Order of Message Contents. **A different order for the content contained in 90-characters WEA messages may improve public response outcomes.** WEA messages currently use the following order: hazard, location, time, guidance, and source. An alternative order had an advantage in improving the public outcomes tested. It was: source, guidance, hazard, location, and time. Although this alternative order only had a statistically weak advantage over the current WEA message content order, if put into practice, the effect of the revised order could be substantial considering how many more people in a population at risk might be inclined to take

action in response to the revised order. The qualitative research provided support this optimized message order for 140-characters messages; however, it does not appear to transfer to 1,380-characters messages for which the optimized order seems to be source, hazard, guidance, location, and time.

2. Message Source. **Source in 90-characters messages had a statistically significant effect on some sense making public response outcomes including interpretation (understanding, believing, and deciding) and personalization, and, hence, likely on protective action-taking.** Quantitative and qualitative findings also suggest that local and recognizable sources might be the most productive sole source to name in a WEA message, but further research is needed to confirm these conclusions. Findings, however, do more conclusively suggest that if a sole source named in a WEA message is not recognizable to the public, then a vigorous public education and marketing campaign would be worthwhile. Quantitative findings also suggest that there may not be a single sole source that works for all WEA messages. The same conclusions were reached based on qualitative investigations of 140- and 1,380-characters messages.

3. Map Inclusion. **High information map inclusion (specifying the areas affected and not affected and the receiver's location) in 90-characters messages had a statistically significant and positive effect on public response outcomes including interpretation and personalization, and, hence, could have a positive effect on protective action-taking.** Inclusion of a low information map (specifying the areas affected and not affected, but not the receiver's location) had the opposite effect. The results of the qualitative research indicated that inclusion of a high information map improved most participants' understanding, belief, and risk personalization across all message lengths. The community survey confirmed the relationship between receiving maps and increased personalization. These findings suggest that there certainly would be a benefit from adding a high-information map to a WEA message. Doing so could help the public interpret and personalize the worded message, which could, in turn, move more people at risk to take protective action.

4. Relative Importance of Contents Elements. **Guidance and hazard message content elements played key roles compared to other message content elements (location, time, and source) in facilitating the sense making outcomes of interpretation (understanding, believing, and deciding) and personalization. They also reduced milling (causing delay in taking a protective action). Hence, they have a positive effect on public alert and warning responses.** The additional quantitative and qualitative findings affirm and provide a possible explanation for these findings: Perhaps placing guidance and hazard up front in a 90-characters WEA message optimized outcomes because they are the most important content elements. These findings suggest that the *core content of a public alert and warning: Tell people exactly what to do (guidance), describe why they should do it (hazard), and by when (time).* Those who prepare future public alert and warning messages might consider emphasizing these content topics, but not to the exclusion of the others.

5. Generalizing Across Hazard Types. **Short 90- and 140-characters messages were substantially less effective than 1,380-characters messages at helping people overcome their pre-conceived perceptions about different hazards and likely would be less effective at guiding people to take protective actions appropriate to the risk they face in an actual**

event. In this study, the content elements of 1,380-characters messages have standardized effects on outcomes regardless of hazard type (generalize across hazards). However, 90- and 140-characters messages did not. Shorter messages do not appear to contain sufficient information to help people overcome their pre-conceptions about different hazards based on their personal experience, perceived risk, and knowledge, which likely will not match the event they face. Hence, short messages appear to offer substantially less to effectively manage public alert and warning response than longer messages.

6. Message Length Efficacy. **The scientific evidence assembled led to the conclusion that messages that are 1,380-characters appear to produce optimized interpretation, personalization and milling outcomes, and would likely yield maximized public protective action-taking behavior.** Shorter messages that are 90- and 140-chracters appear less effective at guiding people toward protective action taking. There is nothing inherently better about 1,380-characters messages. What is likely the case is that people need to be provided with sufficiently detailed information about exactly what steps to take to protect themselves, and the number of characters needed to accomplish this likely varies across hazards. **Participant and professional emergency manager opinions, however, led to the conclusion that 140-charactres messages were the most desirable. This reveals what may be an American alert and warning dilemma: Should alert and warning message lengths be based on knowledge gained by application of the scientific method, or on beliefs and opinion?**

7. Inclusion of a URL. **Consideration should be given to including a URL in wireless emergency alert and warning messages of any length.** Doing so would be consistent with the long-standing historical observation that people who are warned engage in a search for additional information before taking a protective action, and was reinforced in our focus group research. Findings from our community event survey also indicated that those who received a message with a URL had a shorter delay (i.e., less milling) before beginning to check media compared to those who did not receive a message with a URL. Delay before avoiding flood areas also was shorter for those who received one or more messages containing a link (compared to those who did not).

8. Familiarity with the WEA System. **Continued outreach and education about the WEA system may help to speed the rate at which members of the general public read and respond to WEA messages.** Findings from the community event survey suggest that some members of the public who receive WEA messages do not read them immediately when they are delivered. Survey findings further suggest that, when received and read, WEA messages can be effective at reaching and motivating immediate protective action taking among a portion of the general public. For example, community event survey results reveal that about a third of the population had been checking local media prior to the issuance of the first WEA message, with an increase to almost 50% within the first 15 minutes following the message delivery.

9. Understanding of Acronyms. **The public may have little or no understanding of many of the acronyms used in WEA messages. Hence, consideration should be given to modifying the system to discontinue the use of acronyms, educate the public about their meaning, or increase the message length to allow for full text descriptions rather than acronyms.** There

may be unique exceptions. For example, *NWS* may be more familiar to the public, as found in our community event survey.

10. How to Best Express Time. **The way WEA messages express time may confuse the public.** Currently, WEA messages express time by stating when the message expires so that such messages do not persist in perpetuity. However, expressing time this way is confusing, and potentially life-threatening. For example, after receiving the outdoor warning sirens along Boulder Creek community event survey respondents reported that they thought they had on average 22.10 minutes to take action before the flood waters reached them when some recipients had only had minutes. In addition, survey analysis revealed that the only significant predictor for time to begin avoiding flooded areas and checking local media was the amount of information about when the flood was expected to begin. If time is expressed in WEA messages with language about the time a message expires, **consideration also should be given to communicating the time a message "begins" (without increasing message length) to reduce public confusion. For example, if the words "now" or "immediately" are used, would capitalizing all the letters in those words help to communicate that the message is already in effect when people receive it? Would providing concrete times when people should begin taking protective action help communicate urgency even more effectively?**

11. How to Best Express Location. Given the 90-character limit of current WEA messages, **the phrase "in this area" does not effectively work to communicate who is and who is not located within the risk area.** For example, more than a quarter of WEA message recipients from our community event survey did not think that the message was meant for them. Furthermore, each WEA disseminated message that states "in this area" but does not apply to the individual receiving the message may train message receivers that the phrase "in this area" may not apply to them. **The effectiveness of current WEA messages may remain suppressed until they can be distributed to finer geospatial targeted populations so that messages only reach the people who are at risk. Results show that including maps that delineate the area at risk and the individual's location relative to the area of risk is more effective at increasing personalization of risk than using the phrase "in this area;" however, we do not yet know how to best communicate in a WEA message who is and who is not at risk, for example, by including impact area maps, finer grained distribution, or the use of longer text messages that allow description of the risk area.**

12. Optimum Level of Fear Arousal. Alert and warning messages elicit a wide range of varied emotional responses. Although, the impact of fear and other emotions have on public alert and warning response could not be clarified based on the Phase II experiments and focus groups, the community survey data allowed for testing the relationship between level of fear and behavioral outcomes. Findings showed that there is no relationship between level of fear and the amount of delay before respondents initiated checking local media and avoiding flood areas. **Messages that are crafted specifically to maximize fear may not be effective in motivating protective actions. The role emotions may play in making sense of and responding to public alert and warning messages remains unclear.**

13. Understanding of Alert and Warning Concepts. **The public may not understand basic alert and warning concepts. Messages should not rely on the assumption that the public**

understands terms such as *shelter*, *evacuate*, and *proceed to higher ground*. Alert and warning messages that are short and contain emergency response recommendations may mean different things to different people who receive the message. For example, survey respondents who reported receiving a WEA message and hearing outdoor warning sirens ranged widely in what they thought *proceed to higher ground* meant. **For messages that are longer than 90- and 140-characters, basic alert and warning concepts should be described to the extent possible.** Short 90- and 140-characters messages may work fine for events whose impact is not imminent.

14. Visualization. Visual stimuli including bullets, bolding, iconography (source logo/seal, for example), indentation, font size, color, or italics, etc. might influence WEA message interpretation and subsequent message response. Additionally, so might the character of audible tones that indicate the arrival of a message. **Sound, color, size, shape, and style could all potentially influence WEA message interpretation and subsequent response but it is not yet know how.**

Introduction

Project purpose. This project sought to **determine the *optimized message contents* of imminent threat alert and warning messages delivered over mobile communication devices.**

Project focus. The key project **focus was on *"fist alert"* messages delivered as wireless emergency alerts (WEA messages) over mobile communication devices** such as cell phones. In practice, multiple WEA messages can be delivered across a drawn out warning event as subsequent messages replace those that have expired. Nevertheless, our prime research focus matched the general intention of the system to view WEA messages as first alerts for imminent one hour to impact threats.

Message lengths investigated. Three different length messages were investigated.

- ***90-characters messages* were the prime message length investigated since these are the message length delivered over today's Wireless Emergency Alert (WEA) system.**

- *140-characters messages* were also investigated because these are possible today using social media (e.g., Twitter), and they may be possible using the WEA system in the near-term future.

- *1,380-characters messages* were investigated since messages of this length are possible today in the description and instruction fields of Emergency Alert System (EAS) messages, and they may be possible using the WEA system in the distant future.

Report purpose. This research used multiple testing methods. **This final report presents details and findings for U.S. adults from quantitative online and laboratory experiments, qualitative focus groups and think-out-loud interviews, and a survey of an actual event performed to determine if the findings generated using controlled research methods held in a *"real world"* event.** The following topics are covered in this report: research approaches, methods, results, conclusions, and identified research needs. The report also presents *actionable guidance and considerations for optimized message contents* for imminent threat alerts and warnings delivered over mobile communication devices based on the findings that held across the multiple testing methods.

Research Methods

Quantitative Experiments

Factors manipulated in the experiments. Each of the eight experiments answered a different research question:

Experiment 1A: Which *order* of message contents in 90-characters messages optimized public response outcomes (see Table 1 in Appendix A).
Experiment 1B: Which single *source* named in 90-characters messages optimized public response outcomes (see Table 1 in Appendix A).
Experiment 1C: Whether the addition of a *map (and what kind of map)* to 90-characters messages optimized public response outcomes (see Table 1 in Appendix A).
Experiment 2: The *relative importance* of different message content elements on public outcomes using 1,380-characters messages (see Table 2 in Appendix A).
Experiment 3A: The *generalizability of findings for 90-characters messages across* different hazards (see Table 3 in Appendix A).
Experiment 3B: The *generalizability of findings for 140-characters messages across* different hazards (see Table 3 in Appendix A).
Experiment 3C: The *generalizability of findings for 1,380-characters messages across* different hazards (see Table 3 in Appendix A).
Experiment 4: Which message length, 90, 140, or 1,380-characters long, optimized public response outcomes (see Table 4 in Appendix A).

The test messages used in these experiments are listed in Appendix B. The maps used in the experiments can be found in Appendix C.

Experimental outcome factors examined. The historical record of public response to alerts and warnings research guided selection of the items used to indicate optimized outcomes. These were factors documented in prior research to *intervene* between receipt of an alert or warning message and initiating a protective action. Two general categories of outcomes were investigated: *perception* (Lindell & Perry, 2012; Mileti & Sorensen, 1990), and *milling* (Drabek, 1969; Griffin, Dunwoody, & Neuwirth, 1999; Mileti & Fitzpatrick, 1992). At the recommendation of stakeholders, we also investigated the third outcome category of *emotion,* which is a topic of growing interest (Janoske, Liu, & Sheppard, 2012; Jin, 2009; Jin & Pang, 2010). However, unlike the former factor categories, emotion was not used as a standard to judge optimized outcomes since its impact on public alert and warning response is not yet sufficiently documented.

Perception outcomes. These are the perceptions that intervene between people receiving an alert or warning message and initiating a protective action. They are the perceptions people form to make personal sense—others call it sense-making—out of a received alert or warning message.

The perception outcome variables examined were:

- *Understanding*: attaching a personal meaning to the received warning message;
- *Believing*: determining if the risk, warning, and message contents are accurate;
- *Personalizing*: coming to think that one is no longer safe and that the given warning is aimed at oneself; and
- *Deciding*: forming an idea about an appropriate course of action.

Milling outcomes. Milling refers to people searching for additional and confirming information from other sources to help shape and reaffirm what one understands, believes, personalizes, and decides to do or not do after receipt of a message (Mileti & Sorensen, 1990). Milling also includes sharing information with others. **Three milling outcome *intentions* were examined:** (1) information seeking about what happened, (2) information seeking about what to do, and (3) information sharing with other people about the need to take action. Based on the research record, optimized milling outcomes were cast as those with lower scores since milling delays public protective action-taking.

Emotion outcomes. Evidence from historical research was not available to document the potential effect of emotions on alert and warning response. We examined research on somewhat related research topics (e.g., Jin & Pang, 2010; Kim & Cameron, 2011), and **the following emotions were investigated: scared, tense, confused, shocked, nervous, sad, outraged, terror-struck, anxious, fearful, angry, and sympathetic.** Although emotion outcomes were generated and reported on, they were not used as message optimization evaluation criteria since the existence and form of their relationship to alert and warning response is largely not documented.

Protective action-taking outcomes. Protective action response behavior is the most important outcome factor of all, but it was not measured in the conducted experiments, and there is good reason why. Research evidence suggests that behavioral protective action-taking intentions are not realistic estimates of protective action-taking in actual events with which people are not very familiar. Since it is known that the perceptual outcomes measured correlate with protective action-taking behavior (Kuligowski et al., 2012; Mileti & Sorensen, 1990), and because perceptions could be accurately measured in an experimental setting, the perception outcomes listed above were seen as better indicators of protective action-taking behavior than response behavioral intentions.

Data collection approach. Of the eight experiments conducted, seven were conducted online to help reduce research costs. The final experiment was conducted in a face-to-face (i.e., laboratory) setting to maximize control.

Participant selection. For the internet experiments (*N*=2,012), volunteer samples were drawn from Survey Monkey, which generated online survey audience panels of individuals recruited for experiment participation in exchange for "points" in a no-cash, point-system of rewards, including sweepstakes and merchandise. The panels included a diverse group of individuals who have Internet access and have joined the Survey Monkey program to take surveys. Eligible panel members were invited by email to participate, and invitations were sent to ensure representation and provide general balance in terms of gender and race/ethnicity. Given that the tested messages were about hypothetical disasters occurring in California, participants were drawn largely from within the state so that the hazards would be familiar and the messages would be salient.
For the laboratory experiments (*N*=155), the CSU Fullerton Social Science Research Center (SSRC) recruited participants from local community organizations by using flyers. Flyers were distributed via email, regular postal

mail, and in person. Interested individuals contacted the SSRC by telephone to set up an interview appointment on campus. Quotas were used to achieve relative balance in terms of gender and race/ethnicity.

To be eligible to participate in this study, individuals had to be: (1) 18 years of age or older, (2) U.S. residents, (3) English speakers, (4) identify as African American, Asian, Latino, White, or Other, and (5) have a working cell phone. Descriptions of key sample characteristics for all experiments are presented in Table 6 (see Appendix E). General methods, including the questionnaire, were identical for both the online and face-to-face data collection approaches. The online and laboratory experiments were conducted June – September, 2013; participants received $50 gift cards for their time.

Questionnaire construction. Questionnaire construction began with the development of a list of constructs pertinent to the research questions under study. **This list included demographic factors:** gender, race/ethnicity, age, income, and education; **prior experience factors:** experience with disasters, experience with cell phones, and experience with mobile alerts; **sense-making constructs:** understanding, believing, personalizing, deciding, and milling; and **other factors investigated such as emotion**. Standard questionnaire items used in prior research[2] were used when they existed and there was evidence that the items had performed well. In some cases, existing items were adapted to the particular context of the project. New items were developed where prior items could not be identified. Once the content was established, the questionnaire was transferred into an online format using online survey software. This programming included eligibility screening, skip rules, and randomization of participants for the particular test message viewed. Examples of the questionnaire used in the internet and laboratory experiments are included in Appendix D.

Questionnaire pretest. The research team pre-tested the online questionnaire to identify any potential problems with programming, skip rules, and question flow, and minor corrections were made. Following this internal review, the questionnaire was pretested by colleagues and associates of the research team (N=54) March 4 through March 11, 2013. About a quarter (15/54, 28%) of the pretest sample were men, and 72% (39/54) were women. The vast majority (49/54, 91%) self-identified as "white." Participants reported that it took 3 – 20 minutes to complete the online questionnaire. Feedback about questionnaire clarity, flow, wording, as well as test message size and placement was collected, and minor revisions were made to improve the readability of the questionnaire. Likewise, a pretest was conducted for the face-to-face questionnaire.

Questionnaire pilot test. The final online questionnaire was pilot tested (N=21) to ensure that the participant selection, screening items, and randomization were all correctly programmed. The pilot test was conducted May 31 through June 1, 2013. About half (57%, 12/21) of the pilot participants were men, and 43% (9/21) were women. No changes were made to the questionnaire following the pilot test. For the face-to-face experiment, study procedures were pilot tested with the first 23 participants recruited. No changes were made following the pilot, and these data were included as final experimental data.

Human subjects and institutional review. The research protocol associated with the online and face-to-face experiments was reviewed and approved (protocol # HSR-13-0093) by the CSU Fullerton Institutional Review Board prior to data collection.

[2] See, for example, Gutteling, J. M. (1993). A field experiment in communicating a new risk: Effects of the source and a message containing explicit conclusions. *Basic and Applied Social Psychology, 14*(3), 295-316.; Kim, H. J., & Cameron, G. T. (2011). Emotions matter in crisis: The role of anger and sadness in the publics' response to crisis news framing and corporate crisis response. *Communication Research*, *38*(6), 826-855; Lindell, M. K., & Perry, R. W. (2012). The protective action decision model: Theoretical modifications and additional evidence. *Risk Analysis, 32*(4), 616-632.

Outcome variable measures. The six outcomes factors of understand, believe, personalize, decide, emotion, and milling were measured as follows.

Understand. Understanding was measured by asking subjects to rate their level of agreement with statements in three different questions. The first question asked subjects to rate their level of agreement using a six-point scale where 1 represented "strongly disagree" and 6 represented "strongly agree," with the following statement: "The message helped me understand what to do." The second question asked subjects to rate their level of understanding using a six-point scale where 1 represented "do not understand at all" and 6 represented "fully understand," with seven statements. The question stem was, "After reading this message, I understand:" The seven statements rated were: "What happened," "The risks," "What to do to protect myself," "What location is affected," "Who the message is from," "When I am supposed to take action to protect myself," and "How long I am supposed to continue taking action to protect myself." The third question asked subjects to rate their level of understanding using a six-point scale where 1 represented "do not understand at all" and 6 represented "fully understand" by after asking the question "How well do you understand the message?"

Belief. For all experiments, belief was measured by asking subjects "After reading this message, do you believe that…." This question was followed by three items: "Radiation is headed your way," "You should immediately take shelter," and "Sheltering will make you safer." Answers were rated using a 6-point scale where 1 represented "do not believe" and 6 represented "believe." Experiment 3, which involved two additional hazard types, used the same question structure and the following items for the active shooter hazard: "A shooter is in the mall", "You should immediately take shelter", and "Sheltering will make you safer." And, the following items were used for the tsunami hazard: "A tsunami is headed your way", "You should immediately evacuate", and "Evacuating will make you safer."

Personalize. Personalizing was measured by asking subjects, "How likely are each of the following statements?" If I received this message on my cell phone, I would think that…" This question was followed by seven items: "I might become injured," "People I know might become injured," "People I don't know might become injured," "I might die," "People I know might die," "People I do not know might die," and "The message was meant for me." Answers were rated using a six- point scale where 1 represented "not very likely" and 6 represented "very likely."

Decide. Deciding was measured by informing subjects to: "Use the scale below to answer yes or no. You may use any number on the scale." This was followed by four items: "The message will help me decide what to do," "It will be easy to decide what to do," "I will be able to decide what to do quickly," and "I can decide what to do with confidence." Answers were rated using a six-point scale where 1 represented "no" and 6 represented "yes."

Emotion. Emotions were measured by asking subjects to rate their agreement with the statement, "This message made me feel…." This stem was followed by twelve emotions: "scared," "tense," "confused," "shocked," "nervous," "sad," "outraged," "terror-struck," "anxious," "fearful," "angry," and "sympathetic." All twelve answers were rated on six-point scales where 1 represented "not at all," and 6 represented "extremely." These twelve emotions were presented to subjects in random order.

Milling. Milling was measured by asking subjects the following three questions: "How likely would you be to look for additional information about what happened before taking action?" "How likely would you be to look for additional information about what to do before taking action?" and "How likely would you be to tell other people about the need to take action?" Answers were rated using a six-point scale where 1 represented "very unlikely" and 6 represented "very likely."

Data analysis plan overview. A data analysis plan was developed that would detect even slight differences in experimental outcomes because some experiments contained only slight variation in the experimental factors being manipulated. For example, for all practical purposes, the alternative message content orders tested in experiment 1A each said the same thing, and the only difference between them was the order in which that same information was presented. A description of the data analysis procedures follows.

Step one: develop outcome scales. The plan was for each experiment to detect differences in the outcomes of understand, believe, personalize, deciding, milling, and emotion. The first data analysis step was to construct a scale using multiple measures of each construct for each of these outcomes. Exploratory and confirmatory factor analysis was used to create composite outcome scores for multiple indicators of each outcome construct. For experiments 1A, 1B, and 1C, a single set of outcome scales was developed. This was also the case for experiments 3A, 3B, and 3C. Once the four sets of outcome scales were developed (for experiments 1A, 1B, and 1C; experiment 2; experiments 3A, 3B, and 3C; and experiment 4), adjustments were made across scales to maximize comparability across all experiments while not compromising scale quality within any experiment. Factor analysis was used to simplify the analysis of multiple measures for multiple constructs (i.e., understand, believe, personalize, decide, and milling).

Step two: eliminate non-promising experimental alternatives. Multiple cross tabulation tables were created that juxtaposed all conditions of the experimental factor being manipulated against each outcome scale. These tables were reviewed to distinguish, where appropriate, between experimental alternatives that showed promise as an optimized message candidate (for example, did one message order produce better outcomes when compared to other message orders and to the current content order for WEA messages?) to be subjected to further test.

Step three: perform regression without controls. Regression analysis was used to predict each of the measures for the outcome factors under investigation using the most promising optimization alternatives discerned in step two. Relationships were classified as significant ($p \leq .05$), near significant ($.05 < p \leq .10$), and not significant ($.10 < p \leq 1.0$).[3]

Step four: perform regression with controls. Finally, the statistically significant relationships from step three were examined using multiple regression controlling for subject selection criteria variables. This was done to determine if relationships discerned in the prior step still held while controlling for subject selection factors. The control variables were gender (dichotomized as 0=female versus 1=male), and race/ethnicity (dichotomized as 0=White versus 1=African American; 0=White versus 1=Latino; and 0=White versus 1=Asian). Additional covariates included age and prior mobile alert and message receipt experience were explored, but had no effect. Hence, they were excluded from the final equations. Relationships were classified as significant ($p \leq .05$), near significant ($.05 < p \leq .10$), and not significant ($.10 < p \leq 1.0$).

Outcome scale construction for experiments 1A, 1B, and 1C. Scales for the outcomes factors investigated in experiments 1A, 1B, and 1C were constructed as follows. The data files from each experiment were merged into one (N=777). All the messages being compared across all of the experiments were re-coded to be consistent across the combined data set. Exploratory and confirmatory factor analysis was conducted to guide scale construction. Factor analysis in SPSS (Principal Axis Factoring and Varimax rotation) was used to assess whether the items reliably represented a single construct. Scree-plot and eigenvalues were examined to determine the maximum number of possible factors for the potential items. Factor loadings were assessed and items that cross-loaded

[3] Given the very slight changes in the test messages that were compared, a near significant result takes on meaning. This is precisely the situation in which one would consider a near significant result as important information (Warner, 2013, pp. 86-89).

across factors were dropped. Five factors were extracted. These were: (1) interpret, (2) fright, (3) personalize, (4) lament, and (5) mill. The coefficient alpha values ranged from .85 to .96. Skewness ranged from -1.13 to 0.32. Kurtosis ranged from -0.78 to 0.80. Descriptive statistics for the five factors are presented in Table 7 (see Appendix E), and the scales were operationalized as follows.

Interpret factor. Fourteen measures of three constructs (understand, believe, and decide) merged together to form the factor labeled "interpret." This included all nine outcome measures for understand, one measure for believe ("after reading this message, do you believe that sheltering will make your safe?"), and all four measures of decide. This composite factor was labeled as "interpretation."

Fright factor. Six emotion measures (tense, nervous, fearful, anxious, scared, and shocked) merged into one factor. This composite factor was labeled as "fright."

Personalize factor. All seven measures of personalize ("I might become injured," "people I know might become injured," "people I don't know might become injured," "I might die," "people I know might die," "people I do not know might die," and "the message was meant for me") merged into one factor. The label "personalize" was retained.

Lament factor. Three emotion measures (angry, outraged, and sympathetic) merged into one factor. This composite factor was labeled as "lament."

Milling factor. Two measures of milling (seek information about what happened and seek information about what to do) merged into one factor. The label "milling" was retained.

Creating dichotomous outcome variables. The interval rating scales were summed and anchored at 0, and then dichotomized based on a median split to simplify interpretation in cross tabulation analysis as follows: (1) 0=0-38 and 1=39-70 for interpretation; (2) 0=0-20 and 1=21-30 for fright; (3) 0=0-22 and 1=23-35 for personalization; (4) 0=0 to 5 and 1=6-15 for lament; and (5) 0=0-8 and 1=9-10 for milling.

Outcome scale construction for experiment 2. Scales for the outcomes factors investigated in experiment 2 (N=468) were constructed as follows. An exploratory and confirmatory factor analysis was run to guide scale construction. Factor analysis in SPSS (Principal Axis Factoring and Varimax Rotation) was used to assess whether the items reliably represented a single construct. Scree-plot and eigenvalues were examined to determine the maximum number of possible factors for the potential items. Factor loadings were assessed and items that cross-loaded across factors were dropped. Six factors were extracted. These were: (1) interpret-protective action, (2) interpret-risk, (3) fright, (4) personalize, (5) lament, and (6) mill. The coefficient alpha values ranged from .81 to .95. Skewness ranged from -0.98 to 0.22. Kurtosis ranged from -0.76 to 0.47. Descriptive statistics for the six factors are presented in Table 7 (see Appendix E), and the scales were operationalized as follows.

Interpret-protective action factor. Nine of the sixteen outcome measures for understand, believe, and decide merged into one factor. These nine measures were "the message helped me understand what to do," "after reading this message I understand what to do to protect myself," "after reading this message I understand when I am supposed to take action to protect myself," "after reading this message I understand how long I am supposed to continue taking action to protect myself," "after reading this message do you believe that sheltering will make you safer," "the message will help me decide what to do," "it will be easy to decide what to do," "I will be able to decide what to do quickly," and "I can decide what to do with confidence." This composite factor was labeled as "interpretation-protective action."

Interpret-risk factor. Three of the sixteen outcome measure for understand, believe, and decide merged into another factor. These three measures were after reading this message, I understand: "what happened," "the risks," and "what location is affected." Composite factor was labeled as "interpret-risk."

Fright factor. Eight emotion measures ("tense," "nervous," "fearful," "terror-struck," "anxious," "scared," "shocked," and "confused") merged into one factor. This composite factor was labeled as "fright."

Personalize factor. Eight measures ("I might become injured," "people I know might become injured," "people I don't know might become injured," "I might die," "people I know might die," "people I do not know might die," "the message was meant for me," and "after reading this message do you believe that radiation is headed your way") merged into one factor. This factor was labeled as "personalize."

Lament factor. Three emotion measures ("angry," "outraged," and "sympathetic") merged into one factor. This composite factor was labeled as "lament."

Milling factor. Two of the three measures of milling ("seek information about what happened" and "seek information about what to do") merged into one factor. The label "milling" was retained.

Creating dichotomous outcome variables. The interval scales for the outcome constructs were summated, anchored at zero, and dichotomized based on a median split to simplify interpretation in cross tabulation analysis as follows: (1) 0=0-35 and 1=36-45 for interpretation of protective action; (2) 0=0-11 and 1=12-15 for interpretation of risk; (3) 0=0-27 and 1=28-40 for fright; (4) 0=0-27 and 1=28-35 for personalization; (5) 0=0-6 and 1=7-15 for lament; and (6) 0=0-7 and 1=8-10 for milling.

Outcome scale construction for experiments 3A, 3B, and 3C. Scales for the outcomes factors investigated in experiments 3A, 3B, and 3C were constructed as follows. The data files from each experiment were merged into one (N=767). All the messages being compared across all of the experiments were re-coded to be consistent across the combined data set. An exploratory and confirmatory factor analysis was run to guide scale construction. Factor analysis in SPSS (Principal Axis Factoring and Varimax Rotation) was used to assess whether the items reliably represented a single construct. Scree-plot and eigenvalues were examined to determine the maximum number of possible factors for the potential items. Factor loadings were assessed and items that cross-loaded across factors were dropped. Five factors were extracted. These were: (1) interpret, (2) fright, (3) personalize, (4) lament, and (5) mill. The coefficient alpha values ranged from .78 to .96. Skewness ranged from -0.77 to 0.38. Kurtosis ranged from -0.70 to 0.12. Descriptive statistics for the five factors are presented in Table 7 (see Appendix E), and the scales were operationalized as follows.

Interpret factor. The three outcome constructs of understand, believe, and decide (and all sixteen of their measures) merged into one factor. This composite factor was labeled as "interpretation."

Fright factor. Six emotion measures ("tense," "nervous," "fearful," "anxious," "scared," and "confused") merged into one factor. This composite factor was labeled as "fright."

Personalize factor. Six of the seven measures of personalize ("I might become injured," "people I know might become injured," "people I don't know might become injured," "I might die," "people I know might die," and "people I do not know might die") merged into one factor. The label "personalize" was retained.

Lament factor. Three emotion measures ("angry," "outraged," and "sympathetic") merged into one factor. This composite factor was labeled as "lament."

Milling factor. Two of the three measures for milling ("seek information about what happened" and "seek information about what to do") merged into one factor. The label "milling" was retained.

Creating dichotomous outcome variables. The interval scales for the outcome constructs were summated, anchored at zero, and dichotomized based on a median split to simplify interpretation in cross tabulation analysis as follows: (1) 0=0-62 and 1=63-80 for interpretation; (2) 0=0-19 and 1=20-30 for fright; (3) 0=0-23 and 1=24-30 for personalization; (4) 0=0-5 and 1=6-15 for lament; and (5) 0=0-6 and 1=7-10 for milling. A series of cross tabulations were computed that juxtaposed outcomes against the test messages.

Outcome scale construction for experiment 4. Scales for the outcomes factors investigated in experiment 4 (N=155) were constructed as follows. An exploratory and confirmatory factor analysis was run to guide scale construction. Factor analysis in SPSS (Principal Axis Factoring and Varimax Rotation) was used to assess whether the items reliably represented a single construct. Scree-plot and eigenvalues were examined to determine the maximum number of possible factors for the potential items. Factor loadings were assessed and items that cross-loaded across factors were dropped. Four factors were extracted. These were: (1) interpret, (2) fright, (3) personalize, and (4) mill. The coefficient alpha values ranged from .65 to .93. Skewness ranged from -1.12 to -0.30. Kurtosis ranged from -0.91 to 0.46. Descriptive statistics for the five factors are presented in Table 7 (see Appendix E), and the scales were operationalized as follows.

Interpret factor. The two outcome constructs of understand and believe (all nine measures of understand and one measure of believe, "After reading this message, do you believe that sheltering will make you safer?") merged into one factor. This composite factor was labeled as "interpretation."

Fright factor. Seven emotion measures ("tense," "nervous," "fearful," "terror struck," "anxious," "scared," and "shocked") merged into one factor. This composite factor was labeled as "fright."

Personalize factor. Six of the seven measures of personalize ("I might become injured," "people I know might become injured," "people I don't know might become injured," "I might die," "people I know might die," and "people I do not know might die") merged into one factor. The label "personalize" was retained.

Milling factor. Two of the three measures for milling ("seek information about what happened" and "seek information about what to do") merged into one factor. The label "milling" was retained.

Creating dichotomous outcome variables. The interval scales for the outcome constructs were summated, anchored at zero, and dichotomized based on a median split to simplify interpretation in cross tabulation analysis as follows: (1) 0=0-34 and 1=35-50 for interpretation; (2) 0=0-22 and 1=23-35 for fright; (3) 0=0-23 and 1=24-35 for personalization; and (4) 0=0-8 and 1=9-10 for milling. A series of cross tabulations were computed that juxtaposed outcomes against the test messages.

Qualitative Think-Out-Loud Interviews and Focus Groups

General Approach to the Think-Out-Louds and Focus Groups. Six test messages for an improvised nuclear device event were presented to "think-out-loud" participants and their individual interpretations were recorded and analyzed. These think-out-louds were then followed by focus groups with those same participants to explore interpretations in depth. The six test messages were generated from the quantitative experiment findings and are included in Table 1 in Appendix F. The map that was included in three of these test messages is provided in Appendix G. The think-out-louds and focus groups were conducted at the University of Colorado Denver, July-August 2013. Think-out-loud (or "think aloud") is an established approach to gathering and analyzing verbal reports (Ericsson & Simon, 1985). Since only one thought can be verbalized at a time, asking a participant to read a particular test message and immediately think-out-loud about what they are reading enables researchers to identify what the participant deems salient, problematic, and/or confusing. The focus group format enabled participants to collectively validate, challenge, and comment upon the findings from the project's quantitative experiments.

This qualitative research sought to better understand how participants made sense of the test messages and managed complex interpretations (Denzin & Lincoln, 2005; Putnam & Pacanowsky, 1983). The research design for this project thus approximated conditions that message recipients might encounter in the "real world": individual cognitions leading to searching for additional and confirming information through interactions with other people. The focus group format exploited the "group effect," which refers to interactions among participants that generate differences in message interpretation.

Methods. A group of 50 adult participants (17 male and 33 female) was recruited from residents within and around Denver, CO. The University of Colorado Denver's Clinical Research Support Center recommended recruitment via Denver's Craigslist community volunteer page, and participants received a $50 Visa Gift Card for their time. Think-out-louds were conducted via telephone and lasted between 3 and 15 minutes each. Each participant's think-out-loud test message corresponded to his or her subsequent focus group session. The focus group sessions were held at the University of Colorado Denver. Each focus group session included 6-8 participants, and the duration averaged between 1.5 and 2 hours. The think-out-loud and focus group sessions were audio recorded and transcribed. No personal identifiers were collected. A total of seven focus groups were conducted. Two messages were shown to each focus group: an "optimized" and a "non-optimized" version of a 90-, 140-, or 1,380-character message. The optimized messages were patterned after message #5 from the quantitative experiments because that message yielded the best outcomes. The non-optimized messages were patterned after the "standard" WEA content order. Within each pair of messages presented, the order of the messages shown to participants was reversed to avoid order effects and to add rigor to the focus group research. The seventh focus group was conducted with emergency management professionals who volunteered to participate after the community recruitment advertisement was posted to a statewide emergency management listserv. This focus group was conducted as a result of stakeholders' suggestion to do so.

Think-out-louds. Participants were presented with a standardized context to imagine that approximated the one developed for the online and face-to-face quantitative experiments (i.e., "You are at home when you receive the following message on your cell phone"). Prior to the focus group, each participant was simultaneously called on the telephone and emailed one of the optimized or non-optimized 90-, 140-, or 1,380-characters messages. These participants were instructed to read the message out loud and "think-out-loud," i.e., describe their thoughts as they interpreted, re-read, questioned, or puzzled over the message. Think-out-loud responses reflected participants' understanding of, belief in, and personalization of messages, as well as their decision-making processes and

emotions. The think-out-loud activity was designed to uncover insights about participants' cognitive processes immediately following message receipt.

Focus groups. Insights from the think-out-louds informed focus group interactions and enabled the moderator to better elicit both explanations for and accounts of participants' commentary. Explanations involve statements concerning how participants interpret warning messages (i.e., "I do not understand why this message is instructing me to shelter"). Accounts focus on justifications or excuses for those interpretations based on complementary and/or argumentative interactions with the moderator and/or other participants (i.e., "I ignore messages from sources that I do not recognize"). During the focus groups, optimized and non-optimized 90-, 140-, or 1,380-character messages were presented to the participants. Several questions followed, in sequence, after each message was presented. In other words, participants discussed one message extensively before the second message was presented for consideration. Each message was presented on a handout given to participants. Additionally, a focus group comprised of emergency management practitioners discussed all of the test messages.

Core questions related to our experimental outcome variables included:

1) Do you understand this message?

2) Do you believe this message?

3) Do you think this message impacts you specifically?

4) What will you decide to do next?

5) What emotions are you feeling after reading this message?

For all questions, probes focused on content elements including source, hazard, guidance, location, and time, if participants did not raise these issues themselves. Conceptually and analytically, participants' responses to these questions reflected their understanding of, belief in, and personalization of the message, as well as their decision-making processes and emotions. Table 2 in Appendix F, summarizes the message presentation order for each focus group.

Transcription. Think-out-loud and focus group sessions were audio recorded and subsequently transcribed by trained graduate research assistants based at the University of Maryland. Completed transcripts were reviewed for accuracy by simultaneously listening to the recording and re-reading the transcript. In the transcripts report, grammar was corrected only when necessary for readability. Punctuation was also added in some cases to promote readability.

Data Analysis Software. NVivo 10 was used for analyzing the qualitative data. NVivo 10 is a qualitative data analysis software package designed for qualitative researchers working with large amounts of information. NVivo 10 assists users in organizing and analyzing unstructured data, allowing researchers to classify, sort, and arrange information, as well as examine relationships within the data. Researchers can cross-examine information in several ways using the software's search engine and query functions. Multiple researchers can also engage in simultaneous data analysis.

Analytical Procedures. The analytical procedures employed in this project aligned with discourse analysis. Within the field of communication studies, discourse analysis involves the study of talk or text in context, wherein

researchers analyze segments of speech or writing in order to make a scholarly argument. Communication scholars who conduct discourse analysis typically prefer to study talk over text, focus on issues of audience design and strategy, tackle interesting problems and situations, use an argumentative writing style, and view talk as a form of practical and moral action (Tracy, 2001). Discourse analysis usually involves "close looking," i.e., audiotaping or videotaping some type of interaction, transcribing the tape, repeatedly listening/viewing the tape, formulating claims about the interaction, and then, finally, building an argument through the analysis of transcript excerpts. This study departed from typical discourse analytic studies in that it explicitly brought extant theoretical concepts to bear during data interpretation.

In order to add additional rigor to our analysis, two graduate research assistants independently coded a 3-page transcript segment using the coding sheet developed for this project (see Appendix I). We allowed for segments of discourse to exemplify multiple analytical categories where warranted. Once reviewed by the lead qualitative researcher, three additional graduate research assistants independently coded a transcript segment and were then shown the example. Once questions were resolved during this training exercise, the three graduate research assistants coded a portion of almost all of the transcripts. The project's lead qualitative researcher independently coded and analyzed all transcripts and relied on the graduate research assistant coding to check and verify interpretations and relationships. The researchers also approached the transcripts inductively, examining any statements that seemed particularly important or revealing that may not have been captured in our initial coding scheme. However, no new categories were generated.

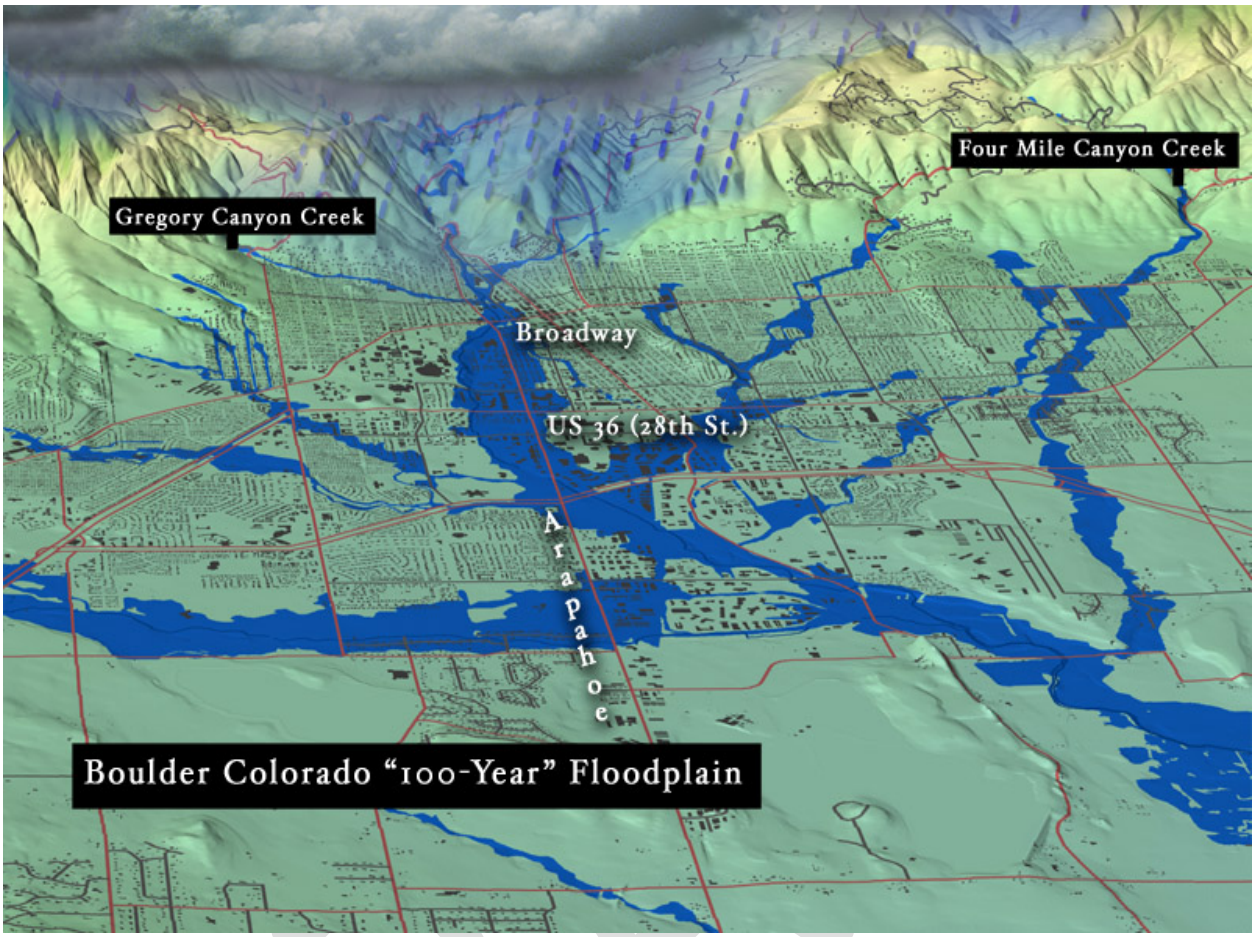
Community Event Survey

Survey purpose. A community event household telephone survey was conducted to determine if findings from the experiments, think-out-loud interviews, and focus groups (all conducted in controlled research settings) held in a *"real world"* event.

Boulder, Colorado. Boulder County is in north-central Colorado. Its natural environment ranges from high plains in the east to mountains and forests in the west that climb to an elevation of more than 12,000 feet at the continental divide.

Population characteristics. According to the 2010 census, Boulder County has a population of 294,567. The City of Boulder has a population of 97,385 people, 41,302 households, and 16,694 families and a population density of 3,942.7 inhabitants per square mile. The estimated median household income in the City of Boulder is $66,479, and the median family income is $90,902. The City of Boulder's population is 88% white, 1% African American, 5% Asian, <1% American Indian/Alaska Native, <1%% Native Hawaiian/Pacific Islander, 3% other, and 3% identify by two or more races.

Flooding history. Flooding has been part of the history of the City of Boulder since Colorado received statehood in 1876. The city contains two hazardous creeks. These are Boulder Creek that runs through the center of the city (Boulder Creek had serious floods in 1876, 1894, 1906, 1914, 1938, 1969, and 2011), and Fourmile Canyon Creek (which flooded in 1909, 1916, 1921, and 2011). The city's 100-year floodplain is illustrated below.



The September 2013 flood. Between September 11 - 15, 2013 Colorado's Front Range experienced catastrophic flash flooding that began when record rainfall from a slow moving cold front stalled over Colorado, colliding with warm humid air from the equator. Boulder received 17.16 inches of rainfall between September 10 - 15, 2013 (the annual average is 20.7 inches). On September 12, Boulder Creek crested at approximately 5,000 cubic feet of water per second (cfs). Normally it flows between 100-300 cfs. Serious damage was sustained to buildings along the creek and the creek path including. The rain the City of Boulder experienced translates to a 1,000-year rain event, and a 100-year flood event.

Disaster emergencies were declared in 14 Front Range counties, including Boulder County. Nine deaths were reported due to widespread flash flooding, three of those occurred in Boulder County. Over 1,600 people were evacuated in Boulder County, with at least 349 homes destroyed and about 4,000 or more in neighboring Lyons, Jamestown and unincorporated Boulder County. Some 900 square miles of the County were affected by flash flooding. Boulder's Office of Emergency Management estimate that almost $50 million in damages to infrastructure, parks and open space occurred in the City of Boulder, and that $89 million more in damages was done to roads and bridges in other parts of Boulder County.

Alerts and warnings issued to the public. Public alerts and warnings urging a range of protective public actions began at 6:39 P.M. on September 11, 2013 and continued for approximately 30 hours. They were distributed over a variety of dissemination channels. These included:

- The Wireless Emergency Alert (WEA) System used by the National Weather Service (NWS) to deliver WEA messages over mobile communication devices such as cell phones.
- The website of the Boulder Office of Emergency Management.
- The sounding of the city's outdoor voice sirens.
- The Boulder Emergency Notification (ENS) reverse 911 System.
- The Boulder Emergency Notification Program that transmits messages directly to people who have opted into the system over mobile communication devices such as cell phones.
- NOAA Weather Radio (NWR) used by the NWS that turns on automatically, sounds an alarm, and delivers a message.
- The Emergency Alert System's (EAS) televised crawlers.

The first public alert message was a WEA and it was distributed to Eastern Boulder County on September 11, 2013 at 6:36 P.M. It follows.

- "Flash Flood Warning in this area til 9:30 PM MDT. Avoid flood areas. Check local media. –NWS."

The same WEA message was distributed many times throughout the course of the event with updated expiration times. A time sequenced catalogue of distributed public alert and warning messages across the entire September 11-15, 2013 Boulder flood event can be found in Appendix F.

Interview firm selection and management. The survey was carried out by the Social Science Research Center at the California State University Fullerton. This survey group was selected because of its proximity to the co-principal investigator, housed at CSFU. Dr. Wood was able to meet regularly with survey staff and interviewers, participated in initial interviewer training, and received weekly updates on survey progress.

Population and sample. The study population and the two samples that were selected for study are described below.

Population. The September 2013 Colorado flood impacted many different communities. We limited the study population as follows:

- Residents of the City of Boulder, Colorado;
- Adults (18 years and older);
- English speakers; and
- Persons present in the city limits from 6:00 P.M. on September 11, 2013 through midnight on September 2013 (this time period included the first public alert message issued through when most people would have taken a protective action).

The population was estimated to be 100,000 people in size including University of Colorado students.

Sample one: adult city residents who received a WEA message(s) (*N*=496). The primary sample for this study consisted on individuals who received the first WEA message over a mobile communication device. We estimated that this sub-population might be 5% of 100,000 or 5,000 people. A sample size of 496 statistically represents a population of 5,000 at the 95% confidence level +/- a 4.2% confidence interval.

Sample two: adult city residents (*N*=597). A second sample was recruited to help answer the question as to what proportion of the general adult population received a WEA message. A sample size of 597 statistically represents a population of 100,000 at the 95% confidence level +/- a 4% confidence interval. A total of 213 of the sample two general population respondents received a WEA message, and hence were included in the WEA sample.

Sample selection. According to state-level estimates by Marketing Systems Group (MSG), one of the premier vendors of statistically sound telephone samples, 39.3% of households in the state of Colorado are wireless-only households, meaning these households do not have a landline telephone.[4] According to data reported by the Centers for Disease Control and Prevention (CDC) in 2009, young adults (under 35 years old), Hispanics, renters, and those with lower incomes are more likely reside in cell-only households.[5] To decrease the under-coverage bias associated with sampling only landline telephone numbers, the study employed a dual-frame design that utilizes a frame of landline telephone numbers and a frame of cell phone numbers. MSG was contracted to obtain both sample frames.

MSG provided a total of 29,826 telephone numbers. Of these, 16,774 (56.2%) were landline records and 13,052 (43.8%) were cellular phone records. Quotas were set to ensure that 20% of completed interviews in each sample would be with cellular records. Telephone numbers were released as necessary to maintain high lab productivity, but taking into account project response and cooperation rates. All records were eventually released and included in the sample frame.

Estimating sample bias. Of the 880 completed interviews, 57.0% (*n* = 502) were conducted with women and 42.8% (*n* = 377) with men.[6] Age ranged from 18 (*n* = 18; 2.1%) to 93 (*n* = 1; 0.1%) years. The majority of respondents self-identified as white (*n* = 786, 90.3%), and more than three quarters (*n* = 686; 78.5%) had earned at least a bachelor's degree.

The distributions of each sample as compared to 2008-2012 five-year American Community Survey population estimates for the City of Boulder, Colorado are displayed in Appendix K. Comparisons on gender, Hispanic/Latino ethnicity, race, highest level of education, annual household income, and respondent age are provided. The survey sample was somewhat more educated, had higher income, and was older than the general population.

Questionnaire construction. The questionnaire was designed to obtain information on pertinent risk communication constructs about the first message people received about the Boulder flood, the first WEA message people received about the flood, and subsequent messages people may have received. The same theoretical constructs used in the experiments were included in the survey questionnaire, and where possible, identical question wording was used. The questionnaire was drafted, pretested, revised, pilot-tested, and then finalized. See Appendix L for the full questionnaire.

Pre-test and pilot. The questionnaire was pretested with interviewers and other project staff. Adjustments were made based on these experiences. This was followed by a pilot study that occurred over a two-day period (6/10/14-6/11/14) and involved 30 respondents who experienced the Boulder Flood. Minor fine-tuning of question wording took place after this field test.

[4] MSG. (2013). *State level wireless only estimates, October 2013.* Retrieved from http://www.m-s-g.com/CMS/ServerGallery/MSGWebNew/Documents/GENESYS/wireless-estimates/wireless-estimates-10-13.pdf

[5] Blumberg, S.J. & Luke J.V. (2009) *Wireless substitution: Early release of estimates from the national health interviewer survey, January-June 2009.* Retrieved from: http://www.cdc.gov/nchs/nhis.htm

[6] One individual (0.2%) indicated some "other" gender but did not specify what this gender was.

Human subjects and institutional review. The study protocol was reviewed by the CSU Fullerton Institutional Review Board (HSR-14-0232, 6/9/14). The consent language is included on the first page of the screener (see Appendix L).

Questionnaire administration. Interviews were conducted from 1:00 pm to 8:00 pm on weekdays and from 11:00 am and 7:00 pm on weekends, local time. Interview length ranged from 11 minutes (n = 3; 0.3%) to 74 minutes (n = 1; 0.1%). The mean survey administration time was 26 minutes and 46 seconds, and the median time was 25 minutes.

Research questions analysis plans. The main reason for conducting a community event survey was to test if previous findings from research approaches in controlled settings held in a *"real world"* event. Another was to answer a few additional research questions that could only be investigated answered in an actual event. The community event survey data collection and analysis plans for each of these research questions follow.

Order of message contents. This question could not be tested in the survey.

Message source. WEA message recipients were asked how believable they considered the sources from whom they received messages: *Considering all of the messages you may have received before you took any action to protect yourself, who were they from? Were they from the/a Boulder Police, National Guard, Boulder Fire Department, Boulder Office of Emergency Management, Colorado governor's office, Boulder sheriff's department, family member or other relative, neighbor or friend, employer, co-worker, TV broadcaster, National Weather Service, or Other (Y/N)? On a scale of 1 to 6, how believable do you think that source is, where 1 means "not at all believable" and 6 means "extremely believable."* Mean believability scores for city, state, and national message sources were calculated along with scores for individuals such as family and friends. A repeated measures Analysis of Variance was conducted to compare believability across source types.

Map inclusion. WEA message recipients were asked whether any of the messages they received contained a map (*Considering all the messages you may have received, did any of them contain a map indicating where within the city of Boulder the flood was expected to occur [Y/N]?*). Those who reported receiving one or more messages containing a map were asked how effective the best map they saw at helping them determine whether or not they were in an area of risk (*On a scale of 1 to 6, how effective was the best map you saw at helping you determine whether you were in an area of risk, where 1 means "not at all effective" and 6 means "extremely effective?*"). Reported map effectiveness was correlated with an overall personalization scale score. The personalization scale was calculated in the same manner as described in the Phase II experiments, above.

Relative importance of message contents. Four multiple linear regressions were conducted to test experimental findings about the relative importance of message contents among WEA message recipients: 1) interpretation, 2) personalization, 3) the amount of time that had elapsed (number of minutes) between the time the first WEA was issued (i.e., 6:36 pm on September 11th, 2013) and the time the respondent began checking local media (*On what day did you begin to check local media? At what time on <date> did you being to check local media?)*, and 4) the amount of time that had elapsed (number of minutes) between the time the first WEA was issued (i.e., 6:36 pm on September 11th, 2013) and the time the respondent began avoiding flood areas *(On what day did you begin to avoid flood areas? At what time on <date> did you being to avoid flood areas?*) were each regressed on measures of how much information the respondent had received on different topics: *Thinking about all the messages you received, how much information did you receive about the following topics, using a scale of 1 to 6, where 1 means "none" and 6 means "a lot?" How much information did you receive about how bad the flood would be, the specific locations that would be flooded, what you should do to protect yourself, when the flood was expected to*

occur, by when you were expected to take action?" Interpretation and personalization were scaled in the same manner described above for the Phase II experiments.

Generalizing across hazard types. This question could not be tested in the survey.

Message length efficacy. This question could not be tested in the survey.

Inclusion of a URL. Respondents were asked whether or not they received a message containing a hyperlink (*Sometimes messages include internet links in them. "Clicking" on these links redirects you to a specified internet address or website. On Wednesday and Thursday, September 11th and 12th, did you receive any messages that contained a link where you could get more information?*), whether they followed that link (*Did you follow that link?*), and how long they spent viewing the linked content (*How much time did you spend viewing information contained in the link?)*. Frequencies were calculated and *t*-tests were conducted comparing those who received a message containing a hyperlink and those who did not on the amount of time delay (in minutes) until beginning to avoid flood areas and beginning to check local media.

Familiarity with the WEA system. WEA message recipients, as well as members of the general population, were asked how knowledgeable they were about mobile public alerts: *Before the flood occurred, on a scale of 1 to 6, how knowledgeable were you about public alerts or warnings for events like floods that are distributed over mobile communication devices such as cell phones, where 1 represents "not at all knowledgeable" and 6 represents "extremely knowledgeable?"* Respondents also were asked how many WEA messages they had received: *Before the flood occurred, how many times had you ever received a government emergency alert about disasters like floods delivered to you over a mobile communication device such as a cell phone? This does not include University alerts.*

Understanding of acronyms. WEA message recipients were asked, *"When you first read that message, what did you think the letters NWS meant?"* Responses were coded as the National Weather Service, some other phrase, don't know, and refused.

How to best express time. WEA message recipients were asked: *At the time you first read the message, how much time did you think you had before you should check local media?* In addition, WEA recipients who heard the outdoor warning siren and/or message along Boulder Creek[7] were asked: *What did you think that "LEAVE IMMEDIATELY" meant?*

How to best express location. WEA message recipients were asked: *After first receiving that message, how much would you say you agreed with each of the following statements on a scale of 1 to 6 where 1 represents "not very likely" and 6 represents "extremely likely?" The message was meant for me.*

Understanding of alert and warning concepts. WEA message recipients who heard the siren and message issued by the outdoor warning sirens along Boulder Creek were asked how many feet above Boulder Creek they thought represented moving to "higher ground:" *Did you receive the following message issued by the outdoor warning sirens along Boulder Creek? 'Warning. Flash flood of Boulder Creek is imminent. Leave immediately. Proceed to higher ground. Do not cross Boulder Creek.' How many feet above the level of Boulder Creek did you think that meant?*

[7] "*Warning. Flash flood of Boulder Creek is imminent. Leave immediately. Proceed to higher ground. Do not cross Boulder Creek."*

WEA diffusion curve. A WEA diffusion curve was created showing the rate at which the WEA message diffused through the general population (see Appendix M). The time that respondents reported having read the WEA message was plotted against 15-minute time increments. Individuals who reported receiving the message before it was issued were set to zero minutes, i.e., the time the alert was issued.

Protective action mobilization curve. A protective action mobilization curve was created showing the rate at which WEA message recipients engaged in checking local media. The times respondents reported taking this protective actions were plotted against elapsed time measured in 15-minute increments, with negative numbers representing the number of minutes before the first WEA was issued and positive numbers representing the number of minutes after the first WEA was issued.

Validation of experimental optimized outcome measures. Intermediate cognitive outcomes—the scale scores for interpretation and personalization—were correlated with the ultimate behavioral outcomes—time elapsed before initiating the protective actions of checking local media and avoiding flood areas. The scales were constructed as described in the Phase II experiments. The time delay until checking local media was calculated by subtracting the time the first WEA message was issued (6:36 pm on September 11, 2013) from the time at which respondents began checking local media: *Did you take any of the following actions after you first received this [initial WEA] message (Y/N)? On what day did you begin to check local media? At what time on <date> did you begin to check local media?* The time delay until checking avoiding flood areas was calculated by subtracting the time the first WEA message was issued (6:36 pm on September 11, 2013) from the time at which respondents began avoiding flood areas: *Did you take any of the following actions after you first received this [initial WEA] message (Y/N)? On what day did you begin to avoid flood areas? At what time on <date> did you begin to avoid flood areas?* Pearson's *r* was calculated to test these relationships.

Optimum level of fear arousal. The twelve emotion items included in the Phase II experiment questionnaires were included in the community survey questionnaire. A fear scale was created following the same procedures described in the Phase II experiments including the items: *After first receiving that message, how much would you say you agreed with each of the following statements on a scale of 1 to 6 where 1 represents "not at all" and 6 represents "extremely?" The message made me feel <…> fearful, anxious, tense, nervous, scared?* The fear scale score was correlated with the behavioral outcomes, time delay until initiating the protective actions, checking local media and avoiding flood areas.

Prime Research Questions Findings

Introduction

This research sought answers to six prime research questions:

- What is the optimized order to the contents of alert and warning messages?
- Is there an optimized source for alert and warning messages?
- Are there public perception and response gains from including a map with alert and warning messages?

- What is the relative importance of the content elements in alert and warning messages, e.g., do some content elements matter more than others?

- Do alert and warning message conclusions generalize across hazard types or do different communication principals apply for different hazards?

- Do different length of alert and warning messages have different levels of outcomes effectiveness?

These six research questions were investigated using multiple research methods: quantitative online and laboratory experiments, and qualitative focus groups and think-out-louds. The conclusions from the prime research questions reported in this chapter were then subjected, to the extent possible, to a final level of testing of this project in an actual community alert and warning event to determine if they hold up the real world.

Order of Message Contents

Purpose. Like others (Mileti & Sorensen, 1990), we did not locate any research in the public record on the effect of the order of different information provided in alert and warning messages. We sought to fill this void with experiment 1A by seeking to determine whether order of the information contained in a 90-characters WEA message made any difference, and, if so, what message content order optimized message outcomes. There was little basis for knowing the exact impact of message order on the sense-making process; however, we suspected that message content order might influence message interpretation and possibly personalization. For example, if specific guidance is presented before the hazard rather than after, the message might be perceived as more personal. We determined optimized message order by observing outcomes across six messages with varied content orders: (1) the WEA message content order that is currently used in practice of hazard, location, time, guidance, and source; (2) hazard, location, guidance, time, and source; (3) guidance, time, hazard, location, and source; (4) source, hazard, location, time, and guidance; (5) source, guidance, hazard, location, and time; and (6) guidance, hazard, location, time, and source. These are presented as messages 1-6 in Appendix B.

Power. For the fixed model simple linear regression (1 predictor) testing the R^2 deviation from zero conducted for Experiment 1A, to achieve a power of .80 for a medium effect size (.15) and alpha=.05, a sample size of N=55 was needed (actual N=218). For the fixed model multiple linear regression (5 predictors) testing the R^2 deviation from zero, to achieve a power of .80 for a medium effect size (.15) and alpha=.05, a sample size of N=92 was needed (actual N=216).

Analysis and Findings.

Elimination of non-promising alternatives. A series of cross tabulations was computed that juxtaposed dichotomous outcomes against the six message content orders: #1=the current WEA message content order used in practice of hazard, location, time, guidance, and source; #2=hazard, location, guidance, time, and source: #3=guidance, time, hazard, location, and source; #4=source, hazard, location, time, and guidance; #5=source, guidance, hazard, location, and time; and #6=guidance, hazard, location, time, and source. Respectively, and in numerical order, the outcomes observed were: 48%, 46%, 44%, 55%, 57%, and 43% for interpretation; 49%, 59%, 49%, 51%, 50%, and 43% for fright; 48%, 41%, 48%, 57%, 60%, and 57% for personalization; 45%, 54%, 50%, 54%, 58%, and 57% for lament; and 43%, 41%, 46%, 42%, 44%, and 50% for milling. **Message order #5 clearly produced the most productive outcomes three out of five times for interpret, personalization, and lament. Hence, message order #5 was carried forward into the regression analyses to compare to the standard message order currently used in practice.**

Regression without controls. The results of the simple regressions on message content order are presented in Table 8 (see Appendix E). The regression for personalization (β=.119, *p*=.080) was statistically near significant. The regressions for interpret and lament outcomes were both not significant. **This suggests, at least based on this analysis, despite the observed consistent patterns in percentages, that the effect of message content order is weak. However, the weak advantage of message content order #5 over the order used in current practice could be substantial considering how many more people in a population at risk might be inclined to take action in response to message order #5 over the order currently used.**

Regression with controls. The results of the multiple regression equations for message content order are presented in Table 9 (see Appendix E). The regression for order number five with the personalization outcome remained statistically near significant (β=.120, *p*=.082), and the regression with the emotion of fright became significant (β=.133, *p*=.050). **The findings from the multiple regression equations led to the same general conclusions as the findings in the simple regression analysis; that is, message order #5 has a slight and weak advantage over the order used in current practice.**

Think-out-loud interviews and focus groups. Unlike the quantitative analyses of optimized message content order reported above, which only investigated 90-charcaters WEA messages, the think-out-louds and focus group research investigated optimized message content order using 90-, 140-, and 1,380-characters messages.

Findings from the think-out-louds and focus groups for the 90- and 140-characters messages supported the conclusion that message order #5 was the optimized message order. That is, this order seems to have a *slight* advantage over the standard WEA message order in use today. The participants in one of the 90-characters focus groups unanimously agreed that message order #5 produced a "better" message. As one participant stated, "I think that the order is important because 'take shelter' is right up front here, and that prompts you to action, whereas in the previous one the 'take shelter' was further along in the message, and I like the way they have that here, [it] prompts you to move."

Another focus group evaluating the 140-characters messages also unanimously found that putting the message source first improved the message's understandability. However, it was also clear that regardless of where source was placed in the message, some participants did not understand the meaning of source acronyms, e.g., "US DHS" and "Denver PD." Focus group research also found that some participants in both the 90- and 140-characters focus groups preferred the standard WEA message order, and even other participants found the two orders equally effective. Notably, the phrase "Denver PD Shelter now" in the optimized 140-characters message led some participants to believe that they should be seeking a "shelter" run by the Denver PD. The removal of the word "take" appears to influence the message's meaning for these participants. Overall, a slight majority of qualitative research participants found message order #5 to be more understandable and believable. Similarly, emergency management participants were divided about whether the source, guidance, or hazard should come at the beginning of the messages. Most emergency management participants argued that placing the hazard information upfront for 140-characters messages would lead to better outcomes, and they noted (as did the community focus groups) that the absence of punctuation and the word "take" in the optimized message could lead to counterproductive interpretations.

Findings from the think-out-louds and focus groups for 1,380-characters messages indicated that message order #5 did not transfer as an optimized order and may only be optimized for short 90- and 140-charcters messages. Message order #5 produced considerable confusion among many participants. The confusion resulted from participants reading a substantial amount of text about the steps to take to protect themselves without knowing

what happened, since information about the hazard was buried within the middle of the message. One participant captured the sentiment of many others when she stated, "At this point, I'm kind of reading and wondering, like, what is happening? Getting a text message with somebody telling me what to do and where to go, but I have no idea why until the end of the message. That kind of bothers me." Most participants in 1,380-characters focus groups nevertheless preferred the source first. Emergency management participants' comments were very similar.

Additional selected participant comments regarding the order of message contents are provided in Tables 1-4 in Appendix H.

Conclusions. To the best of our knowledge, no one has ever investigated whether the order of the information in an alert or warning message has an effect on public outcomes. The varied orders we tested only contained slight differences between them and the experimental messages tested quantitatively were all short 90-characters messages. **A different order for the content contained in 90-characters Wireless Emergency Alert (WEA) messages may improve public response outcomes.** WEA messages currently use the following order: hazard, location, time, guidance, and source. An alternative order had an advantage in improving the public outcomes tested quantitatively and assessed qualitatively. It was: source, guidance, hazard, location, and time. Although this alternative order only had a statistically weak advantage over the current WEA message content order, if put into practice, the effect of the revised order could be substantial considering how many more people in a population at risk might be inclined to take action in response to the revised order. The qualitative research revealed that this optimized message order holds for 140-characters messages; however, it does not transfer to 1,380-characters messages for which the optimized order is source, hazard, guidance, location, and time.

Future research. Quantitative and qualitative research on the optimized order of the contents of alert and warning messages longer than 90 characters is warranted.

Message Source

Purpose. Historical research evidence exists on the impact of varied alert and warning message sources on public perception and protective action response; for example, that a set of mixed sources rather than a sole source work best (Lindell & Perry, 1987; Stephens, Barrett, & Mahometa, 2013), official vs. unofficial sources are better (Mileti & Darlington, 1995; Quarantelli, 1980), and source that are familiar are more effective (Perry, Lindell, & Greene, 1981; Vihalemm, Kiisel, & Harro-Loit, 2012; Wray et al., 2008). Hence, we anticipated that source might influence the sense-making process by influencing message understanding and believing (i.e., interpretation), personalization, and milling. However, we were unable to find publicly available research on which single source might maximize outcomes when messages are limited to 90-characters, and including multiple sources is not possible. Experiment 1B was designed to determine whether a single source to name in a 90-characters WEA message optimized public outcomes. The single sources examined were: (1) the Orange County Fire Authority (OCFA), (2) the California Emergency Management Agency (Cal EMA), (3) the Wireless Emergency Alert system (WEA), (4) the U.S. Centers for Disease Control and Prevention (CDC), and (5) the U.S. Department of Homeland Security (US DHS). These are test message 1 and messages 7-10 in Appendix B.

Power. For the fixed model simple linear regression (1 predictor) testing the R^2 deviation from zero conducted for Experiment 1B, to achieve a power of .80 for a medium effect size (.15) and alpha=.05, a sample size of N=55 was needed (actual N=99). For the fixed model multiple linear regression (5 predictors) testing the R^2 deviation from zero, to achieve a power of .80 for a medium effect size (.15) and alpha=.05, a sample size of N=92 was needed (actual N=97).

Analysis and Findings.

Elimination of non-promising alternatives. A series of cross tabulations was computed that juxtaposed dichotomous outcomes against the five tested sources. Respectively, the outcomes for OCFA, Cal EMA, WEA, CDC, and US DHS were: 52%, 63%, 38%, 52%, and 48% for interpretation; 44%, 57%, 46%, 39%, and 49% for fright; 44%, 57%, 35%, 39%, and 48% for personalization; 48%, 50%, 52%, 39%, and 55% for lament; and 47%, 37%, 46%, 30%, and 43% for milling. **These numbers suggest that Cal EMA scored highest on the outcome measures for three outcomes (interpret, personalize, and fright), and was the second most productive source for milling (recall that a low milling score decreases protective action delay and is preferable).** WEA (coded a 0) versus Cal-EMA (coded as 1) comparisons were selected to carry forward into the regression analysis. WEA was selected for inclusions for two reasons: it had low outcome scores and because it is the name of the Wireless Emergency Alert System.

Regression without controls. The results of the simple regressions that examined the effects of the Cal-EMA and WEA source comparisons in a 90-characters WEA message are presented in Table 10 (in Appendix E). **Source had no effect on fright, lament or milling since none of these relationships were statistically significant. However, source did have a statistically significant effect on interpretation** (β=.199, p=.048) **and personalization** (β=.241, p=.016). These findings suggest that Cal-EMA (the strongest sole source based on a comparison of percentage scores) produced statistically significant outcome differences when compared to WEA (one of the weakest sole sources based on percentage differences). **This suggests that single sources which are local and recognizable (Cal EMA would not be local or recognizable outside of California) might be the most productive sole source to name in a message, at least in short 90-characters WEA messages.** It is also worth pointing out that OCFA is a more local source than Cal EMA, but it may not have been familiar to the bulk of our subjects who came from southern California, but outside of Orange County.

Regression with controls. The results of the five multiple regression equations examined the effects of source in a 90-character WEA message when subject selection criteria were included and, hence, controlled for are presented in Table 11 (see Appendix E). The significant relationships between source and both interpretation and personalization outcomes that were prominent in the simple regressions disappeared when the sample selection criteria were included in the equations (see Table 6 in Appendix A). A statistically significant relationship emerged between source and milling (β=-.221, p=.045). **This suggests that the relationship between message source and warning response is weak at best, and that there actually may not be a best sole source in terms of public outcomes to name in a 90-characters message.**

Think-out-loud interviews and focus groups. **The qualitative research findings also indicated that there might not be a single source that works best for 90-characters messages. This finding also held for 140- and 1,380-chararacters messages that were also investigated qualitatively. Hence, we conclude that no single source will have the same meaning and credibility for all message recipients.** Specifically, most participants cited the Denver Police Department as a more recognizable, believable, and credible source than the U.S. Department of Homeland Security when evaluating the 90- and 140-characters messages. As one participant stated, "When I saw Denver PD, right off, I'm like, okay. Here's an agency I know. Here's somebody that's telling me something's going on. It's Denver PD, it's more likely happening, so it got my attention." However, some participants found the federal source more understandable and believable than the local source because they believed that a radiological hazard warranted a federal response. As one participant stated, "I mean, the first thing I'm seeing is Denver PD. What in the world do they know about radiological warnings that I don't? I mean… I just… I'm not going to take it seriously at all." Other participants were weary of the Denver PD for a variety of personal reasons.

The opposite was found for 1,380-characters messages. Most participants found US DHS a more believable source because the severity of the hazard warranted a federal response. As one participant stated, "When it says Denver Police, I think 'nope, they got hacked or something [meaning that message was not believable].'" In contrast to the Denver community focus groups, emergency management participants unanimously agreed that a local source would be more understandable and/or believable than a federal source across all message lengths. **While source credibility differs among message recipients, and varies based on message length, a local and recognizable sole source *might* work best for most members of the public for most hazards.**

Additional selected participant comments regarding message source are provided in Tables 5-10 in Appendix H.

Community event survey. Results from the community survey showed that 74% (367/496) of WEA recipients identified having received a message from a personal source such as a family member or other relative, neighbor or friend, employer, or coworker, 58% (285/496) received a message from a local source such as the Boulder Police, Boulder Fire Department, Boulder Office of Emergency Management, or Boulder Sheriff's Department, 6% (32/496) received a message from a state source, i.e., the State Governor's office, and 31% (155/496) received a message from a national level source such as the National Guard or National Weather Service. This real world test supported the experiment findings, showing a slight advantage for local sources. Mean believability scores (measured on a 6-point scale) were higher for local sources ($M = 5.61$, $SD = .704$, $N = 285$), than for state ($M = 5.38$, $SD = .907$, $N = 32$), national ($M = 5.53$, $SD = .810$, $N = 410$), and personal ($M = 5.38$, $SD = .874$, $N = 367$) sources. See Table 24 in Appendix E for full results.

Conclusions. There is no way to include a mixed set of message sources (as is suggested by historical research) in a 90-characters WEA message. **Single sources in 90-characters messages had a statistically significant effect on some sense making public response outcomes including interpretation (understanding, believing, and deciding) and personalization, and, hence, likely on protective action-taking.** The quantitative and qualitative findings indicated that local and recognizable sources might be the most productive sole source to name in a WEA message, but further research is needed to confirm these unstable conclusions. Findings here, however, do more conclusively suggest that if a sole source named in a WEA message is not recognizable to the public (e.g., WEA), then a vigorous public education and marketing campaign would be worthwhile. Findings also suggest that there may not be a single sole source that works for all WEA messages. The same conclusions were reached based on qualitative investigations of 140- and 1,380-characters messages.

Future research. If it happens that the nation's wireless emergency alert system adopts "WEA" as the source of wireless emergency alerts, these findings suggest that a vigorous public education campaign would be worthwhile, including formative, process, and outcome evaluation. If it is ever possible that WEA messages can be extended in length beyond 90 characters, research into what would constitute an optimized mixed panel of sources would be desirable. Applied research in local communities could explore what sources are the most understandable and believable for subpopulations in their communities.

Map Inclusion

Purpose. General research on how people interpret maps has been conducted, but little research has been done on how maps included in an alert or warning message might impact outcomes (Dransch, Rotzall, & Poser, 2010; Hagemeier & Wagner, 2009; Mills & Curtis, 2008). We anticipated that the inclusion of maps, the more specific, the better, would facilitate personalization. Experiment 1C was conceived to enable us to compare the relative outcomes of 90-characters WEA messages with: (1) no maps, (2) low information maps (maps that identify the location of the risk but not of the location of the person receiving the message), and (3) high information maps

(indicating the affected and unaffected areas and marking the receiver's location, see Appendix C). These test messages are messages 1, 11, and 12 in Appendix B.

Power. For the fixed model simple linear regression (1 predictor) testing the R^2 deviation from zero conducted for Experiment 1C, to achieve a power of .80 for a medium effect size (.15) and alpha=.05, a sample size of *N*=55 was needed (actual *N*=202). For the fixed model multiple linear regression (5 predictors) testing the R^2 deviation from zero, to achieve a power of .80 for a medium effect size (.15) and alpha=.05, a sample size of *N*=92 was needed (actual *N*=199).

Analysis and Findings.

Elimination of non-promising alternatives. A series of cross tabulations was computed that juxtaposed outcomes against the three experimental map categories (no map, low information map, and high information map). **In all cases, the high information map produced better outcome results than either the low information map or no map.** Respectively, the outcomes for no map, low information map, and high information map comparisons were: 48%, 44%, and 54% for interpretation; 49%, 44%, and 51% for fright; 48%, 43% and 64% for personalization; 55%, 56% and 60% for lament; and 43%, 44%, and 38% for milling. Keep in mind that lower milling rates imply less delay between message receipt and protective action taking and, hence, lower and not higher rates were seen as the optimized result. The high information map was carried forward into the regression analyses.

Regression without controls. The results of the five regressions to examine the effects of inclusion of a high information map, defined as indicating the affected and unaffected areas and marking the receiver's location, along with a 90-characters WEA message, are presented in Table 12 (in Appendix E). **As expected, map inclusion had no effect on fright, lament or milling since none of these relationships were statistically significant. However, the high information map did have a statistically near significant effect on interpretation** (β=.123 and *p*=.081) **and a significant effect on personalization** (β=.158 and *p*=.025)**.** These findings suggest that there would be a benefit from adding a high information map to a WEA message. Doing so would help the public interpret and personalize the worded message, which would (based on historical research), in turn, move people at risk to take protective action.

Regression with controls. The results of the five multiple regressions to examine the effects of the inclusion of a high information map along with a 90-characters WEA message when subject selection criteria were included in the equations are presented in Table 13 (see Appendix E). **Once again, map inclusion had no effect on fright, lament, or milling as none of these relationships were statistically significant. Additionally, the effect of the high information map on interpretation** (β=.121 and *p*=.092) **and personalization** (β=.167 and *p*=.020) **remained stable.**

Think-out-loud interviews and focus groups. **Qualitative findings provided support for the quantitative findings and suggested that inclusion of a high information map can make messages more understandable, believable, and enhance risk personalization. However, inclusion of a map may not influence milling behavior, meaning that the public may still attempt to seek additional information before taking recommended protective actions**. For 90-, 140-, and 1,380-characters messages, the inclusion of a high information map improved understanding, belief, risk personalization, and was cited as preferable. "I think the map lends credibility," said one participant. "For me, the picture [map] really helps to make it believable. I don't know why, but it just kind of gives it that feel that it's professional, or you know, the real deal," said another participant. "I think it's easier to read, but, and I also like the map, and I think there's some entertainment value

when it says 'You,' but I don't know if somehow they GPS'd me and they know I'm in Littleton at the time, but, umm, but I do like that concept of a map even if the map isn't ideal," said another participant. Emergency management participants preferred the inclusion of a high information map across all message lengths.

However, a few other participants stated that the map added little value. For example, "The map doesn't mean anything. It's common sense," said one participant. Other participants explained that inclusion of a high value map would not change their decision-making. "[I'd do] The same thing [after receiving the message with the map], [turn on] radio or TV, try to verify somehow. Telephone, call the police department, something," said one participant. "I'm going to still… I'm going to look at the networks, one of the large networks," said another.

Additional selected participant comments regarding the inclusion of a map are provided in Tables 11-17 in Appendix H.

Community event survey. A total of 199 respondents reported having seen a map (199/461=43%) as part of one or more messages they received about the flood. The correlation between reported map effectiveness and personalization was statistically significant (r=.308, p<.001, DF=173).

Conclusions. The results of the quantitative experiments, corroborated by the qualitative and survey findings, suggest that **it would be wise from a public safety viewpoint for WEA message agencies and carriers to find a way to add a high information map to 90-characters WEA messages and not to include low information maps at all.** High information map inclusion (specifying the areas affected and not affected and the receiver's location) in 90-characters messages had a statistically significant and positive effect on public response outcomes including interpretation and personalization, and, hence, would have a positive effect on protective action-taking. Inclusion of a low information map (specifying the areas affected and not affected, but not the receiver's location) had the opposite effect. The results of the qualitative research indicated that inclusion of a high information map improved most participants' understanding, belief, and risk personalization across all message lengths.

Future research. Visualization research would be worthwhile to determine how to best illustrate hazard and receiver location in maps if consideration is ever given to including maps in a WEA messages.

Relative Importance of Content Elements

Purpose. Historical research supports the conclusion that **there are five key topics to include in an alert and warning message to enhance public response outcomes.** These are:

- *Source* (Drabek & Boggs, 1968; Lindell & Perry, 1987; Mileti & Beck, 1975; Mileti & Darlington, 1995; Stephens, Barrett, & Mahometa, 2013; Sellnow et al., 2012; Vihalemm, Kiisel, & Harro-Loit, 2012; Wray et al., 2008);
- *Guidance* (Drabek, 1999; Mayhorn & McLaughlin, 2012; Mileti & Fitzpatrick, 1992; Sorensen, 1991);
- *Hazard* (Drabek, 1999; Mallett, Vaught, & Brnich, 1993; Neuwirth, Dunwood, & Griffin, 2000; Sellnow et al., 2012; Wray et al., 2008);
- *Location* (Drabek, 1999; King & Cook, 2008; Mileti & Fitzpatrick, 1992); and
- *Time* (Sorensen, Shumpert, & Vogt, 2004).

These are the same topics covered in WEA messages with one exception. Time in the research literature refers to when people at risk should begin or complete taking a protective action; and time in a WEA message refers to when the message expires. However, research has not yet determined if one or some of these topics are more important than others. Experiment 2 was conceived to explore the relative importance of these five WEA message content topics from a public outcomes viewpoint. This was done by comparing outcomes for a message that contained all topics to messages that sequentially excluded one topic at a time. Optimized (based on the results of experiments 1A, 1B, and 1C) 1,380-characters messages were tested because longer messages would help to accentuate the *absence* of content in the experiment. These are test messages 13-18 in Appendix B.

Power. Two multiple regressions were conducted—one with and one without control variables. For the uncontrolled fixed model multiple linear regression (5 predictors) testing the R^2 deviation from zero conducted for Experiment 2, to achieve a power of .80 for a medium effect size (.15) and alpha=.05, a sample size of N=92 was needed (actual N=468). For the fixed model multiple linear regression (9 predictors) testing the R^2 deviation from zero, to achieve a power of .80 for a medium effect size (.15) and alpha=.05, a sample size of N=114 was needed (actual N=464).

Analysis and Findings.

Descriptive outcomes across messages. A series of cross tabulations was computed that juxtaposed outcomes against the test messages. Respectively, the outcomes for messages with all content, source missing, guidance missing, hazard missing, location missing, and time missing were: 52%, 64%, 17%, 47%, 59%, and 58% for interpretation of protective action; 55%, 70%, 60%, 33%, 53%, and 68%, for interpretation of risk; 51%, 60%, 53%, 47%, 46%, and 48% for fright; 50%, 62%, 54%, 33%, 44%, and 54% for personalization; for 48%, 65%, 59%, 37%, 40%, and 51% lament; and 46%, 40%, 66%, 50%, 50%, and 40% for milling. **These results suggested that the *guidance* and *hazard* elements of the contents of alert and warning messages are more important in terms of public outcomes than the other tested elements.** For example, when guidance was absent, only 17% of the subjects were above the median regarding interpreting what protective action to take, but milling was very high (66%). Please recall that a high milling score implies delay in protection action-taking. And when hazard information was absent, only 33% of the subjects were above the median regarding interpretation of risk and the number was also low (33%) for personalization which is another key motivator for people to take action to protect themselves.

Regression without controls. The results of the multiple regression equation that examined the effects of the test messages in comparison to the message that included all elements are presented in Table 14 (see Appendix E). **The same two message factors of guidance and hazard stood out as the key message elements compared to the rest when examined using multiple regression analysis.** When guidance (describing what the public should do and how to do it) was omitted, the effect on interpreting what protective actions to take was negative, relatively strong, and statistically significant (β=-.481, p=<.001), and a significant effect on milling was also observed (β=.161, p=.006). When a description of the hazard (describing the physical event) was omitted, there were significant effects on interpreting the risk (β=.276, p=<.001), personalization (β=-.135, p=.022), and lament (β=-.118 p=.045).

Regression with controls. The results of a series of multiple regression equations that examined the effects of different test messages when subject selection criteria were included and, hence, controlled for are presented in Table 15 in Appendix E. **Guidance and hazard remained the key message elements when examined using multiple regression to control for subject selection criteria. The findings were unchanged from the analysis without control variables.** When guidance (describing what the public should do and how to do it) was omitted,

the effect on interpreting what protective actions to take remained negative, relatively strong, and statistically significant (β=-.464, *p*=<.001), and a significant effect on milling also was observed (β=.154, *p*=.009). When a description of the hazard (describing the physical event) was omitted, the significant effects on interpreting the risk (β=-.265, *p*=<.001) and personalization (β=-.135, *p*=.023) remained. There also was a statistically near significant relationship with the emotion of lament (β=-.114, *p*=.055). In addition, a new significant relationship emerged for interpreting what protective actions to take (β=-.071, *p*=.017). When message source was omitted, the relationship with fright was near significant (β=.104, *p*=.079).

Think-out-loud interviews and focus groups. **Qualitative findings underscored the greater importance of the guidance and hazard elements of messages compared to source, location, and time.** Specifically, for 90-characters messages, most participants indicated that additional protective action guidance and/or information about the hazard was desirable. Strong evidence for this claim comes from the think-out-loud interview: Participants consistently remarked about the lack of hazard and/or guidance specificity of the 90-characters messages. One participant stated, "I don't know what shelter is. I mean, I would assume some buildings are safer than other buildings." Notably, fewer participants asked for additional information about the hazard or protective action guidance for the 140-characters messages. Participants for the 140-characters messages instead tended to critique the messages for their ambiguity concerning time, location, source, and especially acronyms, perhaps because the 140-characters messages contained more information about guidance and hazard than about these factors. For the 1,380-characters messages, comments also related more to the format, length, and intensity of the messages, rather than to the presence/absence or relative importance of content elements (although some participants did express that they wanted additional information about the hazard and its consequences). Emergency management participants also stressed the need for sufficient information about the protective action guidance and hazard. Even for this group of trained professionals, insufficient information in the 90- and 140-characters messages generated intentions to mill, that is, seek additional information prior to taking a protective action. As one participant stated, "I absolutely agree with [two other participants], even as an emergency manager, I don't think I would take shelter first. I think I would try to get more information, and then go and do it."

Additional selected participant comments regarding the relative importance of message contents are provided in Tables 18-20 in Appendix H.

Community event survey. The regression analysis of community survey WEA recipient data found that the amount of information that messages contained about three message elements—what actions respondents should take to protect themselves (β=.221, *p*<.001), what locations would flood (β=.138, *p*=.027), and by when respondents were expected to take action (β=.204, *p*=.001)—correlated with message interpretation. The amount of information messages contained about guidance (β=.202, *p*=.001) and by when respondents were expected to take action (β=.191, *p*=.004) correlated with message personalization.

The same regressions were repeated using behavioral outcomes (i.e., reported delay before initiating the protective actions, checking local media and avoiding flood areas) rather than the cognitive outcomes, interpretation and personalization. When delay until initiating protective action was regressed against the amount of information provided on these same message elements, a somewhat different but related pattern of results emerged. In this case, the amount of information about when the flood was expected was the only statistically significant correlate of delay to begin avoiding flood areas (β=-1.95, *p*=.021); the more information was received, the shorter the delay to protective action taking. See Tables 25-28 in Appendix E for the full data tables.

Conclusions. The message content elements of *guidance* (telling people what to do and how to do it) and *hazard* (describing the physical event) seem to play major roles relative to other message elements in impacting—in

different ways—the outcomes of public interpretation of the protective action recommendation, interpretation of risk, and personalization. The message element of *guidance* also seems to reduce milling (which causes a delay in protective action-taking). These findings affirm and provide an explanation for experiment 1A findings: Placing guidance and hazard up front in a 90-characters WEA message—instead of in the middle or the end of a message—optimized outcomes because they are most important from a public outcomes viewpoint. The community survey results replicated the relative importance of the guidance component of messages (telling people what to do) on cognitive outcomes. Translating these findings to behavioral outcomes, telling people the time by which they are expected to begin initiating those protective actions can be understood as part of the guidance in that telling people how much time they have implies taking the given action. In other words, telling people the time they are expected to begin taking protective action elaborates the guidance to take the action. **The quantitative and qualitative findings suggest a *core content of a public alert and warning: Tell people exactly what to do (guidance), describe why they should do it (hazard), and when (time).*** Those who prepare future public alert and warning messages might consider emphasizing these content topics, but not to the exclusion of the others.

Future research. Research is needed into how visualizations can be used to help supplement and enhance the communication of guidance (protective action) and hazard (the risk) in 90-characters WEA messages. Research should also look at whether minimally expanding WEA message length (i.e., to 280 characters) enhances the communication of guidance and risk.

Generalizing across Hazard Types

Purpose. The research record is populated with studies of public response to alert and warning messages across different hazard. Examples include:

- A*cts of terrorism* such as the World Trade Center Towers on 9/11 (Averill et al., 2005);
- N*atural hazard*s like:
    - Floods (Drabek & Boggs, 1968; Mileti & Beck, 1975),
    - Hurricanes (Haas**,** Cochrane, & Eddy, 1977),
    - Tornadoes (Comstock & Mallonee, 2005),
    - Tsunamis (Lachman, Tatsuoka, & Bonk, 1961),
    - Volcanoes (Saarinen & Sell, 1985), and even
    - Earthquake Forecasts (Mileti & O'Brien, 1992);
- *Technological events* such as the accident at Three Mile Island (Cutter & Barnes, 1982);
- *Biological agents* (Wray et al., 2008);
- *Chemical agents* (Vogt & Sorensen, 1999); and
- *Building fires* (Kuligowski et al., 2012).

Three observations from this research record are salient for experiments 3A, 3B, and 3C. First, observed public responses can widely vary across events within and across hazard types, for example, the number of people who

engage in "shadow evacuation" (safe people who evacuate) can be high (Ziegler & Johnson, 1984) or low (U.S. Fire Administration, 1987). Second, **the content topics of alert and warning messages that influence public outcomes are the same across hazard and event types** (Mileti & Sorensen, 1990). Third, **strong alert and warning messages in terms of adequately stated source, guidance, hazard, location, and time overshadow the effects of non-message factors that can also influence public response, e.g., gender, race and ethnicity, experience, pre-event risk perception and knowledge, and more** (Mileti & Sorensen, 1990).

Experiments 3A, 3B, and 3C were designed to test whether significant relationships between message content topics (source, guidance, hazard, location, and time) and outcome types (interpretation, fright, personalization, lament, and milling) were the same, respectively, for 90, 140, and 1,380-characters messages across different hazard types. A finding of no statistically significant differences would indicate that messages influence outcomes the same way regardless of message length or hazard type.

Hazards investigated. Three hazards were selected for experimental comparisons: radiological, shooter, and tsunami. These hazards were sufficient to generate variation in key non-message characteristics that can influence the message outcome factors under investigation as follows.

- *Pre-event risk perception* can influence how people make sense of an alert or warning message (Mileti & O'Brien, 1992; Perry, Greene, & Mushkatel, 1983; Sharma, Patwardhan, & Parthasarathy, 2009; Windham et al., 1977). Pre-event risk perception is highest for radiation and lower for shooter and tsunami.

- *Pre-event hazard knowledge* also influences alert and warning message sense making (Glik et al., 2004; Haas, Cochrane, & Eddy, 1977; Lehto & Miller, 1986; Villegas et al., 2013). Pre-event knowledge about the hazard and protective actions are higher for shooter and tsunami and lower for radiation.

- *Environmental cues* also influence alert and warning message sense making (Averill et al., 2005; Flynn, 1979; Mack & Baker, 1961; Rogers & Nehnevajsa, 1987). Radiation is invisible, shooters are not, and the tsunami type investigated would lack environmental cues until its arrival.

- *Experience* also impacts alert and warning message sense making (Breznitz, 1984; Comstock & Mallonee, 2005; Donner, Rodriguez, & Diaz, 2007; Haas, Cochrane, & Eddy, 1977; Huang et al., 2012; University of Oklahoma Research Institute, 1953; Mileti & O'Brien, 1992). Although it was unlikely that experimental subjects had experience with any of the selected study hazards, all three hazards have occurred relatively recently and were followed by extensive media coverage such that experimental subjects might have had varied exposures to the stories reported.

Test messages. The influence of message content factors (source, guidance, hazard, location, and time) on outcomes (interpretation, fright, personalization, lament, and milling) across hazard types for *90-characters messages* (experiment 3A) was assessed using optimized messages based on the results of experiments 1A, 1B, and 1C (see messages 19-21 in Appendix B). Respectively, the optimized messages for *140- and 1,380-characters messages* in experiments 3B and 3C are messages 22-24 in Appendix B and messages 13, 25, and 26 in Appendix B.

Power: Experiments 3A, 3B, & 3C. For the fixed model uncontrolled linear regression (2 predictors) testing the R^2 deviation from zero conducted for Experiments 3A, 3B, and 3C, to achieve a power of .80 for a small to medium effect size (.10) and alpha=.05, a sample size of N=100 was needed (actual N=247, 253, and 267 for experiments 3A, 3B, and 3C, respectively). For the fixed model multiple linear regression (6 predictors) testing

the R^2 deviation from zero, to achieve a power of .80 for a small to medium effect size (.10) and alpha=.05, a sample size of *N*=143 was needed (actual *N*=247, 253, and 267 for experiments 3A, 3B, and 3C, respectively).

Analysis and Findings.

Descriptive outcomes for 90-characters messages. Respectively, the outcomes for the radiological hazard, active shooter, and tsunami messages were: 28%, 33%, and 51% for interpretation; 52%, 51%, and 37% for fright; 43%, 33%, and 52% for personalization; 40%, 46%, and 44% lament; and 67%, 53%, and 52% for milling. These results suggested that there are some differences in outcomes across messages for different hazards for the three sense elements of interpretation, personalization, and milling.

Descriptive outcomes for 140-characters messages. Respectively, the outcomes for the radiological hazard, active shooter, and tsunami messages were: 34%, 54%, and 51% for interpretation; 51%, 48%, and 37% for fright; 46%, 41%, and 62% for personalization; 49%, 64%, and 28% lament; and 68%, 38%, and 46% for milling. These results suggested that there are some differences in outcomes across messages for different hazards for two of the sense elements (interpretation and milling) as well as the emotion of lament.

Descriptive outcomes for 1,380-characters messages. Respectively, the outcomes for the radiological hazard, active shooter, and tsunami messages were: 62%, 59%, and 74% for interpretation; 52%, 59%, and 47% for fright; 57%, 59% and 52% for personalization; 47%, 76%, and 33% lament; and 51%, 52%, and 48% for milling. These results suggested that there were no differences regarding the three sense making elements of interpretation, personalization, and milling; however, they also suggest that differences existed for the emotions of fright and lament.

Regression without controls for 90-characters messages. The results of the five regression equations to examine the effects of 90-characters messages for the alternative hazards of active shooter and tsunami in comparison to the radiological hazard on the outcomes of interpretation, fright, personalization, lament, and milling are presented in Table 16 (in Appendix E). Statistically significant differences emerged for the tsunami hazard regarding interpretation (β=.335, *p*=<.001), personalization (β=.149, *p*=.039), and milling (β=-.197, *p*=.007). One near significant relationship existed for the active shooter hazard with milling (β=-.130, *p*=.075). These finding suggest that variation in hazard type influenced 90- characters messages' outcomes in different ways for different hazards. This indicates that 90-characters messages were not able to overcome the effects of pre-event perceptions for different hazards, which are likely based on factors such as experience, perceived risk, and knowledge. Hence, 90-characters messages do not result in standardized message sense making outcomes and are influenced by hazard type.

Regression without controls for 140-characters messages. The results of the five regression equations to examine the effects of 140-characters messages for the alternative hazards of active shooter and tsunami in comparison to the radiological hazard on the outcomes of interpretation, fright, personalization, lament, and milling are presented in Table 17 (in Appendix E). Statistically significant differences emerged for the tsunami hazard regarding interpretation (β=.290, *p*=<.001), lament (β=-.162, *p*=.026), and milling (β=-.229, *p*=.002). For the active shooter hazard, two significant relationships existed for interpretation (β=.249, *p*=.001) and milling (β=-.297, *p*=<.001); and one near significant relationship existed with lament (β=.141, *p*=.052). These findings suggest that variation in hazard type influenced 140-characters messages' outcomes in different ways for different hazards. This indicates that 140-characters messages were also not able to overcome the effect of pre-event perceptions for different hazards, which are likely based on factors such as experience, perceived risk and knowledge. Hence,

messages of 140-characters appear to not result in standardized message sense making outcomes and are influenced by hazard type.

Regression without controls for 1,380-characters messages. The results of the five regressions to examine the effects of 1,380-characters messages for the alternative hazards of active shooter and tsunami in comparison to the radiological hazard on the outcomes of interpretation, fright, personalization, lament, and milling are presented in Table 18 (in Appendix E). No statistically significant differences emerged for any of the sense making relationships for any of the comparison hazards. Two statistically significant relationships existed for the active shooter hazard for the emotion of fright (β=.153, *p*=.031), and with the emotion of lament (β=.318, *p*=<.001). These findings suggest that variation in hazard types had no impact on the sense making outcome factors examined. They also suggest that 1,380-characters messages (which provide more information than 90- or 140-characters messages) help people *overcome pre-event hazard-specific perceptions* based on factors such as experience, pre-event perceived risk, and knowledge. Hence, in contrast to shorter messages, messages of 1,380 characters in length *can* result in standardized message sense making outcomes regardless of hazard type. However, 1,380-characters messages also can result in different emotional outcomes for different hazards, which is to be expected. Different hazards are likely to elicit different emotional reactions based on any number of factors including, for example, recent news coverage about similar events.

Regression with controls for 90-characters messages. The results of the five multiple regression equations to examine the effects of 90-characters messages for the alternative hazards of active shooter and tsunami in comparison to the radiological hazard on the outcomes of interpretation, fright, personalization, lament, and milling while controlling for the subject selection criteria of gender and race/ethnicity are presented in Table 19 in Appendix E. The findings that emerged were virtually identical to the regression results obtained without control variables in place. Statistically significant differences emerged for the tsunami hazard regarding interpretation (β=.337, *p*=<.001), personalization (β=.149, *p*=.041), and milling (β=-.190, *p*=.010). One near significant relationship existed for the active shooter hazard with milling (β=-.126, *p*=.087). These finding reaffirm the finding that variation in hazard type influenced message outcomes in different ways for different hazards indicating that 90-characters messages were not able to overcome the effect of pre-event perceptions of different hazards likely based on pre-event factors such as experience, perceived risk, and knowledge. Messages of 90 characters in length do not result in standardized message sense making outcomes and are influenced by hazard type.

Regression with controls for 140-characters messages. The results of the five multiple regression equations to examine the effects of 140-characters messages for the alternative hazards of active shooter and tsunami in comparison to the radiological hazard on the outcomes of interpretation, fright, personalization, lament, and milling while controlling for the subject selection criteria of gender and race/ethnicity are presented in Table 20 (in Appendix E). The findings that emerged were virtually identical to the regression results obtained without control variables in place. Statistically significant differences emerged for the tsunami hazard regarding interpretation (β=.284, *p*=<.001), lament (β=- .150, *p*=.040), and milling (β=-.242, *p*=.001). Three statistically significant relationships were present for the active shooter hazard with interpretation (β=.253, *p*=.001), lament (β=.152, *p*=.036) and milling (β=-.307, *p*=<.001). These finding reaffirm the finding that variation in hazard type influenced message outcomes in different ways for different hazards indicating that 140-characters messages were not able to overcome the effect of pre-event perceptions of different hazards likely based on pre-event factors such as experience, perceived risk, and knowledge. Messages of 140 characters in length do not result in standardized message sense making outcomes and are influenced by hazard type.

Regression with controls for 1,380-characters messages. The results of the five multiple regression equations to examine the effects of 1,380-characters messages for the alternative hazards of active shooter and tsunami in comparison to the radiological hazard on the outcomes of interpretation, fright, personalization, lament, and milling while controlling for the subject selection criteria of gender and race/ethnicity are presented in Table 21 (in Appendix E). No statistically significant differences emerged for relationships with the sense making outcomes of interpretation, personalization, and milling. Two near significant relationships existed with interpretation (β=.122, *p*=.086) and the emotion of fright (β=.133, *p*=.058), and one significant relationship was present with the emotion of lament (β=.316, *p*=<.001). These findings reaffirm the findings that variation in hazard type had no impact on the sense making outcomes of interpretation, personalization, and milling. They also suggest that 1,380-characters messages (which provide more information than 90- or 140-characters messages) help people *overcome pre-event hazard-specific perceptions* based on factors such as experience, pre-event perceived risk, and knowledge. Hence, messages of 1,380 characters in length *do* result in standardized message sense making outcomes regardless of hazard type. However, these findings also suggest that hazard type does impact the emotions of fright and lament, which was revealed while controlling for subject selection factors such as gender.

Think-out-loud interviews and focus groups. The focus group format could not accommodate exploration of more than one hazard since multiple hazards would have increased the time needed to perform the focus groups beyond reasonable limits. Hence, only the radiological hazard was examined, and generalizability across hazard types was not assessed. Cross-hazard generalizability was examined in the emergency management focus group. One emergency management professional raised the point that a WEA recipient's prior knowledge of hazard types could influence milling behavior: "One thing that would make the determination in my mind—whether I took immediate action or attempted to verify—is what the hazard is. If you tell me 'active shooter,' 'flash flood,' something that I understand could have immediate consequence to me, I would do that [take protective action] before attempting to verify. But for a hazmat, for radiological, for something that, to me, in my frame of reference, maybe I didn't quite understand, I would attempt to verify." **Nevertheless, emergency management focus group participants unanimously agreed that content elements and order should, ideally, remain consistent across hazard types given the challenges of attempting to customize message elements to particular hazards.** "I don't think it [message content structure] should [differ across hazard types]," said one participant. "Do you reorder the pieces of the message based on the hazard? I don't think so because I think, then, even just from a data collection standpoint, how do you know the effectiveness of one message versus another, if you're constantly changing it, asked another." "I think that's a standardization piece that you learn; part of that public information," said a third.

Conclusions. Short messages that are 90- and 140-characters seem to be substantially less effective at helping people overcome their *pre-event hazard-specific perceptions* and, consequently, likely would be less effective than longer messages of 1,380 characters at guiding people to take protective actions appropriate to the risk they face in an actual event. The content elements of 1,380-characters messages delivered over mobile communication devices seem to have standardized effects on outcomes *regardless of hazard type* (generalize across hazards). However, 90- and 140-characters messages do not. Shorter messages likely do not contain sufficient information to overcome people's *pre-alert and warning event perceptions* of different hazards based on personal experience, perceived risk, and knowledge which may or may not match the event they face. Hence, 90- and 140-characters messages offer less to help effectively manage public protective action-taking than messages that are 1,380 characters.

Future research. Research is needed to determine the character and intensity of public education that might yield effective public response to short WEA messages. This research could begin with exploring analogous events

such as effective public response to earthquake early warnings in Japan, and public radiological impact readiness in America during the Cold War.

Message Length Efficacy

Purpose. Publicly available general research on how the character length of alert and warning messages impact public perception and response behavior does not exist. General communication practice suggests that shorter is better, but practice based on merchandizing and consumer sales may not transfer to community wide alerts and warnings. Historical research on public alert and warning response suggests that messages that provide people with sufficient details about what to do, how to do it, and why they should do it, work best (Mileti & Sorensen, 1990) at motivating protective action taking. Given the arrival of mobile alerts and warnings, an investigation of the role that message length plays on public response outcomes is timely.

Power. Two multiple regressions were conducted—one with and one without control variables. For the uncontrolled fixed model multiple linear regression (3 predictors) testing the R^2 deviation from zero conducted for Experiment 4, to achieve a power of .80 for a medium effect size (.15) and alpha=.05, a sample size of *N*=77 was needed (actual *N*=155). For the fixed model multiple linear regression (9 predictors) testing the R^2 deviation from zero, to achieve a power of .80 for a medium effect size (.15) and alpha=.05, a sample size of *N*=103 was needed (actual *N*=147).

Analysis and Findings.

Descriptive outcomes for message length. Respectively, the outcomes for the standard WEA and the optimized 90, 140, and 1,380-characters messages were: 33%, 44%, 43%, and 80% for interpretation; 46%, 50%, 57%, and 43% for fright; 38%, 59%, 37%, and 66% for personalization; and 54%, 52%, 54%, and 29% for milling. These results suggest that there are large differences in the outcomes of interpretation, fright, personalization and milling across different message lengths compared the standard WEA message. The 1,380-characters message yielded increased levels of interpretation, and personalization and decreased delay time spent milling. The opposite was the case for shorter messages as compared to the standard 90-characters WEA message. Thus, 1,380-characetrs messages would lead to maximized public protective action response taking because of the effect on the intervening factors of interpretation, personalization, and milling.

Regression without controls. The results of the four multiple regressions comparing the effects of optimized messages of three different lengths to the standard 90-characters WEA message on response outcomes are presented in Table 22 (see Appendix E). **The 1,380-characters optimized message showed better outcomes for interpretation, personalization, and milling, than did the standard 90-characters characters WEA message; all of these relationships were statistically significant** (β=.417 and *p*=<.001; β=.246 and *p*=.012; β=-.351 and *p*=<.001, respectively)**.**

Regression with controls. The results of the four multiple regressions comparing the effects of optimized messages of three different lengths to the standard 90-characters WEA message on response outcomes when subject selection criteria were included in the equations are presented in Table 23 (see Appendix E). **Again, the 1,380-characters optimized message showed better outcomes for interpretation, personalization and milling, than did the standard 90-characters WEA message; all of these relationships were statistically significant** (β=.385 and *p*=<.001; β=.234 and *p*=.017; β=-.332 and *p*=.001, respectively)**.**

Think-out-loud interviews and focus groups. **Longer messages improved understanding and slightly reduced milling**. The 90- and 140-characters messages may, for most people, contain too little information about the hazard and too little guidance compared to the 1,380-characters message. One participant who received the 90-characters message stated, "To me, it's not specific enough." Another claimed, "I don't think there's enough information in either one of these [standard or optimized] to really follow." For 140-characters messages, some participants also found these insufficiently detailed. Nevertheless, as indicated in Table 22 in Appendix H, 140-characters messages appeared to slightly reduce milling – searching for additional information—when compared to 90-characters messages because they contained more information. In contrast, shorter messages seemed to delay protective action because people said they would spend more time searching for information before they act to protect themselves.

Some participants found the 140-characters messages understandable and sufficient. One participant stated, "I think the message is perfect as is, because it's pretty short and concise. If you do a whole paragraph, no one's going to read it. They just may be freaking out, nuclear explosion! So the shorter it is, the more likely people are to really take the message." Another stated, "For me personally, I understand the message, so I don't really need anything longer." However, most participants reported that the 1,380-characters messages significantly improved their understanding. Nevertheless, despite the historical evidence that more informative messages work best, even professional emergency managers voiced preference for 140-characters messages rather than 1,380-characters messages. They also argued that the 90-characters message was too short, but they were concerned that the 1,380-characters message might be too long. While the emergency management participants acknowledged that only the 1,380-characters messages contained enough information to enable people to take actions that would maximize their health and safety, they nevertheless stated that 140-characters messages were preferable. "It's because of our background. We know that the probability of them reading—we've already learned that they don't read, and the attention—it's a sound byte society," explained one participant. Additional selected participant comments regarding message length are provided in Tables 21-24 in Appendix H.

Conclusions. The scientific evidence assembled led to the conclusion that messages that are 1,380-characters produce optimized interpretation, personalization and milling outcomes, and would likely yield maximized public protective action-taking behavior. Shorter messages that are 90- and 140-characters seem to be less effective at guiding people toward protective action taking. There is nothing inherently better about 1,380-characters messages. What is likely the case is that people need to be provided with sufficiently detailed information about exactly what steps to take to protect themselves, and the number of characters needed to accomplish this likely varies across hazards. **Participant and professional emergency manager opinions, however, led to the conclusion that 140-charactres messages were the most desirable. This reveals what may be an American alert and warning dilemma: Should alert and warning message lengths be based on knowledge gained by application of the scientific method, or on beliefs and opinion gained in other ways?**

Future research. Translation research is needed to help bridge the divide between the opinions and beliefs of emergency managers and the scientific record about optimal alert and warning message length. A well designed workshop should be conducted that brings together key alert and warning researchers and practitioners to consider the most productive pathway forward to resolve the divide that now exists regarding alert and warning message length.

Conclusions

Short alert and warning messages (90- and 140-characters messages) are unique and unlike any others: The optimized order of their contents is unique; their limited length constrains public understanding of the source of

the message; people are less able to understand if the message is meant for them; the key content elements of guidance (describing what to do and how to do it) and hazard (describing why they should do it) cannot be adequately communicated; and short messages cannot overcome people's pre-event hazard-specific perceptions. Hence, to be effective at motivating public protective action taking, the short messages in use today rely on information provided by others.

There are pathways forward to optimize today's wireless emergency alert messages: An alternative order of message contents could be put into practice, message sources of a particular kind could be selected, and a public education and marketing campaign about the WEA system could be conducted.

The project's findings provide concrete insights to help imagine optimized wireless emergency alert and warning messages that could exist in the future. These messages would not rely on information provided by others, but would instead be sufficient to motivate public protective action taking on their own. These messages, in addition to putting into practice an alternative order of message contents, selecting message sources of a particular kind, and conducting a public education and marketing campaign about the WEA system, as optimized messages of the future, could also include high information maps, indicate more precisely by what time people should begin taking recommended protective actions, and allow for up to 1,380-characters in message length.

Add-on Research Questions' Findings

Introduction

This research sought answers to seven add-on research questions. The questions were generated during the project workshop of agency representatives, academic researchers, and practitioners held in Washington, D.C. during November of 2012, and they were investigated using focus groups. They were:

- Would there be benefit from including a URL in Wireless Emergency Alert (WEA) messages?
- How familiar are people with WEAs?
- Do people understand the acronyms that are currently included in WEAs?
- How might time best be expresses in a WEA message?
- How might location best be expressed in a WEA message?
- Is there an optimum level of fear arousal in public recipients of messages?
- How well do people understand the alert and warning concepts used in messages?

The conclusions to these questions reported in this chapter will be subjected to a final level of testing, to the extent possible, in Phase III of this project following an actual community alert and warning event to determine whether or not they transfer into the real world.

Inclusion of a URL

Purpose. Ever since the initial discovery (Drabek & Boggs, 1968; Drabek, 1969) that people who receive alert and warning messages typically engage in a search for additional information to confirm information and to make sense out of the situation, milling has been empirically documented to preceded public protective action taking (Ball-Rokeach, 1973; Griffin, Dunwoody, & Neuwirth, 1999; Hodler, 1982; Mileti & Darlington, 1997; Quarantelli, 1984; Turner & Killian, 1987). A logical extension of this tendency in today's world of wireless emergency alerts and warnings was to determine if referring people to a URL would facilitate the natural human tendency to mill, but to do so electronically, seemed worthwhile.

Analysis and findings. Participants were asked about the possible inclusion of a URL (uniform resource locator) directing them to additional information. Almost all participants agreed that inclusion of a URL would be desirable, and this was true regardless of message length. However, some participants indicated that inclusion of a URL was not as important as an instruction to check media because participants who did not own a smart phone noted that inclusion of a URL would not be helpful for them. Some participants worried that a URL could be misinterpreted as possibly containing a virus. Below are examples of suggestions by participants who considered 90-characters messages:

"I would think that, like, overall a phone number or a radio station or something more reliable would be, like, better."

"You know how in the national parks you'll be driving through and it'll say, there'll be those blue signs that will say, like, turn to channel 548 for weather conditions or something. If they had room to put something like that in there."

"Could they send a follow up? The character – 90 characters – say 'if you need information on shelter, ask here or look here or here's where to go.'"

"Could the link, could it not just be a link but could the address also be there so you could access it via your email if you were near your computer?"

For 140-characters messages, participants also valued a URL and described how it should look:

"[Moderator] What about the inclusion of a URL? To take you to another site where you could get more information? Everybody's, almost everybody's nodding their head."

"I think it needs to end in like a .gov."

"Bold letters."

"Maybe a different color, so that it really stands out."

"Like it begins with h-t-t-p-s."

For 1,380-characters, participants unanimously agreed that inclusion of a URL with additional information was a good idea.

Community event survey. A third (34%) of WEA message recipients (141/418) reported that they had received one or more messages containing a hyperlink, and 66% (277/418) had not (an additional 78 could not recall). Of those who received a message containing a link, 65% (90/138) followed the link, and 35% (48/138) did not (an additional 3 individuals could not recall). Of those who followed the link, the amount of time spent viewing the linked content ranged from 1 to 240 minutes (M=47.51 minutes, SD=55.647, N=84).

Delay before checking local media was shorter for those who received one or more messages containing a link (M=-99.97 minutes, SD=511.204, N=104) compared to those who did not (M=14.80 minutes, SD=567.068, N=195), but this only approached statistical significance (t = 1.721, df = 295, p = .086). Delay before avoiding flood areas also was shorter for those who received one or more messages containing a link (M=112.18 minutes, SD=629.184, N=90) compared to those who did not (M=298.36 minutes, SD=633.854, N=150), and this was statistically significant (t = 2.209, df = 238, p = .028).

Conclusion. Consideration should be given to including a URL in wireless emergency alert and warning messages regardless of message length. This finding is consistent with the long-standing historical observation that people who are warned engage in a search for additional information before taking a protective action. Inclusion of a URL in alerts and warnings might reduce or increase the delay in taking a protective action after message receipt.

Future research. The causal nature of these relationships should be investigated. Research on how the inclusion of a URL in wireless emergency alert and warning messages influences perceptual and behavioral outcomes, as well as how the inclusion of a URL might shorten or lengthen public response delay time, is needed.

Familiarity with the WEA System

Purpose. The research record on public response to alert and warning messages has repeatedly found that pre-event knowledge about a hazard, a protective action, and about the alerts and warning that could one day be received is significantly related to protective action behavior (Glik, Harrison, Davoudi, & Riopelle, 2004; Haas et al., 1977; Lehto & Miller, 1986; Villegas et al., 2013). Consequently, an investigation of people's familiarity with the relatively new WEA system was deemed to be important.

Analysis and findings. Participants for the 90-, 140-, and 1,380-characters messages were asked about their familiarity with WEA messages. Most participants were unfamiliar with them. Some participants were familiar with other text-based warning messages as a result of participation in various opt-in alert and notification systems. Others had previously received Amber Alerts on their mobile devices. Several participants implied that improved public education about WEA messaging could potentially decrease the amount of time spent searching for additional information upon receiving a message. Other participants, however, expressed concern or disbelief that the technology or warning officials were capable of determining the physical location of individual mobile devices, reflecting a lack of understand of how the WEA system works. Below are examples of participants' comments regarding their familiarity with WEAs.

> "And in the case of a national emergency, all of a sudden they're going to calculate hundreds of thousands of locations to send those of us a personalized message? That's Santa Claus [make believe]."
>
> "First of all, just seeing the, I don't know if uh this is like my cell phone, and I actually had, and I was used to getting the, a message of this kind of text, that would be one thing. But since I haven't before, it's the first time I'm seeing it, that is a degree of ambiguity, just lack of, um, any prior exposure. And lack of any degree of being used to something like that."
>
> "I was thinking this was something we would have signed up for, I'm hoping, because if this just came on my phone, I might be a little bit, you know, think somebody's playing a joke on me or something. But I'm hoping I signed up for this […]."
>
> "I think it's a general message, sent, it might be to a geographic area, but not me in particular, or you know. It could be just everybody, even."
>
> "So they can track where I am, and I was just looking at it and I was wondering if they are."

Community event survey. The average level of self-reported knowledge about public mobile alerts and warnings before the flood was 4.17 (*SD*=1.619, *N*=495) for WEA message recipients and 3.46 (*SD*=1.839, *N*=595) among the general population. This was measured using a 6-point scale ranging from 1= "not knowledgeable" to 6="extremely knowledgeable." Among the WEA sample, a third (34%, 168/495) could be classified as "not knowledgeable;" among the general population, half (51%, 304/595) could be classified as "not knowledgeable." Before the flood occurred, the number of WEA messages respondents had received ranged from 0 to 100, with an

average of 4.73 (*SD*=11.923, *N*=479) for WEA recipients, and an average of 3.20 (*SD*=10.664, *N*=583) for the general population.

Conclusion. There appears to be a lack of public familiarity with the WEA system. One might hypothesize that this lack of familiarity would play a role in the effectiveness of the system when in use. The general population and Boulder Flood WEA alert recipients, alike, had low experience with prior WEA messages.

Future research. Research on the effect of prior knowledge about the WEA system on public response outcomes, including response delay, is needed. **If it is determined that prior knowledge improves public response, then a campaign to educate the public about the WEA system would be appropriate.** Prior knowledge of the WEA system may well help recipients make sense of and respond to WEA messages.

Understanding Acronyms

Purpose. Understanding or attaching personal meaning to the contents of an alert or warning message has long been demonstrated in the research record to be a key intervening factor that links a message with protective action taking. Studies that document the effect of message content and style factors on understanding include: Lachman et al. (1961); McGee & Gow (2012); Mikami & Ikeda (1985); and Quarantelli (1984). Studies that document the effect of non-message factors on understanding include: Diggory (1956); Nehnevajsa (1985); and Oliver & Reardon (1982). Studies that document the effect of understanding on protective action-taking behavior include: Hammarstrom-Tornstam (1977); McGee & Gow (2012); and Perry (1982). Since WEA messages require that acronyms are used to identify the source of the message, an investigation of people's understanding of those acronyms was conducted.

Analysis and findings. Participants were asked about their understanding of the acronyms that currently are used in WEA messages, such as "Denver PD," "US DHS," and "MDT." While some participants understood the meaning of these acronyms, others did not. For example, several participants expressed that the acronyms used in 90-characters WEA message might cause confusion.

> "I don't know, it says PD take shelter, I'm asking what is 'PD,' and the rest of it, I would just be looking for more information as well."
>
> "With all the acronyms there, I would spell out Police Department."
>
> "That 'DHS,' that was very ambiguous."

For 140-characters messages, participants expressed similar sentiments:

> "And a minor note, I got a little tripped up on MDT, and US DHS took me awhile. It's Department of Homeland Security. Those kinda tripped me up for a second, but yeah."
>
> "I was confused. It [US DHS] looks like something, since I'm a mom, it's looks like something on the meat or something I buy. That's the first thing that comes into my mind. Because, I'm a mom."
>
> "And I'm thinking about all the middle school kids that have texts and smart phones and stuff now. Those kids obviously have no idea what that stuff is."

Participants in the 1,380-characters messages, focus groups also expressed similar sentiments:

> "Right, what is MDT? I, I never, it sounds silly, I'm like, you know when I was on the recording, I was like 'MDT… Mountain Stan'… no, it's not that. I'm like, what is that? What does that mean? I felt kind of silly."

Community event survey. The community survey allowed us to test residents' familiarity with the NWS acronym. Among WEA recipients, 72% indicated that before receiving the WEA message, they believed 'NWS' stood for the National Weather Service (310/429), 12% said some other phrase (51/429), and 16% did not know (68/429).

Conclusion. The public many have little or no understanding of some of the acronyms used in WEA messages. Hence, consideration should be given to modifying the system to discontinue the use of acronyms, educate the public about their meaning, or increase the message length to allow for full text descriptions rather than acronyms. There may be unique exceptions. For example, NWS is an acronym that may be more familiar to the public than others. Among WEA message recipients in the Boulder Flood event, 72% were familiar with the NWS acronym. It is likely that in tornado alley, members of the public are well aware that NWS represents the National Weather Service.

Future research. Research on the best strategy for addressing response delays attributable to unfamiliar acronyms is warranted.

How to Best Express Time

Purpose. A synthesis of the research record on public response to alerts and warnings reveals that time is an important message element, along with others. Time is part of providing an at risk public with adequate guidance. A reasonable synthesis of what research concludes on this topic is: tell people what they should do to maximize their health and safety, exactly how to do it, *by when they should begin and complete the protective action* (or time), and link the protective action to a basic human value, e.g., evacuate to keep your family safe (Drabek 1999; Mayhorn & McLaughlin, 2012; Mileti & Fitzpatrick, 1992; Sorensen, 1991). Since time is part of the required content of WEA alerts, an investigation of how it might be best expressed was conducted.

Analysis and findings. Participants were asked their reactions to how time is communicated in WEA messages of all three lengths under study. Both the absence of a message "sent" time and the inclusion of a message "expiration" time caused confusion for some participants. Moreover, participants expressed mixed reactions and understanding of words such as "now," "immediately," and "urgent."

For example, for 90-characters messages, some participants remarked that a "sent" time was desirable:

> "We only know when it stops [the warning] but we don't know when it started."

> "And they would need a date. You know, a month and a date so we also know, like is it an old, old warning?"

> "When was this sent?!"

> "If they would put an alert time, I think they do that on some child Amber Alerts – 'Alert Issued At'."

Some participants in the 140-characters messages focus groups expressed confusion regarding the "expiration" time:

> "Like 9:00 pm [the warning expiration time, which was vague]. Because radiation doesn't just, like, dissipate into—you know—even if it's 20 hours away."
>
> "I was kind of thrown off by 'the warning expires.' I mean, that doesn't really tell me if something has happened or what I should do or, you know, it's not really informative on the warning […]."
>
> "I think it would be easier if it would just say like 'Update 9:00 pm.' You know, 'Warning expires' to me means like, yeah, there's no concern anymore about radiation, but chances are at 9:00 pm there's still gonna be things to talk about. So just saying like, 'Update at 9:00 pm,' cuts down your character limit, and it's a lot clearer."

Some participants the 1,380-characters messages focus groups considered what specific words would speed protective action taking:

> "I thought that if you said 'immediately,' it would make me, I would move faster, you know? I think if you tell me how much time I've got to work with, I'd try to plan it out and see what you could get done before, you know? But if it's immediate, it's almost not, immediate's going to take a couple minutes, but you start going right away."

Emergency management participants also considered what specific words would speed protective action taking:

> "The 'now' word for me is an important qualifier. You're telling me this is urgent, and I need to do it now. I need to not wait, prepare—so that specific word in a message implies, to me, urgency. And the action piece is important."
>
> "I think that, potentially, the word 'urgent' up front could make it—I think there's something about that word that—people don't hear it that often, and they realize if something starts with 'urgent, take shelter,' following the 'Denver PD,' something about that."

Community event survey. After receiving the outdoor siren and message issued along the Boulder Creek, respondents reported that they thought they had between 0 to 270 minutes before the flood waters would reach them, with an average of 22.10 (*SD* 43.029, *N*=376). Just over half (52%, 196/376) reported 0 minutes (i.e., immediately), 19% reported between 1 and 10 minutes (73/376), and 28% reported more than 10 minutes (107/376).

Conclusion. The way time is expressed in WEA messages may confuse the public. Currently, WEA messages express time by stating when the message expires so that such messages do not persist in perpetuity. This serves an important function, but also confuses the public and may delay action taking. If time is expressed in WEA messages with language about the time a message expires, **consideration also should be given to communicating the time a message "begins" (without increasing message length) to reduce public confusion. Specifically, messages should clearly by what time people should begin taking the recommended protective action.**

Future research. Focused research on how to best communicate the onset of a WEA message without increasing message length is needed. For example, if the word "now" or "immediately" is used, would capitalizing all the letters in those words help to communicate that the message is already in effect when people receive it.

How to Best Express Location

Purpose. A general conclusion from the historical research record is that alert and warning messages work to foster public protective action response if they provide information about exactly who should and who should not take the protective action in terms that the public can readily understand, e.g., the physical geographical boundaries for the location where people who need to take protective action are located (Drabek, 1999; King & Cook, 2008; Mayhorn & McLaughlin, 2012; Mileti & Fitzpatrick, 1992). Such information could be expressed in words and/or by use of a map that people can understand that visualizes who should take action to help people determine if they are at risk or not (Dransch, Rotzoll, & Poser, 2010; Hagemeier-Klose & Wagner, 2009). This research record led to an investigation of how to best express location in wireless emergency alerts.

Analysis and findings. Participants were asked about their reactions to the way hazard location is expressed in WEA messages. Several participants suggested that the best way to express location would be to increase message length so that location descriptions could be added that included the names and geographical boundaries of the affected areas. Below are examples of participants' comments:

> "Maybe this isn't a good analogy, but when you have a warning about tornados, for instance, they say for Adams, Arapahoe, and Denver counties, there's a tornado warning until 10 o'clock. I think if this were a bit more specific, like 'affecting Littleton, Arapahoe County, Elbert County' whatever, it'd be more informative."
>
> "Like when we're, we watch TV and they're like 'tornado' and they say the county, so that's sort of the way we already know that identifies where it's at."
>
> "I think the best thing to do would just be to put counties on it, so just like storm warnings, so members of Jefferson, Adams, whatever counties. I think that would be better, 'cause they you can tell better right away, cause everyone knows which county they're in."

Community event survey. On average, WEA recipients thought the likelihood that that the WEA message they received was meant for them was 4.59 (*SD*=1.630, *N*=427) on a 6-point scale where 1 meant "not very likely" and 6 meant "extremely likely." More than a quarter (29%, 122/427) of WEA message recipients can be classified as thinking it was not likely, and 71% (305/427) can be classified as thinking it was likely, that the message was meant for them.

Conclusion. Given the 90-character limit of current WEA messages, **the phrase "in this area" does not effectively work to communicate who is and who is not located within the risk area.** Each WEA message that states "in this area" but does not apply to the individual receiving the message trains the receiver that the phrase "in this area" may not apply. **The effectiveness of current WEA messages may remain suppressed until they can be distributed to finer geospatial targeted populations so that the messages only reach the people who are at risk.**

Future research. Research is needed to determine the degree to which the current approach to distributing WEA messages to a broad geographical area, which may include many people not at risk, may or may not be training

the public to ignore WEA messages altogether. Research also is needed on how to communicate in a WEA message who is and who is not at risk, for example, by including impact area maps, finer grained distribution, or the use of longer text messages that allow description of the risk area.

Understanding of Alert and Warning Concepts

Purpose. As stated previously, understanding or attaching personal meaning to the contents of an alert or warning message has long been demonstrated in the research record to be a key intervening factor that links a message with protective action taking. Studies that document the effect of message content and style factors on understanding include: Lachman et al. (1961); McGee & Gow (2012); Mikami & Ikeda (1985); and Quarantelli (1984). Studies that document the effect of non-message factors on understanding include: Diggory (1956); Nehnevajsa (1985); and Oliver & Reardon (1982). Studies that document the effect of understanding on protective action-taking behavior include: Hammarstrom-Tornstam (1977); McGee & Gow (2012); and Perry (1982). Therefore, public understanding of the basic alert, warning, and response concepts used in WEA message where assessed.

Analysis and findings. Participants were asked about their understanding of the concepts used in alert and warning messages, for example, "watch", "warning," and "shelter." While some participants understood the meaning of such terms, others did not. Below are examples of comments made by participants who considered 90-characters messages, however, similar sentiments were expressed for the use of such terms in 140- and 1,380-characters messages:

> "Just thinking of the word 'warning,' I know that in a weather reporting and alerts there are different levels. There's a 'watch,' a 'warning,' an alert, and a hazard – I don't know all the classifications – but it also makes me wonder on this how far along on the scale are we? Yeah. Imminent danger?"
>
> "That's the thing. I don't… Is that what it ['warning'] means?"
> "Also, I would assume that I would have been educated as to what 'shelter' is prior to receipt of this message, through some sort of educational campaign."
>
> "It should say, 'go to the basement' -- 'stay inside' -- or it should say, 'go to your school' -- it should say something like, what… I mean you say 'shelter,' yeah, is it like, is your house good enough?"
>
> "Actually, I think a lot of people would [attempt to drive to a 'shelter']. They'd be looking for where do we go, where do we go?"

Community event survey. A total of 13% of WEA message recipients (62/485) reported that they heard the siren, and 44% reported that they heard both the siren and the message (212/485) issued by the outdoor warning sirens along Boulder Creek. These individuals also were asked how many feet above Boulder Creek they thought represented moving to "higher ground." Responses ranged from 0 to 500, with an average of 20.44 feet (*SD*=48.112). A total of 61% reported 0 to 10 feet (85/140), and 39% reported more than 10 feet (55/140).

Conclusion. The public may not understand basic alert and warning concepts. Messages should not rely on the assumption that the public understands terms such as *shelter, evacuate*, and *higher ground*. Alert and warning messages that are short and contain concepts such as *shelter, evacuate*, *and higher ground* will mean very different things to different people who receive the message. For example, the standard *evacuate to higher ground* tsunami message may mean twenty feet above sea level to some, and one hundred feet above sea level to others.

Similar confusion exists regarding flood evacuation as evidenced in our community event survey. Short 90- and 140-characters messages are, therefore, not likely to provide for public health and safety in rapid onset events such as a poison gas release in a subway, a locally generated tsunami, and more. **For messages that are longer than 90- and 140-characters, basic alert and warning concepts should be described to the extent possible.** Short 90- and 140-characters messages may work fine for events whose impact is not imminent.

Future research. Cost benefit research is warranted to determine whether it is worth the investment it would take to replace 90-characters messages with longer messages in which basic alert and warnings concepts could be described.

WEA Diffusion Curve

Community event survey. A WEA Diffusion Curve was created using general population survey data. Of the respondents from the general population sample, 539 recalled whether or not they received the WEA message (539/597, 90%). A total of 223 reported having received the first WEA (223/539, 41%). Of the 539 general sample respondents who remembered whether or not they received a WEA message, 59% did not receive the first WEA message (316/539), 36% received a message and remembered the time (193/539), and 5% remembered receiving the first WEA, but could not remember the time (30/539). Those who reported reading the WEA message before it was issued were recoded to "zero" minutes. Just over 15% of city residents received and read the first WEA message when it was issued, more than 20% read it within the first half hour, with just over a third of the population eventually reading the message. The WEA Diffusion Curve is included in Appendix M.

Conclusion. Evidence suggests that some members of the public who receive WEA messages do not read them immediately when they are delivered. Additional **outreach and education about the WEA system and WEA messages are needed to help speed the rate at which members of the general public read the WEA messages they receive.**

Protective Action Mobilization Curve

Community event survey. A mobilization curve representing the protective action "check local media" was created using the WEA survey sample. Of respondents who received the first WEA message (i.e., members of the WEA sample), 86% remembered whether or not they checked local media (428/496). Of those who recalled whether or not they checked local media, 87% indicated that they had checked local media (374/428), and 13% did not (54/428). Of this group, 32% (137/428) reported having checked local media before the first WEA message was issued (represented as negative numbers indicating the number of minutes before the first WEA was issued), 44% (188/428) reported checking local media when the first WEA was issued (represented as zero minutes) or later, 13% (54/428) reported not checking local media, and 11% (49/428) reported not remembering when they did so. Time checking local media ranged from 14 hours and 15 minutes before the first WEA was issued to 23 hours and 30 minutes after the first WEA was issued. About a third of the sample had been checking local media prior to the issuance of the first WEA message, with an increase to almost 50% within the first 15 minutes following the message delivery. The mobilization curve for this protective action is included in Appendix M.

Conclusion. Evidence suggests that WEA messages can be effective at reaching and motivating immediate protective action taking among a portion of the general public. Public education about the WEA system, WEA messages, and hazards in general may increase the rate of public response.

Validation of Experimental Optimized Outcome Measures

Community event survey. The community event survey provided the rare opportunity to test the relationship between the cognitive outcome measures used in the experiments and the ultimate behavioral dependent variables they sought to represent. Five of these six relationships were statistically significant. The only relationship that was not significant was the one between the personalization scale score and the amount of time that elapsed before WEA recipients began checking local media. Specifically, the interpretation scale score was negatively associated with delay until checking local media (r=-.163, p=.007, df=268); the greater the interpretation, the shorter the delay in initiating the protective action. The interpretation (r=-.133, p=.015, df=332) and personalization (r=-.128, p=.031, df=280) scale scores were negatively associated with time delay until respondents began avoiding flood areas; the greater the interpretation and personalization, the shorter the delay in initiating the protective action. (See the correlation matrix included in Appendix N.)

Conclusion. Evidence supports the outcome scale scores used in the Phase II experiments. **The fact that both the interpretation and personalization scale scores correlated with behavioral outcomes lends further credibility to the Phase II findings. Theory-based scales created to measure cognitive constructs can be effectively used in warnings and risk communication research.** It is not particularly surprising that the relationship between the personalization scale score and time delay until checking local media was not significant given the fact that the protective action, "check local media" is relatively routine compared to other protective actions. Furthermore, members of the public may be inclined to check local media during weather events because of curiosity, even when they do not feel they are the intended recipients of the message.

Future research. Future research should investigate the importance of personalization for different recommended protective actions.

Optimum Level of Fear Arousal

Purpose. Emotions are often described as either positive (e.g., happiness, relief, compassion, hope) or negative (e.g., fear, anger, sadness, anxiety). Due to their unique adaptive functions, it is necessary to talk about *discrete* emotions when addressing the topic of emotion (Nabi, 2002a). Alerts and warnings inherently deal with issues of risk and crisis, and the four primary negative emotions in risk and crisis are fear, anger, sadness, and anxiety (Janoske, Liu, & Sheppard, 2012; Jin, 2009; Jin & Pang, 2010). Little existing research exists on how emotions impact public alert and warning response. A brief overview of emotions research on other topics follows.

Fear: This refers to the amount of fear that might arise among message recipients when a situation is threatening to their physical and/or psychological selves and out of their control (Frijda, 1986; Lazarus, 1991; Scherer, 1984). Relatively little research has been conducted on fear responses to warning messages, with existing studies focused on fear in health warning messages (Kees, Burton, Andrews, & Kozup, 2006, 2010; Timmers & van der Wijst, 2007; Witte, 2013). This research suggests that the effectiveness of fear-based messaging is context-dependent and varies among groups and individuals (Sellnow et al., 2012). However, a meta-analysis of empirical research suggests that strong fear appeals are more persuasive than low or weak fear appeals, which leads to greater fear arousal (Witte & Allen, 2000). Additionally, strong fear-based messages produce the greatest behavior change when combined with high-efficacy messages (Witte & Allen, 2000).

Anger: Research shows that while anger-inducing messages are not always effective, they can reduce certain risk perceptions, reduce negative risk estimates, and motivate people to take action (Lazarus, 1993; Lerner, Gonzalez, Small, & Fischoff, 2003; Turner, 2007).

Sadness: When unintentionally evoked, sadness has demonstrated a positive correlation in attitude change and motivates careful information processing (Dillard & Peck, 2000; Nabi, 2002b).

Anxiety: Anxiety arousal results from uncertainty, which results in people looking for concrete, immediate solutions to the threat (Jin, 2010; Lazarus, 1991).

Mixed emotions: Research has also explored mixed emotional appeals and responses (Brehm, 1999; Brehm & Miron, 2006). Mixed sequential (negative-positive) emotional messages have been found to generate lower post-message discomfort than purely negative messages (Carrera, Munoz, & Caballero, 2010). Additionally, mixed emotion messages motivate participants to control the danger, but a purely negative message involves a higher probability of risk behavior performance (Carrera, Munoz, & Caballero, 2010).

Analysis and findings. The purpose of conducting focus group research on optimum fear arousal was to determine what level of fear (low, medium, or high) produced optimized levels of message understanding, belief, personalization, decision making, and milling. A total of six messages that were 90, 140, and 1,380 characters in length were tested, and they elicited participant emotions ranging from panic to resolve (see Table 3 in Appendix F). No patterns were discerned; thus, it was not possible to answer this research question using this research method.

Community event survey. A total of 87% (374/428) reported having checked local media, and 70% reported having avoided flood areas (300/429). The fear scale score was not correlated with the amount of time that elapsed from the time of WEA receipt until the respondent initiated checking local media (r=-.003, p=.954, n=351), nor was it correlated with the amount of time that elapsed from the time of WEA receipt until the respondent initiated avoiding flood areas (r=-.031, p=.600, n=286).

Conclusion. Alert and warning messages elicit a wide range of varied emotional responses. Although, the impact of fear and other emotions have on public alert and warning response could not be clarified based on the Phase II experiments and focus groups, the community survey data allowed for testing the relationship between level of fear and behavioral outcomes. Findings showed that there is no relationship between level of fear and the amount of delay before respondents initiated checking local media and avoiding flood areas. **Messages that are crafted specifically to maximize fear may not be effective in motivating protective actions. The role emotions may play in making sense of and responding to public alert and warning messages remains unclear.**

Future research. The role of message attributes on fear and other emotional outcomes should be examined and taken into account.

Serendipitous Findings

Focus group participants repeatedly raised an issue that was not anticipated in the focus group research. It was that visual stimuli including bullets, bolding, iconography (source logo/seal, for example), indentation, font size, color, or italics, etc. might influence their message interpretation and subsequent message response. Participants also pointed out the role and influence of audible tones preceding warning messages. Some participants indicated that the type and severity of an audible tone preceding warning message receipt would influence their subsequent

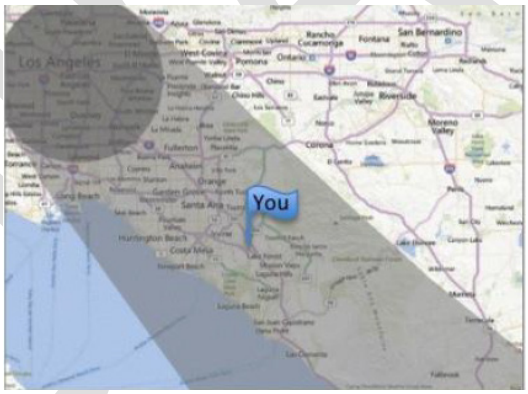
interpretation and response. **Sound, color, size, shape, and style could all potentially influence WEA message interpretation and subsequent response but it is not yet known how.** These topics should be investigated in future research.

Optimized Messages and Templates

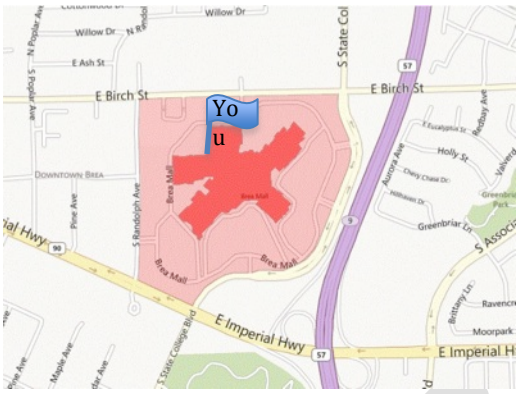
Optimized Test Messages

Construction of the optimized test messages. After the think-out-loud interviews, focus groups, and experiments, the project's test messages were revised to be consistent with research results regarding which message content and order optimized factors that historical research has documented to enhance public protective action taking. These templates merit further revision should additional characters be added to WEAs (e.g., moving from a 90 characters limit to a 280 characters limit), as well as consideration of different map elements. Optimized message factors included interpretation (understanding, believing, deciding), personalizing, and milling The resulting optimized 90, 140, and 1,380-characters messages (with high information maps) for the radiological, shooter, and tsunami hazards test messages follow. The five key alert and warning contents elements in these messages are color coded as follows: source, guidance, hazard, location, and termination time. These messages are for specific hazards, but their content topics and order are applicable across hazards. **Although the 90 and 140-characters messages that follow are optimized, project results also document that they may be too short to complete the public alert and warning mission; however, 1,380-characters optimized messages have sufficient length and content to maximize public health and safety.**

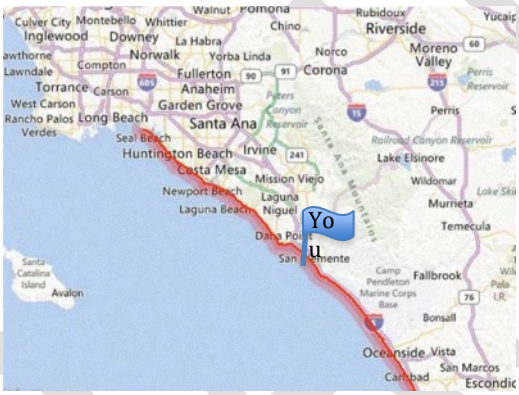
Optimized 90-characters radiological hazard WEA message. Cal EMA Take shelter now Radiological Hazard Warning in this area until 12:00AM PDT



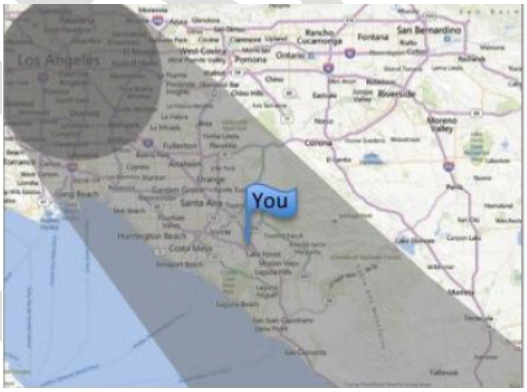
Optimized 90-characters shooter hazard WEA message. Cal EMA Take shelter now Law Enforcement Warning in this area until 4:00 pm PDT



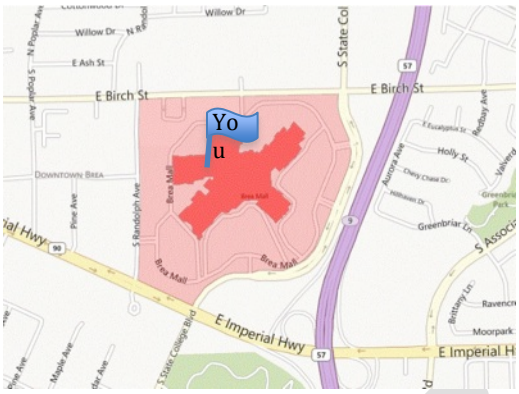
Optimized 90-characters tsunami hazard WEA message. Cal EMA Evacuate now Tsunami Warning in this area until 9:00 PM PDT



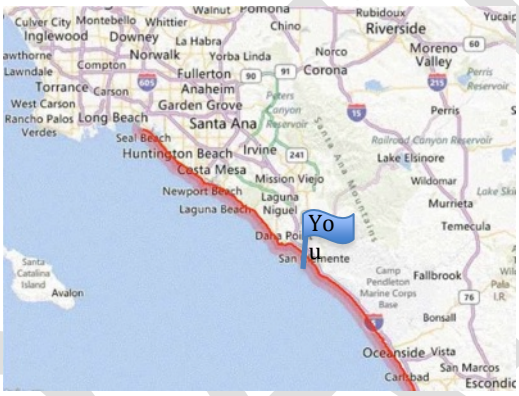
Optimized 140-characters radiological hazard message. Cal EMA Shelter in a sturdy building within 5 min Nuclear explosion in LA Radiation blowing toward Orange County Warning expires 9:00 PM PDT



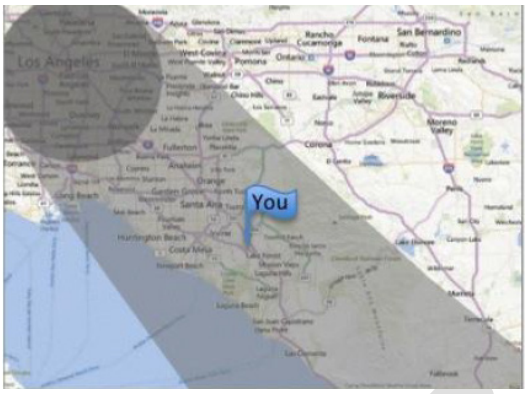
Optimized 140-characters shooter hazard message. Cal EMA If you are in Mall, evacuate if safe Hide if shooter nearby People shot at Brea Shopping Mall Warning expires 9:00 PM PDT



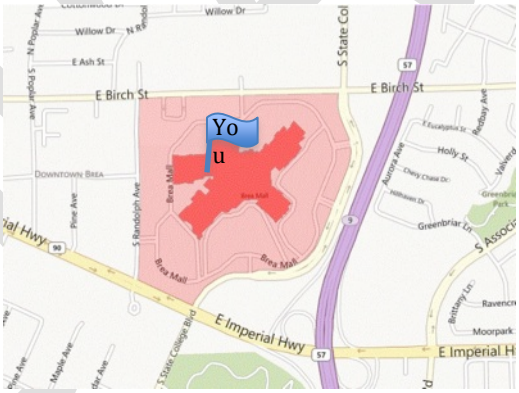
Optimized 140-characters tsunami hazard message. Cal EMA Evacuate to higher ground now Tsunami Warning Waves over 40 feet above sea level in Orange County Warning expires 9:00 PM PDT



Optimized 1,380-characters radiological hazard message. California Emergency Management Agency. A nuclear explosion occurred in Los Angeles at 1:00 PM PDT. High levels of radiation are blowing southeast in the wind and falling to the ground. Exposure to radiation can be deadly and cause illness. The affected area includes: all of Los Angeles and Orange counties, western Riverside County from I-15 west, and northern San Diego County from Oceanside north. This is a Mandatory Shelter Order. You can increase your chances of surviving by immediately going deep inside a tall building, basement, underground garage or earth covered tunnel. Shelters of brick, concrete, and earth protect best. Stay in the building you are in unless you can reach a better shelter in less than 5 minutes. Close windows, doors, and fireplace dampers. Turn off heat, air and ventilation systems. Do not evacuate. Stop driving and take shelter. You and your loved ones will receive less radiation in a shelter no matter how fast you drive. Do not go to schools to get children. School children are being sheltered and cared for. We will give you more information later about how to reunite with them. If you are not in the area, stay out. Stay in your shelter until 1:00 PM PDT March 17, 2013. Keep listening to this and other media for more information and official updates. This message expires at 12:00AM PDT.

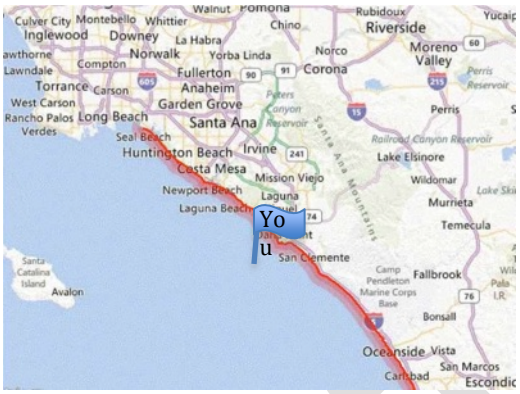


Optimized 1,380-characters shooter hazard message. California Emergency Management Agency. People were shot at the Brea Shopping Mall food court beginning at 2:00 PM PDT. Police believe that the shooter is still inside the Mall. The shooter is armed and deadly. This Police Warning is for the Brea Shopping Mall and surrounding areas. If you are in the Mall and a safe escape path is available use it now. Leave your belongings. Help others escape if possible. Do not move wounded people. If you see the police, keep your hands visible and follow their instructions. If you are in the Mall near the shooter and cannot escape, find a protected place to hide out of the shooter's view. Do not restrict your escape options. Lock and blockade the door. Silence all sources of noise and remain quiet. If evacuation and hiding are not possible, dial 911. If you cannot speak, leave the line open and allow the dispatcher to listen. As a last resort, and only if your life is in danger, attempt to stop the shooter by throwing items, yelling, or using things around you as weapons. If you are concerned about someone who may be inside the Mall, do not to call them. This could alert the shooter to their location. If you are not inside the Mall, stay out. Stay away from the Mall until further notice. Keep listening to this and other media for more information and official updates. This message expires at 4:00PM PDT.



Optimized 1,380-characters tsunami hazard message. California Emergency Management Agency. A large earthquake occurred off the coast of Washington state at 1:00 PM PDT. It has generated a tsunami. The first wave will hit the Orange County coastline at 1:45 PM PDT. Other larger waves will strike over many hours. The waves will move onshore very quickly, and may reach heights of 40 feet above sea level or higher. Tsunami waves can be deadly and cause injury and widespread damage. This Tsunami Warning is issued for the entire Orange County coastline and all surrounding low-lying areas. You will be safest if you immediately get to high ground of at least 50 feet or more if you are on or near a beach anywhere in Orange County. If you cannot reach high ground, evacuate to an upper floor of a high-rise building, if one is available. Evacuate out of the area only if you know where the tsunami run-up zone ends and if you can cross its boundary no later than 1:40 PM PDT. If you see the ocean water pull back and expose the sea floor, run to high ground as fast as you can because a tsunami will strike in a few moments. If you are not in a tsunami impact area, stay away. Once you are in a safe location, stay there

until advised by officials that it is safe to leave. Keep listening to this and other media for more information and official updates. This message expires at 9:00PM PDT.



Optimized Message Templates

Construction of optimized message templates. Three sets of optimized message templates (for the radiological, shooter, and tsunami study hazards) for 90, 140, and 1,380-characters messages are provided below. The five key alert and warning contents elements in these messages remain color coded as follows: source, guidance, hazard, location, and termination time.

Optimized 90-characters radiological hazard WEA message template. source guidance hazard location and termination time.

Optimized 90-characters mall shooter hazard WEA message template. source guidance hazard location and termination time.

Optimized 90-characters tsunami hazard WEA message template. source guidance hazard location and termination time.

Optimized 140-characters radiological hazard message template. [*insert name of a local and familiar message source]* Shelter in a sturdy building within 5 min Nuclear explosion in *[insert location here]* Radiation blowing toward *[insert location here]* Warning expires *[insert time here]* [*limit the length of this message to 140 characters including spaces]*.

Optimized 140-characters mall shooter hazard message template. [*insert name of a local and familiar message source]* If you are in Mall, evacuate if safe Hide if shooter nearby People shot in *[insert name of mall here]* *Warning expires [insert time here]* [*limit the length of this message to 140 characters including spaces]*.
Optimized 140-characters tsunami hazard message template. [*insert name of a local and familiar message source]* Evacuate to higher ground now Tsunami Warning Waves over *[insert height in feet here]* in *[insert location here]* Warning expires *[insert time here]* [*limit the length of this message to 140 characters including spaces]*.

Optimized 1,380-characters radiological hazard message template. [*insert name of a local and familiar message source]*. A nuclear explosion occurred in [*insert location* here] at [*insert time* here]. High levels of radiation are blowing [*insert wind direction* here] in the wind and falling to the ground. Exposure to radiation can be deadly and cause illness. The affected area includes: [*insert a readily identifiable description of the plume's northern,,*

southern, eastern, and western boundaries here]. This is a Mandatory Shelter Order. You can increase your chances of surviving by immediately going deep inside a tall building, basement, underground garage or earth covered tunnel. Shelters of brick, concrete, and earth protect best. Stay in the building you are in unless you can reach a better shelter in less than 5 minutes. Close windows, doors, and fireplace dampers. Turn off heat, air and ventilation systems. Do not evacuate. Stop driving and take shelter. You and your loved ones will receive less radiation in a shelter no matter how fast you drive. [*insert the following if it is part of your radiological emergency plan: Do not go to schools to get children. School children are being sheltered and cared for. We will give you more information later about how to reunite with them*.] If you are not in the area, stay out. Stay in your shelter until [*insert time and date* here]. Keep listening to this and other media for more information and official updates. This message expires at [*insert time* here]. [*limit the length of this message to 1,380 characters including spaces]*.

Optimized 1,380-characters mall-shooter hazard message template. [*insert name of a local and familiar message source]*. People were shot at the [*insert a readily identifiable name or description of the location* here] beginning at [*insert time* here]. Police believe that the shooter is still [*insert location* here]. The shooter is armed and deadly. This Police Warning is for the Brea Shopping Mall and surrounding areas. If you are in [*insert mall name* here} and a safe escape path is available use it now. Leave your belongings. Help others escape if possible. Do not move wounded people. If you see the police, keep your hands visible and follow their instructions. If you are in the mall near the shooter and cannot escape, find a protected place to hide out of the shooter's view. Do not restrict your escape options. Lock and blockade the door. Silence all sources of noise and remain quiet. If evacuation and hiding are not possible, dial 911. If you cannot speak, leave the line open and allow the dispatcher to listen. As a last resort, and only if your life is in danger, attempt to stop the shooter by throwing items, yelling, or using things around you as weapons. If you are concerned about someone who may be inside [*insert mall name* here], do not to call them. This could alert the shooter to their location. If you are not inside [*insert mall name* here], stay out. Stay away from [*insert mall name here*] until further notice. Keep listening to this and other media for more information and official updates. This message expires at [*insert time* here]. [*limit the length of this message to 1,380 characters including spaces]*.

Optimized 1,380-characters tsunami hazard message template. [*insert name of a local and familiar message source]*. A large earthquake occurred off the coast of [*name location here*] at [*insert time* here]. It has generated a tsunami. The first wave will hit [*name the at risk coastline here*] at [*inset time here*]. Other larger waves will strike over many hours. The waves will move onshore very quickly, and may reach heights of [*insert estimated wave height here*] above sea level or higher. Tsunami waves can be deadly and cause injury and widespread damage. This Tsunami Warning is issued for the entire Orange County coastline and all surrounding low-lying areas. You will be safest if you immediately get to high ground of at least 50 feet or more if you are on or near a beach anywhere in [*insert the name of or a description of the coastline at risk here*]. If you cannot reach high ground, evacuate to an upper floor of a high-rise building, if one is available. Evacuate out of the area only if you know where the tsunami run-up zone ends and if you can cross its boundary no later than [*insert estimated time of tsunamis arrival here*]. If you see the ocean water pull back and expose the sea floor, run to high ground as fast as you can because a tsunami will strike in a few moments. If you are not in a tsunami impact area, stay away. Once you are in a safe location, stay there until advised by officials that it is safe to leave. Keep listening to this and other media for more information and official updates. This message expires at [*insert time* here]. [*limit the length of this message to 1,380 characters including spaces]*.

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Appendix A: Experimental Designs

Table 1. Experiment 1 Design (Conducted Online):

90-Characters Messages Mobile Devices (Order, Source, Maps)

	Experiment 1A Order						**Experiment 1B Source**					**Experiment 1C Maps**		
Unique Message #:	1	2	3	4	5	6	7	8	1	9	10	1	11	12
Message Feature	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3***	**4**	**5**	**1***	**2**	**3**
Order – 1 (HLTGS) *WEA Standard	X						X	X	X	X	X	X	X	X
Order – 2 (HLGTS)		X												
Order – 3 (GTHLS)			X											
Order – 4 (SHLTG)				X										
Order – 5 (SGHLT)					X									
Order – 6 (GHLTS)						X								
Source level – 1 (local)							X							
Source level – 2 (state)								X						
Source level – 3 (federal)	X	X	X	X	X	X			X			X	X	X
Source level – 4 (IPAWS)										X				
Source level – 5 (CDC)											X			
Maps – 1 (absent)	X	X	X	X	X	X	X	X	X	X	X	X		
Maps – 2 (low information)													X	
Maps – 3 (high information)														X

Table 2. Experiment 2 Design (Conducted Online):

1,380-Characters Message for Mobile Devices (Relative Importance of Content Elements)

Unique Message #:	13	14	15	16	17	18
Message Feature	**1**	**2**	**3**	**4**	**5**	**6**
Element – 1 (Source)	X		X	X	X	X
Element – 2 (Guidance specificity, including time, milling)	X	X		X	X	X
Element – 3 (Hazard specificity)	X	X	X		X	X
Element – 4 (Location specificity, including map)	X	X	X	X		X
Element – 5 (Termination specificity)	X	X	X	X	X	

Table 3. Experiment 3 Design (Conducted Online):

90-, 140-, and 1,380-Characters Messages for Mobile Devices (Generalizability across Hazards)

	Experiment 3A 90 Generalizability			**Experiment 3B 140 Generalizability**			**Experiment 3C 1,380 Generalizability**		
Unique Message #:	19	20	21	22	23	24	13	25	26
Message Feature	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
Length – 1 (90 characters)	X	X	X						
Length – 2 (140 characters)				X	X	X			
Length – 3 (1,380 characters)							X	X	X
Hazard Type – 1 (IND)	X			X			X		
Hazard Type – 2 (Active Shooter)		X			X			X	
Hazard Type – 3 (Tsunami)			X			X			X

Appendix B: Experimental Messages

Table 5.

Experimental Messages

Table 4: Experiment 4 Design (Conducted in the Laboratory):

90-, 140-, and 1,380-Characters Messages for Mobile Devices (Relative Efficacy

Unique Message #:	1	19	22	13
Message Feature	**1**	**2**	**3**	**4**
Length – 1 (90 characters – STANDARD WEA)	X			
Length – 2 (90 characters – optimized)		X		
Length – 3 (140 characters – optimized)			X	
Length – 4 (1,380 characters – optimized)				X

Message Number	Message Text	Maps
1 90 WEA Current	Radiological Hazard Warning in this area until 12:00AM PDT Take shelter now US DHS	NONE
2 90 HLGTS	Radiological Hazard Warning in this area Take shelter now until 12:00AM PDT US DHS	NONE
3 90 GTHLS	Take shelter now until 12:00AM PDT Radiological Hazard Warning in this area US DHS	NONE
4 90 SHLTG	US DHS Radiological Hazard Warning in this area until 12:00AM PDT Take shelter now	NONE
5 90 SGHLT	US DHS Take shelter now Radiological Hazard Warning in this area until 12:00AM PDT	NONE
6 90 GHLTS	Take shelter now Radiological Hazard Warning in this area until 12:00AM PDT US DHS	NONE
7 90 Local	Radiological Hazard Warning in this area until 12:00AM PDT Take shelter now OCFA	NONE
8 90 State	Radiological Hazard Warning in this area until 12:00AM PDT Take shelter now CAL EMA	NONE
9 90 WEA	Radiological Hazard Warning in this area until 12:00AM PDT Take shelter now WEA	NONE
10 90 CDC	Radiological Hazard Warning in this area until 12:00AM PDT Take shelter now CDC	NONE
11 90 Map-Low	Radiological Hazard Warning in this area until 12:00AM PDT Take shelter now US DHS	A
12 90 Map-High	Radiological Hazard Warning in this area until 12:00AM PDT Take shelter now US DHS	B

13 1380 Best Full	CAL EMA. This is a Mandatory Shelter Order. You can increase your chances of surviving by immediately going deep inside a tall building, basement, underground garage or earth covered tunnel. Shelters of brick, concrete, and earth protect best. Stay in the building you are in unless you can reach a better shelter in less than 5 minutes. Close windows, doors, and fireplace dampers. Turn off heat, air and ventilation systems. Do not evacuate. Stop driving and take shelter. You and your loved ones will receive less radiation in a shelter no matter how fast you drive. Do not go to schools to get children. School children are being sheltered and cared for. We will give you more information later about how to reunite with them. If you are not in the area, stay out. Stay in your shelter until 1:00 PM PDT March 17, 2013. Keep listening to this and other media for more information and official updates. A nuclear explosion occurred in Los Angeles at 1:00 PM PDT. High levels of radiation are blowing southeast in the wind and falling to the ground. Exposure to radiation can be deadly and cause illness. The affected area includes: all of Los Angeles and Orange counties, western Riverside County from I-15 west, and northern San Diego County from Oceanside north. This message expires at 12:00AM PDT.	BEST ORDER, SOURCE, MAP: SGHLT CAL EMA MAP B
14 1380 Omit: Source	This is a Mandatory Shelter Order. You can increase your chances of surviving by immediately going deep inside a tall building, basement, underground garage or earth covered tunnel. Shelters of brick, concrete, and earth protect best. Stay in the building you are in unless you can reach a better shelter in less than 5 minutes. Close windows, doors, and fireplace dampers. Turn off heat, air and ventilation systems. Do not evacuate. Stop driving and take shelter. You and your loved ones will receive less radiation in a shelter no matter how fast you drive. Do not go to schools to get children. School children are being sheltered and cared for. We will give you more information later about how to reunite with them. If you are not in the area, stay out. Stay in your shelter until 1:00 PM PDT March 17, 2013. Keep listening to this and other media for more information and official updates. A nuclear explosion occurred in Los Angeles at 1:00 PM PDT. High levels of radiation are blowing southeast in the wind and falling to the ground. Exposure to radiation can be deadly and cause illness. The affected area includes: all of Los Angeles and Orange counties, western Riverside County from I-15 west, and northern San Diego County from Oceanside north. This message expires at 12:00AM PDT.	BEST ORDER, SOURCE, MAP: SGHLT ~~CAL EMA~~ MAP B
15 1380 Omit: Guidance	CAL EMA. A nuclear explosion occurred in Los Angeles at 1:00 PM PDT. High levels of radiation are blowing southeast in the wind and falling to the ground. Exposure to radiation can be deadly and cause illness. The affected area includes: all of Los Angeles and Orange counties, western Riverside County from I-15 west, and northern San Diego County from Oceanside north. This message expires at 12:00AM PDT.	BEST ORDER, SOURCE, MAP: SGHLT CAL EMA MAP B

16 1380 Omit: Hazard	CAL EMA. This is a Mandatory Shelter Order. You can increase your chances of surviving by immediately going deep inside a tall building, basement, underground garage or earth covered tunnel. Shelters of brick, concrete, and earth protect best. Stay in the building you are in unless you can reach a better shelter in less than 5 minutes. Close windows, doors, and fireplace dampers. Turn off heat, air and ventilation systems. Do not evacuate. Stop driving and take shelter. You and your loved ones will receive less radiation in a shelter no matter how fast you drive. Do not go to schools to get children. School children are being sheltered and cared for. We will give you more information later about how to reunite with them. If you are not in the area, stay out. Stay in your shelter until 1:00 PM PDT March 17, 2013. Keep listening to this and other media for more information and official updates. The affected area includes: all of Los Angeles and Orange counties, western Riverside County from I-15 west, and northern San Diego County from Oceanside north. This message expires at 12:00AM PDT.	BEST ORDER, SOURCE, MAP: SGHLT CAL EMA MAP B
17 1380 Omit: Location	CAL EMA. This is a Mandatory Shelter Order. You can increase your chances of surviving by immediately going deep inside a tall building, basement, underground garage or earth covered tunnel. Shelters of brick, concrete, and earth protect best. Stay in the building you are in unless you can reach a better shelter in less than 5 minutes. Close windows, doors, and fireplace dampers. Turn off heat, air and ventilation systems. Do not evacuate. Stop driving and take shelter. You and your loved ones will receive less radiation in a shelter no matter how fast you drive. Do not go to schools to get children. School children are being sheltered and cared for. We will give you more information later about how to reunite with them. If you are not in the area, stay out. Stay in your shelter until 1:00 PM PDT March 17, 2013. Keep listening to this and other media for more information and official updates. A nuclear explosion occurred in Los Angeles at 1:00 PM PDT. High levels of radiation are blowing southeast in the wind and falling to the ground. Exposure to radiation can be deadly and cause illness. This message expires at 12:00AM PDT.	BEST ORDER, SOURCE, MAP: SGHLT CAL EMA MAP B
18 1380 Omit: Termi-nation	CAL EMA. This is a Mandatory Shelter Order. You can increase your chances of surviving by immediately going deep inside a tall building, basement, underground garage or earth covered tunnel. Shelters of brick, concrete, and earth protect best. Stay in the building you are in unless you can reach a better shelter in less than 5 minutes. Close windows, doors, and fireplace dampers. Turn off heat, air and ventilation systems. Do not evacuate. Stop driving and take shelter. You and your loved ones will receive less radiation in a shelter no matter how fast you drive. Do not go to schools to get children. School children are being sheltered and cared for. We will give you more information later about how to reunite with them. If you are not in the area, stay out. Stay in your shelter until 1:00 PM PDT March 17, 2013. Keep listening to this and other media for more information and official updates. A nuclear explosion occurred in Los Angeles at 1:00 PM PDT. High levels of radiation are blowing southeast in the wind and falling to the ground. Exposure to radiation can be deadly and cause illness. The affected area includes: all of Los Angeles and Orange counties, western Riverside County from I-15 west, and northern San Diego County from Oceanside north.	BEST ORDER, SOURCE, MAP: SGHLT CAL EMA MAP B

19 Best 90 – IND	CAL EMA Take shelter now Radiological Hazard Warning in this area until 12:00AM PDT [ORDER, SOURCE, MAPS DETERMINED BASED ON EXPERIMENT 1 RESULTS]	BEST ORDER, SOURCE, MAP: SGHLT CAL EMA MAP B
20 Best 90 – Shooter	CAL EMA Take shelter now Law Enforcement Warning in this area until 4:00 pm PDT [ORDER, SOURCE, MAPS DETERMINED BASED ON EXPERIMENT 1 RESULTS]	BEST ORDER, SOURCE, MAP: SGHLT CAL EMA MAP B
21 Best 90 – Tsunami	CAL EMA Evacuate now Tsunami Warning in this area until 9:00 PM PDT [ORDER, SOURCE, MAPS DETERMINED BASED ON EXPERIMENT 1 RESULTS]	BEST ORDER, SOURCE, MAP: SGHLT CAL EMA MAP B
22 Best 140 – IND	CAL EMA Shelter in a sturdy building within 5 min Nuclear explosion in LA Radiation blowing toward Orange County Warning expires 9:00 PM PDT [ORDER, SOURCE, MAPS DETERMINED BASED ON EXPERIMENT 1 RESULTS]	BEST ORDER, SOURCE, MAP: SGHLT CAL EMA MAP B
23 Best 140 – Shooter	CAL EMA If you are in Mall, evacuate if safe Hide if shooter nearby People shot at Brea Shopping Mall Warning expires 9:00 PM PDT [ORDER, SOURCE, MAPS DETERMINED BASED ON EXPERIMENT 1 RESULTS]	BEST ORDER, SOURCE, MAP: SGHLT CAL EMA MAP B

24 Best 140 – Tsunami	CAL EMA Evacuate to higher ground now Tsunami Warning Waves over 40 feet above sea level in Orange County Warning expires 9:00 PM PDT [ORDER, SOURCE, MAPS DETERMINED BASED ON EXPERIMENT 1 RESULTS]	BEST ORDER, SOURCE, MAP: SGHLT CAL EMA MAP B
25 Best 1380 – Shooter	CAL EMA. If you are in the Mall and a safe escape path is available use it now. Leave your belongings. Help others escape if possible. Do not move wounded people. If you see the police, keep your hands visible and follow their instructions. If you are in the Mall near the shooter and cannot escape, find a protected place to hide out of the shooter's view. Do not restrict your escape options. Lock and blockade the door. Silence all sources of noise and remain quiet. If evacuation and hiding are not possible, dial 911. If you cannot speak, leave the line open and allow the dispatcher to listen. As a last resort, and only if your life is in danger, attempt to stop the shooter by throwing items, yelling, or using things around you as weapons. If you are concerned about someone who may be inside the Mall, do not to call them. This could alert the shooter to their location. If you are not inside the Mall, stay out. Stay away from the Mall until further notice. Keep listening to this and other media for more information and official updates. People were shot at the Brea Shopping Mall food court beginning at 2:00 PM PDT. Police believe that the shooter is still inside the Mall. The shooter is armed and deadly. This Police Warning is for the Brea Shopping Mall and surrounding areas. This message expires at 4:00PM PDT. [ORDER, SOURCE, MAPS DETERMINED BASED ON EXPERIMENT 1 RESULTS]	BEST ORDER, SOURCE, MAP: SGHLT CAL EMA MAP B

26 Best 1380 – Tsunami	CAL EMA. You will be safest if you immediately get to high ground of at least 50 feet or more if you are on or near a beach anywhere in Orange County. If you cannot reach high ground, evacuate to an upper floor of a high-rise building, if one is available. Evacuate out of the area only if you know where the tsunami run-up zone ends and if you can cross its boundary no later than 1:40 PM PDT. If you see the ocean water pull back and expose the sea floor, run to high ground as fast as you can because a tsunami will strike in a few moments. If you are not in a tsunami impact area, stay away. Once you are in a safe location, stay there until advised by officials that it is safe to leave. Keep listening to this and other media for more information and official updates. A large earthquake occurred off the coast of Washington state at 1:00 PM PDT. It has generated a tsunami. The first wave will hit the Orange County coastline at 1:45 PM PDT. Other larger waves will strike over many hours. The waves will move onshore very quickly, and may reach heights of 40 feet above sea level or higher. Tsunami waves can be deadly and cause injury and widespread damage. This Tsunami Warning is issued for the entire Orange County coastline and all surrounding low-lying areas. This message expires at 9:00PM PDT. [ORDER, SOURCE, MAPS DETERMINED BASED ON EXPERIMENT 1 RESULTS]	BEST ORDER, SOURCE, MAP: SGHLT CAL EMA MAP B

Key: Message Elements

Source

Guidance (includes milling)

Hazard (includes consequence)

Location

Termination

Map Descriptions

Map A: IND (Radiological Hazard) Low Information

Map B: IND (Radiological Hazard) High Information

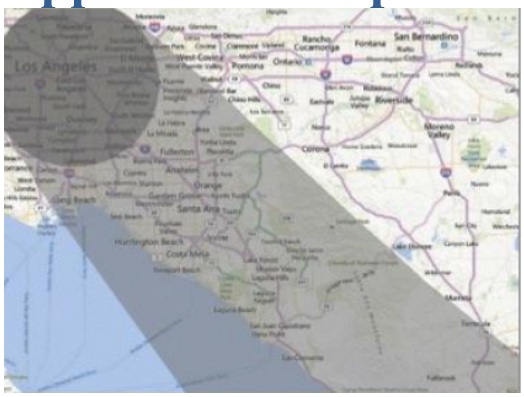
Map C: Shooter Low Information

Map D: Shooter High Information

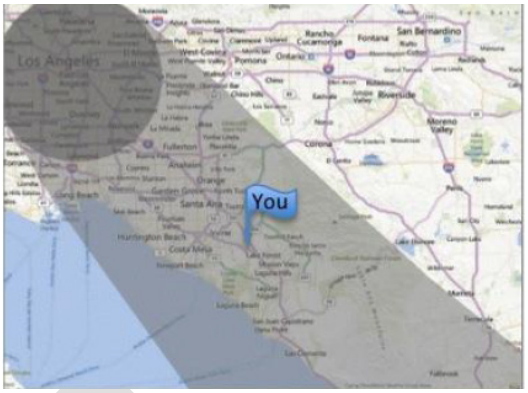
Map E: Tsunami Low Information

Map F: Tsunami High Information

Appendix C: Experimental Maps

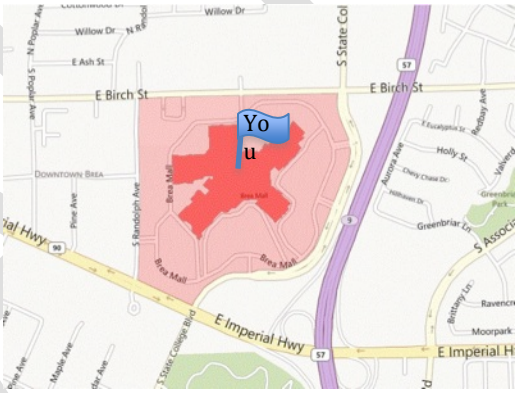


Map A (Low Information Radiation Map)

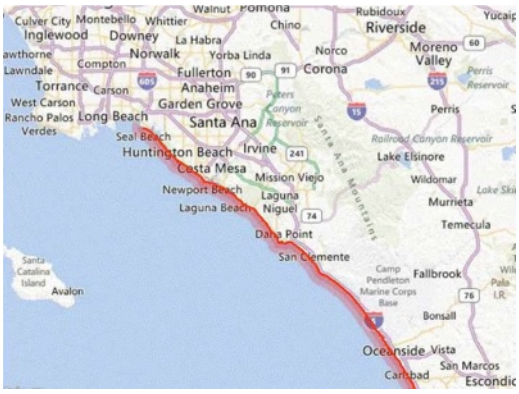


Map B (High Information Radiation Map)

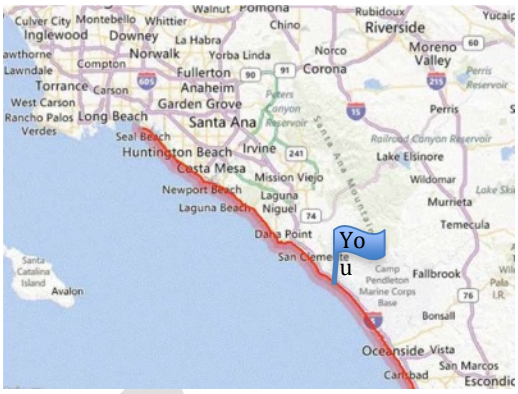
Map C (Low Information Shooter Map)



Map D (High Information Shooter Map)



Map E (Low Information Tsunami Map)



Map F (High Information Tsunami Map)

Appendix D: Example Questionnaires from Internet and Laboratory Experiments

Message Testing - 1A

Consent

This online survey is being conducted as part of a research study. Please read the description below and indicate whether or not you wish to participate.

Why is this study being conducted?
The purpose of this study is to learn how to better communicate with the public using alerts and warnings delivered on cell phones and other mobile devices. The study will explore what people think about different types of warning messages.

What happens if I participate in this study?
If you choose to participate, you will be asked to answer some questions about different warning messages; the questions will take approximately 10 minutes to answer.

What are the possible discomforts or risks?
There are no foreseeable risks to participating in this research.

What are the possible benefits?
There are no benefits to you as a research participant.

Who is paying for this study?
This research is being paid for by the U.S. Department of Homeland Security Science & Technology First Responder Group via a contract administered by the National Consortium for the Study of Terrorism and Responses to Terrorism (START), a DHS-funded Center of Excellence based at the University of Maryland.

Is my participation voluntary?
Your participation is voluntary. You have the right to choose not to participate. If you choose to participate, you have the right to stop at any time. If you refuse or decide to withdraw, you will not lose any benefits or rights to which you are entitled.

Who will see my research information?
Your identity will remain anonymous to the researcher. Your name and contact information will not be stored with your answers. The results from the research may be published. Your identity will not be disclosed and your name will not be linked with your answers in any published reports.

Who do I call if I have questions?
This study is being conducted by Michele Wood, a researcher at the California State University, Fullerton. Michele Wood may be contacted at (657) 278-7330 or mwood@fullerton.edu should you have questions or to report a research-related problem. You may contact the California State University Fullerton IRB at (657) 278-7640 if you have questions or comments about your rights as a study participant.

Consent
If you wish to participate, click "Next" below. If you do not wish to participate, click "Exit this survey" at the upper right corner of your web browser.

By clicking "Next" you give your consent to participate in this research.

Page 1

Message Testing - 1A

***1. Do you currently have a working mobile or cell phone, or not?**

- ◯ Yes, I do
- ◯ No, I do not

Message Testing - 1A

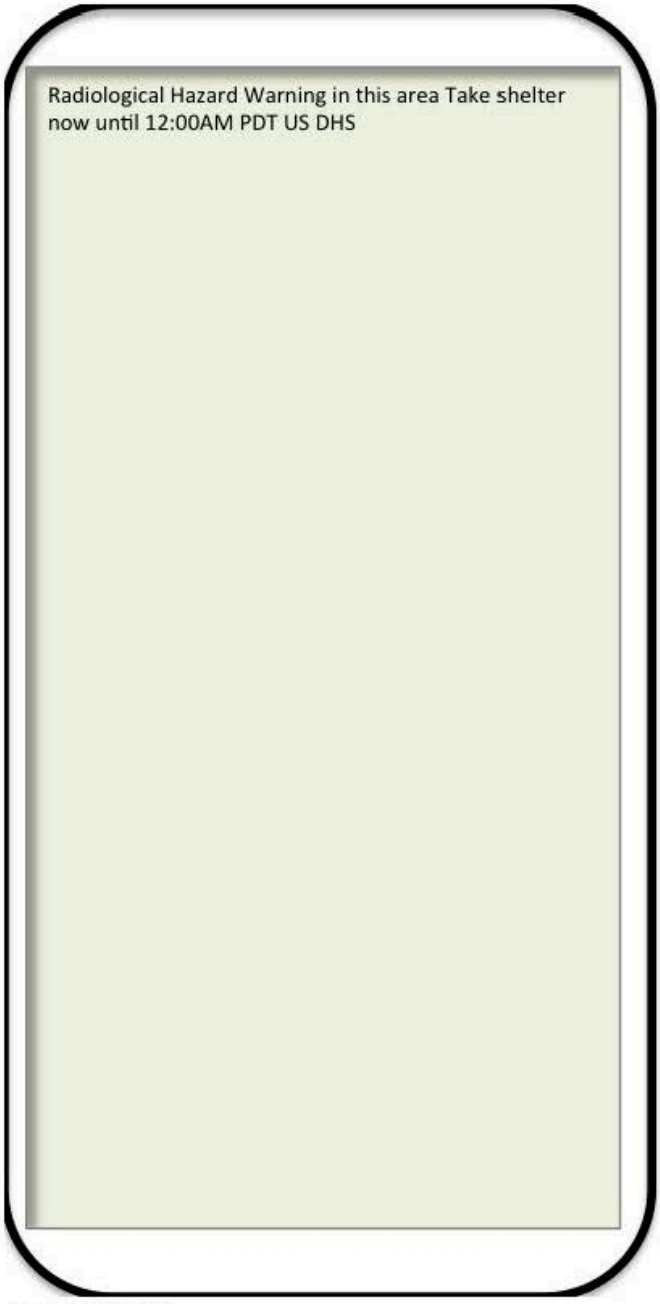
Message

Next, assume that you either live in or are visiting Southern California. You are home alone, and you just received the following message on your cell phone.

US DHS = United States Department of Homeland Security

Message Testing - 1A

- Respondents: 16.7%



US DHS = United States Department of Homeland Security

- Respondents: 16.66%

Message Testing - 1A

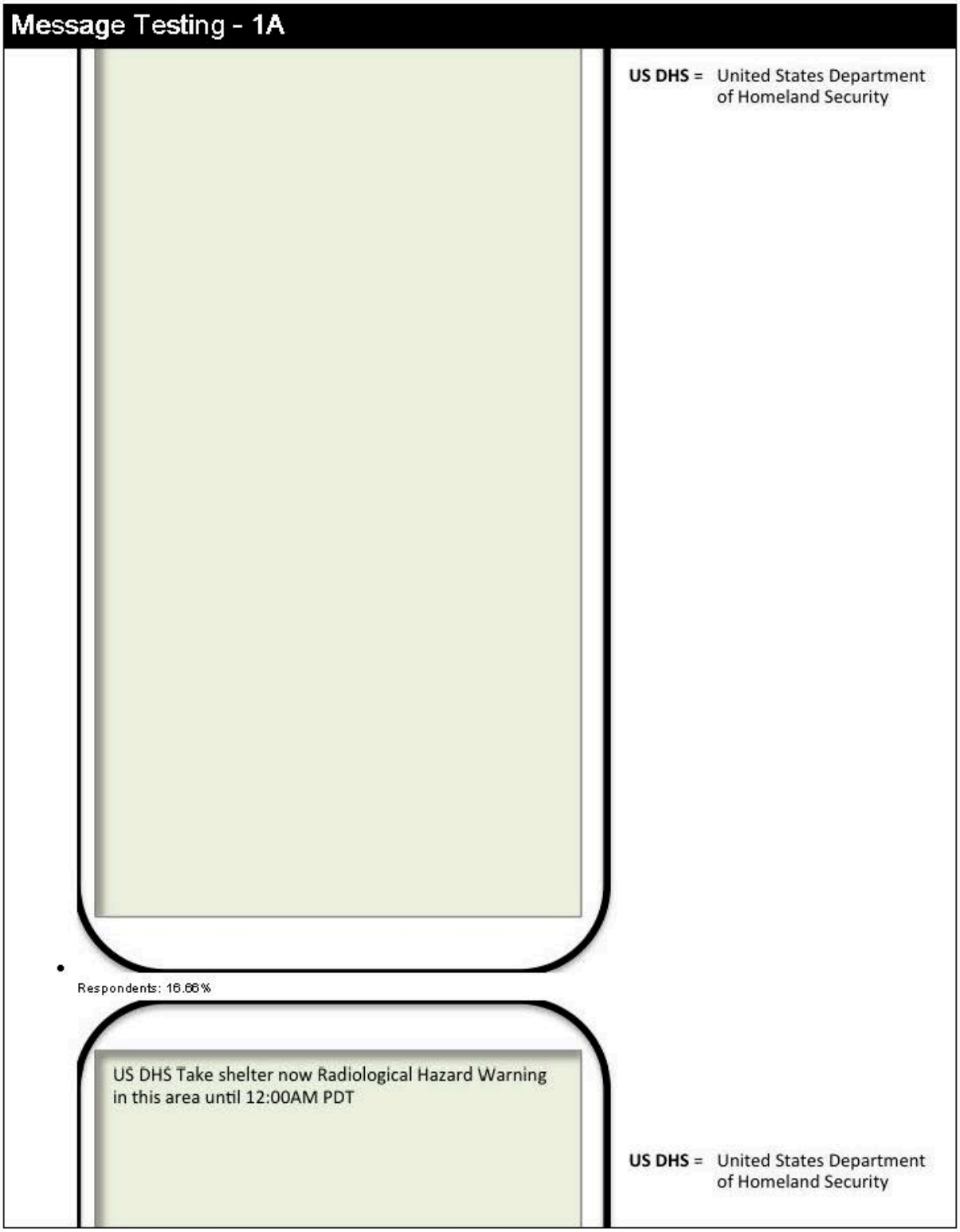
Take shelter now until 12:00AM PDT Radiological Hazard Warning in this area US DHS

US DHS = United States Department of Homeland Security

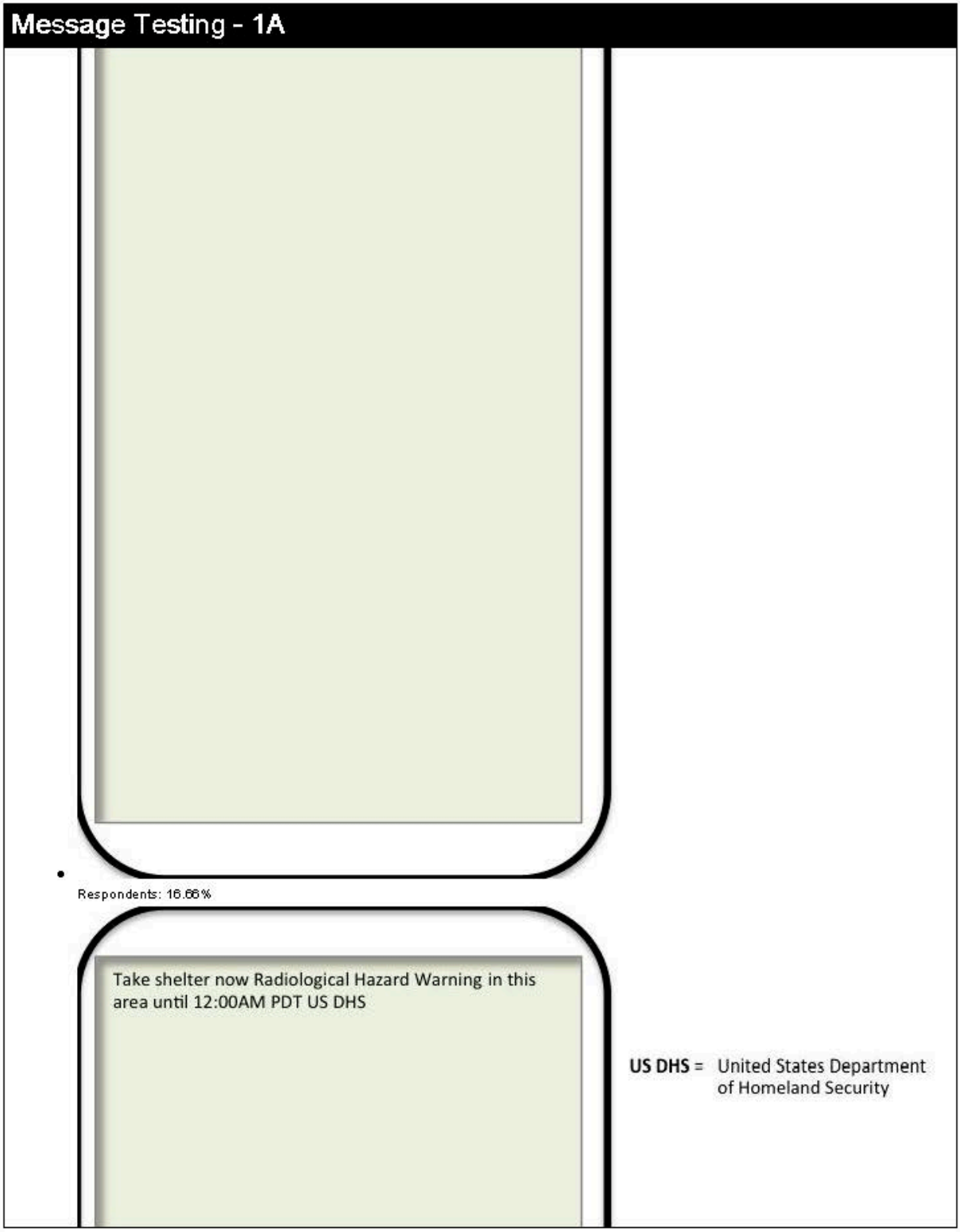
- Respondents: 16.66%

US DHS Radiological Hazard Warning in this area until 12:00AM PDT Take shelter now

Message Testing - 1A



Message Testing - 1A

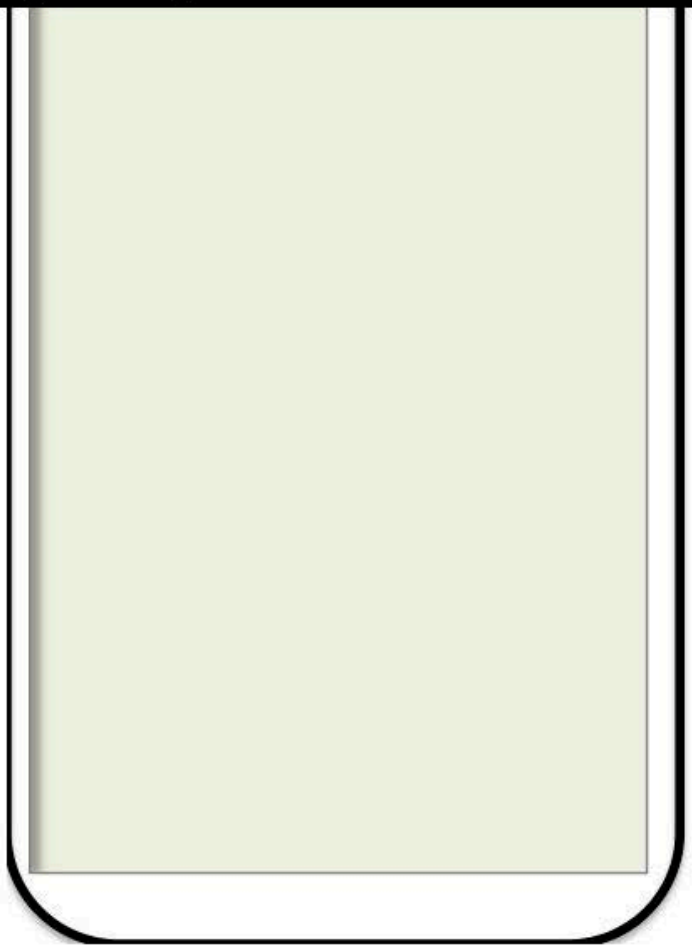


- Respondents: 16.66%

Take shelter now Radiological Hazard Warning in this area until 12:00AM PDT US DHS

US DHS = United States Department of Homeland Security

Message Testing - 1A



Respondents: 16.66%

Answer the following questions using the rating scales provided. You may use any number on the scale.

***2. The message helped me understand what to do.**

Strongly Disagree					Strongly Agree
1	2	3	4	5	6
○	○	○	○	○	○

Message Testing - 1A

***3. After reading this message, I understand:**

	Do not understand at all 1	2	3	4	5	Fully Understand 6
What happened	○	○	○	○	○	○
The risks	○	○	○	○	○	○
What to do to protect myself	○	○	○	○	○	○
What location is affected	○	○	○	○	○	○
Who the message is from	○	○	○	○	○	○
When I am supposed to take action to protect myself	○	○	○	○	○	○
How long I am supposed to continue taking action to protect myself	○	○	○	○	○	○

***4. How well do you understand the message?**

Do not understand at all 1	2	3	4	5	Fully understand 6
○	○	○	○	○	○

***5. After reading this message, do you believe that:**

	Do not believe 1	2	3	4	5	Believe 6
Radiation is headed your way?	○	○	○	○	○	○
You should immediately take shelter?	○	○	○	○	○	○
Sheltering will make you safer?	○	○	○	○	○	○

***6. How much do you agree with the following statements?**

If I received this message on my cell phone, I would think that:

	Not very likely 1	2	3	4	5	Very likely 6
I might become injured	○	○	○	○	○	○
People I know might become injured	○	○	○	○	○	○
People I do not know might become injured	○	○	○	○	○	○
I might die	○	○	○	○	○	○
People I know might die	○	○	○	○	○	○
People I do not know might die	○	○	○	○	○	○
The message was meant for me	○	○	○	○	○	○

Message Testing - 1A

***7. Use the scale below to answer yes or no. You may use any number on the scale.**

	No 1	2	3	4	5	Yes 6
The message will **help** me decide what to do.	○	○	○	○	○	○
It will be **easy** to decide what to do.	○	○	○	○	○	○
I will be able to decide what to do **quickly**.	○	○	○	○	○	○
I can decide what to do with **confidence**.	○	○	○	○	○	○

***8. How likely would you be to look for additional information about <u>what happened</u> before taking action?**

Very unlikely 1	2	3	4	5	Very likely 6
○	○	○	○	○	○

***9. How likely would you be to look for additional information about <u>what to do</u> before taking action?**

Very unlikely 1	2	3	4	5	Very likely 6
○	○	○	○	○	○

Message Testing - 1A

***10. Would you try to get additional information in any of the following ways? (Check ALL that apply.)**

- [ ] Face-to-face from another person (friend, family, co-worker, employee, employer)
- [ ] Television
- [ ] Telephone call - by land line or by cell phone
- [ ] Radio
- [ ] Text message
- [ ] E-mail
- [ ] Twitter
- [ ] Facebook
- [ ] Instagram
- [ ] Pinterest
- [ ] Blogs
- [ ] YouTube
- [ ] Other Internet
- [ ] Some other way
- [ ] NONE OF THESE - I would not try to get additional information

(If you chose "Some other way", please explain)

***11. How likely would you be to tell other people about the need to take action?**

Very unlikely					Very likely
1	2	3	4	5	6
○	○	○	○	○	○

Message Testing - 1A

***12. This message made me feel...**

	Not at all 1	2	3	4	5	Extremely 6
Sad	○	○	○	○	○	○
Anxious	○	○	○	○	○	○
Terror-struck	○	○	○	○	○	○
Nervous	○	○	○	○	○	○
Outraged	○	○	○	○	○	○
Shocked	○	○	○	○	○	○
Sympathetic	○	○	○	○	○	○
Angry	○	○	○	○	○	○
Tense	○	○	○	○	○	○
Fearful	○	○	○	○	○	○
Confused	○	○	○	○	○	○
Scared	○	○	○	○	○	○

Sometimes text messages include internet hyperlinks in them. "Clicking" on these links redirects your browser to the specified internet address or website. For example, clicking on a link to "www.FEMA.gov" directs you to the FEMA (Federal Emergency Management Agency) website.

The next few questions are about how you would respond if the message you read above also contained an internet link to additional information.

***13. If the message above contained an internet link to additional information, how likely is it that you would "click" on the link?**

Very unlikely 1	2	3	4	5	Very likely 6
○	○	○	○	○	○

Message Testing - 1A

***14. If the message above contained an internet link to additional information, what kind of information would you want to see when you "click" on the link?**

	No	Yes
The size and speed of the Radiological Hazard	◯	◯
The physical consequences of the Radiological Hazard	◯	◯
Where the Radiological Hazard will strike and where it won't expressed in words	◯	◯
Where the Radiological Hazard will strike and where it won't expressed in a map	◯	◯
What you should do to protect yourself	◯	◯
How much time you have to protect yourself before the Radiological Hazard strikes	◯	◯
The time the warning will end	◯	◯
Local media article with more information	◯	◯
Who the message was from	◯	◯
Some other information	◯	◯

(If you chose "Some other information", please specify)

***15. If you were to "click" on the internet link to get additional information, how likely is it that you would act on that information without <u>first</u> confirming the information somewhere else?**

Very unlikely					Very likely	Not Applicable Would not "click" link
1	2	3	4	5	6	
◯	◯	◯	◯	◯	◯	◯

Please explain:

***16. If the internet link contained clear instructions about what to do to protect yourself, how likely is it that you would follow those instructions?**

Very unlikely					Very likely
1	2	3	4	5	6
◯	◯	◯	◯	◯	◯

Please explain:

Message Testing - 1A

***17. How likely would you be to...**

	Very unlikely 1	2	3	4	5	Very likely 6
Share the information in the internet link with others before taking action to protect yourself?	○	○	○	○	○	○
Forward the internet link to other people before taking action to protect yourself?	○	○	○	○	○	○
Share the information in the internet link with others after taking action to protect yourself?	○	○	○	○	○	○
Forward the internet link to other people after taking action to protect yourself?	○	○	○	○	○	○

Message Testing - 1A

Ranking

This is the last page about messages.

We would like to know which message is most likely to get you to take action to protect yourself.
Read the following messages, and then place them in rank order.

Message A:
Radiological Hazard Warning in this area until 12:00AM PDT Take shelter now US DHS

Message B:
Radiological Hazard Warning in this area Take shelter now until 12:00AM PDT US DHS

Message C:
Take shelter now until 12:00AM PDT Radiological Hazard Warning in this area US DHS

Message D:
US DHS Radiological Hazard Warning in this area until 12:00AM PDT Take shelter now

Message E:
US DHS Take shelter now Radiological Hazard Warning in this area until 12:00AM PDT

Message F:
Take shelter now Radiological Hazard Warning in this area until 12:00AM PDT US DHS

(US DHS = United States Department of Homeland Security)

***18. Place the messages in rank order, where:**

1 means MOST likely to get you to take action to protect yourself, and
6 means LEAST likely to get you to take action to protect yourself.

☐	Message A
☐	Message B
☐	Message C
☐	Message D
☐	Message E
☐	Message F

Message Testing - 1A

***19. Please explain why you ranked the messages the way you did.**

Message Testing - 1A

Demographics

Next we would like to ask you some questions about yourself. You are almost done.

***20. Which of the following activities do you do on your mobile or cell phone? (Check all that apply)**

- [ ] General internet use (other than using social networking websites)
- [ ] Make or receive phone calls
- [ ] Play games
- [ ] Play music
- [ ] Play podcasts
- [ ] Play videos (other than video games)
- [ ] Purchase products or services
- [ ] Record videos
- [ ] Send or receive emails
- [ ] Send or receive instant messages
- [ ] Send or receive photos
- [ ] Send or receive texts
- [ ] Send or receive videos
- [ ] Take photos
- [ ] Use social networking websites

***21. Last week, about how much time did you spend using your mobile or cell phone to send or receive phone calls?**

Hours _____

Minutes _____

***22. Last week, about how much time did you spend using your mobile or cell phone to send or receive texts?**

Hours _____

Minutes _____

***23. About how comfortable are you using mobile or cell phones?**

Extremely **Uncomfortable**					Extremely **Comfortable**
1	2	3	4	5	6
○	○	○	○	○	○

***24. Are you male or female?**

- ○ Male
- ○ Female

***25. Which one of these racial/ethnic groups best describes you? Would you say: White; Hispanic or Latino; Black or African American; Asian; Native Hawaiian or other Pacific Islander; American Indian or Alaskan Native; or Other? If you identify with more than one, choose the group you identify with the most.**

- ○ White
- ○ Hispanic or Latino
- ○ Black or African-American
- ○ Asian
- ○ Native Hawaiian or other Pacific Islander
- ○ American Indian or Alaskan Native
- ○ Some other race (please specify)

***26. What was your age on your last birthday?**

Years

***27. What is the highest level of school you have completed or the highest degree you have received?**

- ○ Less than high school degree
- ○ High school degree or equivalent (e.g., GED)
- ○ Some college but no degree
- ○ Associate degree
- ○ Bachelor degree
- ○ Graduate degree

Message Testing - 1A

***28. How much total combined money did all members of your household earn in 2012? This includes money from jobs; net income from business, farm, or rent; pensions; dividends; interest; social security payments; and any other money income received by members of your household that are eighteen (18) years of age or older. Please report the total amount of money earned - do not subtract the amount you paid in taxes or any deductions listed on your tax return.**

- ◯ $0 to $24,999
- ◯ $25,000 to $49,999
- ◯ $50,000 to $74,999
- ◯ $75,000 to $99,999
- ◯ $100,000 to $124,999
- ◯ $125,000 to $149,999
- ◯ $150,000 to $174,999
- ◯ $175,000 to $199,999
- ◯ $200,000 or More

***29. Which of the following categories best describes your employment status?**

- ◯ Employed, working 1-39 hours per week
- ◯ Employed, working 40 or more hours per week
- ◯ Not employed, looking for work
- ◯ Not employed, NOT looking for work
- ◯ Retired
- ◯ Disabled, not able to work

***30. Are you a student?**

- ◯ Yes - Part-time
- ◯ Yes - Full-time
- ◯ No

***31. Sometimes disasters happen that affect people living in a community. Please think about the worst disaster you have ever experienced. How much did it affect you?**

	NO effect 1	2	3	4	5	A LOT of effect 6
	◯	◯	◯	◯	◯	◯

Message Testing - 1A

***32. Have you ever received an alert or warning message on your cell phone or other mobile device?**

- ◯ Yes
- ◯ No

***33. Are you subscribed to any cell phone warning services that can send you a text message?**

- ◯ Yes
- ◯ No

***34. Do you live in California?**

- ◯ Yes
- ◯ No

You are almost done!

Message Testing - 1A

CA County

***35. In what county do you live?**

- ◯ Los Angeles County, California
- ◯ San Diego, California
- ◯ Orange County, California
- ◯ Riverside County, California
- ◯ San Bernardino County, California
- ◯ Kern County, California
- ◯ Ventura County, California
- ◯ Santa Barbara County, California
- ◯ San Luis Obispo County, California
- ◯ Imperial County, California
- ◯ Some OTHER County in California

Message Testing - 1A

State

***36. In what state or U.S. territory do you live?**

- ◯ Alabama
- ◯ Alaska
- ◯ American Samoa
- ◯ Arizona
- ◯ Arkansas
- ◯ Colorado
- ◯ Connecticut
- ◯ Delaware
- ◯ District of Columbia (DC)
- ◯ Florida
- ◯ Georgia
- ◯ Guam
- ◯ Hawaii
- ◯ Idaho
- ◯ Illinois
- ◯ Indiana
- ◯ Iowa
- ◯ Kansas
- ◯ Kentucky
- ◯ Louisiana
- ◯ Maine
- ◯ Maryland
- ◯ Massachusetts
- ◯ Michigan
- ◯ Minnesota
- ◯ Mississippi
- ◯ Missouri
- ◯ Montana
- ◯ Nebraska

Message Testing - 1A

- Nevada
- New Hampshire
- New Jersey
- New Mexico
- New York
- North Carolina
- North Dakota
- Northern Marianas Islands
- Ohio
- Oklahoma
- Oregon
- Pennsylvania
- Puerto Rico
- Rhode Island
- South Carolina
- South Dakota
- Tennessee
- Texas
- Utah
- Vermont
- Virginia
- Virgin Islands
- Washington
- West Virginia
- Wisconsin
- Wyoming

Message Testing - 1A

Last Question

***37. Do you think there are important questions about warning messages that we should have asked about, or topics we should have covered but didn't in this interview? What else should we have talked about?**

Imminent Threat Messages for Mobile Devices - 4 (FACE-TO-FACE)

Consent

(INTRODUCE YOURSELF AND EXPLAIN THAT YOU WILL BE CONDUCTING THE INTERVIEW.)

***1. IDNUM**

ENTER ID# WRITTEN ON CONSENT FORM HERE:

Before we begin, I'm going to tell you about the study. Here is a copy of the consent form so you can read along.
(GIVE THE PARTICIPANT A COPY OF THE CONSENT FORM TO FOLLOW AS YOU READ IT ALOUD.)

MESSAGE TESTING CONSENT FORM

Why is this study being conducted? The purpose of this study is to learn how to better communicate with the public using alerts and warnings delivered on cell phones and other mobile devices. The study will explore what people think about different types of warning messages.

What happens if I participate in this study? If you choose to participate, you will be asked to answer some questions about different warning messages; the questions will take approximately 20-30 minutes to answer.

What are the possible discomforts or risks and possible benefits? There are no foreseeable risks to participating in this research. There are no benefits to you as a research participant. You will receive a $50 Amazon gift certificate to thank you for your time.

Who is paying for this study? This research is being paid for by the U.S. Department of Homeland Security Science & Technology First Responder Group via a contract administered by the National Consortium for the Study of Terrorism and Responses to Terrorism (START), a DHS-funded Center of Excellence based at the University of Maryland.

Is my participation voluntary? Your participation is voluntary. You have the right to choose not to participate. If you choose to participate, you have the right to stop at any time. If you refuse or decide to withdraw, you will not lose any benefits or rights to which you are entitled.

Who will see my research information? Your identity will remain confidential to the researcher to the extent allowed by law. Your data will be stored on the SurveyMonkey server and will be password protected. Your name and contact information will not be stored with your answers, and will be kept under lock and key. They will be destroyed when the study is completed. The results from the research may be published. Your identity will not be disclosed and your name will not be linked with your answers in any published reports.

Who do I call if I have questions? This study is being conducted by Michele Wood, a researcher at the California State University, Fullerton. Michele Wood may be contacted at (657) 278-7330 or mwood@fullerton.edu should you have questions or to report a research related problem. You may contact the California State University Fullerton IRB at (657) 278-7640 if you have questions or comments about your rights as a study participant.

Conflict of Interest. The researchers involved in this study have no financial or other conflict of interest relating to results of this study.

I have carefully read and/or I have had the terms used in this consent form and their significance explained to me. By signing below, I agree that I am at least 18 years of age and agree to participate in this project.

Before you sign, do you have any questions? (ANSWER ANY QUESTIONS.)

(HAVE THE PARTICIPANT SIGN AND DATE THE CONSENT FORM.)

IF THE PARTICIPANT CONSENTS (SIGNS THE FORM): CONTINUE.

IF THE PARTICIPANT REFUSES (DOES NOT SIGN THE FORM): THANK THE PARTICIPANT AND ESCORT HIM/HER OUT. SUBMIT THE CONSENT FORM WITH THE ID# ON IT AND THE WORD "REFUSED" IN THE SIGNATURE LINE. DO NOT REUSE THE ID #.

Imminent Threat Messages for Mobile Devices - 4 (FACE-TO-FACE)

Screener

This study is about mobile or "cell" phones. Before we begin, I have to confirm that you have a working cell phone.

***2. Do you currently have a working mobile or cell phone, or not?**

- ◯ Yes, I do
- ◯ No, I do not

(IF PARTICIPANT DOES NOT HAVE A WORKING CELL PHONE, QUESTIONNAIRE SKIPS TO THE DISQUALIFICATION PAGE.)

Imminent Threat Messages for Mobile Devices - 4 (FACE-TO-FACE)

Message

Now, I will begin the interview. Assume that you either live in or are visiting Southern California. You are home alone, and you just received the following message on your cell phone. (HAND MESSAGE CARD A, B, C, OR D TO THE PARTICIPANT BASED ON RANDOM ASSIGNMENT INDICATED BELOW.)

Hand Participant Message A
Respondents: 25%
Hand Participant Message B
Respondents: 25%
Hand Participant Message C
Respondents: 25%
Hand Participant Message D
Respondents: 25%

I will ask you some questions about the message using different rating scales. (HAND RESPONDENT THE RESPONSE CARD.) Use this card to rate your answers. You may use any number on the scale.

For example, using Scale A, if you strongly disagree, you would choose 1, if you strongly agree, you could choose 6, or you could choose any number in between to show a different amount of agreement.

***3. We'll start with Scale A.**

On a scale of 1-to-6 where 1 means "strongly disagree" and 6 means "strongly agree", please rate the following statement. The message helped me understand what to do. Would you say 1 "strongly disagree", 6 "strongly agree" or any number in between?

Strongly disagree					Strongly agree	Refused or Don't know
1	2	3	4	5	6	
○	○	○	○	○	○	○

Imminent Threat Messages for Mobile Devices - 4 (FACE-TO-FACE)

***4. Now, we'll use Scale B.**

On a scale of 1-to-6 where 1 means "Do not understand at all" and 6 means "Fully understand", please rate the following statement. After reading this message, I understand: (READ LIST)

	Do not understand at all 1	2	3	4	5	Fully understand 6	Refused or Don't know
What happened	○	○	○	○	○	○	○
The risks	○	○	○	○	○	○	○
What to do to protect myself	○	○	○	○	○	○	○
What location is affected	○	○	○	○	○	○	○
Who the message is from	○	○	○	○	○	○	○
When I am supposed to take action to protect myself	○	○	○	○	○	○	○
How long I am supposed to continue taking action to protect myself	○	○	○	○	○	○	○

***5. How well do you understand the message?**

Do not understand at all 1	2	3	4	5	Fully understand 6	Refused or Don't know
○	○	○	○	○	○	○

***6. Now, we'll use Scale C.**

Using a scale of 1-to-6 where 1 means "Do not believe" and 6 means "Believe", please rate how much you believe the following statements. After reading this message, do you believe that: (READ LIST)

	Do not believe 1	2	3	4	5	Believe 6	Refused or Don't know
Radiation is headed your way?	○	○	○	○	○	○	○
You should immediately take shelter?	○	○	○	○	○	○	○
Sheltering will make you safer?	○	○	○	○	○	○	○

Imminent Threat Messages for Mobile Devices - 4 (FACE-TO-FACE)

***7. Now, we'll use Scale D.**

Using a scale of 1-to-6 where 1 means "Not very likely" and 6 means "Very likely", how likely is each of the following statements?

If I received this message on my cell phone, I would think that: (READ LIST)

	Not very likely 1	2	3	4	5	Very likely 6	Refused or Don't know
I might become injured	○	○	○	○	○	○	○
People I know might become injured	○	○	○	○	○	○	○
People I do not know might become injured	○	○	○	○	○	○	○
I might die	○	○	○	○	○	○	○
People I know might die	○	○	○	○	○	○	○
People I do not know might die	○	○	○	○	○	○	○
The message was meant for me	○	○	○	○	○	○	○

***8. Next, use Scale E.**

On a scale of 1-to-6 where 1 means "No" and 6 means "Yes", please rate your response to the following statements. You may use any number on the scale. (READ LIST)

	No 1	2	3	4	5	Yes 6	Refused or Don't know
The message will **help** me decide what to do.	○	○	○	○	○	○	○
It will be **easy** to decide what to do.	○	○	○	○	○	○	○
I will be able to decide what to do **quickly**.	○	○	○	○	○	○	○
I can decide what to do with **confidence**.	○	○	○	○	○	○	○

***9. Now, use Scale F.**

On a scale of 1-to-6 where 1 means "Very unlikely" and 6 means "Very likely", how likely would you be to look for additional information about <u>what happened</u> before taking action?

Very unlikely 1	2	3	4	5	Very likely 6	Refused or Don't know
○	○	○	○	○	○	○

Imminent Threat Messages for Mobile Devices - 4 (FACE-TO-FACE)

***10. How likely would you be to look for additional information about <u>what to do</u> before taking action?**

Very unlikely 1	2	3	4	5	Very likely 6	Refused or Don't know
○	○	○	○	○	○	○

***11. Would you try to get additional information in any of the following ways? Please answer "yes" or "no." (READ LIST)**

	No	Yes	Refused or Don't know
Face-to-face from another person (friend, family, co-worker, employee, employer)	○	○	○
Television	○	○	○
Telephone call - by land line or by cell phone	○	○	○
Radio	○	○	○
Text message	○	○	○
E-mail	○	○	○
Twitter	○	○	○
Facebook	○	○	○
Instagram	○	○	○
Pinterest	○	○	○
Blogs	○	○	○
YouTube	○	○	○
Other Internet	○	○	○
Some other way	○	○	○
NONE OF THESE - I would not try to get additional information	○	○	○

(If you chose "Some other way", please explain)

***12. We are still using Scale F.**

How likely would you be to tell other people about the need to take action?

Very unlikely 1	2	3	4	5	Very likely 6	Refused or Don't know
○	○	○	○	○	○	○

Imminent Threat Messages for Mobile Devices - 4 (FACE-TO-FACE)

***13. Now, use Scale G.**

On a scale of 1-to-6 where 1 means "Not at all" and 6 means "Extremely", please indicate how the message made you feel. This message made me feel... (READ LIST)

	Not at all 1	2	3	4	5	Extremely 6	Refused or Don't know
Scared	○	○	○	○	○	○	○
Angry	○	○	○	○	○	○	○
Tense	○	○	○	○	○	○	○
Sad	○	○	○	○	○	○	○
Fearful	○	○	○	○	○	○	○
Nervous	○	○	○	○	○	○	○
Anxious	○	○	○	○	○	○	○
Terror-struck	○	○	○	○	○	○	○
Confused	○	○	○	○	○	○	○
Outraged	○	○	○	○	○	○	○
Shocked	○	○	○	○	○	○	○
Sympathetic	○	○	○	○	○	○	○

Sometimes text messages include internet hyperlinks in them. "Clicking" on these links redirects your browser to the specified internet address or website. For example, clicking on a link to "www.FEMA.gov" directs you to the FEMA (Federal Emergency Management Agency) website.

The next few questions are about how you would respond if the message you read above also contained an internet link to additional information.

***14. We are using Scale F again.**

On a scale of 1-to-6 where 1 means "Very unlikely" and 6 means "Very likely, please rate your response. If the message above contained an internet link to additional information, how likely is it that you would "click" on the link?

Very unlikely 1	2	3	4	5	Very likely 6	Refused or Don't know
○	○	○	○	○	○	○

Imminent Threat Messages for Mobile Devices - 4 (FACE-TO-FACE)

***15. If the message above contained an internet link to additional information, what kind of information would you want to see when you "click" on the link? Answer "yes" or "no." (READ LIST)**

	No	Yes	Refused or Don't know
The size and speed of the Radiological Hazard	◯	◯	◯
The physical consequences of the Radiological Hazard	◯	◯	◯
Where the Radiological Hazard will strike and where it won't expressed in words	◯	◯	◯
Where the Radiological Hazard will strike and where it won't expressed in a map	◯	◯	◯
What you should do to protect yourself	◯	◯	◯
How much time you have to protect yourself before the Radiological Hazard strikes	◯	◯	◯
The time the warning will end	◯	◯	◯
Local media article with more information	◯	◯	◯
Who the message was from	◯	◯	◯
Some other information	◯	◯	◯

(If you chose "Some other information", please specify)

***16. Use Scale F.**

On a scale of 1-to-6 where 1 means "Very unlikely" and 6 means "Very likely", if you were to "click" on the internet link to get additional information, how likely is it that you would act on that information without <u>first</u> confirming the information somewhere else?

Very unlikely 1	2	3	4	5	Very likely 6	Refused or Don't know	Not Applicable Would not "click" link
◯	◯	◯	◯	◯	◯	◯	◯

Please explain:

Imminent Threat Messages for Mobile Devices - 4 (FACE-TO-FACE)

***17. If the internet link contained clear instructions about what to do to protect yourself, how likely is it that you would follow those instructions?**

Very unlikely 1	2	3	4	5	Very likely 6	Refused or Don't know
○	○	○	○	○	○	○

Please explain:

***18. How likely would you be to... (READ LIST)**

	Very unlikely 1	2	3	4	5	Very likely 6	Refused or Don't know
Share the information in the internet link with others before taking action to protect yourself?	○	○	○	○	○	○	○
Forward the internet link to other people before taking action to protect yourself?	○	○	○	○	○	○	○
Share the information in the internet link with others after taking action to protect yourself?	○	○	○	○	○	○	○
Forward the internet link to other people after taking action to protect yourself?	○	○	○	○	○	○	○

Imminent Threat Messages for Mobile Devices - 4 (FACE-TO-FACE)

Ranking

This is the last page about messages.

(PLACE ALL 4 MESSAGES ON THE TABLE IN FRONT OF THE PARTICIPANT IN ORDER FROM A-TO-D.)

We would like to know which message is most likely to get you to take action to protect yourself.
Read the following messages, and then place them in rank order.

CAL EMA means California Emergency Management Agency.
US DHS means United States Department of Homeland Security.

19. Place the messages in rank order, where:

1 means MOST likely to get you to take action to protect yourself, and
6 means LEAST likely to get you to take action to protect yourself.

☐	Message A
☐	Message B
☐	Message C
☐	Message D

***20. Please explain why you ranked the messages the way you did.**

(REMOVE THE MESSAGE CARDS FROM THE TABLE.)

Imminent Threat Messages for Mobile Devices - 4 (FACE-TO-FACE)

Demographics

Next we would like to ask you some questions about yourself. You are almost done.

***21. Which of the following activities do you do on your mobile or cell phone? Answer "yes" or "no." (READ LIST.)**

	No	Yes	Refused or Don't know
General internet use (other than using social networking websites)	◯	◯	◯
Make or receive phone calls	◯	◯	◯
Play games	◯	◯	◯
Play music	◯	◯	◯
Play podcasts	◯	◯	◯
Play videos (other than video games)	◯	◯	◯
Purchase products or services	◯	◯	◯
Record videos	◯	◯	◯
Send or receive emails	◯	◯	◯
Send or receive instant messages	◯	◯	◯
Send or receive photos	◯	◯	◯
Send or receive texts	◯	◯	◯
Send or receive videos	◯	◯	◯
Take photos	◯	◯	◯
Use social networking websites	◯	◯	◯

***22. Last week, about how much time did you spend using your mobile or cell phone to send or receive phone calls? (ENTER "99999" FOR REFUSED OR DON'T KNOW.)**

Hours ☐

Minutes ☐

***23. Last week, about how much time did you spend using your mobile or cell phone to send or receive texts? (ENTER "99999" FOR REFUSED OR DON'T KNOW.)**

Hours ☐

Minutes ☐

Imminent Threat Messages for Mobile Devices - 4 (FACE-TO-FACE)

***24. Now use Scale H.**

On a scale of 1-to-6 where 1 means "Extremely uncomfortable" and 6 means "Extremely comfortable", about how comfortable are you using mobile or cell phones?

Extremely **Uncomfortable**					Extremely **Comfortable**	Refused or Don't know
1	2	3	4	5	6	
○	○	○	○	○	○	○

***25. Are you male or female?**

- ○ Male
- ○ Female
- ○ Refused or Don't know

***26.**

- ○ White
- ○ Hispanic or Latino
- ○ Black or African-American
- ○ Asian
- ○ Native Hawaiian or other Pacific Islander
- ○ American Indian or Alaskan Native
- ○ Refused or Don't know
- ○ Some other race (please specify)

***27. What was your age on your last birthday?**
(ENTER "99999" FOR REFUSED OR DON'T KNOW.)

Years

Imminent Threat Messages for Mobile Devices - 4 (FACE-TO-FACE)

***28. What is the highest level of school you have completed or the highest degree you have received, less than a high school degree, a high school degree or equivalent such as a GED, some college but no degree, an associate degree, a bachelor degree, or a graduate degree?**

- ◯ Less than high school degree
- ◯ High school degree or equivalent (e.g., GED)
- ◯ Some college but no degree
- ◯ Associate degree
- ◯ Bachelor degree
- ◯ Graduate degree
- ◯ Refused or Don't know

***29. (FLIP THE RESPONSE CARD FROM THE RATING SCALE SIDE OVER TO THE INCOME SIDE.)**

How much total combined money did all members of your household earn in 2012? This includes money from jobs; net income from business, farm, or rent; pensions; dividends; interest; social security payments; and any other money income received by members of your household that are eighteen (18) years of age or older. Please report the total amount of money earned - do not subtract the amount you paid in taxes or any deductions listed on your tax return. Use this card to indicate your answer.

- ◯ A. $0 to $24,999
- ◯ B. $25,000 to $49,999
- ◯ C. $50,000 to $74,999
- ◯ D. $75,000 to $99,999
- ◯ E. $100,000 to $124,999
- ◯ F. $125,000 to $149,999
- ◯ G. $150,000 to $174,999
- ◯ H. $175,000 to $199,999
- ◯ I. $200,000 or More
- ◯ Refused or Don't know

Imminent Threat Messages for Mobile Devices - 4 (FACE-TO-FACE)

***30. Which of the following categories best describes your employment status, employed, working 1-39 hours per week; employed, working 40 or more hours per week; Not employed, looking for work; retired; or disabled, not able to work?**

- ◯ Employed, working 1-39 hours per week
- ◯ Employed, working 40 or more hours per week
- ◯ Not employed, looking for work
- ◯ Not employed, NOT looking for work
- ◯ Retired
- ◯ Disabled, not able to work
- ◯ Refused or Don't know

***31. Are you a student? (IF "YES", ASK: Part-time or full-time?)**

- ◯ Yes - Part-time
- ◯ Yes - Full-time
- ◯ No
- ◯ Refused or Don't know

***32. Now use Scale I. (FLIP THE RESPONSE CARD FROM THE INCOME SIDE BACK OVER TO THE RATING SCALE SIDE.)**

Sometimes disasters happen that affect people living in a community. Please think about the worst disaster you have ever experienced. On a scale of 1-to-6 where 1 means "No effect" and 6 means "A lot of effect", how much did it affect you?

NO effect 1	2	3	4	5	A LOT of effect 6	Refused or Don't know
◯	◯	◯	◯	◯	◯	◯

***33. Have you ever received an alert or warning message on your cell phone or other mobile device?**

- ◯ Yes
- ◯ No
- ◯ Refused or Don't know

Imminent Threat Messages for Mobile Devices - 4 (FACE-TO-FACE)

***34. Are you subscribed to any cell phone warning services that can send you a text message?**

- ◯ Yes
- ◯ No
- ◯ Refused or Don't know

***35. Do you live in California?**

- ◯ No (SKIPS Q36, ANSWERS Q37)
- ◯ Yes (ANSWERS Q36, SKIPS Q37)
- ◯ Refused or Don't know (SKIPS Q36 & Q37)

You are almost done!

Imminent Threat Messages for Mobile Devices - 4 (FACE-TO-FACE)

CA County

***36. In what county do you live?**

- ◯ Los Angeles County, California
- ◯ San Diego, California
- ◯ Orange County, California
- ◯ Riverside County, California
- ◯ San Bernardino County, California
- ◯ Kern County, California
- ◯ Ventura County, California
- ◯ Santa Barbara County, California
- ◯ San Luis Obispo County, California
- ◯ Imperial County, California
- ◯ Some OTHER County in California
- ◯ Refused or Don't know

Imminent Threat Messages for Mobile Devices - 4 (FACE-TO-FACE)

State

***37. In what state or U.S. territory do you live?**

- ◯ Alabama
- ◯ Alaska
- ◯ American Samoa
- ◯ Arizona
- ◯ Arkansas
- ◯ Colorado
- ◯ Connecticut
- ◯ Delaware
- ◯ District of Columbia (DC)
- ◯ Florida
- ◯ Georgia
- ◯ Guam
- ◯ Hawaii
- ◯ Idaho
- ◯ Illinois
- ◯ Indiana
- ◯ Iowa
- ◯ Kansas
- ◯ Kentucky
- ◯ Louisiana
- ◯ Maine
- ◯ Maryland
- ◯ Massachusetts
- ◯ Michigan
- ◯ Minnesota
- ◯ Mississippi
- ◯ Missouri
- ◯ Montana
- ◯ Nebraska

Imminent Threat Messages for Mobile Devices - 4 (FACE-TO-FACE)

- Nevada
- New Hampshire
- New Jersey
- New Mexico
- New York
- North Carolina
- North Dakota
- Northern Marianas Islands
- Ohio
- Oklahoma
- Oregon
- Pennsylvania
- Puerto Rico
- Rhode Island
- South Carolina
- South Dakota
- Tennessee
- Texas
- Utah
- Vermont
- Virginia
- Virgin Islands
- Washington
- West Virginia
- Wisconsin
- Wyoming
- Refused or Don't know

Imminent Threat Messages for Mobile Devices - 4 (FACE-TO-FACE)

Last Question

***38. Do you think there are important questions about warning messages that we should have asked about, or topics we should have covered but didn't in this survey? What else should we have asked about? (ENTER "No" IF NONE.)**

Appendix E: Additional Experimental and Survey Statistical Results

Table 6.

Sample Description (N=777) (N=468) (N=767) (N=155)

	Experiments 1A, 1B, 1C		*Experiment 2*		*Experiments 3A, 3B, 3C*		*Experiment 4*	
Characteristic	***N***	***%***	***N***	***%***	***N***	***%***	***N***	***%***
Gender								
Men	342	44	234	50	358	47	78	50
Women	435	56	234	50	409	53	77	50
Race/ethnicity								
African American	97	13	81	17	164	21	33	21
Asian	173	22	121	26	189	25	35	23
Hispanic/Latino	114	15	85	18	111	14	37	24
White	383	49	177	38	283	37	42	27
Other	10	1	4	1	20	3	8	5
Age [a]								
Younger (18-54 years)	588	76	363	78	540	70	118	76
Older (55+ years)	189	24	105	22	227	30	37	24
Income								
$0 - $74,999	444	57	293	63	476	62	118	76
$75,000+	333	43	175	37	291	38	37	24
Prior Mobile Alert Received								
Yes	196	25	139	30	272	36	104	73

No	581	75	329	70	495	64	38	27
Live in California								
Yes (Southern)	638	82	124	27	116	15	155	100
Yes (Other)	18	2	108	23	116	15	0	0
No	121	16	236	50	535	70	0	0

[a] Mean age for experiments 1A, 1B, and 1C=44.4; for experiment 2=43.4; for experiments 3A, 3B, and 3C=44.8; and for experiment 4=40.3 years.

Table 7.

Descriptive Statistics

Scale [a]	Mean	SD	No. of Items	Cronbach's α
Experiments 1A, 1B, 1C (*N*=777)				
Interpret	38.12	18.00	14	.95
Fright	19.26	7.87	6	.95
Personalize	22.05	8.88	7	.96
Lament	6.02	4.16	3	.85
Mill	7.61	2.59	2	.86
Experiment 2 (*N*=468)				
Interpret – Protective Action	33.00	10.74	9	.95
Interpret – Risk	11.31	3.41	3	.83
Fright	25.86	10.40	8	.94
Personalize	25.56	8.28	7	.95
Lament	6.65	4.24	3	.81
Mill	6.75	2.87	2	.86
Experiments 3A, 3B, 3C (*N*=767)				
Interpret	58.32	18.73	16	.96
Fright	18.10	7.79	6	.91
Personalize	21.36	7.54	6	.96
Lament	5.39	4.02	3	.78

Mill	6.39	3.13	2	.84
Experiment 5 (*N*=155)				
Interpret	33.28	11,82	10	.87
Fright	20.90	9.73	7	.93
Personalize	22.50	9.57	7	.92
Mill	7.61	2.73	2	.65

[a] Items were rated on a 6-point scale, summed, with the lowest possible value set to zero.

Table 8

Regressions without Controls: Current Content Order v. Order Number 5 (N=218)

		Model				
					Adjusted	
Outcome	***Predictor***	***B***	***β***	***95% CI (B)***	***R^2 %***	***F (p)***
Interpretation	Order Number 5	2.943	.074	(-2.385, 8.271)	0.1	1.18 (.277)
Fright	Order Number 5	1.594	.108	(-0.375, 3.564)	0.7	2.55 (.112)
Personalization	Order Number 5	2.241	.119	(-0.271, 4.752)	1.0	3.09 (.080)
Lament	Order Number 5	0.577	.068	(-0.558, 1.712)	0.0	1.00 (.317)
Milling	Order Number 5	0.480	.096	(-0.191, 1.151)	0.5	1.99 (.160)

Table 9

Regressions with Controls: Current Content Order v. Order Number 5 (N=216) [a]

		Model					
						Adjusted	
Outcome	***Predictor***	***B***	***β***	***p***	***95% CI (B)***	***R^2 %***	***F (p)***
Interpretation	Order Number 5	2.150	.054	.426	(-3.167, 7.467)	2.2	1.97 (.085)
	Gender [b]	4.823	.123	.071	(-00.416, 10.062)		
	African American [c]	8.584	.133	.059	(-00.338, 17.505)		
	Latino	-3.112	-.053	.455	(-11.306, 05.082)		
	Asian	-0.487	-.011	.877	(-6.682, 5.708)		
Fright	Order Number 5	1.995	.133	.050	(0.004, 3.906)	3.5	2.56 (.028)
	Gender	-2.889	-.200	.003	(-4.811, -0.966)		
	African American	-1.591	-.067	.339	(-4.865, 1.683)		
	Latino	-0.118	-.005	.938	(-3.125, 2.888)		
	Asian	-0.763	-.047	.509	(-3.036, 1.510)		
Personalization	Order Number 5	2.251	.120	.082	(-0.290, .4.792)	0.8	1.36 (.239)
	Gender	-0.160	-.009	.900	(-2.664, 2.344)		
	African American	2.788	.091	.199	(-1.475, 7.051)		
	Latino	-1.447	-.052	.467	(-5.363, 2.469)		
	Asian	-1.070	-.051	.477	(-4.030, 1.890)		

Lament	Order Number 5	0.570	.067	.331	(-0.584, 1.725)	-0.8	0.64 (.667)
	Gender	0.376	.045	.516	(-0.762, 1.514)		
	African American	-1.171	-.085	.235	(-3.109, 0.766)		
	Latino	-0.098	-.008	.914	(-1.877, 1.682)		
	Asian	-0.610	-.065	.372	(-1.956, 0.735)		
Milling	Order Number 5	0.432	.086	.213	(-0.250, 1.115)	-0.7	0.71 (.617)
	Gender	0.054	.011	.875	(-0.619, 0.726)		
	African American	-0.035	-.004	.952	(-1.180, 1.111)		
	Latino	-0.262	-.035	.624	(-1.314, 0.790)		
	Asian	-0.530	-.095	.190	(-1.325, 0.265)		

[a] Due to classifying their race/ethnicity as "other", two subjects were excluded from these analyses.
[b] For gender, the reference group was "men."
[c] For race/ethnicity, the reference group was "white."

Table 10

Regressions without Controls: CAL EMA v. WEA as Source (N=99)

		Model				
					Adjusted	
Outcome	***Predictor***	***B***	***β***	***95% CI (B)***	***R^2 %***	***F (p)***
Interpretation	CAL EMA	7.426	.199	(00.066, 14.787)	3.0	4.01 (.048)
Fright	CAL EMA	1.301	.074	(-2.238, 4.841)	-0.5	0.53 (.467)
Personalization	CAL EMA	4.765	.241	(0.892, 8.639)	4.8	5.96 (.016)
Lament	CAL EMA	-0.126	-.014	(-1.977, 1.725)	-1.0	0.02 (.893)
Milling	CAL EMA	-0.894	-.158	(-2.019, 0.231)	1.5	2.49 (.118)

Table 11

Regressions with Controls: CAL EMA v. WEA as Source (N=97) [a]

		Model					
						Adjusted	
Outcome	***Predictor***	***B***	***β***	***p***	***95% CI (B)***	***R^2 %***	***F (p)***
Interpretation	CAL EMA	5.641	.151	.168	(-02.427, 13.709)	1.6	1.31 (.267)
	Gender [b]	6.203	.181	.081	(-00.786, 13.192)		
	African American [c]	3.147	.056	.615	(-09.251, 15.545)		
	Latino	-1.519	-.036	.754	(-11.109, 08.070)		
	Asian	0.442	.011	.919	(-8.129, 9.012)		
Fright	CAL EMA	2.265	.128	.250	(-1.623, 6.153)	-0.7	0.87 (.505)
	Gender	-2.059	-.126	.228	(-5.427, 1.309)		
	African American	-3.653	-.137	.228	(-9.628, 2.322)		
	Latino	0.482	.024	.836	(-4.139, 5.104)		
	Asian	-1.493	-.080	.475	(-5.624, 2.638)		
Personalization	CAL EMA	3.255	.163	.135	(-1.034, 7.543)	2.9	1.57 (.176)
	Gender	1.428	.078	.447	(-2.287, 5.143)		
	African American	4.625	.154	.167	(-01.965, 11.215)		
	Latino	2.236	.099	.386	(-2.861, 7.333)		
	Asian	0.762	.037	.740	(-3.793, 5.318)		

Lament	CAL EMA	-0.238	-.026	.816	(-2.261, 1.785)	-1.2	0.77 (.574)
	Gender	1.534	.181	.085	(-0.218, 3.287)		
	African American	-0.137	-.010	.930	(-3.246, 2.972)		
	Latino	0.109	.010	.929	(-2.296, 2.514)		
	Asian	-0.906	-.094	.405	(-3.055, 1.244)		
Milling	CAL EMA	-1.264	-.221	.045	(-2.502, -0.026)	2.0	1.39 (.237)
	Gender	-0.273	-.052	.614	(-1.346, 0.799)		
	African American	0.880	.102	.361	(-1.023, 2.782)		
	Latino	0.994	.153	.183	(-0.477, 2.466)		
	Asian	-0.473	-.079	.476	(-1.789, 0.842)		

[a] Due to classifying their race/ethnicity as "other", two subjects were excluded from these analyses.

[b] For gender, the reference group was "men."

[c] For race/ethnicity, the reference group was "white."

Table 12

Regressions without controls: No Map v. High Information Map (N=202)

		Model				
					Adjusted	
Outcome	***Predictor***	***B***	***β***	***95% CI (B)***	***R^2 %***	***F (p)***
Interpretation	High Resolution Map	4.727	.123	(-00.586, 10.040)	1.0	3.08 (.081)
Fright	High Resolution Map	0.814	.053	(-1.324, 2.952)	-0.2	0.56 (.454)
Personalization	High Resolution Map	2.916	.158	(0.379, 5.454)	2.0	5.14 (.025)
Lament	High Resolution Map	0.463	.055	(-0.713, 1.640)	-0.2	0.60 (.438)
Milling	High Resolution Map	0.210	.040	(-0.531, 0.951)	-0.3	0.31 (.577)

Table 13

Regressions with Controls: No Map v. High Information Map (N=199) [a]

		Model					
						Adjusted	
Outcome	***Predictor***	***B***	***β***	***p***	***95% CI (B)***	***R^2 %***	***F (p)***
Interpretation	High Resolution Map	4.622	.121	.092	(-0.754, 9.997)	1.9	1.78 (.118)
	Gender [b]	0.517	.014	.843	(-4.631, 5.664)		
	African American [c]	9.550	.163	.028	(01.055, 18.045)		
	Latino	1.072	.020	.786	(-6.714, 8.858)		
	Asian	3.539	.083	.267	(-2.730, 9.807)		
Fright	High Resolution Map	1.030	.068	.344	(-1.112, 3.173)	1.2	1.50 (.195)
	Gender	-2.445	-.167	.020	(-4.497, -0.393)		
	African American	-1.980	-.085	.250	(-5.366, 1.406)		
	Latino	-0.455	-.021	.773	(-3.559, 2.649)		
	Asian	0.354	.021	.780	(-2.145, 2.853)		
Personalization	High Resolution Map	3.061	.167	.020	(0.497, 5.624)	2.7	2.09 (.068)
	Gender	-0.248	-.014	.842	(-2.703, 2.206)		
	African American	3.383	.121	.101	(-0.668, 7.434)		
	Latino	-1.229	-.048	.515	(-4.942, 2.484)		
	Asian	-0.313	-.015	.837	(-3.302, 2.676)		

Lament	High Resolution Map	0.532	.063	.386	(-0.675, 1.740)	-1.5	0.41 (.841)
	Gender	0.377	.046	.521	(-0.780, 1.534)		
	African American	-0.702	-.054	.469	(-2.611, 1.207)		
	Latino	0.359	.030	.686	(-1.391, 2.108)		
	Asian	-0.123	-.013	.863	(-1.532, 1.285)		
Milling	High Resolution Map	0.201	.038	.599	(-0.552, 0.955)	-1.0	0.60 (.697)
	Gender	0.247	.048	.501	(-0.475, 0.968)		
	African American	0.236	.029	.696	(-0.955, 1.426)		
	Latino	-0.718	-.097	.196	(-1.809, 0.373)		
	Asian	-0.179	-.030	.688	(-1.058, 0.699)		

[a] Due to classifying their race/ethnicity as "other", three subjects were excluded from these analyses.

[b] For gender, the reference group was "men."

[c] For race/ethnicity, the reference group was "white."

Table 14

Regressions without Controls: Full Contents v. Excluded Content Elements (N=468)

		Model					
						Adjusted	
Outcome	***Predictor***	***B***	***β***	***p***	***95% CI (B)***	***R^2 %***	***F (p)***
Interpretation:	Source Omitted	0.366	.013	.810	(-2.622, 3.355)	21.3	26.33 (<.001)
Protective	Guidance Omitted	-14.001	-.481	<.001	(-16.999, -11.002)		
Action	Hazard Omitted	-2.417	-.084	.111	(-5.396, 0.562)		
	Location Omitted	-0.648	.023	.669	(-3.626, 2.331)		
	Termination Omitted	0.047	.002	.975	(-2.922, 3.016)		
Interpretation:	Source Omitted	0.252	.027	.631	(-0.778, 1.283)	7.1	8.14 (<.001)
Risk	Guidance Omitted	-0.128	-.014	.808	(-1.163, 0.906)		
	Hazard Omitted	-2.518	-.276	<.001	(-3.545, -1.490)		
	Location Omitted	-0.812	-.089	.121	(-1.840, 0.215)		
	Termination Omitted	0.213	.023	.683	(-0.811, 1.237)		
Fright	Source Omitted	2.711	.097	.101	(-0.530, 5.952)	1.4	2.29 (.045)
	Guidance Omitted	0.785	.028	.636	(-2.467, 4.037)		
	Hazard Omitted	-2.271	-.081	.168	(-5.502, 0.959)		
	Location Omitted	-1.618	-.058	.326	(-4.848, 1.613)		
	Termination Omitted	0.151	.005	.927	(-3.069, 3.371)		
Personalization	Source Omitted	0.919	.041	.483	(-1.653, 3.492)	1.9	2.82 (.016)
	Guidance Omitted	-0.017	-.001	.990	(-2.598, 2.564)		
	Hazard Omitted	-3.002	-.135	.022	(-5.566, -0.438)		
	Location Omitted	-1.271	-.057	.330	(-3.835, 1.293)		

	Termination Omitted	1.202	.054	.356	(-1.354, 3.758)		
Lament	Source Omitted	0.719	.063	.284	(-0.597, 2.035)	2.0	2.95 (.012)
	Guidance Omitted	0.699	.061	.299	(-0.621, 2.020)		
	Hazard Omitted	-1.339	-.118	.045	(-2.651, -0.027)		
	Location Omitted	-0.813	-.072	.224	(-2.125, 0.499)		
	Termination Omitted	-0.079	-.007	.906	(-1.386, 1.229)		
Milling	Source Omitted	-0.438	-.057	.331	(-1.324, 0.448)	3.1	3.94 (.002)
	Guidance Omitted	1.250	.161	.006	(0.361, 2.139)		
	Hazard Omitted	-0.045	-.006	.921	(-0.928, 0.838)		
	Location Omitted	-0.250	-.033	.578	(-1.133, 0.633)		
	Termination Omitted	-0.484	-.063	.280	(-1.364, 0.396)		

Table 15

Regressions with Controls: Full Contents v. Excluded Content Elements (N=464) [a]

		Model					
						Adjusted	
Outcome	***Predictor***	***B***	***β***	***p***	***95% CI (B)***	***R^2 %***	***F (p)***
Interpretation:	Source Omitted	0.169	.006	.910	(-2.751, 3.088)	25.8%	18.91 (<.001)
Protective	Guidance Omitted	-13.605	-.464	<.001	(-16.557, -10.653)		
Action	Hazard Omitted	-2.042	-.071	.017	(-4.960, 0.876)		
	Location Omitted	-0.537	-.019	.716	(-3.440, 2.366)		
	Termination Omitted	0.116	.004	.937	(-2.789, 3.022)		
	Gender [b]	1.998	.093	.023	(0.278, 3.718)		
	African American [c]	4.173	.148	.001	(1.701, 6.644)		
	Latino	1.117	.040	.363	(-1.294, 3.527)		
	Asian	-2.696	-.109	.015	(-4.858, -0.535)		
Interpretation:	Source Omitted	0.219	.024	.674	(-0.802, 1.240)	9.1%	6.17 (<.001)
Risk	Guidance Omitted	0.093	.010	.860	(-0.939, 1.125)		
	Hazard Omitted	-2.406	-.265	<.001	(-3.427, -1.386)		
	Location Omitted	-0.771	-.085	.136	(-1.786, 0.244)		
	Termination Omitted	0.263	.029	.611	(-0.753, 1.279)		
	Gender	0.222	.033	.469	(-0.380, 0.823)		
	African American	1.209	.135	.006	(0.345, 2.074)		
	Latino	0.066	.008	.877	(-0.777, 0.909)		
	Asian	-0.484	-.062	.209	(-1.239, 0.272)		
Fright	Source Omitted	2.916	.104	.079	(-0.334, 6.166)	2.4%	2.25 (.018)
	Guidance Omitted	0.946	.033	.572	(-2.340, 4.232)		

	Hazard Omitted	-1.990	-.071	.229	(-5.239, 1.258)		
	Location Omitted	-1.612	-.058	.328	(-4.843, 1.620)		
	Termination Omitted	0.067	.022	.968	(-3.167, 3.302)		
	Gender	-2.020	-.097	.039	(-3.935, -0.106)		
	African American	-0.613	-.022	.662	(-3.364, 2.139)		
	Latino	2.206	.082	.107	(-0.477, 4.889)		
	Asian	1.217	.051	.321	(-1.190, 3.623)		
Personalization	Source Omitted	0.748	.034	.568	(-1.821, 3.316)	2.7%	2.45 (.010)
	Guidance Omitted	0.274	.012	.836	(-2.322, 2.871)		
	Hazard Omitted	-2.980	-.135	.023	(-5.547, -0.413)		
	Location Omitted	-1.332	-.060	.306	(-3.886, 1.222)		
	Termination Omitted	1.065	.048	.413	(-1.491, 3.620)		
	Gender	1.437	.087	.063	(-0.076, 2.950)		
	African American	1.005	.046	.364	(-1.169, 3.179)		
	Latino	1.008	.047	.351	(-1.113, 3.128)		
	Asian	-1.335	-.070	.168	(-3.237, 0.566)		
Lament	Source Omitted	0.783	.069	.244	(-0.535, 2.101)	2.6%	2.36 (.013)
	Guidance Omitted	0.868	.075	.201	(-0.465, 2.200)		
	Hazard Omitted	-1.287	-.114	.055	(-2.605, 0.030)		
	Location Omitted	-0.768	-.068	.250	(-2.078, 0.543)		
	Termination Omitted	-0.099	-.009	.882	(-1.411, 1.213)		
	Gender	0.483	.057	.222	(-0.293, 1.260)		
	African American	-0.561	-.050	.323	(-1.677, 0.554)		

	Latino	0.639	.058	.249	(-0.449, 1.727)		
	Asian	-0.387	-.040	.436	(-1.363, 0.589)		
Milling	Source Omitted	-0.494	-.064	.278	(-1.388, 0.400)	2.6%	2.37 (.013)
	Guidance Omitted	1.202	.154	.009	(0.299, 2.106)		
	Hazard Omitted	-0.104	-.014	.820	(-0.997, 0.790)		
	Location Omitted	-0.301	-.039	.506	(-1.190, 0.588)		
	Termination Omitted	-0.505	-.066	.266	(-1.394, 0.385)		
	Gender	0.314	.055	.242	(-0.213, 0.841)		
	African American	-0.138	-.018	.720	(-0.895, 0.619)		
	Latino	0.290	.039	.441	(-0.448, 1.028)		
	Asian	0.060	.009	.858	(-0.602, 0.722)		

[a] Due to classifying their race/ethnicity as "other", four subjects were excluded from these analyses.

[b] For gender, the reference group was "men."

[c] For race/ethnicity, the reference group was "white."

Table 16

90-Characters Messages Regressions without Controls: Radiological v. Active Shooter and Tsunami Hazard (N=247)

		Model					
						Adjusted	
Outcome	***Predictor***	***B***	***β***	***p***	***95% CI (B)***	***R^2 %***	***F (p)***
Interpretation	Active Shooter	2.951	.072	.306	(-2.712, 8.614)	8.6	12.51 (<.001)
	Tsunami	13.535	.335	<.001	(7.923, 19.147)		
Fright	Active Shooter	-0.601	-.035	.633	(-3.073, 1.871)	-0.3	0.58 (.558)
	Tsunami	-1.341	-.080	.282	(-3.791, 1.109)		
Personalization	Active Shooter	-1.937	-.114	.114	(-4.344, 0.471)	4.5	6.74 (.001)
	Tsunami	2.509	.149	.039	(0.123, 4.895)		
Lament	Active Shooter	0.414	.050	.500	(-0.793, 1.622)	-0.6	0.27 (.764)
	Tsunami	0.356	.043	.559	(-0.841, 1.552)		
Milling	Active Shooter	-0.795	-.130	.075	(-1.671, 0.081)	2.2	3.79 (.024)
	Tsunami	-1.193	-.197	.007	(-2.060, -0.325)		

Table 17

140-Characters Messages Regressions without Controls: Radiological v. Active Shooter and Tsunami Hazard (N=253)

		Model					
						Adjusted	
Outcome	***Predictor***	***B***	***β***	***p***	***95% CI (B)***	***R^2 %***	***F (p)***
Interpretation	Active Shooter	9.709	.249	.001	(4.157, 15.261)	6.1	9.24 (<.001)
	Tsunami	12.092	.290	<.001	(6.161, 18.023)		
Fright	Active Shooter	-0.288	-.018	.805	(-2.587, 2.011)	-0.2	0.77 (.464)
	Tsunami	-1.447	-.087	.247	(-3.903, 1.009)		
Personalization	Active Shooter	-0.522	-.035	.640	(-2.717, 1.674)	0.7	1.87 (.156)
	Tsunami	1.592	.099	.182	(0.753, 3.938)		
Lament	Active Shooter	1.133	.141	.052	(-0.011, 2.278)	6.3	9.46 (<.001)
	Tsunami	-1.395	-.162	.026	(-2.618, -0.172)		
Milling	Active Shooter	-1.966	-.297	<.001	(-2.909, -1.023)	6.0	9.09 (<.001)
	Tsunami	-1.618	-.229	.002	(-2.626, -0.611)		

Table 18

1,380-Characters Messages Regressions without Controls: Radiological v. Active Shooter and Tsunami Hazard (N=267)

		Model					
						Adjusted	
Outcome	***Predictor***	***B***	***β***	***p***	***95% CI (B)***	***R^2 %***	***F (p)***
Interpretation	Active Shooter	-1.287	-.038	.588	(-5.952, 3.379)	1.1	2.41 (.092)
	Tsunami	3.702	.111	.117	(-0.937, 8.342)		
Fright	Active Shooter	2.504	.153	.031	(0.236, 4.773)	1.2	2.58 (.078)
	Tsunami	0.596	.037	.604	(-1.660, 2.851)		
Personalization	Active Shooter	0.750	.049	.487	(-1.371, 2.871)	-0.6	.26 (.773)
	Tsunami	0.533	.035	.619	(-1.576, 2.643)		
Lament	Active Shooter	2.799	.318	<.001	(1.659, 3.938)	13.9	22.49 (<.001)
	Tsunami	-0.925	-.106	.109	(-2.059, 0.208)		
Milling	Active Shooter	-0.439	-.065	.364	(-1.389, 0.511)	-0.4	.42 (.656)
	Tsunami	-0.160	-.024	.739	(-1.105, 0.785)		

Table 19

90-Characters Messages Regressions with Controls: Radiological v. Active Shooter and Tsunami Hazard (N=247)

		Model					
						Adjusted	
Outcome	***Predictor***	***B***	***β***	***p***	***95% CI (B)***	***R^2 %***	***F (p)***
Interpretation	Active Shooter	3.433	.084	.239	(-2.292, 9.158)	8.4	4.77 (<.001)
	Tsunami	13.640	.337	<.001	(07.970, 19.309)		
	Gender [a]	0.517	.013	.828	(-4.156, 5.190)		
	African American [b]	2.828	.060	.371	(-3.383, 9.038)		
	Latino	-1.934	-.034	.599	(-9.179, 5.311)		
	Asian	-3.540	-.079	.239	(-9.441, 2.362)		
Fright	Active Shooter	-0.797	-.047	.533	(-3.307, 1.714)	-1.4	0.44 (.849)
	Tsunami	-1.496	-.089	.237	(-3.982, 0.990)		
	Gender	-1.173	-.073	.261	(-3.222, 0.876)		
	African American	0.004	<.001	.998	(-2.719, 2.727)		
	Latino	-0.181	-.008	.911	(-3.357, 2.996)		
	Asian	0.439	.024	.738	(-2.148, 3.027)		
Personalization	Active Shooter	-1.747	-.103	.157	(-4.174, 0.680)	4.9	3.11 (.006)
	Tsunami	2.505	.149	.041	(0.102, 4.908)		
	Gender	-0.208	-.013	.836	(-2.188, 1.773)		
	African American	1.676	.085	.211	(-0.956, 4.308)		
	Latino	-0.566	-.024	.717	(-3.637, 2.505)		

	Asian	-1.639	-.088	.198	(-4.148, 0.863)		
Lament	Active Shooter	0.635	.077	.292	(-0.549, 1.819)	5.2	3.23 (.005)
	Tsunami	0.611	.074	.306	(-0.562, 1.783)		
	Gender	1.212	.155	.014	(0.246, 2.179)		
	African American	1.511	.157	.021	(0.227, 2.796)		
	Latino	2.360	.206	.002	(0.861, 3.859)		
	Asian	1.287	.142	.039	(0.066, 2.508)		
Milling	Active Shooter	-0.769	-.126	.087	(-1.650, 0.112)	3.1	2.31 (.035)
	Tsunami	-1.146	-.190	.010	(-2.018, -0.274)		
	Gender	-0.076	-.013	.836	(-0.794, 0.643)		
	African American	1.053	.149	.031	(0.098, 2.009)		
	Latino	0.880	.105	.121	(-0.235, 1.994)		
	Asian	0.730	.109	.114	(-0.178, 1.638)		

[a] For gender, the reference group was "men."

[b] For race/ethnicity, the reference group was "white."

Table 20

140-Characters Messages Regressions with Control Factors: Radiological v. Active Shooter and Tsunami Hazard (N=253)

		Model					
						Adjusted	
Outcome	***Predictor***	***B***	***β***	***p***	***95% CI (B)***	***R^2 %***	***F (p)***
Interpretation	Active Shooter	9.887	.253	.001	(4.315, 15.460)	6.8	4.08 (.001)
	Tsunami	11.857	.284	<.001	(5.874, 17.840)		
	Gender [a]	2.278	.060	.337	(-2.383, 6.940)		
	African American [b]	-1.287	-.029	.674	(-7.308, 4.734)		
	Latino	1.858	.035	.603	(-5.176, 8.891)		
	Asian	-5.895	-.129	.058	(-12.001, 00.211)		
Fright	Active Shooter	-0.021	-.001	.986	(-2.295, 2.253)	3.4	2.49 (.023)
	Tsunami	-1.798	-.108	.148	(-4.239, 0.644)		
	Gender	-3.316	-.216	.001	(-5.218, -1.414)		
	African American	-0.302	-.017	.809	(-2.759, 2.155)		
	Latino	0.528	.025	.717	(-2.342, 3.398)		
	Asian	-0.908	-.049	.474	(-3.400, 1.583)		
Personalization	Active Shooter	-0.414	-.028	.713	(-2.624, 1.796)	0.8	1.36 (.233)
	Tsunami	1.354	.084	.262	(-1.019, 3.727)		
	Gender	-0.381	-.026	.685	(-2.230, 1.468)		
	African American	-0.874	-.051	.472	(-3.262, 1.514)		
	Latino	0.682	.033	.630	(-2.107, 3.472)		

	Asian	-2.079	-.118	.092	(-4.501, 0.342)		
Lament	Active Shooter	1.227	.152	.036	(0.078, 2.376)	7.0	4.16 (.001)
	Tsunami	-1.295	-.150	.040	(-2.528, -0.062)		
	Gender	-0.835	-.106	.088	(-1.796, 0.126)		
	African American	0.983	.107	.120	(-0.259, 2.224)		
	Latino	-0.384	-.035	.602	(-1.834, 1.066)		
	Asian	0.312	.033	.625	(-0.946, 1.571)		
Milling	Active Shooter	-2.035	-.307	<.001	(-2.988, -1.081)	5.4	3.38 (.003)
	Tsunami	-1.712	-.242	.001	(-2.735, -0.689)		
	Gender	0.011	.002	.978	(-0.786, 0.808)		
	African American	-0.718	-.095	.171	(-1.748, 0.312)		
	Latino	-0.232	-.026	.705	(-1.435, 0.971)		
	Asian	0.009	.001	.987	(-1.035, 1.053)		

[a] For gender, the reference group was "men."

[b] For race/ethnicity, the reference group was "white."

Table 21

1,380-Characters Messages Regressions with Controls: Radiological v. Active Shooter and Tsunami Hazard (N=267)

		Model					
						Adjusted	
Outcome	***Predictor***	***B***	***β***	***p***	***95% CI (B)***	***R^2 %***	***F (p)***
Interpretation	Active Shooter	-1.116	-.033	.642	(-5.842, 3.610)	1.0	1.43 (.203)
	Tsunami	4.079	.122	.086	(-0.584, 8.741)		
	Gender [a]	-0.580	-.108	.768	(-4.442, 3.282)		
	African American [b]	1.529	.038	.569	(-3.754, 6.812)		
	Latino	-4.094	-.092	.164	(-9.872, 1.684)		
	Asian	-2.314	-.064	.351	(-7.186, 2.559)		
Fright	Active Shooter	2.183	.133	.058	(-0.070, 4.436)	4.9	3.27 (.004)
	Tsunami	0.510	.031	.652	(-1.713, 2.733)		
	Gender	-3.512	-.226	<.001	(-5.353, -1.670)		
	African American	-0.236	-.012	.854	(-2.755, 2.283)		
	Latino	-0.945	-.044	.500	(-3.700, 1.810)		
	Asian	-0.505	-.029	.669	(-2.829, 1.818)		
Personalization	Active Shooter	0.724	.048	.502	(-1.398, 2.846)	1.8	1.82 (.095)
	Tsunami	0.714	.047	.502	(-1.379, 2.808)		
	Gender	-1.713	-.119	.053	(-3.447, 0.021)		
	African American	1.025	.057	.396	(-1.347, 3.397)		
	Latino	-2.378	-.119	.072	(-4.972, 0.217)		

	Asian	-1.548	-.095	.165	(-3.736, 0.640)		
Lament	Active Shooter	2.780	.316	<.001	(1.620, 3.941)	12.9	7.56 (<.001)
	Tsunami	-0.927	-.106	.112	(-2.072, 0.218)		
	Gender	0.263	.031	.586	(-0.686, 1.211)		
	African American	0.361	.034	.585	(-0.937, 1.658)		
	Latino	0.465	.040	.519	(-0.954, 1.884)		
	Asian	0.364	.038	.549	(-0.832, 1.561)		
Milling	Active Shooter	-0.540	-.079	.265	(-1.492, 0.412)	1.6	1.73 (.115)
	Tsunami	-0.188	-.028	.694	(-1.127, 0.751)		
	Gender	0.341	.053	.389	(-0.437, 1.119)		
	African American	1.053	.131	.052	(-0.011, 2.118)		
	Latino	1.480	.165	.013	(0.316, 2.644)		
	Asian	1.087	.148	.030	(0.105, 2.068)		

[a] For gender, the reference group was "men."

[b] For race/ethnicity, the reference group was "white."

Table 22

Regressions without Controls: Standard WEA v. optimized 90, 140, and 1,380 characters messages (N=155)

		Model					
						Adjusted	
Outcome	***Predictor***	***B***	***β***	***p***	***95% CI (B)***	***R^2 %***	***F (p)***
Interpretation	Optimized 90 char.	3.843	.149	.116	(-0.959, 8.646)	10.8	7.20 (<.001)
	Optimized 140 char.	3.314	.118	.204	(-1.824, 8.451)		
	Optimized 1,380 char.	11.742	.417	<.001	(6.605, 16.879)		
Fright	Optimized 90 char.	0.029	.001	.989	(-4.191, 4.249)	-1.7	0.17 (.919)
	Optimized 140 char.	1.248	.054	.586	(-3.266, 5.761)		
	Optimized 1,380 char.	-0.238	-.010	.917	(-4.752, 4.275)		
Personalization	Optimized 90 char.	4.236	.203	.041	(0.177, 8.295)	2.7	2.45 (.066)
	Optimized 140 char.	2.949	.129	.182	(-1.392, 7.291)		
	Optimized 1,380 char.	5.607	.246	.012	(-1.265, 9.948)		
Milling	Optimized 90 char.	-0.300	-.050	.598	(-1.420, 0.821)	9.0	6.08 (.001)
	Optimized 140 char.	-0.171	-.026	.779	(-1.369, 1.028)		
	Optimized 1,380 char.	-2.285	-.351	<.001	(-3.484, -1.086)		

Table 23

Regressions with Controls: Standard WEA v. optimized 90, 140, and 1,380 characters messages (N=147) [a]

		Model					
						Adjusted	
Outcome	***Predictor***	***B***	***β***	***p***	***95% CI (B)***	***R^2 %***	***F (p)***
Interpretation	Optimized 90 char.	3.284	.125	.207	(-1.836, 8.403)	9.6	3.20 (.004)
	Optimized 140 char.	2.488	.087	.372	(-3.001, 7.977)		
	Optimized 1,380 char.	11.004	.385	<.001	(5.598, 16.410)		
	Gender [b]	0.511	.021	.791	(-3.304, 4.326)		
	African American [c]	4.164	.146	.118	(-1.070, 9.398)		
	Latino	2.216	.081	.395	(-2.921, 7.353)		
	Asian	0.011	.000	.997	(-5.160, 5.183)		
Fright	Optimized 90 char.	-0.637	-.030	.776	(-5.046, 3.772)	-2.0	0.60 (.757)
	Optimized 140 char.	0.440	.019	.854	(-4.287, 5.167)		
	Optimized 1,380 char.	-0.464	-.020	.844	(-5.119, 4.192)		
	Gender [b]	2.499	.129	.135	(-0.786, 5.784)		
	African American [c]	-0.841	-.036	.713	(-5.238, 3.667)		
	Latino	0.366	.016	.870	(-4.058, 4.789)		
	Asian	-2.590	-.113	.252	(-7.044, 1.863)		
Personalization	Optimized 90 char.	4.180	.200	.048	(-0.032, 8.327)	6.7	2.50 (.019)
	Optimized 140 char.	2.501	.110	.268	(-1.945, 6.948)		
	Optimized 1,380 char.	5.330	.234	.017	(0.950, 9.709)		

	Gender [b]	1.189	.063	.448	(-1.902, 4.279)		
	African American [c]	-3.172	-.139	.141	(-7.412, 1.068)		
	Latino	0.916	.042	.664	(-3.246, 5.077)		
	Asian	-5.116	-.227	.017	(-9.305, -0.926)		
Milling	Optimized 90 char.	-0.105	-.018	.859	(-1.273, 1.062)	8.4	2.90 (.007)
	Optimized 140 char.	0.017	.003	.978	(-1.234, 1.269)		
	Optimized 1,380 char.	-2.151	-.332	.001	(-3.383, -0.918)		
	Gender [b]	0.087	.016	.844	(-0.783, 0.957)		
	African American [c]	-0.573	-.089	.344	(-1.767, 0.620)		
	Latino	0.528	.085	.375	(-0.644, 1.699)		
	Asian	0.227	.035	.705	(-0.953, 1.406)		

[a] Due to classifying their race/ethnicity as "other", eight subjects were excluded from these analyses.

[b] For gender, the reference group was "men."

[c] For race/ethnicity, the reference group was "white."

Table 24.

Messages Received and Believability of Message Source, WEA Recipients (N=496)

Message Source	***N***	*%*	*M*	***SD***
Personal (family member or other relative, neighbor or friend, employer, coworker)	367/496	74	5.38	0.874
Family Member or Relative	218/492	44	5.41	1.002
Neighbor or Friend	284/494	58	5.35	0.923
Employer	85/492	17	5.51	0.983
Co-worker	80/492	16	5.46	0.941
Local (Boulder Police, Boulder fire department, Boulder Office of Emergency Management, Boulder Sheriff's Department)	285/496	58	5.61	0.704
Boulder Police	81/465	17	5.38	0.943
Boulder Fire Department	57/459	12	5.57	0.684
Boulder Office of Emergency Management	205/442	46	5.68	0.680
Boulder Sheriff's Department	119/450	26	5.52	0.811
State (Colorado governor's office)	32/496	6	5.38	0.907
Colorado Governor's Office	32/461	7	5.38	0.907
National (National guard, National Weather Service)	410/496	83	5.53	0.810
National Weather Service	406/484	84	5.56	0.768
National Guard	29/470	6	5.24	1.327

Table 25

Relative Importance of Message Content Elements on Message Interpretation Among WEA Recipients (N=375)

	Model				
				Adjusted	
Predictor	***B***	***β***	***p***	***R^2 %***	***F (p)***
How bad the flood would be (Hazard)	0.313	.043	.465	33.7	28.145 (<.001)
Specific locations that would flood (Location)	1.050	.138	.027		
How to protect oneself (Guidance)	1.745	.221	<.001		
When the flood was expected (Time until event)	0.629	.085	.153		
By when the respondent was expected to take action (Time to take action)	1.514	.204	.001		
When the message expired (Expiration)	0.808	.033	.464		
Who the message was from (Source)	2.158	.067	.125		

Table 26

Relative Importance of Message Content Elements on Message Personalization Among WEA Recipients (N=390)

	Model				
				Adjusted	
Predictor	***B***	***β***	***p***	***R^2 %***	***F (p)***
How bad the flood would be (Hazard)	-.002	.001	.991	15.9	11.50 (<.001)
Specific locations that would flood (Location)	.144	.052	.445		
How to protect oneself (Guidance)	.575	.202	.001		
When the flood was expected (Time until event)	.131	.049	.455		
By when the respondent was expected to take action (Time to take action)	.513	.191	.004		
When the message expired (Expiration)	-.505	-.057	.256		
Who the message was from (Source)	.541	.047	.334		

Table 27

Relative Importance of Message Content Elements on Time Until Taking Action to Avoid Flood Areas Among WEA Recipients (N=270 [a])

	Model				
				Adjusted	
Predictor	***B***	***β***	***p***	***R^2 %***	***F (p)***
How bad the flood would be (Hazard)	-25.914	-.066	.418	4.2	2.67 (.011)
Specific locations that would flood (Location)	-0.493	-.001	.988		
How to protect oneself (Guidance)	11.715	.028	.725		
When the flood was expected (Time until event)	-75.347	-.195	.021		
By when the respondent was expected to take action (Time to take action)	-20.464	-.051	.529		
When the message expired (Expiration)	-19.295	-.015	.812		
Who the message was from (Source)	28.733	.018	.778		

[a] 60% of respondents (300/496) reported that they took action to avoid flood areas. Of these, data were complete for all regression variables for 270 respondents.

Table 28

Relative Importance of Message Content Elements on Time Until Taking Action to Check Local Media Among WEA Recipients (N=328 [a])

	Model				
				Adjusted	
Predictor	***B***	***β***	***p***	***R^2 %***	***F (p)***
How bad the flood would be (Hazard)	-40.216	-.117	.120	2.4	2.12 (.041)
Specific locations that would flood (Location)	1.172	.003	.966		
How to protect oneself (Guidance)	31.106	.084	.247		
When the flood was expected (Time until event)	-41.690	-.119	.127		
By when the respondent was expected to take action (Time to take action)	-23.504	-.068	.376		
When the message expired (Expiration)	-10.231	-.009	.877		
Who the message was from (Source)	37.441	.024	.668		

[a] 75% of respondents (374/496) reported that they took action to check local media. Of these, data were complete for all regression variables for 328 respondents.

Appendix F: Qualitative Test Messages, Research Timeline, and Emotions

Table 1: Test Messages for Qualitative Research

	Optimized	Non-Optimized
90-character	Denver PD Take shelter now Radiological Hazard Warning in this area until 12:00AM MDT	Radiological Hazard Warning in this area until 12:00AM MDT Take shelter now US DHS
140-character	Denver PD Shelter in a sturdy building within 5 min Nuclear explosion in Denver Radiation blowing southeast Warning expires 9:00 PM MDT	Nuclear explosion in Denver Radiation blowing southeast Warning expires 9:00 PM MDT Shelter in a sturdy building within 5 min US DHS
1,380-character	Denver PD. This is a Mandatory Shelter Order. You can increase your chances of surviving by immediately going deep inside a tall building, basement, underground garage or earth covered tunnel. Shelters of brick, concrete, and earth protect best. Stay in the building you are in unless you can reach a better shelter in less than 5 minutes. Close windows, doors, and fireplace dampers. Turn off heat, air and ventilation systems. Do not evacuate. Stop driving and take shelter. You and your loved ones will receive less radiation in a shelter no matter how fast you drive. Do not go to schools to get children. School children are being sheltered and cared for. We will give you more information later about how to reunite with them. If you are not in the area, stay out. Stay in your shelter until 1:00 PM MDT July 23, 2013. Keep listening to this and other media for more information and official updates. A nuclear explosion occurred in Denver at 1:00 PM MDT. High levels of radiation are blowing southeast in the wind and falling to the ground. Exposure to radiation can be deadly and	A nuclear explosion occurred in Denver at 1:00 PM MDT. High levels of radiation are blowing southeast in the wind and falling to the ground. Exposure to radiation can be deadly and cause illness. The affected area includes: Denver, Adams, Arapahoe, Broomfield, and eastern Jefferson counties defined by North West Parkway/E-470 on the north, Highway C-470 on the south, Highway 285 on the west, and eastern Adams and Arapahoe counties. This message expires at 12:00AM MDT. This is a Mandatory Shelter Order. You can increase your chances of surviving by immediately going deep inside a tall building, basement, underground garage or earth covered tunnel. Shelters of brick, concrete, and earth protect best. Stay in the building you are in unless you can reach a better shelter in less than 5 minutes. Close windows, doors, and fireplace dampers. Turn off heat, air and ventilation systems. Do not evacuate. Stop driving and take shelter. You and your loved ones will receive less radiation in a shelter no matter how fast you drive. Do not go to schools to

	cause illness. The affected area includes: Denver, Adams, Arapahoe, Broomfield, and eastern Jefferson counties defined by North West Parkway/E-470 on the north, Highway C-470 on the south, Highway 285 on the west, and the eastern Adams and Arapahoe counties. This message expires at 12:00AM MDT	get children. School children are being sheltered and cared for. We will give you more information later about how to reunite with them. If you are not in the area, stay out. Stay in your shelter until 1:00 PM MDT July 23, 2013. Keep listening to this and other media for more information and official updates. US DHS

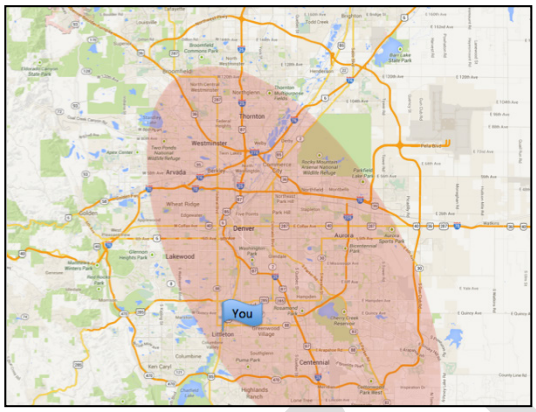
Table 2: Timeline and Message Presentation Order

#	Participants	Character Length	"Think-out-loud" Message	Focus Group Message Order	Date
1	8	90	Non-optimized	Non-optimized; Optimized	7/25/13
2	8	90	Optimized	Optimized; Non-optimized	7/22/13
3	8	140	Non-optimized	Non-optimized; Optimized	7/29/13
4	7	140	Optimized	Optimized; Non-optimized	8/8/13
5	6	1,380	Non-optimized	Non-optimized; Optimized	8/26/13
6	7	1,380	Optimized	Optimized; Non-optimized	8/28/13
7	6	All	N/A	N/A	8/23/13

Table 3: Participants' Reported Emotions by Message Type

Message Type and Length	Reported Emotions
Standard 90-characters	Anxiety, confusion, curiosity, disbelief, fear, indifference, panic, skepticism, and worry.
Optimized 90-characters	Anger, anxiety, concern, confusion, denial, fear, indifference, panic, and skepticism. However, in one focus group, the optimized 90-characters message also elicited feelings of acceptance, calmness, and resolve for some participants.
Non-optimized 140-characters	Anxiety, concern, intrigue, panic, panic leading to calm, resolve.
Optimized 140-characters	Anxiety, compassion, concern, confusion, determination, euphoria (adrenaline rush), fear, focus, panic, resolve, scared, suspicious
Non-optimized 1,380-characters	Calm, disbelief, fear, numbness, panic, scared
Optimized 1,380-characters	Calm, disbelief, fear, numbness, panic, scared, worry, terror

Appendix G: Qualitative Focus Groups Research Map



Appendix H: Selected Participants' Comments from Qualitative Research

Unless specified as the emergency management focus group, all findings are drawn from the Denver community focus groups. Additionally, all message lengths refer to focus groups unless otherwise indicated.

Order

Table 1: Understand

Message Length	Key Findings	Exemplar Quote(s)
90-characters	Some participants found the source, guidance, hazard, location, and time order ("optimized") for the 90-character message more understandable.	"I guess in thinking more about the kid scenario [another participant raised the idea of children receiving a WEA on a mobile device], 'take shelter now' first thing upfront would be very important. Because if you look at this other one, you have to read through all this stuff before you can [learn the protective action] – and if they [children] don't understand the first few words […]."
90-characters	Some participants expressed that the optimized order for the 90-character message was confusing.	"It's nice that's kind of in front [the source of the message] so we know, ok, that it's from the police or something, I'm assuming. But if the first thing it says is 'take shelter now.' Like [another participant] said, we don't know exactly the nature of the radiological hazard warning at all. Well, 'warning' is written at, like, the third part of the message, which is, like, for a message that should be an emergency message, that should probably be one of the first things to come up rather than take shelter now."

140-characters	Placing the source upfront improved its understandability for some participants.	"Yeah, I liked seeing that [source] up front."
140-characters	One group of participants unanimously argued that putting the source first improved its understandability.	"[Moderator speaking] Okay, so let me just get a quick poll. Raise your hand if you think that the location of Denver PD, being in the front of the message like that, improves the understandability. Raise your hand if you believe it. All of you. Okay."
140-characters	In another focus group, however, some participants preferred the standard order.	"This makes sense to me. It tells you to find the best shelter that you can." Moderator: "But this is exactly the same language that's in the first message." Participant: "Mm-hmm. And my opinion in the first message is that if they rearranged it, it would make a lot more sense [several participants voice agreement]."

Table 2: Believe

Message Length	Key Findings	Exemplar Quote(s)
90-characters	Some participants found the optimized order for the 90-characters message more believable.	"I much prefer the second one [optimized order] because the action to 'take shelter' is right up front. I think that's important. And I do think the Denver PD lends credibility to it. They're obviously the major city police department; I'm pretty sure they would work more closely with Homeland Security. So the first one, 'Denver PD: take shelter,' makes the second one a lot better for me."
90-characters	Some participants did not perceive content order for the 90-character messages to influence believability.	"I do think that the order of the words could make a difference, but, in this situation, no." "I don't think where it's located [source] is important."
140-characters	Some participants claimed that putting the source upfront increased the message's believability.	"I think it's more believable just 'cause it starts off Denver Police Department."

Table 3: Other Outcomes

Message Length	Key Findings	Exemplar Quote(s)
90- and 140-characters	Participants in the 90- and 140-character focus groups did not directly state how message content order influenced their personalization of the message, intention to mill, or emotions. Indirectly, several participants stated that placing the source first and/or the time last produced a better or preferred message.	"I like that the source is first. I don't know about Denver PD, but […]." "I like the putting in the different name [for the source], and putting it at the beginning, and the picture [map]. I like that."
90- and 140-characters	Other participants did not prefer the optimized order, or found both messages equally useful.	"I wanted the US DHS at the bottom because I would want an alert at the top [participant agrees], like she was saying, 'nuclear alert' or 'Amber alert' or whatever at the top, and then I could read the message and after, the signature at the bottom." "I guess I don't get hung up on semantics. I know what the main message is—seek shelter within 5 minutes."

Table 4: Emergency Managers

Message Length	Key Findings	Exemplar Quote(s)
90-characters	Similar to some of the community focus groups, emergency management participants were divided about whether the source, guidance, or hazard should come at the beginning of the 90-characters message.	"[The optimized message with source first] gives a location and who's running the show—who's the message from [and is a more understandable message]." "I would say, just for message content, eliminating the map, I would go the opposite direction [and prefer the standard order]—I think number one is a more understandable message, but the map definitely brings in more clarity." "So, by listing that [source] at the beginning, it makes it appear that this is who is supposed to take that particular action. It becomes confusing in the order. However, to list first the action that should be taken, to me, is paramount. If I received that and the first part of it said 'take shelter,' and the reason why, and then who—to me, that would make more sense in the flow."
140-characters	Most participants agreed that placing the hazard information upfront would lead to better outcomes, and they noted (as did the community focus groups) that the absence of punctuation and the word "take" in the optimized message could lead to counterproductive interpretations.	"I think having the 'nuclear'—that word alone gets your attention immediately, and having that up front—as I look at the one with the map, you don't hit the 'nuclear' until about halfway through." "As far as the source goes, depending on the message layout, I guess, to me, that's not as important. So, I could have that source at the end. I think that's okay for me. I'd rather have—tell

		me the hazard, tell me what to do first, and I can see the source at the end." "I feel that the sentence is structured wrong in the second example. 'Denver PD Shelter in sturdy building.' I think they're describing a Denver PD shelter. I mean, it's two different concepts and stuff."

Source

Table 5: Understand

Message Length	Key Findings	Exemplar Quote(s)
90-characters	For the 90-characters message, some participants initially did not understand the meaning of US DHS (see "Acronyms" section in Chapter 5). Once that was made clear, some participants wondered why a federal agency would be authoring the message.	"I didn't know that at all. I would have thought maybe Denver Health Center or… Health Shelter." "This one [says] US DHS, it's like what the heck is that? You know, I mean, it's not very clear at all."
140-characters	For 140-characters messages, some participants also found Denver PD a more understandable source.	"I think this [Denver PD] is a good source, but I'd also be thinking, didn't they get blown to bits at this point? 'Cause I mean they're a reliable source and such, but contacting people in Littleton, I don't know, it would seem like that would make its way through the chain and get distributed out first, and then the people, I don't know. But I think it's a better source."
140-characters	Others participants did not find Denver PD more understandable.	"Um, like I mentioned when we talked about it on the phone, after I went home and thought about it for a while what 'PD' was, I was like, 'public defense? Police department?' And so I felt kind of stupid saying that one thing, but I ultimately want clarification whether or not this is coming from something like the military or the police, because that pretty much indicates how severe that is."

1,380-characters	Participants also expressed confusion over the meaning of the source.	"So I'm thinking that's the Department of Health Services? But I don't know if that's true. That's just my guess, and I'm in a very calm and very relaxed environment right now. I don't know how calm and relaxed if this was real I would be."

Table 6: Believe

Message Length	Key Findings	Exemplar Quote(s)
90-characters	For the 90-character message, source influenced its believability. Participants expressed concern that if they were not expecting to receive a WEA (and had never received one before) they might mistake the message for a hoax, joke, or spam.	"I think preceding any messages like this there needs to be some sort of unique identifier […] so I know—we all know—it's not a prank from somebody." "There needs to be something that verifies that this is indeed coming from Homeland Security, [so] that we can trust [it]."
140-characters	For 140-characters messages, some participants did not find US DHS to be a very believable source in contrast to the Denver PD.	"I think, I have, you know, I think we have more exposure to the Denver Police Department than Homeland Security. It's someone maybe we know a little better, or at least trust a little bit more right away."
140-characters	Other participants found either source to be equally believable.	"Honestly, I wouldn't care who sent it."
1,380-characters	At 1,380-characters, US DHS was the more believable source.	"I believe that I would still want to double check [US DHS source], maybe turn on the TV and make sure I'm getting the same message, or call a friend. But as I'm doing that, I'm gathering my blankets and things to take shelter, but I would need something else to confirm that it's real." "I think it [believability] would go up for me, because the Department of Homeland Security, before you ever said anything, I didn't know

		who that was, like, I know it's somebody big, but I wouldn't know it's bigger than the police, I guess. And, especially with it being Denver Police or something, I'd know it's something local in the area it's coming from and it's around there, so I think it'd go up for me."

Table 7: Personalizing

Message Length	Key Findings	Exemplar Quote(s)
90-characters	Source influenced the personalization of the 90-character message for some participants, in both positive and negative ways.	"And so, like, maybe Denver Police Department does have some immediate information that other police departments don't have. So they're really, really trying to focus on this little area, right, that we can see on our phone." "I like the Denver PD a lot better because I know that it's local and they're gonna know first and foremost, I would hope, what was going on in our town before the feds would. But, you know, if they did, I would feel a lot better having this."
140-characters	US DHS personalized the message at 140-characters because it indicated a larger problem that affects more people.	"I would say the second one [the US DHS message is more personally relevant]. Pretty much totally based on the fact that the United States Department of Homeland Security got involved. It's not just the Denver police, you know? It's not just the small scale. The entire country is concerned about this. So that shows me that everybody is worried, so I should be worried, too."

Table 8: Milling Intention

Message Length	Key Findings	Exemplar Quote(s)
90-characters	At the 90-character level, message source influenced some participants' intention to search for additional and confirming information.	"I would call Denver Police Department, now that I realize 'D' is Denver and 'PD' is Police Department, and I would ask for a supervisor, somebody on the floor, seeing what they know." "Yeah, I would have to say with this one, considering the source [US DHS], I probably wouldn't research it more. I'd, you know, maybe I'd check the news or something, to see if there was something going on in the area, but I wouldn't… it wouldn't be a sense of urgency for me."

Table 9: Emotion

Message Length	Key Findings	Exemplar Quote(s)
140-characters	Participants discussed emotions of fear and panic associated with the messages.	"I'm still feeling the fear and the panic mode at this point, because it's coming from US DHS, so there's more urgency in it now." "Um, I feel more of a panic and more of a worry with the second one [US DHS source], in addition to my focus and all the rest of the stuff on the first one, just because it's Denver-specific, which implies to me that it hasn't hit Littleton yet and I've still got time, which is a small window of opportunity. In the first one, I'm in it already [as shown by the map]."

Table 10: Emergency Managers

Message Length	Key Findings	Exemplar Quote(s)
90- and 140-characters	Emergency managers described the credibility of the local source as greater than the federal source.	"I think the part that says 'Denver PD' makes it more credible as far as, I think some people might read 'US DHS' on number one and think, 'I don't know what that is,' unless they maybe work in the field. And so, I think for locals, having it be a local source makes it taken more seriously. But, at the same time, I think there needs to be some clear way that it's saying, 'Denver PD is saying this.'" "I'd agree with that. A local agency's tag on there of some kind would be local credibility."

Maps

Table 11: Understanding

Message Length	Key Findings	Exemplar Quote(s)
90-characters	Inclusion of a map in the 90-character message made the message more understandable for some participants, and omitting the map made the message less understandable.	"The other one had a map. And it shows in this area. And in this is, it says in this area, [but] there's no map. There's no depicting what area it is or, you know, anything else." "I don't understand. It says warning in this area. What area is that? There's no map. Doesn't say. I guess I would assume it's my area. I don't know."
140-characters	Participants usually explained that the map made the message more understandable.	"[Moderator] So, #19 says the 'You' in the map really makes it understandable. Okay. So, do you all agree that the 'You' on the map increases the understandability of this message? Everybody says yes."
140-characters	A few participants noted, however, that the quality of the map image used in the test message reduced the message's understandability. The map could also produce a false sense of security.	"I think the red blob is also kind of bad, because that's just an estimated area of radiation, and I think if people see this map and they live outside of that, they think 'oh I'm safe,' but in reality, it's still a problem." "[Moderator] So you want more information about protective actions? [Participant] Yeah, like, 'How am I going to stay alive?' Versus, 'Oh, I'm in the dying

		zone. Good.’”
1,380-characters	At this character-level, participants generally preferred the map. A few participants, however, did not find value in it.	“And me, for someone who’s directionally challenged, that would be vital. Because, or if you’re someone who just moved there, and you don’t know the surrounding area, and you don’t know any of the streets or anything like that, or any of the towns around you. I’ve been here 12 years and I still don’t know most of the towns around me.” “I never even really looked at the map.”

Table 12: Belief

Message Length	Key Findings	Exemplar Quote(s)
90-characters	For 90-character messages, the inclusion of a map increased the believability of the message for several participants.	"I will say that I have a little more belief for this one because it does answer the question of where [the hazard is]."
140-characters	For 140-character messages, the map similarly improved message believability for most participants.	"With this [map], you know that it was specifically added by the agency, you know, and that it's important." "I agree with everybody else. The map gives it more credibility, and I mean, I'm not going to over analyze everything in 5 minutes, so I'll look at it and do my game plan."
140-characters	A few participants, however, stated that the inclusion of a map made the message less believable.	"Well, I mean, in my opinion, it's like, this can't be that big of an emergency if we have time making graphs about it to put into texts to send to people. It's like, 'Oh, we've spent the last 15 minutes making this flow chart on radiation.' A little late now."

Table 13: Decide

Message Length	Key Findings	Exemplar Quote(s)
90-characters	The influence of inclusion of a map in the 90-characters message did not generally arise in participants' reports of their decision-making.	"Do I really need to go into my basement, or do I just need to drive over five miles that way and then I'm good?"
90-characters	In some cases, participants evaluating 90-characters messages appeared to reconsider their decision in light of their proximity to the edge of the depicted hazard area.	"My initial reaction would be to get in the… get in the basement with my kids, and get on my iPad and radio and figure out what's going on. Because if everybody else is thinking, 'Wow, I'm at the edge of this,' getting in their cars and going, I might not – I might be putting myself in even more danger by getting stuck on the roads. So that's what, that's what I would do."
1,380-characters	A few participants, however, stated that the inclusion of a map made the message less believable.	"The map doesn't mean anything. It's common sense. The radiation is going southeast. You don't need a map to show 'I'm here. Ok, let me look.' It's just common sense in my eyes: You can be exposed to radiation. It's coming regardless." "Well, I mean, in my opinion, it's like, this can't be that big of an emergency if we have time making graphs about it to put into texts to send to people. It's like, 'Oh, we've spent the last 15 minutes making this flow chart on radiation.' A little late now."

Table 14: Personalizing

Message Length	Key Findings	Exemplar Quote(s)
90-characters	Inclusion of a map in the 90-characters message made it easier for participants to determine personal risk.	When asked why, one participant elicited loud laughter from the group when she stated, "because there is a flag that says 'You' [near the middle of the map]." "It's obvious you're in the Red Zone, yeah, the Red wherever that is. So, obviously […] you're impacted."
140-characters	Similarly, for 140-characters messages, map inclusion improved risk personalization.	"So, it [the map] gave me another point of reference, and I think even within 5 minutes, I should be able to make that point of reference. If their lines are jammed, then other people just like me are questioning that, and it may make me move in a different direction to shelter in place." "Actually, I kind of find the 'You' a little joking. I think I saw that, I'd be like, are you kidding me? We're about to die."
1,380-characters	At 1,380-characters, some participants acknowledged that the map improved risk personalization.	"There's a graphic that says 'You' in the second [message]," noted one participant."

Table 15: Milling Intention

Message Length	Key Findings	Exemplar Quote(s)
90-characters	The inclusion of a map in the 90-characters message did not generally change participants' milling intention.	"Again, I'd probably just delete it, but this time I might think – it might, like, pop back in my head because I saw this map, and, you know, I might Google it if it's convenient."
140-characters	Participants discussed how the inclusion of a map might reduce their milling intention.	"Ok, I'm hearing people saying, 'Well, you know, we don't need a map and all of that.' I was involved in a catastrophe, and when you are in a catastrophe such as nuclear anything, or any type of catastrophe, you're not thinking. And you know what, I want as much help as I can get. I want a map, I want a message, I want- because you're just gonna go blank! You're not going to be sitting there going, 'Ok, well, this is what I would do.' Your mind is going to go blank. You're going to go in a catastrophe mode, and I'm just like, give me all the help I can get. Like a marquee sign, or a map, police, everything. Because I'm not going to be thinking."
1,380-characters	Participants also discussed how a map might help reduce milling behavior, especially for someone unfamiliar with the area.	"What I feel the map does, it gives me an instant way to figure out where the problem is. Where in the first printout, I have to think it through. And that's taking valuable time. There's no valuable time here. For somebody who's traveling or is not as familiar with the area, I think it's a huge help."

Table 16: Emotion

Message Length	Key Findings	Exemplar Quote(s)
90-characters	The inclusion of a map in the 90-characters message produced few substantive differences in participants' reported emotional reactions.	"I don't feel as much fear [with the map], because I'm very much information oriented, and the more information I have the less fear I have, so this one makes me feel, like I said, a sense of urgency and to take action, but I don't feel as afraid. Because to me, like, just if I was thinking about it, an area this big probably isn't a nuclear bomb, it's probably a spill, and to me it gives me a little more information." "I'd go with the one with the map, because it's more information, so I just, uh, don't feel just ad hoc full of terror. Right now they've got it pinned down, so I feel like (a) it's controllable, (b) we've got a chance, and, you know, (c) you know, lets just try to calm down a little bit and follow this information."
140-characters	For 140-characters messages, inclusion of a map did not influence most participants' stated emotional responses.	"I think it [the map] causes more panic. […] Because before, it's kind of an abstract idea of where it is, but then if people look at this map, and that's where we are, yeah, but if you were somebody further east, you would freak out if you're in the middle of this red blob, and it would cause a state of panic in the entire region, and nobody would be able to get inside, or there are multiple, multiple problems with that."
1,380-characters	At 1,380-characters, the same themes emerged,	"Well, like I said before, from

	with participants' emotional responses mostly remaining consistent.	where it looks like on the map and what I'm thinking is my emotion would go down. Less fear because I'm thinking that's going to pass in a few hours, I'm at the edge of it."

Table 17: Emergency Managers

Message Length	Key Findings	Exemplar Quote(s)
90-, 140-, and 1,380-characters	The emergency managers overall thought the inclusion of maps helped to provide an important reference point and convey a sense of urgency.	"So to have a visual that provides me a reference, or to have words that provide me a reference that indicates this really means me, would help." "I think it's important even to have that flag there, with 'You' on it. There's an urgency in that, knowing that—just looking at it and realizing—at first you probably want to try and convey where you are on this, but being able to see that I am in this—for me, that puts me more in action mode, realizing that there's an out group and an in group, basically."

Relative Importance

Table 18: Importance of Guidance

Message Length	Key Findings	Exemplar Quote(s)
90-characters (think-out-loud)	Think-out-loud participants discussed the lack of thorough guidance information that 90-characters could provide.	"'Take shelter now.' I guess my thought would be, and I don't know who you'd address this, is: how long would I stay in the shelter? And how will I know when it's time to vacate?" "How do I protect myself from this? Where do I go? 'Radiological.' It could give me cancer. And the fact that it ends—I mean that's—it's alarming."
90-characters	Similarly to think-out-loud participants, focus group participants felt that 90-characters was insufficient to provide enough guidance information.	"What if you'd left your dog outside? What if your kids were at – riding their bikes outside or something?" "Do you bring them in [pets] or do you leave them outside?"

Table 19: Importance of Hazard

Message Length	Key Findings	Exemplar Quote(s)
90-characters (think-out-loud)	Most think-out-loud participants were confused by the radiological hazard and the severity of the threat.	"Okay, my thoughts are: What the fuck? That's my first thought. Because I don't know what a 'radiological warning' is. I've never seen or heard that before, it's not been spelled out anywhere, it doesn't redirect me to a website—'click on this link to find out a little more information.'" "Well, the first thing I would say is, 'radiological'—what is that? I don't have a clue what a 'radiological hazard' is. 'Take shelter now.' I would just wonder, really, how serious is it? Because I don't have a clue what that first word means. You know, it doesn't really look that urgent. The whole message—I would probably just ignore it after I read it."
90-characters	Similar to think-out-loud participants, focus group participants also stated that 90-characters was insufficient to explain an unfamiliar hazard.	"When I hear radiological hazard, I'm not a scientist of any sort, so does this mean that Iran has decided to lob a nuclear weapon at Cheyenne Mountain and, like, we're at war?" "And there's absolutely no details as to what kind of hazard it is, when it started, where it is happening, what's the radius that has been effected."
1,380-characters	Even at 1,380-characters, some participants desired more information about the hazard and guidance.	"So put, like, where would be the best form of broadcast to get, like, the needed information."

		"Like, are you feeling dizzy, are you feeling, you know – and are these types of things – where do you present yourself then? Do you stay in your shelter? Or do you [trails off]."

Table 20: Emergency Managers

Message Length	Key Findings	Exemplar Quote(s)
90-, 140-, and 1,380-characters	Emergency managers offered suggestions for greater specificity for explaining the hazard and protective actions to take. For example, the inclusion of the word "inside" might be important to further explain the concept of sheltering.	"That's also—that kind of started for me—it might be helpful to have 'take shelter inside now.' And maybe that's implied with 'shelter.' I mean, I saw people on the highway yesterday taking shelter underneath the overpass. And that's not going to do them very good in a radiological hazard—or not as much, for sure. That might not be something that can happen in a 90-character text out to them, but if there's going to be a 'take shelter inside now' hazard warning, that's, I think, for the simple person who just wants to read the essence of it, that might be more for them than knowing that it's a radiological hazard." "Just 'warning' or 'watch,' I see us tend to put those inside of messages because we understand what that means, the magnitude. The general public does not. So, if you're trying to indicate 'hazard,' simply indicate 'hazard,' and communicate urgency via other words such as 'now,' 'soon.' Something that's more understandable."

Length

Table 21: Sufficient Information

Message Length	Key Findings	Exemplar Quote(s)
1,380-characters	Some participants acknowledged the completeness of the 1,380-character messages.	"Very informative." "So, I think it is very informative, and yeah. I think it's a good thing. Important information."

Table 22: Milling Intentions

Message Length	Key Findings	Exemplar Quote(s)
90-characters	Participants discussed milling intentions, such as turning on the television to verify the information.	"I'd turn on the TV to verify." "Yeah, I'd turn on the TV immediately and verify." "I'd go in the basement, get out my radio and my iPad, and start trying to get as much information as possible."
140-characters	Participants receiving the 140-characters message discussed fewer intentions to mill.	"[I'd] grab my cell phone, grab my kids, grab closest thing to me, and seek shelter." "I'd probably just gather up some, some things. But if it's radiation, I'd probably, I'd try driving away from the house. I'd just drive." "I probably would just grab the pets and get into a shelter."
1,380-characters	At 1,380-characters, participants' intention to mill resembled responses to the 140-characters message: a mix between milling and protective action taking.	"I guess I would, my first thing would be to see if it was really real. And then if I could verify it either by TV, radio, another website, whatever, and I felt the threat was real, then I would try to find shelter. Take food. Take whatever I would need depending on the shelter environment." "Yeah I would probably be simultaneously doing it, multitasking somehow, probably calling somebody and also gathering shelter things to go

		wherever I need to go. But I don't have any of these places to go, so I don't know!"
1,380-characters (think-out-louds)	Participants in the think-out-loud group felt that there was too much information in the 1,380-characters message, which cut into time to take protective actions.	"There's a lot of information in here. I don't know if I can comprehend the information." "It's also really long. I mean, I understand all the precautions that you need to take, but it's really long. It takes a long time to read. I mean, I think it took me two minutes. You know, if I was sitting in my car and I was reading this message and I had three minutes to get somewhere because it took me so long, I'd be kind of scared."

Table 23: Emergency Managers

Message Length	Key Findings	Exemplar Quote(s)
90-, 140-, 1,380-characters	The emergency management group discussed the 140-characters message as the most ideal message length to provide more information than 90-characters but appear less overwhelming than the 1,380-characters message.	"Obviously, this is not a black-and-white thing, or an all-or-nothing. I do think that this [90-characters] is, as a minimum amount, enough to create some action. I think that, if you add 100-characters or 500-characters or 1,380 characters, for some people it's still not going to be enough. So, looking at it from that lens, I think, from a minimum amount, that you. " I think what 140-characters versus 90-characters allows is better content. Because one of the critical factors, we said, was clearly identifying the area. And what 140-characters allows is that. I also like, as I compare them back and forth—'radiological hazard' with the space is 19-characters, and 'nuclear explosion' is 17, so, to me, again, the word 'explosion' conveys urgency. Here, we've chosen in the message, in the 140-character, to indicate the direction that the hazard is continuing to travel. So, 140-characters simply allows more flexibility for the content. You don't have to be quite as concise. You don't have to make quite as many decisions about what are the most critical pieces that we actually tell somebody."

Table 24: Message Length's Influence on Understanding

Message Length	Key Findings	Exemplar Quote(s)
90-characters	At this length, understanding was limited.	"I don't know what a radiological hazard is. Maybe more explanation would be helpful." "I don't know what shelter is." "I don't know what this area is." "I would like to know, when they say shelter, do they mean shelter in place in my home, go to a basement like in a tornado? Or do they mean go to an outside shelter that the city has set up?" "I could use a little more detail on the warning." "I don't fully understand radiological, it almost sounds like a made-up word almost."
140-characters	At this length, understanding was still limited, but slightly improved.	"I understand the message, but the connection to where is it close to, is there a plant, what created this?" "I think it needs to be more precise." "I was confused with the shelter part thought. Um, what qualifies as

		a shelter from nuclear explosion?" "Yes, I understand that there's a building within five minutes from Denver." "So, I know what this means, but it doesn't exactly tell you where to go […] What do I do? There are not really any detailed instructions." "I was kind of thrown off by 'the warning expires.' I mean, that doesn't really tell me if something has happened or what I should do or, you know, it's not really informative on the warning- I mean, I understand it was- I don't know if there was an explosion, or if the radiation was done, you know, it's fired, or whatever."
1,380-characters	At this length, understanding was superior to 90- and 140-characters massages.	"Because I'm really, I'm just so unfamiliar with the area. So yeah, about a fourth of it I would actually just discard because it means nothing to me. Umm, and, I do understand it, I just think it has too much detail." But I think it's very important, overall I understand it -- but just listing the counties, Denver County, it doesn't matter what area if it's a different county and I'm in a different county it's important."

		"I think that it's really great that they included the school children are being sheltered. […] However, I am also new to Denver, and I do think that there could be less information. It's just like, there's a lot of stuff in there." "[Moderator] So, the first question is, do you understand this message? Do you understand it? [All participants] Yes."

Appendix I: Qualitative Research Coding Sheet

Green = Outcome Variables

Orange = Message Variables

Red = Other Variables

Code	Description
Belief	Determining if the warning is real and the risk, warning, and contents of the message are accurate. "I would never expect to get a message that I didn't subscribe to, so I wouldn't believe it. I would just think it was spam."
Emotion	Emotional responses such as fear, panic, dread, sadness, anger, etc. "I'm nervous, I'm scared, you've disrupted my day, and I don't know what the fuck I'm supposed to do, where I'm supposed to go, or how I'm supposed to be there because this, with this very ambiguous message."
Decision-making	Forming an idea about what, if anything, to do about the risk. "My initial reaction would be to get in the, get in the basement with my kids, and get on my iPad and radio and figure out what's going on. Because if everybody else is thinking 'Wow, I'm at the edge of this,' getting in their cars and going, I might not – I might be putting myself in even more danger by getting stuck on the roads. So that's what, that's what I would do."
Milling	Searching and confirming via physical and social cues. "If I'm at home I'm going to try to verify this by turning on the TV or the radio."
Personalizing	Thinking of warnings in personal terms—that is, in terms of implications of risk for themselves, their families, or their group. "I worked in Littleton for the past year and I mean certainly like I lived or a worked up in close enough proximity to the Lockheed Martin plant or Boeing whichever is, like, real south [Wadsworth?] if there were a nuclear attack on that, my workplace would be affected."
Understanding	Attaching meaning to the received warning message. Understanding does not refer to correct interpretation as meaning or understanding can vary between different people and may or may not conform to the meaning intended by alert issuers. "I don't know what a radiological hazard is. Maybe more explanation

	would be helpful."
Acronyms	Understanding of the acronyms typically used in warning messages, i.e., "NWS," "US DHS" "And I don't think, uhh, H, uhh, Homeland Security, the US Homeland Security is easily recognized, Denver PD was."
Perceptions of technical message terms	Perception of meanings of terms such as "watch," "warning," "shelter," and others. "I don't know what shelter is. I mean, I would assume some buildings are safer than other buildings."
URL	Discussion of the inclusion of a URL that refers people to additional information. "For me, my phone has issues accessing the Internet so having a URL wouldn't help me at all."
WEA	Familiarity with the Wireless Emergency Alert system. "I've seen WEA but I don't know too much about it."
Content: Guidance	The protective action. "But again, the first thing that I wonder, again, take shelter, do they mean in my basement? In my bathroom if I don't have a basement? Or do I go to an outside shelter that the city has set up? I don't know what they're telling me to do."
Content: Hazard	The threat or danger. "So I want to know, when I hear radiological hazard, I'm not a scientist of any sort, so does this mean that Iran has decided to lob a nuclear weapon at Cheyenne Mountain and, like, we're at war? Or does this mean there is a nuclear reactor melting down somewhere and not only do I need to take shelter somewhere but I also don't need to drink the water."
Content: Location	How location is understood and best expressed in warning messages. "And besides having, like, a landmark or some sort indicator of the region or county, it's like knowing the level of the actual hazard would be nice. For instance, if it's a small radioactive, like, spill or something it might only impact within 5 or 10 miles of the original, over the original

	location.”
Content: Map	The inclusion of a map in warning messages. “I think the map is a good addition because it really spotlights where this is at.”
Content: Source	Trust and credibility associated with message sender. “I mean, the first thing I’m seeing is Denver PD. What in the world do they know about radiological warnings that I don’t?”
Content: Time	How time is understood and best expressed in warning messages. “I mean, at least, your start time is whenever you get the message. And then it says an end time.”
Cross-Hazard	Discussion of specific elements of another hazard, not the IND hazard referenced in the test message. “So, for instance, if this was a tornado warning, I would know what to do.”
Message length	Discussion of warning message length. “Keeping in mind all these comments, it is good that you’ve kept it short.”
Order	Order of different information provided in alert and warning messages. “I think that the order is important because ‘take shelter’ is right up front here, and that prompts you to action, whereas in the previous one the ‘take shelter’ was further along in the message and I like the way they have that here prompts you to move.”

Appendix J: Timeline of Boulder Flood Alerts and Warnings

We constructed of information communicated to the public in the City of Boulder during the September 2013 flood. The entries in the timeline present alerts, warnings, and selected other salient public information distributed over a variety of communication channels. These channels are:

1. The website of the Boulder Office of Emergency Management.
2. The sounding of outdoor warning sirens.
3. The Wireless Emergency Alert (WEA) system used by the National Weather Service (NWS) to deliver WEA messages over mobile communication devices such as cell phones.
4. The Boulder Emergency Notification system (ENS) which is a reverse 911 system.
5. The Boulder Emergency Notification Program which transmits messages directly to people who have opted-into the system over mobile communication devices such as cell phones. This system purposefully excludes mobile communication devices on the University of Colorado campus,
6. NOAA Weather Radio (NWR) used by the NWS which turns on automatically, sounds an alarm, and delivers a message.
7. The Emergency Alert System's (EAS) televised crawlers that resulted from the NWS's use of the EAS system.

September 11, 2013

6:36 p.m. Source: National Weather Service. Channel: Mobile communication devices. Boulder Specific Distribution Area: Eastern Boulder County in Northeast Colorado, Northeastern Boulder. Message: Flash Flood Warning this area til 9:30 PM MDT. Avoid flood areas. Check local media. –NWS.

6:36 p.m. Source: National Weather Service. Channel: NWR and EAS. Boulder Specific Distribution Area: Eastern Boulder County in Northeast Colorado, Northeastern Boulder. Message:

The National Weather Service in Denver has issued a flash flood warning for... Southwestern Weld County in northeast Colorado... northeastern Broomfield County in northeast Colorado... Eastern Boulder County in northeast Colorado... until 930 pm mdt.

* At 634 pm mdt...local law enforcement reported heavy rain in Erie...in southeastern Boulder County. Up to two and a half inches of rain has been reported by a spotter in Erie. Flash flooding is expected to begin shortly. Law enforcement officials were closing the Erie parkway as high water was moving towards the old town section of Erie.
* Some locations that will experience flooding include... northeastern Boulder... Longmont... Northeastern Broomfield…Lafayette... Louisville...Erie...Firestone...Frederick...Dacono and Niwot.

Precautionary/Preparedness Actions...

Move to higher ground now. Act quickly to protect your life. Excessive runoff from heavy rainfall will cause flooding of small creeks and streams...urban areas...highways...streets and underpasses as well as other drainage areas and low lying spots.

7:02 p.m. Source: National Weather Service. Channel: Mobile communication devices. Boulder Specific Distribution Area: Central Boulder County in Northeast Colorado. Message: Flash Flood Warning this area til 10:00 PM MDT. Avoid flood areas. Check local media. –NWS.

7:02 p.m. Source: National Weather Service. Channel: NWR and EAS. Boulder Specific Distribution Area: Central Boulder County in Northeast Colorado. Message: The National Weather Service in Denver has issued a flash flood warning for... central Boulder County in northeast Colorado... until 1000 pm mdt.

* At 658 pm mdt...doppler radar indicated moderate to heavy rain moving westward over Boulder. As these showers move into the foothills...heavy rain is expected to continue for the next hour. Flash flooding is expected to begin shortly. Excessive rainfall over the burn scar will result in debris flow within the Fourmile burn area. The debris flow can consist of

rock...mud...vegetation and other loose materials.

* Some locations that will experience flooding include... Summerville... Salina... Crisman... Gold Hill... Sunshine and Wallstreet.

Precautionary/Preparedness Actions...

Soil moisture levels have reached saturation from rainfall over the last couple days. Additional rainfall amounts of one-half to three-quarters of an inch can be expected over the next hour. Heavy rainfall will cause flash flooding of creeks...streams...and ditches in the fourmile burn area. Some drainage basins affected by excessive runoff include Fourmile Creek...Gold Run...and Fourmile Canyon Creek. Water will be flowing down roadways. Rock slides or debris flows can also be expected.

7:58 p.m. Source: National Weather Service. Channel: Mobile communication devices. Boulder Specific Distribution Area: Boulder County in Northeast Colorado, Boulder. Message: Flash Flood Warning this area til 10:45 PM MDT. Avoid flood areas. Check local media. –NWS.

7:58 p.m. Source: National Weather Service. Channel: NWR and EAS. Boulder Specific Distribution Area: Boulder County in Northeast Colorado, Boulder. Message: The National Weather Service in Denver has issued a flash flood warning for... Extreme southwestern Weld County in northeast Colorado... Extreme northwestern Adams County in northeast Colorado... Northern Broomfield County in northeast Colorado... Boulder County in northeast Colorado until 1045 pm mdt. This warning supercedes all previous warnings and advisories for the Boulder... Broomfield.. and Weld County areas...

* At 752 pm mdt...doppler radar indicated thunderstorms producing heavy rain across the warned area. Up to two inches of rain have already fallen. Flash flooding is already occurring in the Erie... Lafayette...and Niwot areas. Flash flooding is expected to become more widespread as heavy rain continues.

* Some locations that will experience flooding include... Extreme northern Thornton...Northeastern Westminster...Boulder...Northern Broomfield... Brighton... Lafayette...

Louisville...Erie... Frederick...Fort Lupton...Dacono...Lyons... Jamestown...Salina... Crisman...Gold Hill... Niwot... Summerville...Wallstreet...Raymond... Sunshine... Eldorado Springs and Allenspark. Additional rainfall amounts of 1 to 1.5 inches are possible in the warned area.

Precautionary/Preparedness Actions...

This is a life threatening situation. Heavy rainfall will cause extensive and severe flash flooding of creeks...streams...and ditches in the Fourmile burn area. Some drainage basins impacted include Fourmile Creek...Gold Run...and Fourmile Canyon Creek. Severe debris flows can also be anticipated across roads. Roads and driveways may be washed away in places. If you encounter flood waters...climb to safety. Outside of the Fourmile burn... excessive runoff from heavy rainfall will cause flooding of small creeks and streams... highways and underpasses. Additionally... country roads and farmlands along the banks of creeks...streams and other low lying areas are subject to flooding. Be especially cautious at night when it is harder to recognize the dangers of flooding. Turn around...dont drown when encountering flooded roads. Most flood deaths occur in vehicles.

9:20 p.m. Source: Boulder Office of Emergency Management. Channel: Website. Message: *Sept. 11, 2013 – Flooding in Boulder and parts of Boulder County.* A flash flood warning is in effect until 10:45 p.m., with continued rain expected throughout Boulder County until 1 a.m. tomorrow morning. In Erie, Vista Parkway at Singletree has water 3 feet deep. City of Boulder police officers are reporting street flooding in the areas of 17th and 18th on the Hill, Baseline, and Foothills, 28th Street under passes, 9th and Alpine, Manhattan and Baseline. Rain is also falling heavily in the Fourmile Fire burn area. Residents are cautioned to stay alert, avoid driving in flooded areas and move to higher ground if near waterways or high-risk flood areas. Stay away from Boulder Creek. The Emergency Operations Center has been activated, and city public information officers are en route. The media will be sent a separate advisory with the media line phone number shortly.

9:46 p.m. Source: National Weather Service. Channel: Mobile communication devices. Boulder Specific Distribution Area: Boulder County in Northeast Colorado, Boulder. Message: Flash Flood Warning this area til 12:45 AM MDT. Avoid flood areas. Check local media. –NWS.

9:46 p.m. Source: National Weather Service. Channel: NWR and EAS. Boulder Specific Distribution Area: Boulder County in Northeast Colorado, Boulder. Message: The National Weather Service in Denver has issued a flash flood warning for... Northwestern Jefferson County in northeast Colorado... Boulder County in northeast Colorado... * until 1245 am mdt

* At 945 pm mdt...local law enforcement reported a continuation of flash flooding in Boulder County...with numerous road closures and stalled vehicles due to flooding. Up to 3.5 inches of rain has already fallen in southeast boulder...with widespread rainfall of 1.5 to 2.5 inches over the rest of the warned area. Another one to as much as 2 inches of rain can be expected in some locations before decreasing.

* Some locations that will experience flooding include... Northwestern Arvada... Boulder...Northern Broomfield...Lafayette... Louisville... Erie... Lyons... Jamestown... Salina...Eldorado Springs... Crisman... Gold Hill... Niwot... Summerville... Wallstreet... Rocky Flats...Raymond...Sunshine...White Ranch Open Space and Allenspark.

Precautionary/Preparedness Actions...

This is a life threatening situation. Heavy rainfall will cause extensive and severe flash flooding of creeks...streams...and ditches in the Fourmile burn area. Some drainage basins impacted include Fourmile Creek...Gold Run...and Fourmile Canyon Creek. Severe debris flows can also be anticipated across roads. Roads and driveways may be washed away in places. If you encounter flood waters...climb to safety. Outside of the Fourmile burn scar...excessive runoff from heavy rainfall will cause flooding of small creeks and streams...highways and underpasses. Additionally... country roads and farmlands along the banks of creeks...streams and other low lying areas are subject to flooding. Be especially cautious at night when it is harder to recognize the dangers of flooding. Turn around...dont drown.

9:55 p.m. Source: Boulder OEM. Channel: 4 Outdoor Warning Sirens along Boulder Creek. Area: New Britain building, Near Folsom Field, Fire Station #3, and the CU research center. Message: "Warning. Flash flood of Boulder Creek is imminent. Leave immediately. Proceed to higher ground. Do not cross Boulder Creek."

10:00 p.m. Source: Boulder Office of Emergency Management. Channel: Website. Message: *Correction - flash flood warning is until 10:45 a.m. not p.m.* Flash flood warning for Boulder County will remain in effect until 10:45 a.m. tomorrow. This includes the City of Boulder.

10:01 p.m. Source: Boulder Office of Emergency Management. Channel: Website. Message: Boulder Office of Emergency Management Website: *Sept., 11, 2103 – Flood sirens activated near Boulder Creek.* The City of Boulder has activated flood sirens near Boulder Creek urging anyone near the waterway to seek higher ground immediately. Do not cross or attempt to flee the area in a vehicle. The safest route is on foot, away from lower lying areas. If you are on the south side of the creek, head south along Broadway to the university. If you are on the north side of the creek, head north to Spruce Street or higher.

10:30 p.m. Source: Boulder Office of Emergency Management. Channel: Website. Message: *NWS updated Flash Flood Warning for Boulder County until 12:45 a.m.* National Weather Service has updated the Flash Flood Warning is in effect until 12:45 a.m. on Thursday, Sept. 12

11:10 p.m. Source: Boulder Office of Emergency Management. Channel: Website. Message: *Four Mile Canyon mudslide closes road.* A mudslide on Four Mile Canyon has rendered the road impassible at Hwy. 119 and Gold Hill. 4" of water on roadway. No evacuations yet. People should prepare to evacuate if and when necessary.

11:16 p.m. Source: National Weather Service. Channel: Mobile communication devices. Boulder Specific Distribution Area: Boulder County in Northeast Colorado, Boulder. Message: Flash Flood Warning this area til 4:15 AM MDT. Avoid flood areas. Check local media. –NWS.

11:16 p.m. Source: National Weather Service. Channel: NWR and EAS. Boulder Specific Distribution Area: Boulder County in Northeast Colorado, Boulder. Message: The National Weather Service in Denver has issued a flash flood warning for... Northern Jefferson County in northeast Colorado... Boulder County in northeast Colorado... * until 415 am mdt

* At 1115 pm mdt...law enforcement reported considerable flash flooding in the warned area. Torrential rainfall approaching 5 inches in the last 6 hours has occurred in some areas. Additional heavy rain will continue through the midnight hour...increasing the intensity of the flash flooding. Flooding along Fourmile canyon creek is expected to push into northern Boulder with residential

flooding expected. Fourmile and Boulder creeks will continue to rise with continued flash flooding. South Boulder Creek through Eldorado Springs will also continue to rise. Flash flooding has also been reported at the base of Coal Creek Canyon near highway 72.

* Some Locations That Will Experience Flooding Include... Northwestern Arvada... Western Westminster... Boulder... Western Broomfield... Lafayette... Louisville... Erie... Superior... Lyons... Jamestown... Salina...Eldorado Springs...Crisman...Gold Hill... Niwot... Summerville... Peaceful Valley... Allenspark... Wallstreet... Rocky Flats...Raymond...Meeker Park...Sunshine and White Ranch Open Space.

Precautionary/Preparedness Actions...

This is a life threatening situation for people along boulder creek in the city of Boulder...in the Fourmile burn area...and in Boulder Canyon. Heavy rainfall will cause extensive and severe flash flooding of creeks and streams from the Fourmile burn area downstream through the city of Boulder. Some drainage basins impacted include Boulder Creek...Fourmile Creek...Gold Run...Fourmile Canyon Creek... and Wonderland Creek. Severe debris flows can also be anticipated across roads. Roadways and bridges may be washed away in places. If you encounter flood waters...climb to safety. Excessive runoff from this storm will cause flash flooding of creeks and streams... Roads and roadside culverts. The heavy rains couldv also trigger rock slides or debris flows in steep terrain. Be especially cautious at night when it is harder to recognize the dangers of flooding.

~11:29 p.m.[8] Source: Boulder Office of Emergency Management. Channel: Website. Message: *FOUR MILE CANYON AREA – MOVE TO HIGH GROUND.* FOUR MILE CANYON SITUATION TO WORSEN. CLIMB TO HIGH GROUND IMMEDIATELY, RECOMMENDED EVACUATION ROUT – POORMAN ROAD UP TO HIGHER GROUND, WEST OF INGRAHAM GULCH CAN TAKE GOLD RUN TO GOLD HILL. PLEASE BEGIN TO MOVE TO HIGHER GROUND ASAP.

11:29 p.m. Source:@boulderoem. Channel: Twitter. Message: Situation in Fourmile Canyon worsening. CLIMB TO HIGH GROUND IMMEDIATELY.

11:30 p.m. Source:@boulderoem. Channel: Twitter. Message: Recommended evac route for Fourmile: POORMAN ROAD to higher ground. W. of Ingraham Gulch should take Gold Run to Gold Hill.

~11:54 p.m. Source: Boulder Office of Emergency Management. Channel: Website. Message: *EVACUATION ORDERED FOR FOUR MILE CANYON.* MANDATORY EVACUATION FOR FOUR MILE CANYON AREA ORDERED. MOVE TO HIGHER GROUND IMMEDIATELY. CLIMB TO HIGH GROUND IMMEDIATELY. RECOMMENDED EVACUATION ROUTE – POORMAN ROAD UP TO HIGHER GROUND. WEST OF INGRAHAM GULTCH CAN TAKE GOLD RUN TO GOLD HIL. PLEASE BEGIN TO MOVE TO HIGHER GROUND ASAP. CITY OF BOULDER RESIDENTS ARE ADVISED THAT PEOPLE IN LOW- LYING AREAS SHOULD MOVE TO HIGHER GROUND IMMEDIATELY

Note: the symbol ~ is used here and hereafter to approximate the time of several public alerts from Boulder Office of Emergency Management. Certain archived alerts did not include a timestamp. The approximate time given for these alerts is based on @boulderoem twitter posts relaying similar information.

11:54 p.m. Source:@boulderoem. Channel: Twitter. Message: Fourmile Canyon residents: move to higher ground NOW via Poorman Rd or if west of Ingraham Gulch, Gold Run to Gold Hill.#boulderflood

~11:58 p.m. Source: Boulder Office of Emergency Management. Channel: Website. Message: *MESSAGE III – FOUR MILE CANYON LIFE THREATENING FLASH FLOOD IMMINENET – MOVE TO HIGHER GROUND NOW.* MESSAGE 3 FLASH FLOOD WARNING – LIFE THREATENING FLASH FLOOD IMMINENET IN FOUR MILE CANYON AREA. MOVE AWAY IMMEDIATELY. DEBRIS ON POORMAN AND GOLD HILL ROADS, BUT THEY ARE PASSABLE. DRIVE CAREFULLY, BUT MOVE IMMEDIATELY.

11:58 p.m. Source:@boulderoem. Channel: Twitter. Message: Life-threatening flash flood imminent in Fourmile area. Debris in Poorman Road and Gold Run but they are passable. #boulderflood

September 12, 2013

12:06 a.m. Source:@boulderoem. Channel: Twitter. Message: Fourmile Canyon Rd. closed at Hwy 119 (Boulder Canyon). Do not seek to exit 4Mile out of the mouth of the canyon. Go up Poorman or Gold Hill

12:18 a.m. Source:@boulderoem. Channel: Twitter. Message: RT @boulderpolice: El Dorado Springs - S. Boulder Creek is at 1600 CFS. Please go to higher ground ASAP.

12:49 a.m. Source:@boulderoem. Channel: Twitter. Message: An evacuation notice has been issues for Jamestown. Head for higher ground.

12:55 a.m. Source: Boulder Office of Emergency Management. Channel: Website. Message: *MANDATORY EVACUATION FOR JAMESTOWN.* MANDATORY EVACUATION OF JAMESTOWN HAS BEEN ORDERED. USE OVERLAND ROAD AND HEAD TOWARDS NEDERLAND.

1:01 a.m. Source:@boulderoem. Channel: Twitter. Message: Mandatory evacuation of Jamestown. Use Overland Road and head towards Nederland. #Boulderflood

7:12 a.m. Source: National Weather Service. Channel: Mobile communication devices. Boulder Specific Distribution Area: Northern Boulder County in Northeast Colorado. Message: Flash Flood Warning this area til 10:15 AM MDT. Avoid flood areas. Check local media. –NWS.

7:12 a.m. Source: National Weather Service. Channel: NWR and EAS. Boulder Specific Distribution Area: Northern Boulder County in Northeast Colorado. Message: The National Weather Service in Denver has issued a flash flood warning for... Northern Boulder County in northeast Colorado *until 1015 am mdt

* At 709 am mdt...doppler radar indicated heavy rain across the warned area. Rainfall amounts of 4 to 6 inches have already fallen since last evening with locally up to 7 inches in a few locations. Flash flooding will continue.

* Some locations that will experience flooding include... Lyons... Jamestown... Peaceful Valley... Allenspark... Raymond... Meeker Park And Longs Peak.

Precautionary/Preparedness Actions...

Excessive runoff from this storm will cause flash flooding of creeks and streams...roads and roadside culverts. The heavy rains could also trigger rock slides or debris flows in steep terrain. Move to higher ground now. Act quickly to protect your life. Stay away or be swept away. River banks and culverts can become unstable and unsafe.

~7:12 a.m. Source: Boulder OEM. Channel: Website. Message: *NWS Flood Warning Extended to 10a.m.* NWS extended the Flood Warning for Boulder County to 10 a.m.

8:17 a.m. Source: @boulderoem. Channel: Twitter. Message: Update on rescue at Dillon Road and U.S. 287 http://t.co/3FnhRbXaTM #boulderflood

~8:17 a.m. Source: Boulder Office of Emergency Management. Channel: Website. Message: *Update on Dillon Rd and 287.* Public safety crews responded to submerged vehicles on Dillon Road 0.2 miles east of 287. When they arrived, they discovered a culvert had washed out and three cars were under water. One vehicle was upside down. North Metro Fire pulled three individuals out of the upside down vehicle. They were transported to a local hospital with minor injuries. The occupants of the other vehicles had already managed to escape the water. Motorists are reminded that conditions remain dangerous throughout the region. Do not get in a car and drive unless absolutely necessary.

8:36 a.m. Source: National Weather Service. Channel: Mobile communication devices. Boulder Specific Distribution Area: Central Boulder County in Northeast Colorado. Message: Flash Flood Warning this area til 11:30 PM MDT. Avoid flood areas. Check local media. –NWS.

8:36 a.m. Source: National Weather Service. Channel: NWR and EAS. Boulder Specific Distribution Area: Central Boulder County in Northeast Colorado. Message: The National Weather Service in Denver has issued a flash flood warning for central Boulder County in northeast Colorado... *until 1130 am mdt.

* At 834 am mdt...doppler radar indicated heavy rain across the Fourmile burn area. Up to one inch of rain may fall in the next 45 minutes. Flash flooding is expected to begin shortly.

* Some locations that will experience flooding include... Northwestern Boulder... Salina... Crisman...Gold Hill...Wallstreet... Summerville and Sunshine.

Precautionary/Preparedness Actions...

Heavy rainfall will cause flash flooding of creeks...streams...and ditches in the Fourmile burn area. Some drainage basins affected by excessive runoff include Fourmile Creek...Gold Run...And Fourmile Canyon Creek. Water will be flowing down roadways. Rock slides or debris flows can also be expected. Excessive runoff from this storm will cause flash flooding of creeks and streams...roads and roadside culverts. The heavy rains could also trigger rock slides or debris flows in steep terrain. Move to higher ground now. Act quickly to protect your life. Stay away or be swept away. River banks and culverts can become unstable and unsafe.

9:40 a.m. Source: Boulder Office of Emergency Management. Channel: Website. Select Message Elements: *Situation Updates.* Overview of updates from 9 a.m. Boulder County flooding press conference.

- Boulder County Sheriff Joe Pelle requests that Boulder County residents stay inside and stay off the roads.
- Helicopters ready for search and rescue but grounded due to weather conditions.

- This storm is impacting every drainage in Boulder County from St. Vrain to Coal Creek Canyon.
- U.S. 36 is out at Longmont Dam Road near Lyons.
- Sheriff Pelle: "This event is not over. It's far from over. It's continuing to build" … After initial surge of rain, debris builds … In some places in mountains, there are reports of 10 ft. debris walls with 6-8 feet of water behind them.
- No evacuation ordered. It's very dangerous to put people in their cars on the roads during flash flooding … They need to seek shelter and high ground … More people are killed in cars in flash flooding than anyplace else.
- Forecast suggests dangerous conditions will continue today, tomorrow and the next day.
- The City of Boulder and Boulder County officials are urging people to stay off the roads and away from all waterways. The conditions remain dangerous and unpredictable.

9:45 p.m. Source: Boulder Office of Emergency Management. Channel: Website. Message: *Public Safety Alert about the Water conditions.* Boulder County Public Health is asking everyone to stay out of the flood water. Even if it looks calm or clean do not wade in, play in or go near the water. The water likely contains sewage, bacteria, and debris.

10:02 a.m. Source: National Weather Service. Channel: Mobile communication devices. Boulder Specific Distribution Area: Boulder County in Northeast Colorado, Fourmile. Message: Flash Flood Warning this area til 1:00 PM MDT. Avoid flood areas. Check local media. –NWS.

10:02 a.m. Source: National Weather Service. Channel: NWR and EAS. Boulder Specific Distribution Area: Boulder County in Northeast Colorado, Fourmile. Message: The National Weather Service in Denver has issued a flash flood warning for... Boulder County in northeast Colorado... * until 100 pm mdt.

* At 958 am mdt...emergency management reported flash flooding continuing over portions of central Boulder County. Several inches of rain ranging from 6 to 10 inches has fallen in the past 12 to 18 hours over central Boulder County.

* Some locations that will experience flooding include...Fourmile Burn Area... Boulder... Lyons... Jamestown... Ward... Salina... Eldorado Springs... Crisman...Gold Hill... Summerville... Peaceful Valley...Allenspark... Wallstreet... Raymond... Meeker Park and Sunshine.

Precautionary/Preparedness Actions...

Heavy rainfall will cause flash flooding of creeks...streams...and ditches in the Fourmile burn area. Some drainage basins affected by excessive runoff include Fourmile Creek...Gold Run...and Fourmile Canyon Creek. Water will be flowing down roadways. Rock slides or debris flows can also be expected. Excessive runoff from this storm will cause flash flooding of creeks and streams...roads and roadside culverts. The heavy rains could also trigger rock slides or debris flows in steep terrain. Move to higher ground now. Act quickly to protect your life.

11:30 a.m. Source: Boulder Office of Emergency Management. Channel: Website. Message: *Large Surge of Water in Fourmile Creek.* A large surge of water was reported in Fourmile Creek passing Logan Mill at 10:55. The cubic feet per second (cfs) increased from 100 cfs to 1,000 cfs. Residents downstream should climb to higher ground.

11:31 a.m. Source: @boulderoem. Channel: Twitter. Message: Large wall of water passed Logan Mill in Fourmile Creek around 10:55 a.m., residents downstream should climb to higher ground. #boulderflood

11:38 a.m. Source: Boulder OEM. Channel: 4 Outdoor Warning Sirens along Boulder Creek. Area: New Britain building, near Folsom Field, Fire Station #3, and the CU research center. Message: "Warning. Flash flood of Boulder Creek is imminent. Leave immediately. Proceed to higher ground. Do not cross Boulder Creek."

11:38 a.m. Source: Boulder OEM. Channel: Everbridge notification system (opt-in and Reverse 911). Area: Boulder Creek Message: Everbridge system stated flooding was imminent, evacuate area, move away from creek, move to higher ground.

11:38 a.m. Source: @boulderoem. Channel: Twitter. Message: Large surge of water in Fourmile Creek near Logan Mill Road around 10:55 a.m.; downstream seek safety. http://t.co/zC1VRp5Ss0 #boulderflood

12:25 p.m. Source: Boulder Office of Emergency Management. Channel: Website. Select Message Elements: *Situation Update from Noon News Conference.* Boulder County, City of Boulder, CU, other local officials updated the community as follow.

- Please continue to stay away from the water and stay off the roads unless you absolutely must travel by car, conditions remain dangerous and emergency personnel need clear access to roads.
- So far, only Jamestown evacuated. Emergency sirens sounded in Jamestown.
- Residents near drainage from St. Vrain to Coal Creek should seek high ground.
- Flood sirens set off in Boulder near Boulder Creek. No new danger, but people in Boulder need to stay away from the creek. Recent sirens WERE NOT an order to evacuate.
- Families evacuated from CU family housing near Boulder Creek remain evacuated.

12:30 p.m. Source: Boulder Office of Emergency Management. Channel: Website. Message: *Closure of Boulder County Parks, Trails and Open Space.* All Boulder County parks, trails and open space have been closed.

1:48 p.m. Source: Boulder Office of Emergency Management. Channel: Website. Message: *All city facilities will remain closed Friday, Sept. 13.* All City of Boulder facilities, including libraries and recreation centers, will remain closed throughout the day tomorrow, Friday, Sept. 13. City Manager Jane Brautigam is asking that non-essential employees not report to work.

4:45 p.m. Source: Boulder Office of Emergency Management. Channel: Website. Select Message Elements: *Situation Update from 4:00 p.m. News Conference.*

- All canyons from flats to mountains are closed due to road damage and debris.
- 12 dams have overtopped across Boulder County.
- In Boulder, 1 fatality on Linden, 1 person in car was not found.
- We've been assisting people stranded in vehicles, homes.
- Lyons still cut off with water and road damage.

5:00 p.m. Source: Boulder Office of Emergency Management. Channel: Website. Message: *Request from Sheriff Pelle.* Boulder County Sheriff Joe Pelle requests that Boulder County residents stay inside and stay off the roads tonight and tomorrow. Conditions are dangerous, roads are impassable in many areas, schools, government offices, private businesses are closed. Give responders room to work and keep yourself safe and alive by not trying to travel anywhere in the region unless it's absolutely necessary to do so.

7:00 p.m. Source: Boulder Office of Emergency Management. Channel: Website. Message: *Boulder County Fairgrounds Closed.* Due to flooding at the evacuation center at the Boulder County Fairgrounds in Longmont, the fairgrounds are now closed. Animal control is advising to have all livestock shelter in place at this time.

7:25 p.m. Source: Boulder Office of Emergency Management. Channel: Website. Message: *Current Road Closure Information.* All Boulder County residents are asked to stay inside and off the roads tonight and tomorrow. Driving conditions are dangerous and roads are impassable in many areas. Please don't drive unless absolutely necessary and avoid driving through floodwaters.

8:00 p.m. Source: Boulder Office of Emergency Management. Channel: Website. Message: *Evacuation Centers.*

- Boulder: YMCA of Boulder Valley, 2800 Mapleton Ave., Boulder, CO 80301
- Niwot: Niwot High School, 8989 Niwot, Niwot.
- Erie: Erie Community Center, 450 Powers, Erie.
- Jamestown: Jamestown Elementary School, 111 Mesa St., Jamestown, CO 80455.
- Lyons: Lyons Elementary School, 338 High St., Lyons, CO 80540.
- Nederland: Nederland Community Center, 750 Colorado 72 N., Nederland, CO 80466.
- Lafayette: Bob L. Burger Recreation Center, 111 Baseline Rd. Lafayette.

For any other inquiries of information, please call the Emergency Call Center at 303-413-7730.

10:10 p.m. Source: Boulder OEM. Channel: Everbridge emergency notification (opt-in and Reverse 911). Area: 3,495 phone numbers from the mouth of Boulder Canyon to Broadway as west and east boundaries, and within Pearl and Marine streets as north and south boundaries. Message: Move to higher ground immediately without crossing the creek. (The one exception in this area is a senior living facility at 10th and Arapahoe that is being assisted with sheltering in place on upper levels.)

10:10 p.m. Source: Boulder OEM. Channel: 4 Outdoor Warning Sirens. Area: Along Boulder Creek at

New Britain building, near Folsom Field, Fire Station #3, and the CU research center. Message: "Warning. Flash flood of Boulder Creek is imminent. Leave immediately. Proceed to higher ground. Do not cross Boulder Creek."

10:13 p.m. Source: @boulderoem. Channel: Twitter. Message: Evacuation ordered: Mouth of Boulder Canyon to Broadway, Pearl to Marine GO TO HIGHER GROUND immediately #boulderflood

10:14 p.m. Source: @boulderoem. Channel: Twitter. Message: Sirens are sounding. All those east of Broadway, shelter in place, head upstairs #boulderflood

10:14 p.m. Source: @boulderoem. Channel: Twitter. Message: While evacuating DO NOT cross Boulder Creek #boulderflood

10:19 p.m. Source: Boulder OEM. Channel: Everbridge emergency notification (opt-in and Reverse 911). Area: 4,034 phone numbers in areas along the Boulder Creek corridor east of Broadway to 75th Street. Message: Shelter in place but move to upper floors, if possible. If this is not possible, these individuals should seek higher ground, at least 12 feet above creek level, without crossing the creek.

~10:19 p.m. Source: Boulder Office of Emergency Management. Channel: Website. Message: *Boulder Creek evacuation.* Urgent! An evacuation has been ordered and warning sirens were activated at 10:15 p.m. for all residents along Boulder Creek from the mouth of Boulder Canyon east to Broadway between Marine and Pearl Streets. All residents are warned to go

higher ground immediately due to the potential for flash flooding along the creek. Residents north of Boulder Creek should move at least to Spruce Street, if not further. Residents south of Boulder Creek should move past Euclid Street. Residents near Boulder Creek east of Broadway are urged to shelter in place on high ground. Do not cross Boulder Creek for any reason. Do not drive unless absolutely necessary and avoid driving through flood waters. Boulder Creek is currently flowing at approximately 4, 900 cubic feet per second; almost double the volume from earlier today. There are mudslides at the mouth of Boulder Canyon 400 feet long and 4 feet deep as the sides of the canyon give way due to the saturation from the day's long rain. Boulder County officials are worried that the mud and rock slides will clog Boulder Creek, causing water to collect upstream and then release, causing a sudden surge in water volume downstream.

10:28 p.m. Source: @boulderoem. Channel: Twitter. Message: Surge expected in Boulder Canyon around midnight due to Emerson Gulch blowing, evacuation order is still in effect #boulderflood

10:33 p.m. Source: @boulderoem. Channel: Twitter. Message: When evacuating do so on foot. Do not attempt to drive through the streets. #boulderflood

10:35 p.m. Source: @boulderoem. Channel: Twitter. Message: Boulder Canyon closed down due to mudslides #boulderflood

10:38 p.m. Source: @boulderoem. Channel: Twitter. Message: Boulder Creek evacuation details can be found here: http://t.co/7pEebrsyPT #boulderflood

10:52 p.m. Source: National Weather Service. Channel: Mobile communication devices. Boulder Specific Distribution Area: Boulder. Message: Flash Flood Warning this area til 3:45 AM MDT. Avoid flood areas. Check local media. –NWS.

10:52 p.m. Source: National Weather Service. Channel: NWR and EAS. Boulder Specific Distribution Area: Boulder. Message: The National Weather Service in Denver has issued a flash flood warning for... northern Jefferson County in northeast Colorado... Boulder County in northeast Colorado... * until 345 am mdt.

* At 1045 pm mdt...widespread and life threatening flash flooding was occurring across Boulder and northern Jefferson counties. ...this is a flash flood emergency for boulder and northern Jefferson County. Seek higher ground now! This is life threatening situation! New evacuations

have been ordered from the mouth of Boulder Canyon along Broadway... And then Pearl to Marine.

Widespread flash flooding was causing numerous and widespread road closures were reported across all of boulder County...as well as northwestern Jefferson County. Travel is virtually impossible...stay off the roads and stay safe. Leyden reservoir in northwestern Arvada is also releasing flows at a high rate...with evacuations now occurring downstream of the dam to Alkire Street.

Doppler radar indicated rain had diminished somewhat in intensity...but another half inch of rain can still be expected in the next hour or two. This will continue to produce flash flooding.

* Some locations that will experience flooding include... Western Arvada... Western Westminster... Boulder...Western Longmont...Southwestern Broomfield... Lafayette...Northwestern Golden... Louisville...Superior... Lyons... Nederland... Jamestown... Ward... Salina...Niwot... Eldora... Allenspark... Wallstreet...Rocky Flats... Brainard Lake... White Ranch Open Space...Eldorado Springs... Crisman...Gold Hill... Summerville...Peaceful Valley... Raymond...Meeker Park...Sunshine and Longs Peak.

Precautionary/Preparedness Actions...

Move to higher ground now. This is an extremely dangerous and life threatening situation. Do not attempt to travel unless you are fleeing an area subject to flooding or under an evacuation order. Travel is nearly impossible. This is a life threatening situation...including people along Boulder Creek in the City of Boulder...in the Fourmile burn area...in Boulder Canyon....Lefthand Canyon...and St Vrain Canyon through the town of Lyons...along south Boulder Creek through Eldorado Springs...and Coal Creek Canyon. Heavy rainfall will cause extensive and severe flash flooding. Numerous roads and bridges have been washed out. Turn around...dont drown when encountering flooded roads. Most flood deaths occur in vehicles. Be especially cautious at night when it is harder to recognize the dangers of flooding.

11:15 p.m. Source: Boulder Office of Emergency Management. Channel: Website. Message: *Emergency Alerts for Boulder Creek.* City of Boulder issues two emergency alerts due to rising levels along Boulder Creek. The City of Boulder, moments ago, sounded flood sirens and sent out

Everbridge notifications to a total of about 8,000 telephone numbers in two separate areas along Boulder Creek. The first message urges individuals from the mouth of Boulder Canyon to Broadway as west and east boundaries, and within Pearl and Marine streets as north and south boundaries, to move to higher ground immediately without crossing the creek. The one exception is this area is a senior living facility at 10th and Arapahoe that is being assisted with sheltering in place on upper levels. This alert was sent to 3,495 telephone numbers. City models show that higher ground with little or no expectation of impact on the north side of the creek means that individuals in that area should head for Spruce Street or farther north. Higher ground with little or no expectation of impact on the south side of the creek means that individuals in that area should head for all points south of Marine Street. The second alert instructed individuals in the areas along the Boulder Creek corridor east of Broadway to 75th Street to shelter in place but move to upper floors, if possible. If this is not possible, these individuals should seek higher ground, at least 12 feet above creek level, without crossing the creek. This alert was sent to 4,034 phone numbers. Both messages were prompted by rapidly rising creek levels, water that is backing up at the mouth

of the canyon due to debris, mud and water coming off the mountainsides in the canyon and current weather patterns. Boulder officers and firefighters are in the area working to keep community members safe.

11:20 p.m. Source: Boulder Office of Emergency Management. Channel: Website. Message: *Four Mile Canyon flash flood.* A large surge of water, mud, rocks and debris, including cars, about 30 feet deep is heading down Fourmile Creek, according to an 11:10 p.m. call to Boulder County by a resident of Emerson Gulch. The flow is expected to reach Boulder Creek at about midnight. Residents are warned to get to higher ground!

11:58 p.m. Source: National Weather Service. Channel: Mobile communication devices. Boulder Specific Distribution Area: Boulder County in Northeast Colorado, Message: Flash Flood Warning this area til 6:00 AM MDT. Avoid flood areas. Check local media. –NWS.

11:58 p.m. Source: National Weather Service. Channel: NWR and EAS. Boulder Specific Distribution Area: Boulder County in Northeast Colorado, Message: The National Weather Service in Denver has issued a flash flood warning for northern Jefferson County in Northeast Colorado... Boulder County in northeast Colorado... * until 600 am mdt Friday

* At 1153 pm mdt...emergency management reported a new round of severe flash flooding in Fourmile Creek...Boulder Creek...and Lefthand Canyon in Boulder County. This is a flash flood emergency for the Fourmile burn area...the City of Boulder...and Lefthand Creek. Seek higher ground now! This is a potentially life threatening situation!

* Some locations that will experience flooding include... Western Arvada... Western Westminster... Boulder... Western Longmont... Southwestern Broomfield... Lafayette... Northwestern Golden... Louisville... Superior... Lyons... Nederland... Jamestown... Ward... Salina... Niwot... Eldora...Allenspark...Wallstreet...Rocky Flats...Brainard Lake...White Ranch Open Space...Eldorado Springs...Crisman...Gold Hill... Summerville... Peaceful Valley... Raymond... Meeker Park... Sunshine and Longs Peak.

At 1150 pm...Boulder County emergency management reported significant rises coming down Fourmile Creek out of the Fourmile burn area and into Boulder Canyon. This surge is expected to reach the mouth of boulder canyon in the City of Boulder within the next 20 minutes. There was also a 10 foot wall of water coming down Lefthand Canyon. Residents downstream can expect a significant increase in water levels...even east of the canyons...over the next hour. If you are near Boulder or Fourmile creeks...get to higher ground now! Do not try to outrun this flash flood!

Precautionary/Preparedness Actions...

Move to higher ground now. This is an extremely dangerous and life threatening situation. Do not attempt to travel unless you are fleeing an area subject to flooding or under an evacuation order. This is a life threatening situation. Heavy rainfall will cause extensive and severe flash flooding of creeks...streams...and ditches in the Fourmile burn area. Some drainage basins impacted include Fourmile creek...gold run...and Fourmile canyon creek. Severe debris flows can also be anticipated across roads. Roads and driveways may be washed away in places. If you encounter flood waters...climb to safety. Move to higher ground now. Act quickly to protect your life.

September 13, 2013

12:20 a.m. Source: Boulder Office of Emergency Management. Channel: Website. Message: *Eldorado Springs evacuation.* An Everbridge notice was sent to all residents of Eldorado Springs shortly after midnight to evacuate immediately due to higher water levels and increased chance of mudslides along South Boulder Creek. Residents have been asked to evacuate to a barn located at 2875 Boulder County Road 67, just south and east of the town of Eldorado Springs.

3:44 a.m. Source: Boulder Office of Emergency Management. Channel: Website. Message: All Boulder County residents are asked to stay inside and off the roads. Driving conditions are dangerous and roads are impassible in many areas. Please don't drive unless absolutely necessary and avoid driving through floodwaters. Visit http://gisweb.ci.boulder.co.us/EMCOP/index.html to view an updated map of road closures throughout Boulder County. The list and map of Boulder County road closures are not all-inclusive and the accuracy of the information cannot be guaranteed. Due to rapidly changing weather conditions and unpredictable floodwaters, all road closures are subject to change at any time.

5:25 a.m. Source: Boulder Office of Emergency Management. Channel: Website. Message: *Longmont cut in half; evacuations requested.* The city of Longmont is cut in half by the St. Vrain River. Main Street/U.S. 287 is closed from Missouri Street south to Plateau Road. This closure joins the closure of other primary north/south arteries including Hover Road/96th Street, airport Road. City of Longmont officials are also requesting that residents in neighborhoods and subdivisions south of Quail Road between Main Street and 119th Street due to flooding along Dry Creek. They are asked to evacuate to Niwot High School. National Guard troops will be gathering with heavy, high-clearance vehicles on Highway 66 west of Longmont to assess the highway into the Town of Lyons and determine if it is sage to enter and take out people who have been trapped there since Wednesday. All roads into and out of Lyons have been washed out or underwater for the past two days. Officials urge all Boulder County residents to stay home if at all possible. And if they must drive, do not cross any standing or moving water in roadways.

9:00 a.m. Source: Boulder Office of Emergency Management. Channel: Website. Message: *Town of Lyons Evacuation.* Because of flood waters and road damage there is no safe access in or out of Lyons. The Colorado National Guard is assisting with the voluntary evacuation of the Town of Lyons. Residents seeking to be evacuated will be transported with tactical vehicles to LifeBridge Church in North Longmont. We are asking people who are looking for family or friends in Lyons to not go to the evacuation site. Volunteers and staff will be taking names of evacuees as they arrive. Starting at 9:300 today, LifeBridge Church will staff a public phone bank at 303-776-2927 to help Lyons evacuees reconnect with their family members.

9:30 a.m. Source: Boulder Office of Emergency Management. Channel: Website. Message: *Closure of I-25.* The Colorado Department of Transportation has closed I-25 from Hwy 7 North of Denver to the Wyoming border because of flooding. Please continue to check closures and conditions on this site and www.cotrip.org.

3:45 p.m. Source: Boulder Office of Emergency Management. Channel: Website. Message: *Left Hand Water District Boil Water Advisory.* The Left Hand Water District has decided to issue a boil water advisory. Residents whose homes are being served by the Left Hand Water District should use

boiled water for drinking, cooking, making ice, washing dishes, and brushing teeth until testing shows the water is safe. Heat water until it bubbles vigorously (boils) for at least one minute. Let it cool before using. Bottled water is also an option. Because of special concerns for infants, use only bottled water to mix formula, or use canned baby formula that does not require additional water be added. If you become ill after drinking contaminated water, seek medical attention as soon as possible. Symptoms of illness from drinking unsafe water include upset stomach, vomiting, diarrhea, fever, cramps, and headaches.

5:00 p.m. Source: Boulder Office of Emergency Management. Channel: Website. Message:

295 Residents Evacuated from Jamestown. Help has arrived for Jamestown. With the assistance of the Colorado National Guard 295 people have been airlifted out of Jamestown, first group now on buses en route to evacuation center.

5:10 p.m. Source: Boulder Office of Emergency Management. Channel: Website. Selected Message Elements: *Media Briefing Summary.* Boulder County – Three confirmed fatalities have occurred in Boulder County. Many communities in our western mountains are completely isolated, no water, no septic, no sewer, have our hands full…we lost every roadway leading to western end of our County. We have four helicopters in use, 3 large black hawk, using them to relay humanitarian aid to Jamestown and other communities, and to insert search/rescue and for medical evacuation; heavily dependent on air ops for a while due to road conditions. Restoration/recovery will be hampered by this. We've made good progress in terms of evacuating Lyons – several hundred so far. High profile vehicles taking evacuees to HWY 66 then to evacuation center in Longmont. We're documenting everyone who is evacuated. This operation will continue throughout today with as many as 2,500 people being transported out of this community. Lyons has lost sewer, water, and power. We don't yet know about homes and lives lost in canyons and mountain communities. This will go on for several days….Waters are receding. People will now want to travel. We have forecast for flash flood warnings still. Progress by next week – little solace for people in the mountains who are waiting for help.

City of Boulder – We have more rain in the forecast; a storm tonight could set us back. We have issues on some of the roads. Some have dried out, but large debris piles in a lot of the intersection. Table Mesa and Broadway is shut down. Pavement is buckling due to saturated grounds. Boulder Creek CFS is 2300. It was 3,000 this morning. Usually it's at 100. Boulder Police: please stay off roads and don't travel. Public Works needs room to get to these areas. National Guard using Boulder airport to make evacuee deliveries. Open Space in Mountain Park – illegal for people to go out there now. Unstable bridges, mudslides, issues with trailheads. Safety issues we're trying to mitigate. Two evacuation orders last night – they'll stay in place. 4,000 people mouth of Canyon to Broadway, Pearl to Marine. Then an area from Broadway to eastern limits of city. Still concerned about the weather that may be coming up. Small business in downtown Boulder in evacuation area collapsed. People need to stay out of floodwaters – rebar, tree branches, depth

10:00 p.m. Source: Boulder Office of Emergency Management. Channel: Website. Message: *Boulder Announces Breach in Wastewater Pipeline.* There is no immediate threat to drinking water or public safety. The City of Boulder is reporting a significant breach in the main wastewater pipeline to the 57th Street Wastewater Treatment Plant. As flood waters began to recede, staff had visual confirmation at about 8:20 p.m. of a breach southwest of the wastewater treatment plant. There is no immediate threat to drinking water.

September 14, 2013

9:00 a.m. Source: Boulder Office of Emergency Management. Channel: Website. Message: *Media Briefing Summary.* Emergency personnel are focusing on life safety and rescue operation. Lots of air support will be used throughout the day to evacuate people. Numerous mountain roads are flooded, damaged and impassible, making rescue operations more challenging. Transportation crews are working on repairing roads for rescue and evacuation efforts. More than 200 people are unaccounted for, but necessarily missing. Emergency officials are working hard to collect an updated list of names from hospitals, shelters and evacuation sites. Sunshine Canyon is the only access route to Nederland and is open to emergency vehicles only. Approximately 50 people are still in Jamestown and law enforcement personnel are urging them to evacuate as it is not known when the roads will be repaired. Officials are urging people to stay off the roads, especially in the mountains, to allow emergency personnel to do their job. The children at Cal-Wood Education Center will be rescued today. Officials are still working on a plan for debris and trash removal. Please do not leave debris in streets as this may impede safety vehicles. No immediate threat to drinking water in Boulder, Erie, Lafayette or Longmont. Please limit discretionary water usage, to the extent possible. Stay out of floodwaters, which are contaminated and unsafe.

September 15, 2013

10:41 a.m. Source: National Weather Service. Channel: Mobile communication devices. Boulder Specific Distribution Area: The Fourmile Burn and Jamestown Area in Central Boulder County in Northeast Colorado, Jamestown Message: Flash Flood Warning this area til 1:30 PM MDT. Avoid flood areas. Check local media. –NWS.

10:41 a.m. Source: National Weather Service. Channel: NWR and EAS. Boulder Specific Distribution Area: The Fourmile Burn and Jamestown Area in Central Boulder County in Northeast Colorado, Jamestown Message: The National Weather Service in Denver has issued a flash flood warning for the Fourmile burn and Jamestown area in central Boulder County in northeast Colorado until 130pm mdt

* At 1037 am mdt...doppler radar and automated rain gauges indicated that moderate to heavy rain was moving into the Fourmile burn area from the east. 0.5 to 0.8 inch of rain has fallen in the past hour in and near boulder just east of the burn area. Flash flooding is expected to begin shortly in the Fourmile burn area.

* Excessive rainfall over the burn scar will result in debris flow moving through the Fourmile... Fourmile Canyon and James Creek drainages. The debris flow can consist of rock...mud...vegetation and other loose materials. Some locations that will experience flooding include... Jamestown... Salina... Crisman... Gold Hill... Wallstreet... Summerville and Sunshine.

* Precautionary/preparedness actions...

Heavy rainfall will cause flash flooding of creeks...streams...and ditches in the Fourmile burn area. Some drainage basins affected by excessive runoff include Fourmile creek...Gold Run...and Fourmile Canyon Creek. Water will be flowing down roadways. Rock slides or debris flows can also be expected. Move to higher ground now. Act quickly to protect your life.

11:50 a.m. Source: National Weather Service. Channel: Mobile communication devices. Boulder Specific Distribution Area: South Eastern Boulder County in Northeast Colorado. Message: Flash Flood Warning this area til 3:45 PM MDT. Avoid flood areas. Check local media. –NWS.

11:50 a.m. Source: National Weather Service. Channel: NWR and EAS. Boulder Specific Distribution Area: South Eastern Boulder County in Northeast Colorado. Message: The National Weather Service in Denver has issued a flash flood warning for... Extreme southwestern weld County in Northeast Colorado... Northwestern Adams County in Northeast Colorado... Broomfield County in Northeast Colorado... Southeastern Boulder County in Northeast Colorado until 345 pm mdt

* At 1146 am mdt...doppler radar and automated rain gauges indicated heavy rain falling over Broomfield. One and a quarter inches of rain has fallen since 10 am. Flash flooding is expected to begin in the Big Dry Creek and Rock Creek basins shortly.

* Some locations that will experience flooding include… Northern Thornton... Northeastern Westminster...Broomfield... Brighton... Lafayette... Louisville... Erie and Dacono. Additional rainfall amounts of 1 to 1.5 inches are possible in the warned area through 1 pm.

* Precautionary/Preparedness Actions...

If you are near Big Dry Creek through Broomfield or Rock Creek through Superior and Lafayette...move to higher ground now. Act quickly to protect your life. Excessive runoff from heavy rainfall will cause flooding of small creeks and streams...urban areas... highways... streets and underpasses as well as other drainage areas and low lying spots.

Appendix K: Demographic Distribution of Survey Sample

Table 1. Demographic Distributions of Population of Boulder, CO and Survey Samples (*N*=880) [a]

Characteristic	WEA Sample (%) (*N*=496)	General Sample (%) (*N*=597)	Population (%) [b]
Male	44.0	43.0	50.1
Female	56.0	57.0	49.9
Hispanic	4.9	3.9	7.4
Non-Hispanic	95.1	96.1	92.6
White	94.3	94.4	88.8
Black	2.2	1.9	0.9
Asian	1.0	1.7	4.5
Other/Multi-race	2.5	2.0	5.8
< High School grad	0.4	0.5	3.6
High School grad	8.9	6.4	7.1
Some college	14.2	15.8	36.3
College grad	33.9	33.1	29.2
Graduate degree	42.6	44.2	23.8
< $25K	7.5	12.2	25.7
$25K but < $50K	12.9	17.1	20.3
$50K but < $75K	16.2	17.3	14.9
$75K but < $100K	10.6	9.8	10.0
$100K but < $150K	27.3	23.4	12.6
$150K +	25.5	20.2	16.5
18-29 years	13.3	9.2	44.5
30-39 years	9.2	7.0	14.8
40-49 years	19.2	12.3	13.3
50-59 years	27.8	24.5	12.1
60-69 years	18.6	27.5	7.9
70-79 years	7.4	13.2	4.0

[a] 213 respondents are included in both samples.

[b] Data obtained from the 2008-2012 five-year American Community Survey population estimates for the City of Boulder.

Appendix L: Survey Questionnaire

1406MTE
BOULDER CREEK FLOOD SURVEY
SUMMER 2014

INTRO Hello, I'm <INTERVIEWER NAME> calling from the California State University, Fullerton. We are interviewing people in Boulder, Colorado to find out what they did in response to the flooding that took place on September 11th and 12th, 2013. Your participation may help improve the messages that the public receives during emergencies. Participants will receive a <$25> gift certificate for completing this telephone interview; it will take approximately 30-45 minutes.

This interview is voluntary and completely confidential. Research records will be kept confidential to the extent allowed by the law. Your telephone number and your addresses, if you choose to provide it, will be stored on a password-secured computer at the SSRC. The answers you provided will be stored in a separate file on the same computer. Your contact information will be destroyed at the end of the study, but your answers will be retained and stored indefinitely on a password-protected campus computer for future research. You may refuse to answer any question without penalty.

If you need more information about the survey, you can call toll-free at (657)278-3185. If you have questions about the rights of human research participants, contact the CSUF IRB Office at (657)-278-7640 or irb@fullerton.edu . First, I need to ask you a few questions to see if you are eligible.

S1 Have I reached you at your home phone?

1. YES [SKIP TO S3]
2. NO [ASK S2]

S2 Is this a residence or personal cellular phone?

1. YES [ASK S3]
2. NO [END]

S3 I would like to confirm that I reached you at <PHONE NUMBER>.

1. YES
2. NO [END]

S4 For this survey, I need to speak with someone who lives there who is 18 years old or older. Are you 18 or older?

1. YES [SKIP TO S6]
2. NO [SKIP TO S5]
3. NO ONE IN HH IS 18 OR OLDER [END]

S5 May I speak to an adult 18 years or older who lives there?

1. IF ADULT RESIDENT AVAILABLE, REREAD TO INTRO
2. IF NO ADULT RESIDENT AVAILABLE, ARRANGE FOR AN APPROPRIATE CALLBACK TIME [CALLBACK]
3. NO ONE IN HOUSEHOLD IS 18 OR OLDER [END]

[IF CELLLAND=2, SKIP TO INTRO2]

S6 How many people are there in your household who are 18 years or older?
IF S6=1, SKIP TO S9, OTHERWISE CONTINUE

1. SPECIFY

S7 I would like to speak to the adult in your household, 18 or older, who has had the most recent birthday. Who would that be?

1. IF CURRENT PERSON, GO TO S9
2. IF OTHER ADULT RESIDENT, CONTINUE

S8 Thank you for helping me with this information. May I please speak with him/her?

1. IF AVAILABLE, READ INTRO BELOW
2. IF NOT AVAILABLE, ARRANGE FOR AN APPROPRIATE CALLBACK TIME [END]

INTRO2 Hello, I'm <INTERVIEWER NAME> calling from the California State University, Fullerton. We are interviewing people in Boulder, Colorado to find out what they did in response to the flooding that took place on September 11th and 12th, 2013. Your participation may help improve the messages that the public receives during emergencies. Participants will receive a <$25> gift certificate for completing this telephone interview; it will take approximately 30-45 minutes.

This interview is voluntary and completely confidential. Research records will be kept confidential to the extent allowed by the law. Your telephone number and your addresses, if you choose to provide it, will be stored on a password-secured computer at the SSRC. The answers you provided will be stored in a separate file on the same computer. Your contact information will be destroyed at the end of the study, but your answers will be retained and stored indefinitely on a password-protected campus computer for future research. You may refuse to answer any question without penalty.

If you need more information about the survey, you can call toll-free at (657)278-3185. If you have questions about the rights of human research participants, contact the CSUF IRB Office at (657)-278-7640 or irb@fullerton.edu. First, I need to ask you a few questions to see if you are eligible.

S9 Were you in the city of Boulder on September 11th and 12th, 2013?

1. YES
2. NO [END]
7. DON'T KNOW [END]

9. REFUSED [END]

S10 Did you receive the following message that was sent out by the National Weather Service over a mobile communication device such as a cell phone on Wednesday September 11th 2013? The message was sent at 6:36 pm, but you may have read it later.

Flash Flood Warning this area until 9:30 time MDT (READ AS: EM DEE TEE). Avoid flood areas. Check local media. NWS (READ AS: EN DOUBLE-YOU ESS).

Did you receive this message?

1. YES [IN FIRST ALERT GROUP]
2. NO [NOT IN FIRST ALERT GROUP, SKIP TO S11]
7. DON'T KNOW [NOT IN FIRST ALERT GROUP, SKIP TO S11]
9. REFUSED [NOT IN FIRST ALERT GROUP, SKIP TO S11]

S10DT On what day did you first read that message?

1. Wednesday, September 11, 2013
2. Thursday, September 12, 2013
3. OTHER, SPECIFY DATE
7. DON'T KNOW
9. REFUSED

S10TM At what time on [date] did you read that message?

1. SPECIFY TIME
   AM=1/ PM=2
7. DON'T KNOW
9. REFUSED

S11 We will have a few more questions about this message later. Now we can begin the interview, is that okay?

1. YES
2. NO, ARRANGE FOR AN APPROPRIATE CALLBACK TIME [CALLBACK]

TRANS1 The first questions I will ask are about your thoughts and experiences before the Boulder Creek flood that occurred on September 11th, 2013.

Q1 EXPERIENCE: FLOOD IMPACTS (CONTROL)

On a scale of 1 to 6, how would you rank the damage from the worst flood you ever experienced before the September 2013 Boulder flood, where 1 represents "no damage" and 6 represents "extreme damage?"

[IF NEVER EXPERIENCED A FLOOD, SELECT 1]

1. ONE; NO DAMAGE / NEVER EXPERIENCED FLOOD
2. TWO
3. THREE
4. FOUR
5. FIVE
6. SIX; EXTREME DAMAGE
7. DON'T KNOW
9. REFUSED

Q2 KNOWLEDGE: PROTECTIVE ACTIONS (CONTROL)

Before the flood occurred, on a scale of 1 to 6, how much did you know about what to do to protect yourself from a flood in Boulder, where 1 represents "no knowledge" and 6 represents "sufficient knowledge?"

1. ONE; NO KNOWLEDGE
2. TWO
3. THREE
4. FOUR
5. FIVE
6. SIX; SUFFICIENT KNOWLEDGE
7. DON'T KNOW
9. REFUSED

Q3 KNOWLEDGE: MOBILE COMMUNICATION DEVICES (CONTROL) (WEA FAMILIARITY)

Before the flood occurred, on a scale of 1 to 6, how knowledgeable were you about public alerts or warnings for events like floods that are distributed over mobile communication devices such as cell phones, where 1 represents "not at all knowledgeable" and 6 represents "extremely knowledgeable?"

1. ONE; NOT AT ALL KNOWLEDGEABLE
2. TWO
3. THREE
4. FOUR
5. FIVE
6. SIX; EXTREMELY KNOWLEDGEABLE
7. DON'T KNOW
9. REFUSED

Q4 PRE-EVENT RISK PERCEPTION: DESTRUCTION POTENTIAL (CONTROL)

Before the flood occurred, on a scale of 1 to 6, how destructive did you think a flood in Boulder could be, where 1 represents "not at all destructive" and 6 represents "extremely destructive?"

1. ONE; NOT AT ALL DESTRUCTIVE
2. TWO
3. THREE
4. FOUR
5. FIVE
6. SIX; EXTREMELY DESTRUCTIVE
7. DON'T KNOW
9. REFUSED

Q5 EXPERIENCE: WEA FREQUENCY (CONTROL) (WEA FAMILIARITY)

Before the flood occurred, how many times had you ever received a government emergency alert about disasters like floods delivered to you over a mobile communication device such as a cell phone? This does not include University alerts. PROMPT RESPONDENTS WHO PROVIDE A RANGE TO SELECT A NUMBER REPRESENTING THEIR BEST ESTIMATE.

1. SPECIFY
7. DON'T KNOW
9. REFUSED

TRANS2 The next questions are about information you may have received about the floodThis could be information you received from a government authority, media source, or personal contact, such as a family member, friend, neighbor, or co-worker. It may have included information about what could happen during the flood and what to do to protect yourself. These questions are only about information received on Wednesday and Thursday, September 11th and 12th.

Q6DT FIRST MESSAGE: DATE (FIRST MESSAGE DIFFUSSION CURVE)

Think about the first time you received information about the flood. On what day did you receive that information?

1. Wednesday, September 11, 2013
2. Thursday, September 12, 2013
7. DON'T KNOW
9. REFUSED

Q6TM FIRST MESSAGE: TIME (FIRST MESSAGE DIFFUSSION CURVE)

And at what time on [Date] did you receive that information?

1. SPECIFY TIME
   AM=1/PM=2
7. DON'T KNOW
9. REFUSED

Q7 FIRST MESSAGE: SOURCE (WEA PENETRATION AS FIRST ALERT)

Who was that information from?

1. POLICE
2. NATIONAL GUARD
3. FIRE DEPARTMENT
4. STATE GOVERNOR'S OFFICE
5. BOULDER OFFICE OF EMERGENCY MANAGEMENT
6. SHERIFF'S DEPARTMENT
7. FAMILY MEMBER OR OTHER RELATIVE
8. NEIGHBOR OR FRIEND
9. EMPLOYER/EMPLOYEES
10. CO-WORKER
11. TV BROADCASTER
12. RADIO BROADCASTER
13. NATIONAL WEATHER SERVICE
14. OTHER SPECIFY

77. DON'T KNOW
99. REFUSED

Q8 FIRST MESSAGE: CHANNEL (WEA PENETRATION AS FIRST ALERT)

How was that information communicated to you?

1. 911 REVERSE CALL – BY LAND LINE OR BY CELL PHONE
2. TELEPHONE CALL – BY LAND LINE
3. TELEPHONE CALL – ON A MOBILE COMMUNICATION DEVICE SUCH AS A CELL PHONE
4. TEXT MESSAGE – ON A MOBILE COMMUNICATION DEVICE SUCH AS A CELL PHONE
5. FACE-TO-FACE FROM ANOTHER PERSON: FRIEND, FAMILY, CO-WORKER, EMPLOYEE/ER
6. INTERNET – PERSONAL COMMUNICATION SUCH AS EMAIL
7. INTERNET – SOCIAL MEDIA SUCH AS TWITTER OR FACEBOOK
8. WEBSITE
9. TONE ALERT RADIO
10. TELEVISION
11. RADIO
12. NATIONAL WEATHER RADIO
13. AN AUTHORITY GOING DOOR-TO-DOOR
14. STREET LOUDSPEAKER
15. OUTDOOR WARNING SIREN

16. OTHER [SPECIFY]
77. DON'T KNOW
99. REFUSED

Q9 WEA MESSAGE: RECEIPT (DIFFUSSION CURVE)

Did you receive the following message issued by the National Weather Service over a mobile communication device? This message was issued many times on September 11th and 12th.

Flash Flood Warning this area til [blank] time MDT (READ AS: EM DEE TEE). Avoid flood areas. Check local media. NWS (READ AS: EN DOUBLE-YOU ESS).

1.	YES	
2.	NO	[SKIP TO TRANS4]
7.	DON'T KNOW	[SKIP TO TRANS4]
9.	REFUSED	[SKIP TO TRANS4]

Q10DT WEA MESSAGE: RECEIPT DATE (DIFFUSSION CURVE)

On what day did you first read that message?

1. Wednesday, September 11, 2013
2. Thursday, September 12, 2013
3. OTHER, SPECIFY DATE
7. DON'T KNOW
9. REFUSED

Q10TM WEA MESSAGE: RECEIPT TIME (DIFFUSSION CURVE)

At what time on [date] did you read that message?

1. SPECIFY TIME
   AM=1/ PM=2
7. DON'T KNOW
9. REFUSED

Q11 FIRST WEA MESSAGE: HOW TO BEST EXPRESS TIME (HOW BEST EXPRESS TIME)

At the time you first read the message, how much time did you think you had before you should check local media?

1. SPECIFY MINUTES
7. DON'T KNOW
9. REFUSED

Q12 FIRST WEA MESSAGE: ACTIONS TAKEN (MOBILIZATION CURVE)

Did you take any of the following actions after you first received this message? Did you <…>?

A. Avoid flood areas
B. Check local media
1. Yes [ASK Q14]
2. No
7. DON'T KNOW
9. REFUSED

Q13_1A FIRST WEA MESSAGE: DAY ACTION BEGUN (MOBILIZATION CURVE) (HOW BEST EXPRESS TIME)

On what day did you begin to avoid flood areas?

1. Wednesday, September 11, 2013
2. Thursday, September 12, 2013
7. DON'T KNOW
9. REFUSED

Q13_1B FIRST WEA MESSAGE: TIME ACTION BEGUN (MOBILIZATION CURVE) (HOW BEST EXPRESS TIME)

At what time on [date] did you begin to avoid flood areas?

1. SPECIFY TIME
AM=1/PM=2
7. DON'T KNOW
9. REFUSED

Q13_2A FIRST WEA MESSAGE: DAY ACTION BEGUN (MOBILIZATION CURVE) (HOW BEST EXPRESS TIME)

On what day did you begin to check local media?

1. Wednesday, September 11, 2013
2. Thursday, September 12, 2013
7. DON'T KNOW
9. REFUSED

Q13_2B FIRST WEA MESSAGE: TIME ACTION BEGUN (MOBILIZATION CURVE) (HOW BEST EXPRESS TIME)

At what time on [date] did you begin to check local media?

1. SPECIFY TIME
   AM=1/PM=2
7. DON'T KNOW
9. REFUSED

Q14 FIRST WEA MESSAGE: RESPONSE REASONS FOR TAKING/NOT TAKING ACTION (MOBILIZATION CURVE)

Why [did/didn't] you do that?

A. Avoid flood areas
B. Check local media
   1. NOT IN AREA, TOLD TO TAKE ACTION
   2. PROTECTING RESIDENCE/ STRUCTURE I WAS IN
   3. RESIDENCE/STRUCTURE I WAS IN NOT THREATENED BY FLOOD
   4. PROTECTING ANIMALS
   5. TRYING TO LOCATE FAMILY MEMBER
   6. BOSS WOULD NOT LET US SHELTER
   7. OTHER; SPECIFY
   77. DON'T KNOW
   99. REFUSED

Q15 FIRST WEA MESSAGE: (UNDERSTAND anING ACRONYMS)

When you first read that message, what did you think the letters NWS meant?

1. NATIONAL WEATHER SERVICE
2. SOME OTHER PHRASE
7. DON'T KNOW
9. REFUSED

Q16 FIRST WEA MESSAGE: SOURCE BELIEVABILITY (BEST SOLE SOURCE)

How would you rate the believability of the National Weather Service on a scale of 1 to 6 where 1 represents "not at all believable" and 6 represents "completely believable?"

1. ONE; Not at all believable
2. TWO
3. THREE

4. FOUR
5. FIVE
6. SIX; Completely believable
7. DON'T KNOW
9. REFUSED

Q17 FIRST WEA MESSAGE: FIRST RECEIPT LOCATION (CONTROL)

Where were you when you first received that message? (CHECK ONE)

1. AT HOME
2. AT WORK
3. DRIVING MY CAR
4. IN TRANSIT – NOT DRIVING MY CAR
5. SHOPPING AT A STORE
6. AT A RELATIVE OR FRIEND'S PLACE
7. OTHER: SPECIFY
77. DON'T KNOW
99. REFUSED

Q18 FIRST WEA MESSAGE: FIRST RECEIPT ACTIVITY (CONTROL)

What were you doing when you first received that message?

1. SLEEPING
2. WORKING
3. RECREATING
4. IN TRANSIT
5. OTHER: SPECIFY
7. DON'T KNOW
9. REFUSED

Q19 FIRST WEA MESSAGE: FIRST RECEIPT SOCIAL SETTING (CONTROL)

Who were you with when you first received that message? (CIRCLE ALL)

1. ALONE [SKIP TO Q21]
2. IMMEDIATE FAMILY MEMBERS, INCLUDING PARTNER/ SIGNFICIANT OTHER
3. FRIENDS OR OTHER RELATIVES
4. COWORKERS
5. STRANGERS
6. OTHER(S); SPECIFY
7. DON'T KNOW
9. REFUSED

Q20 FIRST WEA MESSAGE: FIRST RECEIPT FAMILY UNITED (CONTROL)

How many members of your immediate family were with you when you first received that message, all of them, some of them, or none of them?

1. ALL OF THEM
2. SOME OF THEM
3. NONE OF THEM
4. HAS NO IMMEDIATE FAMILY MEMBERS/NA
7. DON'T KNOW
9. REFUSED

Q21 FIRST WEA MESSAGE: FIRST RECEIPT PHYSICAL CUES (CONTROL)

Did you see or hear any evidence of a flood near you when you first received that message?

1. YES
2. NO
7. DON'T KNOW
9. REFUSED

Q22 FIRST WEA MESSAGE: FIRST RECEIPT SOCIAL CUES (CONTROL)

Did you see or hear other people near you taking actions to protect themselves when you first received that message?

1. YES
2. NO
7. DON'T KNOW
9. REFUSED

Q23 FIRST WEA MESSAGE: (UNDERSTAND OUTCOME)

After first receiving that message, how much would you say you understood each of the following things on a scale of 1 to 6 where 1 represents "did not understand at all" and 6 represents "fully understood?"

A. What could happen?
B. The risks?
C. What to do to protect yourself?
D. What location was affected?
E. Who the message was from?
F. When you were supposed to take action to protect yourself?
G. How long you were supposed to continue taking action to protect yourself?
    1. ONE; DID NOT UNDERSTAND AT ALL
    2. TWO
    3. THREE
    4. FOUR

5. FIVE
6. SIX; FULLY UNDERSTOOD
7. DON'T KNOW
9. REFUSED

Q24 FIRST WEA MESSAGE: (BELIEVE OUTCOME)

After first receiving that message, how much would you say you believed each of the following things on a scale of 1 to 6 where 1 represents "did not believe" and 6 represents "fully believed?"

A. A flood was headed your way
B. Avoiding flooded areas would make you safer
C. You should check local media for more information
    1. ONE; DID NOT BELIEVE
    2. TWO
    3. THREE
    4. FOUR
    5. FIVE
    6. SIX; FULLY BELIEVED
    7. DON'T KNOW
    9. REFUSED

Q25 FIRST WEA MESSAGE: RISK PERCEPTION TO SELF, INTIMATES, & GENERAL OTHERS (PERSONALIZATION OUTCOME) (PERCEIVED RISK) (G=HOW TO BEST EXPRESS LOCATION)

After first receiving that message, how much would you say you agreed with each of the following statements on a scale of 1 to 6 where 1 represents "not very likely" and 6 represents "extremely likely?"

A. I might become injured
B. People I know might become injured
C. People I do not know might become injured
D. I might die
E. People I know might die
F. People I do not know might die
G. The message was meant for me
    1. ONE; NOT VERY LIKELY
    2. TWO
    3. THREE
    4. FOUR
    5. FIVE
    6. SIX; EXTREMELY LIKELY
    7. DON'T KNOW
    9. REFUSED

Q26 FIRST WEA MESSAGE: (DECIDE OUTCOME)

After first receiving that message, how much would you say you agreed with each of the following statements on a scale of 1 to 6 where 1 represents "no" and 6 represents "yes?"

A. The message helped me decide what to do
B. It was easy to decide what to do
C. I was able to decide what to do quickly
D. I decided what to do with confidence

1. ONE; NO
2. TWO
3. THREE
4. FOUR
5. FIVE
6. SIX; YES
7. DON'T KNOW
9. REFUSED

Q27 FIRST WEA MESSAGE: (DECIDE OUTCOME)

After you first received that message, what did you decide to do?

1. AVOID FLOODED AREAS
2. CHECK LOCAL MEDIA FOR MORE INFORMATION
3. OTHER: SPECIFY
7. DON'T KNOW
9. REFUSED

Q28 FIRST WEA MESSAGE: (FEAR/EMOTION OUTCOME) (OPTIMAL LEVEL OF FEAR AROUSAL)

After first receiving that message, how much would you say you agreed with each of the following statements on a scale of 1 to 6 where 1 represents "not at all" and 6 represents "extremely?" The message made me feel <…>.

A. Fearful
B. Anxious
C. Sad
D. Angry
E. Tense
F. Nervous
G. Terror-struck

H. Scared
I. Outraged
J. Sympathetic
K. Shocked
L. Confused

1. ONE; Not at all
2. TWO
3. THREE
4. FOUR
5. FIVE
6. SIX; Extremely
7. DON'T KNOW
9. REFUSED

Q29 FIRST WEA MESSAGE: (MILLING ACTIVITY OUTCOME)

After first receiving that message, and before receiving any other messages, did you communicate in any of the following ways and why? Did you communicate <…>?

A. Face-to-face with another person (friend, family, co-worker, employee, employer)
B. Telephone call by landline or cellphone
C. Text message
D. Email
E. Twitter
F. Facebook
G. Blogs
H. YouTube
I. Other internet
J. Some other way: SPECIFY

1. YES [ASK Q30]
2. NO
7. DON'T KNOW
9. REFUSED
10.

Q30 FIRST WEA MESSAGE: (MILLING SEEK &/OR GIVE INFORMATION OUTCOME)

Was that to get additional information for yourself, or to give information to others about the need to avoid flood areas or check local media? [ASK FOR EACH IF Q29 = YES]

1. GET INFO
2. GIVE INFO
3. BOTH
7. DON'T KNOW
9. REFUSED

TRANS4 The next questions are about other messages you may have received about the flood.

Q31 ADDITIONAL MESSAGES: SOURCES (BEST SOLE SOURCE)

Considering <u>all of the messages</u> you may have received before you first took any action to protect yourself, who were they from? Were they from [the/a] <…>?

A. Boulder Police
B. National Guard
C. Boulder Fire Department
D. Boulder Office of Emergency Management
E. Colorado governor's office
F. Boulder sheriff's department
G. Family member or other relative
H. Neighbor or friend
I. Employer
J. Co-worker
K. TV broadcaster
L. National Weather Service
M. Other: Specify

1. YES [ASK Q32]
2. NO
3. DON'T KNOW
4. REFUSED

Q32 ADDITIONAL MESSAGES: SOURCE BELIEVABILITY (BEST SOLE SOURCE)

On a scale of 1 to 6, how believable do you think that source is, where 1 means "not at all believable" and 6 means "extremely believable?" [ASK FOR EACH IF Q31 = YES]

1. ONE; NOT AT ALL BELIEVABLE
2. TWO
3. THREE
4. FOUR
5. FIVE
6. SIX; EXTREMELY BELIEVABLE
7. DON'T KNOW
9. REFUSED

Q33 ADDITIONAL MESSAGES: MAP INCLUSION

Considering all the messages you may have received, did any of them contain a map indicating where within the city of Boulder the flood was expected to occur?

1. YES

2. NO [SKIP TO Q35]
7. DON'T KNOW [SKIP TO Q35]
9. REFUSED [SKIP TO Q35]

Q34 ADDITIONAL MESSAGES: MAP INCLUSION (RISK PERONALIZATION)

On a scale of 1 to 6, how effective was the best map you saw at helping you determine whether you were in an area at risk, where 1 means "not at all effective" and 6 means "extremely effective?"

1. ONE; NOT AT ALL EFFECTIVE
2. TWO
3. THREE
4. FOUR
5. FIVE
6. SIX; EXTREMELY EFFECTIVE
7. DON'T KNOW
9. REFUSED

Q35 ADDITIONAL MESSAGES: CONTENT (RELATIVE IMPORTANCE OF MESSAGE CONTENTS)

Thinking about <u>all the messages you received</u>, how much information did you receive about the following topics, using a scale of 1 to 6 where 1 means "none" and 6 means "a lot?" How much information did you receive about <…>?

A. How bad the flood would be?
B. The specific locations that would be flooded?
C. What you should do to protect yourself?
D. When the flood was expected to occur?
E. By when you were expected to take action?
   1. ONE; NONE
   2. TWO
   3. THREE
   4. FOUR
   5. FIVE
   6. SIX; A LOT
   7. DON'T KNOW
   9. REFUSED

Q36 ADDITIONAL MESSAGES: CONTENT (RELATIVE IMPORTANCE OF MESSAGE CONTENTS)

Thinking about <u>all the messages you received</u>, how many of them were clear about <…>? Would you say, <u>none</u> of them, a <u>few</u> of them, <u>most</u> of them, or <u>all</u> of them?

A. When the message expired?
B. Who was sending the message?
   1. NONE
   2. FEW
   3. MOST
   4. ALL
   7. DON'T KNOW
   9. REFUSED

Q37 ADDITIONAL MESSAGES: SIREN RECEIPT (UNDERSTANDING OF ALERT & WARNING CONCEPTS)

Did you receive the following message issued by the outdoor warning sirens along Boulder Creek?

Warning. Flash flood of Boulder Creek is imminent. Leave immediately. Proceed to higher ground. Do not cross Boulder Creek.

1. YES, SIREN ONLY
2. YES, SIREN AND MESSAGE
3. NO [SKIP TO Q41]
7. DON'T KNOW [SKIP TO Q41]
9. REFUSED [SKIP TO Q41]

Q38 ADDITIONAL MESSAGES: SIREN IMMINENT (UNDERSTANDING CONCEPTS)

How many minutes did you think it would take before the flood waters reached you? ENTER 2(NOT APPLICABLE) IF RESPONDENT THOUGHT "NEVER."

1. SPECIFY MINUTES
2. NOT APPLICABLE
7. DON'T KNOW
9. REFUSED

[IF Q37=1, SKIP TO Q41]

Q39 ADDITIONAL MESSAGES: SIREN HIGHER GROUND (UNDERSTANDING CONCEPTS)

How many feet above the level of Boulder Creek did you think that meant?

1. SPECIFY FEET
7. DON'T KNOW
9. REFUSED

Q40 ADDITIONAL MESSAGES: SIREN LEAVE IMMEDIATELY (UNDERSTANDING CONCEPTS)

What did you think that "LEAVE IMMEDIATELY" meant?

1. MOVE TO HIGHER GROUND
2. CLIMB TO SAFETY
3. EVACUATE AREA
4. MOVE AWAY FROM CREEK
5. DO NOT CROSS BOULDER CREEK
6. HEAD UPSTAIRS
7. SEEK HIGHER GROUND AT LEAST 12 FEET ABOVE CREEK LEVEL (WITHOUT CROSSING CREEK)
8. OTHER: SPECIFY
77. DON'T KNOW
99. REFUSED

Q41 ADDITIONAL MESSAGES: URL WITH HYPERLINK RECEIVED (INCLUSION OF URL)

Sometimes messages include internet links in them. "Clicking" on these links redirects you to a specified internet address or website. On Wednesday and Thursday, September 11th and 12th, did you receive any messages that contained a link where you could get more information?

1. YES
2. NO [SKIP TO TRANS5]
7. DON'T KNOW [SKIP TO TRANS5]
9. REFUSED [SKIP TO TRANS5]

Q42 ANY MESSAGE: URL WITH ADDITIONAL MESSAGES: HYPERLINK FOLLOWED (INCLUSION OF URL)

Did you follow that link?

1. YES
2. NO
7. DON'T KNOW
9. REFUSED

Q43 ADDITIONAL MESSAGES: URL HYPERLINK MILLING (INCLUSION OF URL)

How much time did you spend viewing information contained in the link?

1. SPECIFY TIME
7. DON'T KNOW
9. REFUSED

TRANS5 The last questions I'll ask are about your personal attributes. The answers to these questions will help us learn about how different groups of people might respond to emergency warnings differently based on personal characteristics.

Q44 STATUS: SEX (CONTROL)

Do you consider yourself male, female, or other?

1. MALE
2. FEMALE
3. OTHER: SPECIFY
7. DON'T KNOW
9. REFUSED

Q45 STATUS: ETHNICITY (CONTROL)

Which one of the following racial/ethnic groups best describes you? Would you say White, Hispanic or Latino, Black or African American, Asian, Native Hawaiian or Other Pacific Islander, American Indian or Alaskan Native, or Other? If you identify with more than one, choose the group you identify with the most.

1. WHITE
2. HISPANIC OR LATINO
3. BLACK OR AFRICAN AMERICAN
4. ASIAN
5. NATIVE HAWAIIAN OR OTHER PACIFIC ISLANDER
6. AMERICAN INDIAN OR ALASKAN NATIVE
7. OTHER: SPECIFY
77. DON'T KNOW
99. REFUSED

Q46 STATUS: AGE (CONTROL)

What was your age on your last birthday?

1. SPECIFY AGE
7. DON'T KNOW
9. REFUSED

Q47 STATUS: EDUCATION (CONTROL)

What is the highest level of school you have completed or the highest degree you have received?

1. LESS THAN HIGH SCHOOL DEGREE
2. HIGH SCHOOL DEGREE OF EQUIVALENT, E.G., GED
3. SOME COLLEGE BUT NO DEGREE
4. ASSOCIATE DEGREE
5. BACHELOR DEGREE
6. GRADUATE DEGREE
7. DON'T KNOW
9. REFUSED

Q48 STATUS: INCOME (CONTROL)

Thinking of all the people in your household, was the total household income before taxes from all sources, under $100,000 or over $100,000 in 2012? Please include your income as well. (CIRCLE ONE)

1. UNDER $100,000 [SKIP TO Q48A]
2. OVER $100,000 [SKIP TO Q48B]
7. DON'T KNOW [SKIP TO Q49]
9. REFUSED [SKIP TO Q49]

Q48A As I read the following income categories, would you please tell me which one includes the total income of your household before taxes in 2012?

1. $0 to $24,999
2. $25,000 to $49,999
3. $50,000 to $74,999
4. $75,000 to $99,999
7. DON'T KNOW
9. REFUSED

Q48B As I read the following income categories, would you please tell me which one includes the total income of your household before taxes in 2012?

1. $100,000 to $124,999
2. $125,000 to $149,999
3. $150,000 to $ $174,999
4. $175,000 to $199,999
5. $200,000 or More
7. DON'T KNOW
9. REFUSED

Q49 STATUS: EMPLOYMENT STATUS (CONTROL)

Which of the following categories best describes your employment status?

1. Employed, working 1-39 hours per week

2. Employed, working 40 or more hours per week
3. Not employed, looking for work
4. Not employed, NOT looking for work
5. Retired
6. Disabled, not able to work
7. DON'T KNOW
9. REFUSED

Q50 STATUS: STUDENT STATUS (CONTROL)

Were you a student living on campus during the Boulder flood?

1. YES, FULL-TIME STUDENT LIVING ON CAMPUS
2. YES, PART-TIME STUDENT LIVING ON CAMPUS
3. NO
7. DON'T KNOW
9. REFUSED

Q51 ROLE: ROLES OF RESPONSIBILITY (CONTROL)

The next questions are about those you lived with. When the Boulder flood happened how many <…> lived with you?

A. Family members
B. Children under the age of 18
C. People for whom you felt responsible, such as elders,
D. Pets
    1. SPECIFY
    7. DON'T KNOW
    9. REFUSED

Q52 ROLE: COMMUNITY INVOLVEMENT (CONTROL)

How many different community-based groups or organizations, for example, churches, clubs, and non-profits, did you belong to in September 2013?

1. SPECIFY
7. DON'T KNOW
9. REFUSED

Q53 SOCIAL MEDIA: FREQUENCY OF USE (CONTROL) (SOCIAL MEDIA USE)

On average, about how many times per day do you use Twitter, Facebook, or other kinds of social media?

1. LESS THAN ONCE PER DAY
2. ONCE PER DAY OR MORE (SPECIFY BELOW)
7. DON'T KNOW
9. REFUSED

IF (CELLLAND=1) SKIP TO SHARE

HASLLN Is there a landline in your household?

1.	YES	
2.	NO	[SKIP TO SHARE]
7.	DON'T KNOW	[SKIP TO SHARE]
9.	REFUSED	[SKIP TO SHARE]

LLPHN In order to confirm your household is not counted twice in our survey, could I please have the number of this landline? This information will not be used to contact you, and will be destroyed after our study is complete.

NOTE: IF RESPONDENT DOES NOT WISH TO PROVIDE FULL NUMBER, TELL THEM THE AREA CODE AND LAST FOUR DIGITS IS FINE AND WOULD STILL HELP US. ENTER AREA CODE, "000", AND THEN THE LAST FOUR DIGITS.

1. SPECIFY
7. DON'T KNOW
9. REFUSED

SHARE Finally, do you share your cell phone with another person?

1. YES
2. NO
7. DON'T KNOW
9. REFUSED

IF (CELLLAND = 2), SKIP TO TRANS6

HASCEL Do you own and use a cell phone?

1.	YES	
2.	NO	[SKIP TO TRANS6]
7.	DON'T KNOW	[SKIP TO TRANS6]
9.	REFUSED	[SKIP TO TRANS6]

CELPHN In order to confirm your household is not counted twice in our survey, could I please have the number of this cell phone? This information will not be used to contact you, and will be destroyed after our study is complete.

NOTE: IF RESPONDENT DOES NOT WISH TO PROVIDE FULL NUMBER, TELL THEM THE AREA CODE AND LAST FOUR DIGITS IS FINE AND WOULD STILL HELP US. ENTER AREA CODE, "000", AND THEN THE LAST FOUR DIGITS.

1. SPECIFY
7. DON'T KNOW
9. REFUSED

TRANS6 That was the last survey question. Now I would like to get the email address or mailing address to send the $25 gift certificate to.

Q54 First may I have your email address?

1. SPECIFY EMAIL
7. DON'T KNOW
9. REFUSED

Q55 What is your mailing address, beginning with the house number, street name, and apartment number (if necessary)?

1. SPECIFY STREET ADDRESS
7. DON'T KNOW
9. REFUSED

Q56 And what is the city?

1. SPECIFY CITY
7. DON'T KNOW
9. REFUSED

Q57. And, may I confirm that this is in the state of Colorado?

1. YES
2. NO, SPECIFY STATE
7. DON'T KNOW/ NO RESPONSE
9. REFUSED

Q58 And, what is your zip code?

1. SPECIFY ZIP CODE
7. DON'T KNOW
9. REFUSED

[ASK IF BOTH EMAIL AND MAILING ADDRESS ARE PROVIDED]

Q59 Would you prefer to receive your gift card by email or standard (USPS) mail?

1. EMAIL
2. USPS MAIL
7. DON'T KNOW
9. REFUSED

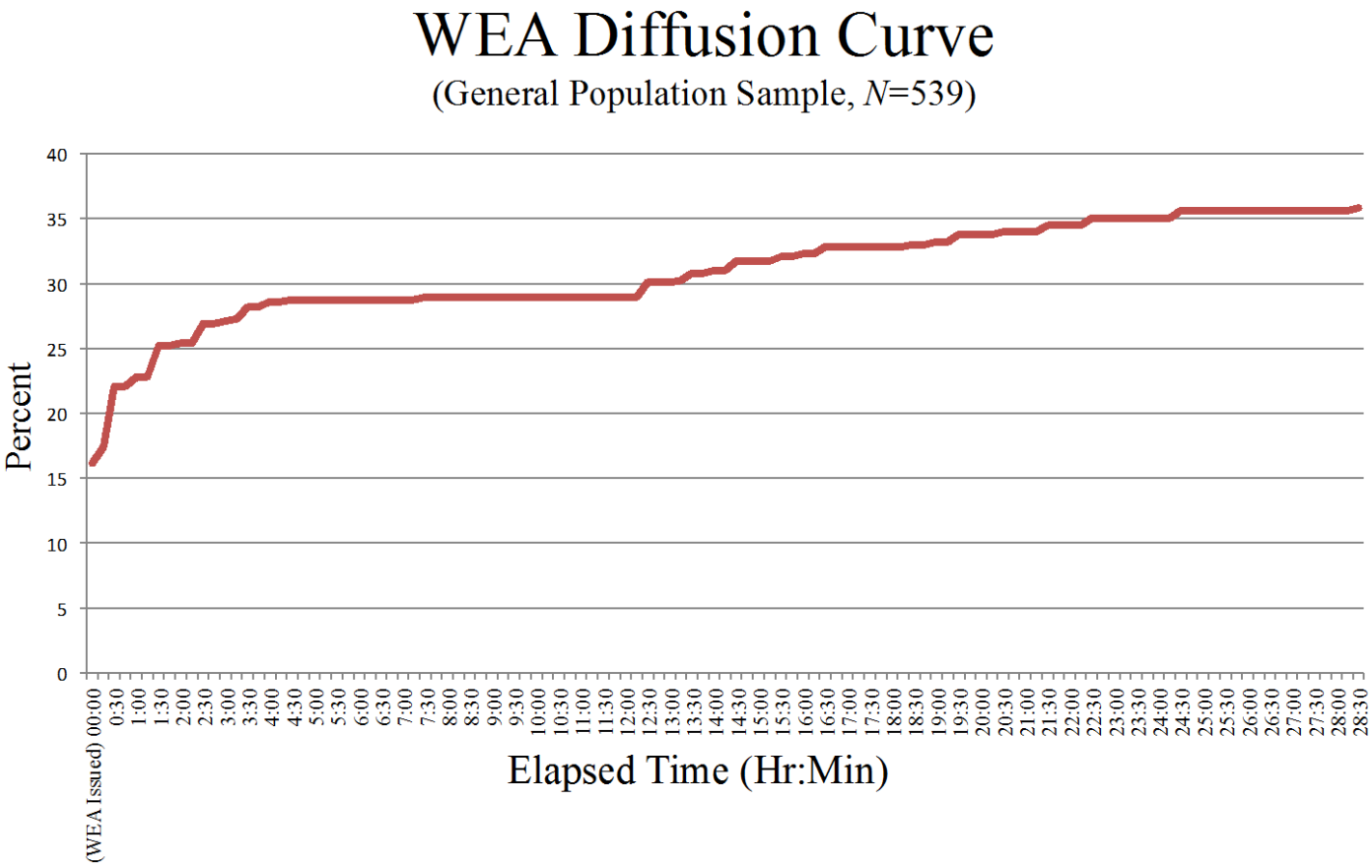
Q60 And finally, would you like an Amazon or Target gift card?

1. AMAZON
2. TARGET
7. DON'T KNOW
9. REFUSED

CONC Thank you for taking the time to complete the survey. After the study is complete, you can visit the University of Maryland's START Center's web site at http://www.start.umd.edu/research-projects/comprehensive-testing-imminent-threat-public-messages-mobile-devices-mdp for more information. We expect the analysis will take several months to complete. You may also contact the Institutional Review Board at California State University, Fullerton for further information at (657) 278-7640. The Survey Research Center at California State University, Fullerton can be reached by phone at (657) 278-3185.

END

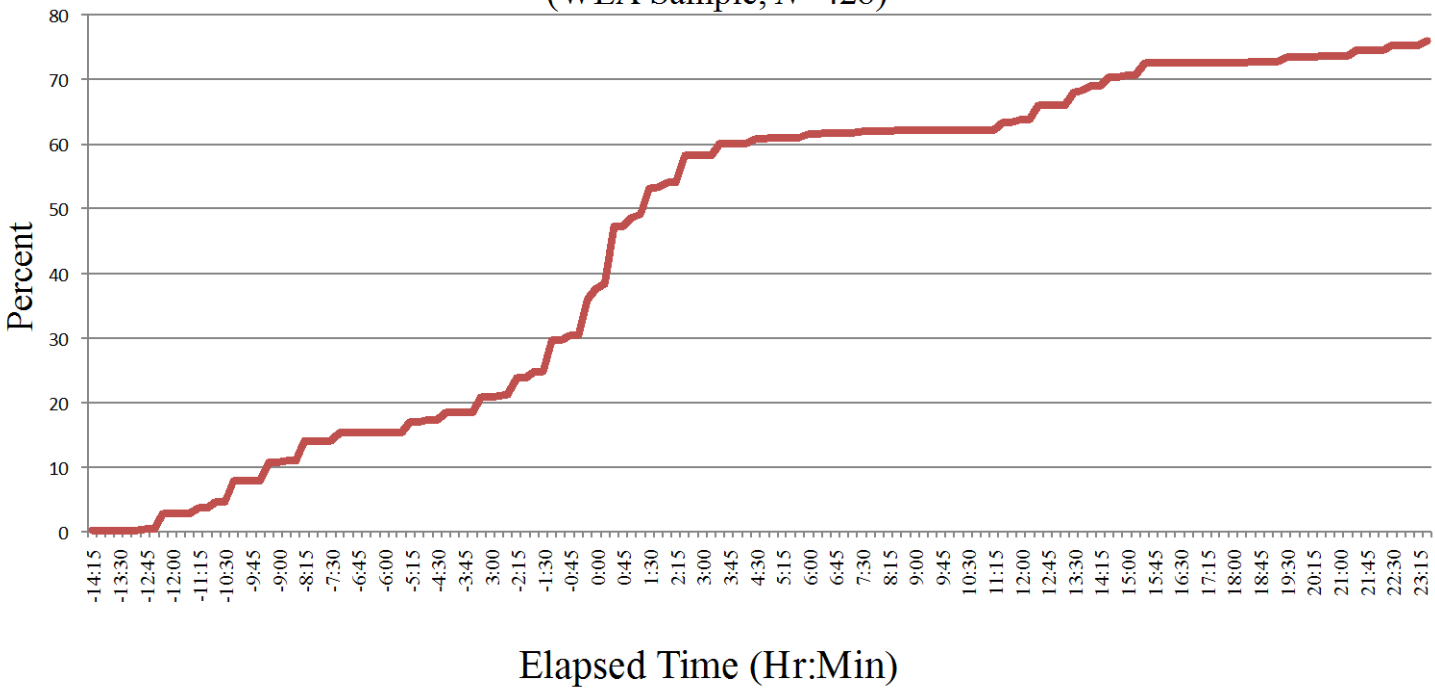
Appendix M: WEA Diffusion and Protective Action Mobilization Curves



Note: Of the 539 general sample respondents who remembered whether or not they received a WEA message, 59% did not receive the first WEA message (316/539), 36% received a message and remembered the time (193/539), and 5% remembered receiving the first WEA, but could not remember the time (30/539).

Protective Action Mobilization Curve: Check Local Media

(WEA Sample, *N*=428)



Note: Of the 428 WEA sample respondents who remembered whether or not they checked local media (428/496, 86%), 87% (374/428) reported that they did check local media, and 13% (54/428) reported that they did not. Thirteen percent (54/428) did not check local media, 76% (325/428) remembered when they checked local media, and 11% (49/428) remembered checking local media, but could not remember when they did so.

Appendix N: Validation of Experimental Optimized Outcomes

Table 1

Correlation Matrix: Relationships Between Cognitive Intermediate Variables and Ultimate Behavioral Outcomes among WEA Recipients (N=496) [a, b]

Variables	X1	X2	X3	X4
X1. Interpretation scale score	-	.784 (<.001) 402	-.163 (.007) 270	-.133 (.015) 334
X2. Personalization scale score			-.128 (.031) 282	-.038 (.482) 348
X3. Time delay before checking local media				.589 (<.001) 255
X4. Time delay before avoiding flood areas				-

[a] Two-tailed Pearson's *r* tests.
[b] A total of 87% (374/428) reported having checked local media; 70% reported having avoided flood areas (300/429).