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TECHNICAL
REPORT

Bridging the Gap

Prototype Tools to Support Local Disaster Preparedness Planning and Collaboration

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Preface

Naturally occurring disasters and the threat of accidental or intentional manmade ones have been the basis for systematic all-hazards emergency preparedness planning in the United States in recent years. The federal government has provided considerable guidance and funding support for such planning across civilian and military sectors.

Ultimately, all disasters are local. Thus, effective local preparedness planning is critical. With that in mind, the Office of the Assistant Secretary for Health Affairs in the U.S. Department of Defense (DoD) and the Public Health and Environmental Hazards Office of the U.S. Department of Veterans Affairs (VA) saw an opportunity to strengthen local disaster preparedness planning by military installations and their civilian counterparts, i.e., local governments and health care providers, including both local VA and other providers. Specifically, they asked us to develop a decision-support tool for risk-informed capabilities-based planning that would be useful to local civilian governments, VA health providers, and military installations.

A report from the first phase of this study described the background research to assess relevant military and civilian policy, understand current planning practices, and learn what kind of tool or tools would be most helpful to local planners (see Moore et al., 2010). The current report describes three prototype tools that were developed on the basis of this information.

The first is an initial prototype for an entirely new tool that draws primarily on existing data and planning factors, fills in some gaps (specifically noted in the appropriate sections of the report) in certain planning factors and disaster effects, and automates a capabilities-based planning process, which should facilitate local planning. This first prototype is the result of our research and analysis to date, including consultation and vetting with local community and military installation emergency planners. Although the prototype will actually perform certain functions within the specified parameters for the limited set of scenarios that we have selected and used, more extensive research and testing, as well as potential modifications to the prototype, will be required before a more fully tested tool will be ready for validation by potential sponsors and end-users. The authors have used the best available data and strategic guidance—e.g., the Hazus model from the Federal Emergency Management Agency (FEMA) and the FluSurge model from the Centers for Disease Control and Prevention (CDC)—for certain disaster effects (FEMA, 2009; CDC, 2006). In other cases, specified later in the report, RAND has developed estimates of disaster effects for the purpose of demonstrating how the tool functions. Although we believe those estimates to be plausible based on information available to us, we are not suggesting that those estimates are valid from a scientific standpoint. While the decision-support tool is functioning and allows demonstration of the type of results the tools can produce, it remains a first prototype, and before being used to support decision making, it needs further validation and revision based on application to past and future disasters, and then further development to address an even wider range of disasters and capabilities. The further research and field-testing that we propose will be necessary before any such estimates or substitutions for those estimates can be considered "valid" for the purpose of evaluating the overall prototype for validity.

The two other tools support networking and cooperation among local agencies; they draw from existing web-based programs and have been tailored to the emergency management context.

This report should be of interest to federal, state, and local policymakers and disaster preparedness planners across the range of departments and agencies that have responsibilities for domestic disaster management, and to the full range of relevant local health and medical care providers and nongovernmental organizations. It should be of particular interest to local emergency management and operations agencies; DoD, VA, and the U.S. Departments of Homeland Security (DHS), and of Health and Human Services (HHS); specific organizational entities within the departments, e.g., the Assistant Secretary of Defense for Homeland Defense and Americas' Security Affairs and the U.S. Northern Command (USNORTHCOM), within DoD, FEMA within DHS, and the Assistant Secretary for Preparedness and Response and the CDC within HHS; and central, regional, and local elements of the Veterans Health Administration. The report should also be of interest to the U.S. Congress and others who seek to improve the efficiency and coordination of domestic all-hazards preparedness.

This research was sponsored by the Office of the Assistant Secretary of Defense for Health Affairs and the Public Health and Environmental Hazards Office of the VA, and conducted jointly by RAND Health's Center for Military Health Policy Research and the Homeland Security and Defense Center of the RAND National Defense Research Institute (NDRI). RAND Health aims to transform the well-being of all people by solving complex problems in health and health care. NDRI is a federally funded research and development center sponsored by the Office of the Secretary of Defense, the Joint Staff, the Unified Combatant Commands, the Navy, the Marine Corps, the defense agencies, and the defense Intelligence Community.

For more information on the Center for Military Health Policy Research, see http://www.rand.org/multi/military/ or contact the co-directors (contact information is provided on the web page). For more information on the Homeland Security and Defense Center, see http://www.rand.org/multi/homeland-security-and-defense.html or contact the director (contact information is provided on the web page).

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Summary

Local disaster preparedness planners face a major challenge in planning and coordinating local response operations, which may involve civilian and military organizations, especially health and medical care providers. Military and civilian organizations are often unaware of each other's planning needs and capabilities in an all-hazards context.

National guidance supports capabilities-based planning for disaster preparedness, focusing on planning to provide capabilities to address a wide range of scenarios. The U.S. Department of Defense (DoD) Office of the Assistant Secretary for Health Affairs, together with the Public Health and Environmental Hazards Office of the U.S. Department of Veterans Affairs (VA), asked RAND to develop a decision-support tool to help local communities conduct risk-informed capabilities-based planning.

In this report, we describe the initial prototype for a capabilities-based planning tool that RAND developed and two prototype networking tools that RAND adapted to help local military and civilian planners collaborate in disaster preparedness:

- The Community Preparedness Planning Tool, created by RAND, is an initial prototype for risk-informed capabilities-based planning. That prototype is a result of our research and analysis to date, including consultation and vetting with local community and military installation emergency planners. Although the prototype will actually perform certain functions within the specified parameters for the limited set of scenarios that we have selected and used, more extensive research and testing and potential modifications to the prototype will be required before a more fully tested tool will be ready for validation by potential sponsors and end-users. The authors have used the best available data and strategic guidance—e.g., the Hazus model from the Federal Emergency Management Agency (FEMA) and the FluSurge model from the Centers for Disease Control and Prevention (CDC)—for certain disaster effects (FEMA, 2009; CDC, 2006). In other cases, specified later in the report, RAND has developed estimates of disaster effects for the purpose of demonstrating how the tool functions. Although we believe those estimates to be plausible based on information available to us, we are not suggesting that those estimates are valid from a scientific standpoint. The further research and field-testing that we propose is necessary before any such estimates or substitutions for those estimates can be considered "valid" for the purpose of evaluating the overall prototype for validity.
- RAND has adapted two existing tools—Liferay Social Office and Cyber Infrastructure Knowledge Networks On the Web (CI-KNOW)—as prototypes designed to facilitate social networking and network monitoring (Liferay, 2008; Northwestern University, 2010).

Specifications for the Plannning and Networking Tools

In an earlier stage of this research, we examined the current policy framework for local disaster preparedness planning in the U.S. civilian and military sectors, examined how those entities are currently undertaking preparedness planning, and inventoried existing preparedness-oriented support tools (Moore et al., 2010). These activities informed the development of specifications for the planning and networking tools for which we subsequently developed the prototypes described in this report:

- Leverage existing models and tools whenever possible, automate linkages for planning activities across disaster phases, and be applicable to all U.S. communities, regardless of size
- Be easy to use and require minimal technical expertise
- Be widely accessible
- Facilitate strengthening of community networks.

Role of the Tools Within Disaster Preparedness and Response

Capabilities-based planning implies a modular, building-block approach to operational planning. It involves an ongoing, iterative process of assessing current capabilities, determining capability gaps, making investment decisions, and reassessing capability levels, all based on relevant local disaster risk. Figure S.1 provides a view of how the prototype planning and networking tools we have developed fit into the broader process of disaster preparedness and response (shown in the boxes with the heavy black outlines).

Local planners should perform a risk assessment for their community, using other existing tools or processes to identify and assess the potential severity of locally relevant disasters and other threats. Then, our planning tool can be used to facilitate pre-disaster capabilities-based planning for major disasters, while the networking tools can be used to enhance networking and collaboration across civilian and military preparedness planners. Although the tool prototypes described in this report are intended to support preparedness planning and not response, the ultimate use of the final tools can help support risk assessment, all aspects of planning, and event management.

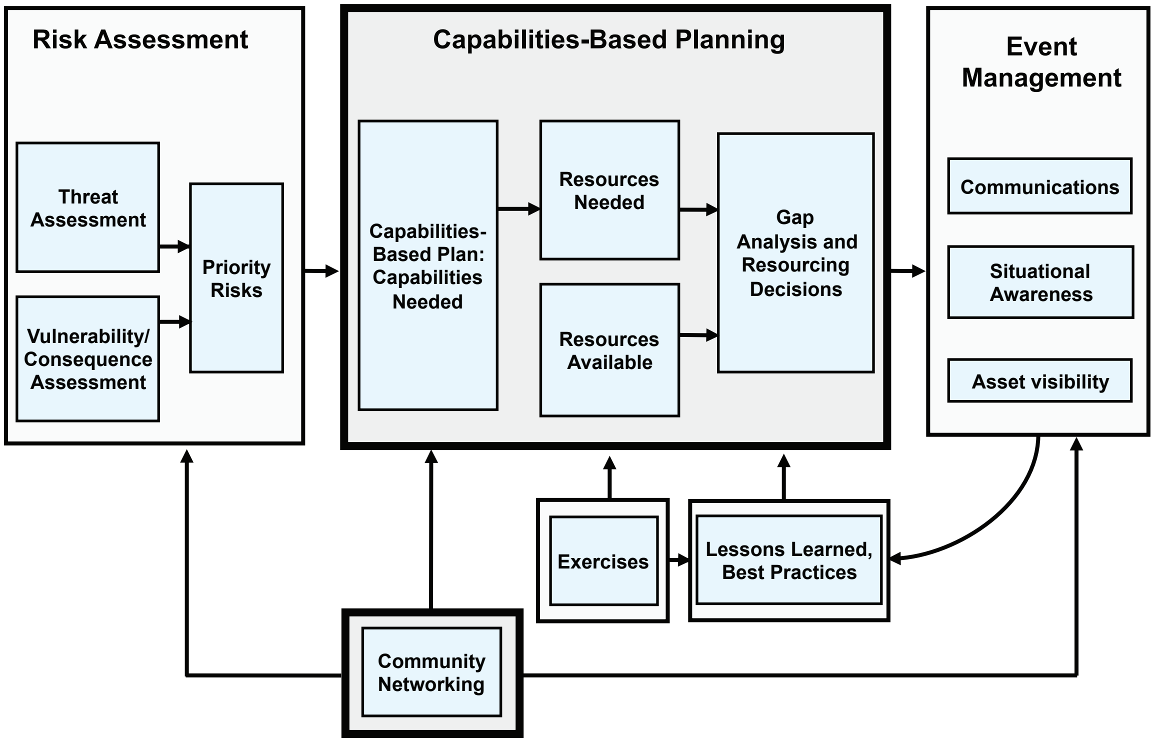
Key Features of the Prototype Community Preparedness Planning Tool

The Community Preparedness Planning Tool is designed to help local military and civilian organizations, either individually or collectively, plan for major disasters. This tool focuses mainly on planning for the first hours and days following a disaster event, when only local resources and capabilities are likely to be available.

Goal and Scope

The goal of the Community Preparedness Planning Tool is to facilitate capabilities-based disaster preparedness planning by local military installations and civilian entities, including local VA and other health care providers and relevant local nongovernmental organizations. The tool

Figure S.1.
Tools to Support Capabilities-Based Planning and Community Networking



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emphasizes the capabilities and resources needed during initial response to a disaster, utilizing only resources that are immediately available. To develop a solid and workable proof of concept and initial prototype, we focused on the health-related capabilities needed for local response to three types of disasters: hurricane, earthquake, and pandemic influenza.

When we interviewed community emergency managers in the exploratory research phase, we heard that many managers were familiar with documents such as the U.S. Department of Homeland Security (DHS) Target Capabilities List (TCL), and the National Planning Scenarios (NPS), but did not use them as the data were difficult to assimilate and did not apply to their communities (Moore et al., 2010; DHS, 2007; White House, 2005). We also heard that many emergency managers were familiar with FEMA's Hazus Software, but did not use it (FEMA, 2009). We did not identify any other tools in existence that provided capabilities-based planning support to local communities and allowed them to determine capabilities and resources that they should either procure in advance or prepare mutual aid agreements to make available were a disaster to strike. We were concerned that undertaking a research project to develop such a tool would be an incredibly difficult endeavor, but we thought that we could make a great contribution by designing and developing an initial prototype to inspire future research and development.

It was our intent to collect the best planning guidance available from the current field of emergency preparedness research, then simplify and consolidate the data into an easily used tool. To the extent possible, we used detailed input information from disaster planning publications and software. We also generally drew data from federal government guidance and other sources that have been widely disseminated and used by planners at all levels. It is beyond the scope of the current project to assess the integrity or vouch for the accuracy of such data. Nevertheless, given the sources of those data and the efforts that were undertaken to compile them, we have assumed that they are reasonably accurate for planning purposes. We have also provided detailed explanation or assumptions for functions we estimated based on more limited guidance data.

The data in this initial prototype tool are derived mainly from the following list of sources: CDC FluSurge 2.0 software, U.S. Department of Health and Human Services (HHS) Area Resource File (ARF), DHS Target Capabilities List, HHS National Health Security Strategy (NHSS), and the Federal Emergency Management Agency Resource Typing, and were used to define functions that estimate the disaster effects, required capabilities, and required resources for a given disaster scenario and community (CDC, 2006; HHS-ARF, 2009; DHS, 2007; HHS-NHSS, 2009; FEMA, 2005).

We did not try to determine the quality of the existing documentation. We chose those that we believe are most relevant and that are currently in wide use by planners nationwide. Because of the limits in the amount of current documentation, we needed to make several assumptions and interpolations for the various functions, especially those used to calculate disaster effects. As a result, these RAND estimates will need particularly close scrutiny as the prototype is tested and developed further. Although we believe the specified RAND estimates (identified later) to be plausible based on information available to us, we are not suggesting that those estimates are valid from a scientific standpoint. Further research and field-testing will be required before any such estimates or substitutions for those estimates can be considered "valid" for the purpose of evaluating the overall prototype for validity.

Local Preparedness Planning with the Community Preparedness Planning Tool

The planning tool prototype uses a modular, building-block approach to preparedness planning and, based upon local risk assessment, allows users to perform these steps:

- **Step 1.** Select one or more disasters (hurricane, earthquake, pandemic influenza)
- **Step 2.** Select and specify planning assumptions related to disaster attributes.
- **Step 3.** Select and specify a variety of the community characteristics.
- **Step 4.** Review the disaster effects generated by the tool and tailor them to local needs, if or as needed.
- **Step 5.** Review the tool-generated capabilities needed to address the specified disaster planning scenario(s).
- **Step 6.** Review the tool-generated required resources needed to address the scenario(s).
- **Step 7.** Specify available resources (Optional). (Users must input data about available organizational resources.)
- **Step 8.** Review resource gaps as calculated by the tool (if optional Step 7 is completed).
- **Step 9.** Generate reports related to capability and resource needs and resource gaps.

Key Features of the Prototype Networking Tools

Well-developed social networks can potentially enhance successful local preparedness planning by building familiarity and relationships and facilitating joint activities and collaboration among local response organizations. RAND developed a community networking framework that makes use of two existing tools, Liferay Social Office, and CI-KNOW.

Goal and Scope

Community networking tools can help preparedness planners improve their understanding of local preparedness relationships and networks, build contacts among relevant partners, and enhance the efficiency of risk assessment, planning, and other preparedness activities as well as disaster response and recovery.

Social Networking with Social Office

Social Office provides tools and practices that can be used to maintain and enhance collaboration among organizations, using an online forum. It can be used to perform the following functions, among others:

- Serve as a common platform to link all three tools created through this project
- Capture and access contact information for local emergency management organizations
- Share information on key roles and capabilities
- Store important documents in a central location
- Enhance readiness exercises and contingency planning
- Provide news, announcements, and links to key resources
- Facilitate resource sharing.

Relationship Management and Network Monitoring with CI-KNOW

CI-KNOW is a relationship management/network monitoring tool that allows emergency preparedness organizations to understand the functioning and overall "health" of their network. It can help to facilitate:

- information sharing
- collaborative readiness exercises and contingency planning
- resource sharing
- exploration of how the network is performing.

Conclusion and Next Steps

The initial prototype for the capabilities-based planning tool and the two functional networking tools developed through this project and described in this report primarily draw from extensive national guidance and other published reports, existing data and existing generic software to provide a new and automated way to perform capabilities-based disaster planning and to facilitate networking among local emergency management agencies. The planning tool is still a prototype but is functional within the scope of its design to allow users to understand what types of results these tools can provide once fully developed and validated. The planning tool prototype, in particular, should be robustly tested by local community and military emergency planners as well as by interested state and federal stakeholders, especially with regard to the disaster effects functions. That process could help identify inaccuracies or other shortcomings both in the underlying, published data and in the assumptions and estimates, and it could inform modifications to the functions themselves and/or to the practical guidance for users of the tool. Testing and modifications are required before the prototype can be fully evaluated for validity and before it can be used in decision making.

The planning tool prototype can also be expanded in the future to include a broader range of disasters, capabilities needed, and required resources. Both the planning tool and the networking tools can also be enhanced to make them capable of linking to other tools that may be available to local planners.

We received input on the tools from a variety of military and civilian planning organizations, as well as colleagues within RAND. To the extent possible within the current scope of work, we have considered this input in the design and adaptation of the prototype planning tool and the networking tools. Future enhancements to the tools will require additions and updates of important sources of new and revised data.

RAND is considering ways to make the tools accessible to local civilian communities, military installations, and other government agencies that may be interested in testing them and suggesting modifications to or substitution for certain assumptions and estimates, thereby informing further development for purposes of subsequent evaluation for validity. Through this process, we will seek additional feedback from users on ways that the tools may be improved in any future effort to expand and distribute them more broadly.

Acknowledgments

Many people gave generously of their time and expertise in support of this project. Our great appreciation goes to former Deputy Assistant Secretary of Defense for Force Health Protection and Readiness, Ellen Embrey, who first had the vision for this project, and to Dr. Mark Gentilman also of the Office of the Assistant Secretary of Defense for Health Affairs, who provided invaluable guidance from the inception of this project to completion of this second phase of work. We are also grateful to Dr. Lawrence Deyton, formerly of the U.S. Department of Veterans Affairs, for his leadership in moving the tool framework into the prototype development stage described in this report, and to Drs. Victoria Davey and Shawn Fultz, also of the Department of Veterans Affairs, who provided early guidance for the second phase of research described in this report.

We thank the civilian and military personnel for important feedback on the prototype tools, including civilian authorities in the City of Columbus and Muscogee County, Georgia; the City of Tacoma and Pierce County, Washington; and the City of Las Vegas and Clark County, Nevada; and military staff at Fort Benning, Joint Base Lewis-McChord, Nellis Air Force Base, the U.S. Northern Command, the Center of Excellence at Tripler Air Force Base, and the Army G3/5 office. We are grateful for the moral support of officials at the U.S. Departments of Homeland Security and Health and Human Services, who expressed interest in our early progress and our plans to develop the prototype tools.

We thank the reviewers of the report—Jeanne Ringel and Tom LaTourrette of RAND—for their comprehensive and thoughtful feedback. We also thank Jeanne Ringel for her separate review and helpful feedback on the associated user's guides. We are indebted to our RAND colleagues Sue Hosek and Terri Tanielian, Co-Directors of the Center for Military Health Policy Research, and to Andrew Morral, Director of the Homeland Security and Defense Center, for their supportive and helpful oversight. Finally, we thank Natalie Ziegler for her help in preparing the final report.

Abbreviations

APAN	All Partners Access Network
ARF	Area Resource File
CARRI	Community and Regional Resilience Institute
CBRNE	Chemical, biological, radiological, nuclear, explosive
CDC	Centers for Disease Control and Prevention
CI-KNOW	Cyber Infrastructure Knowledge Networks On the Web
DHS	U.S. Department of Homeland Security
DoD	U.S. Department of Defense
EMS	Emergency Medical Service
FEMA	Federal Emergency Management Agency
GIS	Geographic Information Systems
HAZMAT	Hazardous materials
HHS	U.S. Department of Health and Human Services
HVA	Hazard Vulnerability Analysis
ICU	Intensive Care Unit
MOU	Memorandum of understanding
NFPA	National Fire Protection Association
NGO	Non-Governmental Organization
NHSS	National Health Security Strategy
NPS	National Planning Scenarios
PPE	Personal protective equipment
OSHA	Occupational Safety and Health Administration
RSS	Really Simple Syndication
SONIC	Science of Networks in Communities
TCL	Target Capabilities List
VA	U.S. Department of Veterans Affairs
VHA	Veterans Health Administration

CHAPTER ONE

Introduction

Local disaster preparedness planners face a major challenge in planning and coordinating with the many agencies that have authority and responsibility for conducting local response operations, including civilian governments, military installations, local health and medical care providers including hospitals affiliated with the U.S. Department of Veterans Affairs (VA) and other medical care organizations, and relevant nongovernmental organizations. Military and civilian organizations in the same region are often unaware of each other's planning needs and capabilities and thus miss opportunities for collaborative community-based disaster planning (Embrey et al., 2010). Another challenge is the need to plan for providing the full range of capabilities that might be needed in an all-hazards context. National level guidance supports capabilities-based planning for disaster preparedness. Rather than developing resources based on a specific threat or scenario, capabilities-based planning addresses a wide range of challenges and circumstances.

The U.S. Department of Defense (DoD) Office of the Assistant Secretary for Health Affairs, together with the Public Health and Environmental Hazards Office of the VA, asked RAND to develop a tool to help local communities conduct risk-informed capabilities-based planning. In an earlier stage of this research, we conducted three tasks. For the first task, we examined the current policy framework for local disaster preparedness planning in the U.S. civilian and military sectors.

For the second task, we examined how military installations and local civilian authorities are currently undertaking preparedness planning. We interviewed military and civilian personnel (including VA officials) in five communities:

- San Antonio, Texas, metropolitan area
- Norfolk/Virginia Beach, Virginia
- City of Columbus and Muscogee County, Georgia
- City of Tacoma and Pierce County, Washington
- City of Las Vegas and Clark County, Nevada.

During our site visits, we asked the military and civilian planners about the guidance they follow, the tools they use, the professional connections they have across local agencies, and what kinds of tools they would find most useful to support their disaster preparedness efforts. Through a separate review of websites and documents and complemented by our site interviews, we also inventoried existing preparedness-oriented support tools.

In our research, we did not identify any tools that provided capabilities-based planning support to local communities, or allowed communities to determine capabilities and resources that they should either procure in advance or prepare mutual aid agreements to make available were a disaster to strike. We were concerned that undertaking a research project to develop such a tool would be an incredibly difficult endeavor, but we thought that we could make a great contribution by designing and developing an initial prototype to inspire future research and development.

For the third task, we used the findings from the previous tasks to identify the design features, components, and data needs for one or more tools to improve preparedness planning at the local level, and then we designed the broad architecture for a capabilities-based planning tool and for a set of community networking tools to enhance local agency connections.

In the current report, we describe the prototype capabilities-based planning tool that RAND developed and the two prototype networking tools that RAND adapted to help local military and civilian planners collaborate in disaster preparedness:

- The initial prototype for the Community Preparedness Planning Tool is a risk-informed capabilities-based planning tool created by RAND to facilitate pre-disaster planning for local disasters. RAND drew upon extensive national guidance and existing data, and filled gaps where necessary, to largely automate and thereby simplify the otherwise complex capabilities-based planning process. We incorporated planning factors from widely accepted planning tools and guidance made available from the federal government. When we did not find well-developed planning factors, we created simple functions to extrapolate planning guidance to apply to all communities in the United States. As a result of our extensive research and analysis to date, including consultation with local community and military installation emergency planners, the initial prototype will actually perform certain functions within the specified parameters for the limited set of scenarios that we have selected and used. Nevertheless, more extensive research and testing, as well as potential modifications to the prototype, will be required before a more fully tested tool will be ready for validation by potential sponsors and end-users. The authors have used the best available data and strategic guidance. In other cases, specified later in the report, RAND has developed several estimates of disaster effects for the purpose of demonstrating the prototype. Although we believe those estimates to be plausible based on information available to us, we are not suggesting that those estimates are valid from a scientific standpoint. The further research and field-testing that we propose is necessary before any such estimates or substitutions for those estimates can be considered "valid" for the purpose of evaluating the overall prototype for validity. Functions in the prototype are listed partially in Chapter 2, and completely in Appendix A. RAND estimates (including any related assumptions and extrapolations of other data) are specifically noted.
- Social Office and Cyber Infrastructure Knowledge Networks On the Web (CI-KNOW) are existing networking tools that are designed to facilitate social networking and network monitoring; they were adapted by RAND for use by military and civilian preparedness planners.

Specifications for the Planning and Networking Tools

The initial activities described above informed the development of specifications for the planning and networking tools (Moore et al., 2010):

- **The tools should leverage existing models and tools whenever possible, automate linkages for planning activities across disaster phases, and be applicable to all U.S. communities, regardless of size.** There are already some well-developed, simple models for risk assessment, as well as several highly developed tools to support exercises, lessons learned, and event management of local disasters. Thus, RAND sought to develop a planning tool that can complement and potentially be used in conjunction with existing tools, rather than duplicating these efforts. The findings from the first stage of our study indicated that there is an opportunity to fill a gap in planning by developing a tool that links planning priorities, based on a risk assessment, to tailored capabilities-based planning for all communities and all hazards, in an automated way that alleviates some of the planning burden for local civilian and military planners.
- **The tools should be easy to use and require minimal technical expertise.** The tools need to be able to run on commonly available computing platforms, and require only a minimal amount of user computing expertise, data entry, and time to use. Our planning tool was designed in a Microsoft Access framework, with which many planners are already familiar. The community networking tools use existing open-source applications that are readily available.
- **There should be no barriers to gaining access to the tools, so that they can be widely distributed.**
- **The tools should facilitate strengthening of community networks.** Overall, the emergency management networks at the five sites we visited were fairly decentralized, and some local planners have had difficulty identifying their counterparts in other civilian and military organizations. Identifying roles and personnel for emergency planning in functional areas—such as public health, fire services, and law enforcement—across civilian and military organizations can provide a starting point for local planners to begin cooperative planning in communities. The community networking tools adapted by RAND (Social Office and CI-KNOW) are intended to help planners identify key organizations with which they can partner to coordinate capabilities during a response, share information about disaster planning, and collaborate on local exercises.

In addition, civilian and military planners identified several specific collaboration needs, which were taken into account when adapting the community networking tools:

- Capture and access names and contact information of counterparts
- Store important collaborative documents in a central location
- Make readiness exercises and contingency planning more collaborative
- Share information with partners on key roles and capabilities
- Facilitate resource sharing
- Explore how the network is performing (and the performance of individual network members).

These considerations guided the development or adaptation of the tools described in this report. In the next section, we provide a brief overview of the tools.

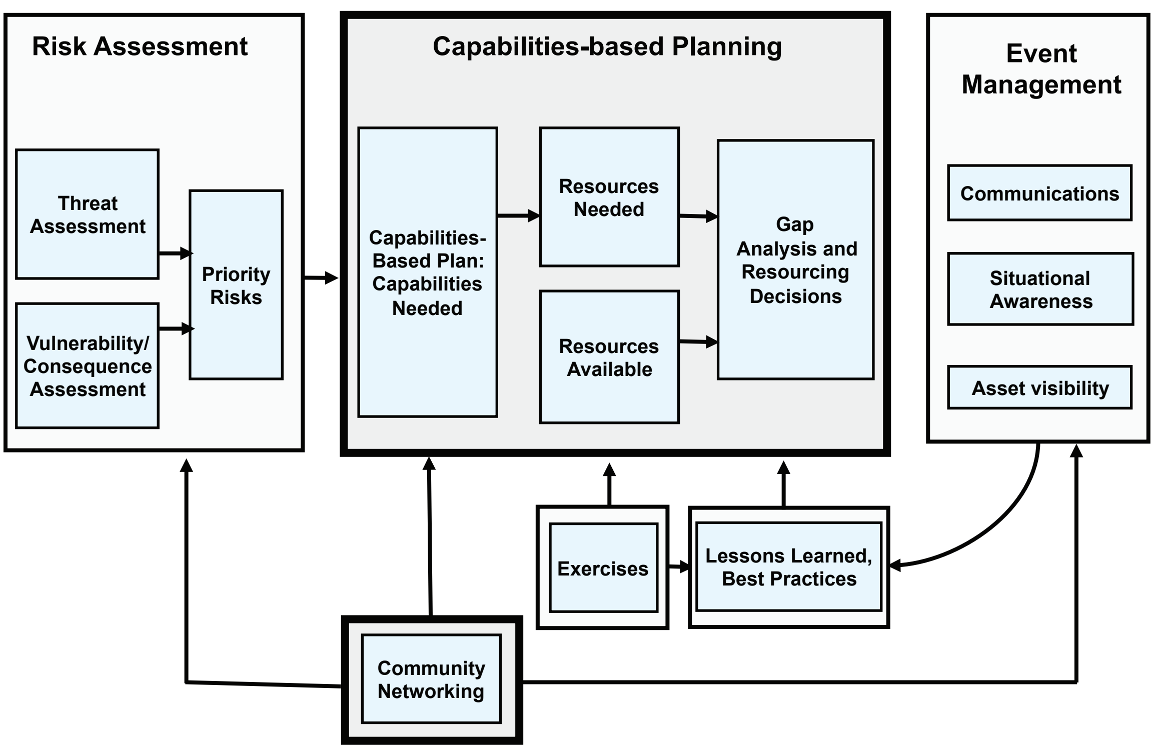
Role of the Tools Within Disaster Preparedness and Response

Figure 1.1 provides a view of how the prototype planning and networking tools fit into the broader process of disaster preparedness and response. The tools are shown in the boxes with the heavy black outlines. The planning tool can be used to facilitate pre-disaster capabilities-based planning for major disasters, while the networking tools can be used to enhance networking and collaboration across civilian and military preparedness planners, feeding into risk assessment, capabilities-based planning, and event management. The tools can be used separately or together.

Risk Assessment

The tools described in this report are designed to be used in conjunction with other existing tools. Before using the planning tool, local planners should perform a risk assessment for their community, using an existing tool to identify and assess the potential likelihood and severity of locally relevant disasters and other threats. The risk assessment process will allow planners to determine which disasters pose the most significant threats to their communities (i.e., have a relatively high probability of occurring and/or are expected to have serious consequences for the community) and thereby to prioritize disaster planning efforts.

Figure 1.1
Tools to Support Capabilities-Based Planning and Community Networking



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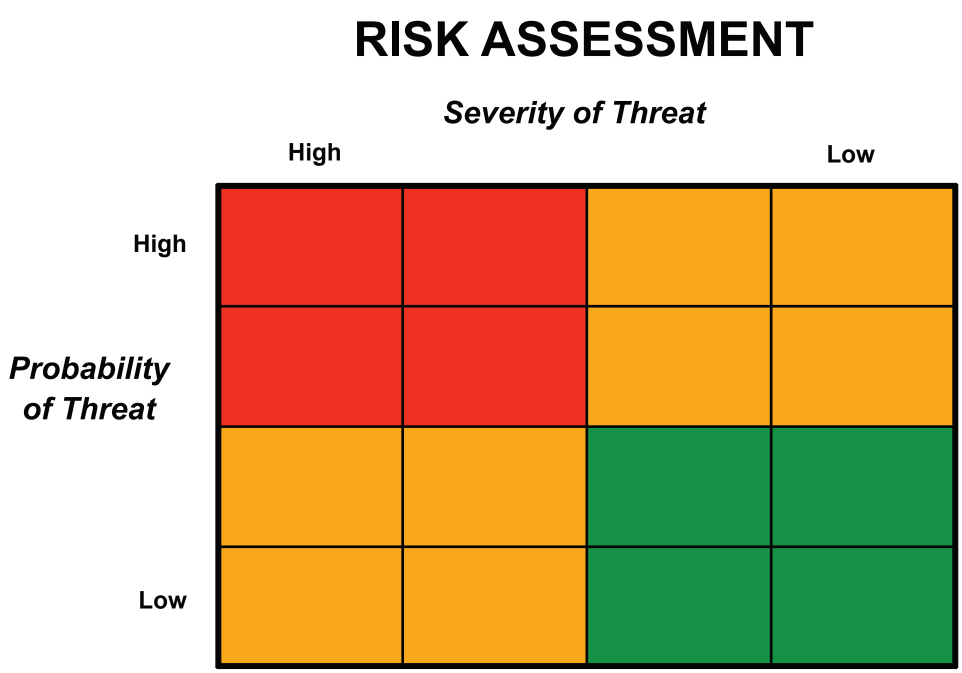
By design, the planning tool does not include a risk assessment component because several risk assessment tools are already available.[1] An example of a risk assessment results matrix is shown in Figure 1.2. Such a tool can help planners identify disasters that their communities are most likely to face and to which they are most vulnerable. The grid shown is used to rate potential disasters on two scales: (1) the probability (i.e., the likelihood) that the disaster will occur), and (2) the severity of the threat if the disaster does occur (i.e., the potential for harm to people or infrastructure). In Figure 1.2, disasters with risk assessment that falls into the top-left quadrant of the matrix have both a high probability and a high potential for serious consequences and thus may be the highest priority for planning purposes. Disasters with risk that falls into the top-right or lower-left quadrants may also be of interest. Planners should use a risk assessment tool such as this one to determine which disasters pose the greatest total risk to a community, or at least which are most relevant for their emergency management planning purposes.

Figure 1.2
Example of a Risk Assessment



RAND *TR928-1.2*

1 Examples include Kaiser Permanente's Hazard Vulnerability Analysis, the DoD Joint Staff Integrated Vulnerability Assessment, and the VA Emergency Management Program Guidebook. For more details, see Moore et al., *Bridging the Gap: Developing a Tool to Support Local Civilian and Military Disaster Preparedness* TR-764-OSD, 2010, Ch. 4.

Capabilities-Based Planning

After completing a risk assessment, planners can use the Community Preparedness Planning Tool to identify required capabilities and resources for planning, review available resources, and identify gaps in required resources for the disasters specified in the tool. Planners can also use the community networking tools to support community-wide risk assessment, planning, and event management across organizations and to increase the visibility of organizational resources that are likely to be available during a disaster.

Capabilities-based planning implies a modular, building-block approach to operational planning. Capabilities (e.g., the ability to provide mass care, to supply and distribute medications, and to manage injured or ill persons and fatalities) are the foundation of preparedness, which helps prepare a community's ability to respond to the full range of potential disasters and other incidents. Capabilities-based planning involves an ongoing, iterative process of assessing current capabilities, determining capability gaps, making investment decisions, and reassessing capability levels.

Use of the planning tool is intended to address priority risks identified through the risk assessment process. In particular, capabilities-based planning can reduce a community's vulnerability to disaster, and can reduce or minimize the consequences should disaster occur. This tool focuses mainly on planning for the first hours and days following a disaster event, when only local resources and capabilities are likely to be available.

Event Management

Although the tools described in this report are intended to support preparedness planning and not response, the information gained through use of the tools can then help support the response process during an event. For example, the planning tool can help provide visibility of available assets. This knowledge can contribute to better situational awareness for response at the local, regional, and state levels. The use of community networking tools can help build relationships, facilitate communications, and identify opportunities for resource sharing, all of which can be beneficial during an event.

In the chapters that follow, we will discuss the functions of the planning tool and networking tools in greater detail.

Development and Vetting of the Tools

The methods we used to develop the prototype planning tool and adapt the social networking tools are described in the respective chapters that follow. The Community Preparedness Planning Tool is a limited but functioning initial prototype that allows users to demonstrate the types of results that it can produce.

The community networking and collaboration tools, Social Office and CI-KNOW, are fully functional. Both the new prototype tool and the networking tools have been vetted within and outside of RAND. Table 1.1 lists the organizations and sites visited and the dates of the vetting sessions. However, the vetting sessions were not used to test the accuracy of the underlying input data or functions and, therefore, the outputs of the planning tool. The sessions were simply to determine if the tool was presented clearly and performed functions that would be useful to local community planners.

Table 1.1
Organizations Involved in Vetting the Prototype Tools

Organization/Site	Date
RAND, Santa Monica, CA, and Arlington, VA	August 11 and August 18, 2010
Fort Benning and City of Columbus and Muscogee County, GA	September 17, 2010
U.S. Northern Command, military services, and VA representatives, Arlington, VA	September 20, 2010
Joint Base Lewis-McChord and Pierce County, WA	September 28, 2010
Center for Excellence in Disaster Management and Humanitarian Assistance, Tripler Army Medical Center, Hawaii, and Army G-3/5	October 1, 2010
Nellis Air Force Base, City of Las Vegas, and Clark County, NV	October 5, 2010

The planning tool is still a prototype but is functional within the scope of its design to allow users to understand what types of results the tool could provide once fully developed and validated. The planning tool prototype should be robustly tested by local community and military emergency planners as well as by interested state and federal stakeholders, especially with regard to the disaster effects functions. That process could help identify inaccuracies or other shortcomings both in the underlying, published data and in the assumptions and estimates, and inform modifications to the functions themselves and/or to the practical guidance for users of the tool. That process is required before the prototype can be fully evaluated for validity and before it can be used in decision making processes. Nevertheless, it may help representatives from civilian and military organizations easily construct a starting point for cooperative planning. The quantities of capabilities and resources prescribed in the tool may be more accurate in some cases than others. In future iterations, this tool may gain additional capability to refine its outputs to local communities, and it may inspire other research efforts to develop similar functions. In any case, the goal has been to help put planning guidance in the hands of users at a local level, who can use the collected wisdom with a very low burden of effort, to serve as a catalyst in further cooperative planning in their communities.

Organization of This Document

In the following chapters, we describe the functions of the planning and community networking tools and the methodology used to develop or adapt the tools. The remainder of this document is organized as follows:

- Chapter 2 describes the Community Preparedness Planning Tool.
- Chapter 3 describes the community networking tools.
- Chapter 4 provides conclusions and next steps.

Appendix A contains a list of source documents used in the creation of the Community Preparedness Planning Tool. Appendix B provides a list of the required capabilities used in the tool. Appendix C contains a list of all data elements used in the Community Preparedness Planning Tool including disaster attributes, community characteristics, disaster effects, required capabilities, and required resources. Appendix D details the functions and planning factors used by the tool.

CHAPTER TWO

Community Preparedness Planning Tool

In this chapter, we describe the initial workable prototype for the Community Preparedness Planning Tool that was developed by RAND. This prototype is a result of our research and analysis to date, including consultation and vetting with local community and military installation emergency planners. Although the prototype will actually perform certain functions within the specified parameters for the limited set of scenarios that we have selected and used, more extensive research and testing, as well as potential modifications to the prototype, will be required before a more fully tested tool will be ready for validation by potential sponsors and end-users. The authors have used the best available data and strategic guidance—e.g., the Hazus model from the Federal Emergency Management Agency (FEMA) and the FluSurge software from the Centers for Disease Control and Prevention (CDC)—for certain disasters' effects (FEMA, 2009; CDC, 2006). In other cases, specified later in the report, RAND has developed several estimates of disaster effects for the purpose of demonstrating the prototype. Although we believe those estimates to be plausible based on information available to us, we are not suggesting that those estimates are valid from a scientific standpoint. The further research and field-testing that we propose is necessary before any such estimates or substitutions for those estimates can be considered "valid" for the purpose of evaluating the overall prototype for validity.

A fully developed and validated planning tool will help military installations and local civilian organizations, either individually or collectively, plan for major disasters, especially for response during the early post-disaster period. The tool is intended to help local planners identify gaps in capabilities and resources for purposes of resource allocation and mutual aid.

We begin with an overview of the goal and scope of the tool, and then summarize the approach used to develop the initial workable prototype. Next, we take readers through a nine-step process used by the prototype tool to generate data about capabilities and resources required for local disaster preparedness and to assess resource gaps. Finally, we describe feedback that we received on the tool during the vetting process, including feedback that was incorporated into our prototype tool and recommendations for its further testing and development.

Goal and Scope

The goal of the Community Preparedness Planning Tool is to facilitate capabilities-based disaster preparedness planning by local military installations and civilian entities, including local VA and other health and medical care providers (both public and private), and relevant nongovernmental organizations (such as the local Red Cross chapter, local chapters of the National

Voluntary Organizations Active in Disasters, and others). This tool emphasizes the capabilities and resources needed during the first hours or days after a disaster, when only local resources may be available. To develop a solid and workable proof of concept, we focused the scope of the prototype tool on the health-related capabilities needed for local response to three types of disaster—hurricane, earthquake, and pandemic influenza.

The prototype tool draws its underlying data and functions from guidance, mostly from the federal government, that is currently widely disseminated and used. It aims to make the planning process based on that guidance easier and potentially more collaborative. We have not attempted to validate the accuracy of much of the data contained in that guidance or improve, therefore, the accuracy of the guidance itself. Nevertheless, given the sources of those data and the efforts that were undertaken to compile them, we have assumed that they are reasonably accurate for planning purposes. Because of the limits in the amount of current documentation, however, we needed to make several assumptions and interpolations for the various functions, especially those used to calculate disaster effects. As a result, these will need particularly close scrutiny as the prototype is further tested and developed. We provide detailed explanations or assumptions for functions we estimated based on more limited guidance data (see Appendix D).

The tool allows planners to enhance community preparedness by identifying capabilities and resources that would be required to meet a specific *disaster scenario* (i.e., specific combination of disaster[s] and planning assumptions) and assessing resource gaps for different disaster scenarios. Within the tool, planners can create and access different disaster scenarios, known as *scenario runs* or *planning runs*. Planners can also change planning assumptions for each disaster—e.g., Saffir-Simpson hurricane category and earthquake magnitude on the Richter scale—to help plan across a range of different outcomes. They can use the tool outputs (e.g., required resources) to consider priorities for their agency's budget requests.

It was our intent to collect the best planning guidance available from federal and other credible sources and from the current field of emergency preparedness research, and to consolidate the data into an easily used tool. When we interviewed community emergency managers in the exploratory research phase, we heard that many managers were familiar with documents such as the U.S. Department of Homeland Security (DHS) Target Capabilities List (TCL), and the National Planning Scenarios (NPS), but did not use them as the data were difficult to assimilate and did not apply to their communities (Moore et al., 2010; DHS, 2007; White House, 2005). We also heard that many emergency managers were familiar with FEMA's Hazus Software, but did not use it. In developing the prototype tool, we gathered data from these sources and others and embedded them in a basic tool that could tailor guidance and planning inputs to individual communities.

Approach and Methods for Developing the Prototype Community Preparedness Planning Tool

The major specifications for this tool derived from the formative phase of our research and are presented in Chapter One.[1] The framework we developed from that phase, which was the

[1] A complete discussion of the design goals we considered when building the prototype Capabilities Based Planning Tool can be found Moore et al., 2010, Ch. 6.

basis for the initial prototype tool described in this report, is also presented in Chapter One. The tool allows local preparedness planners to determine the quantified capabilities needed for disaster response and the resources needed to meet those capabilities. If users enter available resources for their own and, if desired, other organizations involved in local disaster planning, the tool also generates resource gap reports in the form of both a high-level stoplight chart and a detailed resource report. In this section, we include a brief discussion of the approach used in developing the prototype tool, specifically addressing the software, pre-populated data, planning functions, and user interface.

Software

We chose to program the tool in Visual Basic for Applications© and Microsoft Access©. Access provided a useful environment in which to store the data we would include with the tool. Also by using Access, we were able to create a compact executable program that we could distribute to any computer running Microsoft Windows©, and the executable program would allow users to run the tool for free without requiring Access to be loaded on the computer.

Pre-Populated Input Data

The tool works through a combination of pre-populated inputs and user-generated inputs, as shown across the top of Figure 2.1. We gathered data for the pre-populated inputs from a range of sources, including military guidance, federal planning documents and tools, civilian after-action reports and lessons learned, and other research reports. We list the source documents for all of the data included in the tool in Appendix A.

The data in the tool are derived largely from several prominent sources. Beginning with the pre-populated data in the upper left corner of Figure 2.1, we will summarize the main sources of the data, starting with the disaster attributes and community characteristics.

We derived the data to define the characteristics and outcomes of major disasters from two well-used federal government planning tools. The data for the earthquake and hurricane scenarios were derived largely from the FEMA Hazus software. The data for the pandemic flu scenario were derived largely from the CDC FluSurge 2.0 software (FEMA, 2009; CDC, 2006).

The data used to populate the tool with community characteristics were derived largely from the U.S. Department of Health and Human Services (HHS) Area Resource File (HHS, 2009a).

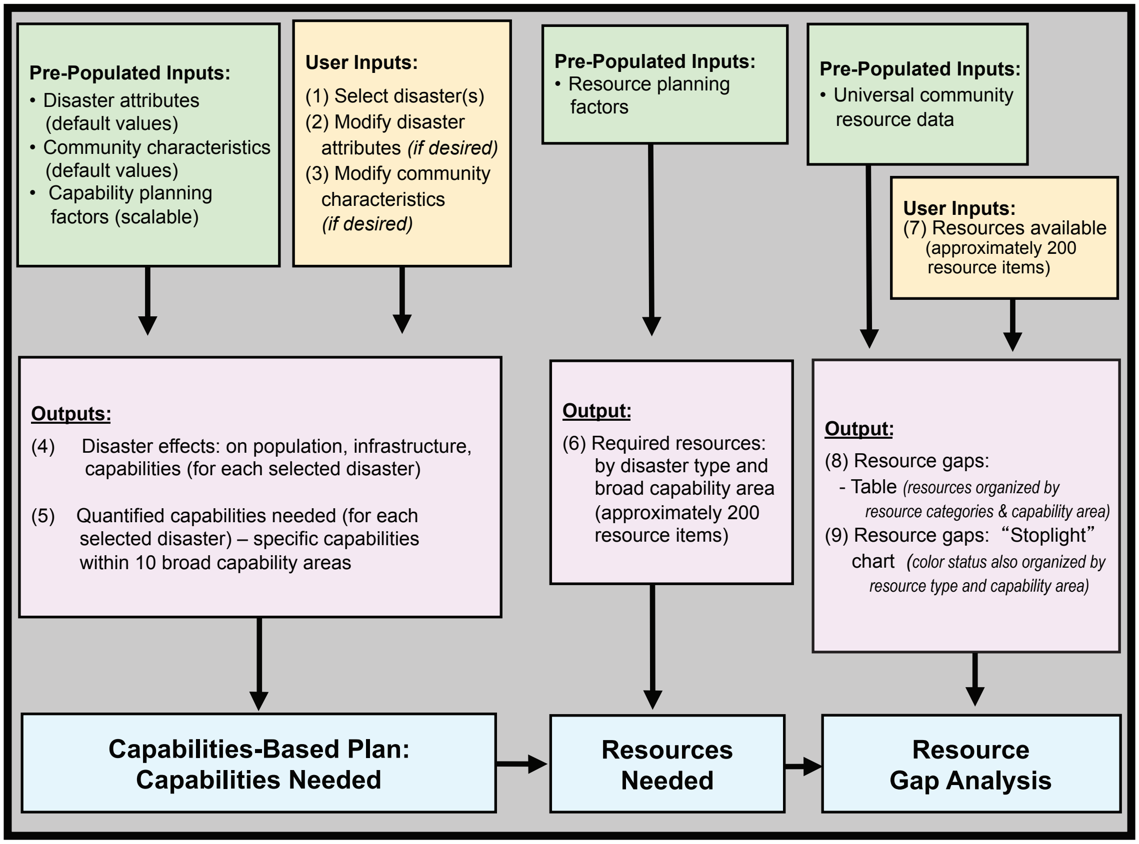
Completing the set of pre-populated data in the upper left corner of Figure 2.1, the set of capabilities used in emergency response was derived mostly from the DHS TCL and the HHS National Health Security Strategy (DHS, 2007; HHS, 2009b).

In the upper middle section of Figure 2.1, we show the role of pre-populated inputs describing resource planning factors. We derived the data to describe resource planning factors largely from the DHS TCL, and the FEMA Resource Typing (DHS, 2007; FEMA, 2005).

In the upper right section of Figure 2.1 we display a role in the tool for pre-populated data describing existing resources present in communities. We attempted to pre-populate these data to reduce the data entry burden for users as much as possible. In the current prototype the only pre-populated data on existing community resources are capacity data for local hospitals derived from the HHS Area Resource File (HHS, 2009a).

The numbered steps described in this chapter, reflecting both inputs and outputs, are labeled from one to nine in the figure. As indicated by the three boxes across the bottom of the

Figure 2.1
Design of the Capabilities-Based Community Planning Tool



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figure, the main outputs of the planning tool are the capabilities needed within a capabilities-based plan, the resources needed to meet those capabilities, and the resource gap analysis.

Functions and Planning Factors

We defined functions and planning factors to provide the basis for calculating the quantitative outputs of the Community Preparedness Planning Tool. They translate inputs (pre-populated and user-specified disaster attributes, community characteristics, capability planning factors) into estimates of disaster effects, required capabilities, and required resources, as described in more detail below. The functions are mathematical equations that generate outputs from inputs, and the planning factors are numerical values (typically coefficients) within these functions. For example, the function to estimate the population with mobility disabilities that require pre-disaster evacuation (a disaster effect) is: *f4^2(Pop)=0.005·Pop*; within this, the planning factor is 0.005, or 0.5 percent of the specified population (a community characteristic).

To define both the functions and the planning factors, as well as the assumptions underlying them, we conducted a comprehensive review of the sources listed in the first paragraph of the preceding section ("Pre-Populated Input Data"), compiled documented functions and planning factors that were relevant to the prototype tool, and adapted documented functions and planning factors to be suitable for use in the tool, noting the underlying assumptions for each such adaptation or other RAND estimate (see Appendix D).

When the federal guidance or literature source defined functions or planning factors specific to given disasters and communities (e.g., a function that defines the relationship among the number of injuries, earthquake attributes, and community characteristics in a magnitude 8 earthquake in a population of 10 million people), we created functions and/or planning factors as needed, which were scalable across the full range of disaster attributes and community characteristics. In general, the functions were (a) drawn directly from a guidance document, (b) scaled (usually linearly, except where described otherwise) around a single point estimate from a guidance source, or (c) derived by applying assessed needs to the entire affected population. In the functions listed in Appendix Tables D1, D2, and D3, the column labeled "Explanations and Assumptions" indicates when and how a point estimate was scaled to write the function. The following three examples illustrate how each type of function was written:

- Direct function: Population displaced and requiring shelter: This function follows the estimate methodology presented by Hazus. This estimate is dependent on the population size, the estimated number of households displaced, age distribution, ethnicity distribution, income level distribution, and the fraction of home ownership as specified by Hazus. This function is also dependent on the building stock composition from the census track data contained in Hazus and earthquake magnitude. This function considers the effects of the physical effects and attenuation as done in Hazus.
- Scaling functions given source point estimates: The TCL states that, for a disaster that displaces 313,000 people who need shelter, 193,000 companion animals will also need shelter (DHS, 2007, p. 512). From this point estimate, and assuming the point estimate is scalable, we wrote the function that estimates the number of companion animals that need to be sheltered as 0.617 (i.e., 193,000/313,000) multiplied by the estimate of the number of people displaced and needing shelter.
- Needs applied to affected population: The need to treat, triage, and stabilize patients for transport is stated in the TCL, but there is no planning factor in this document (DHS, 2007, p. 462). We wrote the function to estimate the capability for triage, treatment, and initial stabilization as equal to the estimated number of injured people from the disaster.

Approximately 40 percent of the functions are the result of scaling source point estimates; 60 percent of the functions either are written directly from the source or are trivial extrapolations.

To the extent possible, we used certain functions and planning factors of other tools (e.g., FEMA's Hazus Software, CDC's FluSurge model) to estimate the disaster effects. As noted above, our tool draws from current, widely used guidance and does not purport to endorse its accuracy. The sources used for construction of the functions and planning factors are those listed in Appendix A. A streamlined list of all the required capabilities included in the tool is presented in Appendix B. The full list and characteristics of variables reflecting disaster attributes, community characteristics, disaster effects, capabilities, and resources is presented in Appendix C. The full list of functions, including the planning factors and underlying assumptions within them, for calculating disaster effects, required capabilities, and required resources is provided in Appendix D. Functions we deemed conceptually important but unreliable for purposes of the tool were omitted from the prototype tool but retained in our list of functions;

we shaded the lines with those functions in gray in Appendix D. The resulting unshaded functions and planning factors are those we used in the current prototype.

There may be a range of fidelity of the defined functions and planning factors, depending on whether the function is taken directly or extrapolated in minor or more major ways from supporting literature and the quality of the literature sources used. Our sources are largely official government planning documents or peer-reviewed articles which we consider, for modeling purposes, as legitimate planning sources. It is beyond the scope of this research to assess the fidelity of specific details or planning factors obtained from and across the sources. The reader is advised to consider the sources specified in Appendix A when assessing the validity of the functions and planning factors. However, we offer our qualitative opinion on the level of uncertainties for groups of functions developed in similar fashions. In general, we have listed in Appendixes C and D all elements and functions that we considered important in our tool. However, some elements and functions are shaded gray (Appendix Tables C.1, C.2, C.3, C.4, C.5, D.1, D.2, and D.3.). Although we did not use them directly in the tool, we have retained them in these tables to signify their importance to emergency planning and our inability to find reliable sources, or to define viable function relationships, for them.

Approximately three-fourths of the disaster effects functions derive from widely used planning guidance, with relatively trivial interpolations along the lines of those described above. RAND needed to estimate the remaining quarter of those functions; Table D.1 in Appendix D provides explanations and assumptions underlying those estimates. It is those estimates (including related assumptions and extrapolations) that require further research and more comprehensive field testing in order to identify any modifications to or substitutions for those estimates before the prototype can be submitted for validation.

In general, we consider the functions directly taken or adapted from FEMA's Hazus software as accurate for these planning purposes. It is clear from their documentation that FEMA has invested a significant amount of time and effort to capture the causal relationships between earthquakes and hurricanes and the resulting point estimates for the structural damage and other disaster effects. Similarly, we consider the influenza functions that were developed from the CDC's FluLabSurge and FluSurge software as credible for the same reason (CDC, 2009; CDC, 2006). Also, we consider the community characteristics obtained from the HHS's Area Resource File as accurate. Functions that are directly taken from one of the other government documents, such as the TCL, or peer reviewed publications are also deemed credible for planning purposes and thus for the purposes of our tool.

For some functions, we fit a mathematical model or have interpreted a source's planning factor as scalable to any community. These functions are noted as such in the "Explanations and Assumptions" column in Appendix tables D.1, D.2, and D.3. These functions are arguably less accurate because they assume, without knowing for certain, that the source intended its planning factors to be scaled to other communities. There may be significant, albeit unknown, uncertainties for such functions, especially those for calculating disaster effects. Since the disaster effects *outputs* are the main *inputs* for calculation of required capabilities and required resources, considerable further testing is needed to assess the face validity of those functions in particular.

The uncertainties about inputs manifest themselves differently in the disaster effect estimates, depending on the sources used. FEMA's Hazus and CDC's FluSurge models estimate disaster effects as accurately as possible (i.e., expected value estimate) and are widely used as-is for local planning purposes around the United States. Therefore, functions built from these two sources produce estimates under an expected case scenario. In general, the disaster effect functions are planning estimates for the worst-case scenario for a *given disaster magnitude,* because the source documentation is for planning purposes. The TCL and NPS are prime examples of planning documents whose content is intended for worst-case disaster preparedness planning and not necessarily to predict expected disaster effects. As an illustrative example, consider the TCL's estimate that 3 percent of the population will need evacuation after a magnitude 8.0 earthquake. Because the TCL planning document is designed for preparedness, the 3 percent estimate may be at the 90th percentile given an 8.0 earthquake, whereas the expected value may be at 1.5 percent given an 8.0 earthquake. In other words, planning documents may estimate disaster effects for a given disaster magnitude well above the expected outcome (i.e., "worst case") to increase preparedness. We are unable, at this juncture, to assess the accuracy of the function estimates as compared to actual disaster outcomes. This accuracy assessment would require data from actual disasters across many types of communities. We do not have access to such data, and, in many cases, such data do not exist. Moreover, since the planning guidance is geared toward a worst-case scenario, validation of the tool against actual past disasters would be expected to result in generally less severe actual disaster effects as compared to those used for planning purposes. The required capabilities and required resources functions are almost exclusively defined from planning documents and, therefore, also reflect estimates for the worst-case scenario. More vetting of the prototype tool with communities that may possess such data will assist in determining the level of uncertainty in the data and functions that we have used. Broad vetting with local planners will also help to determine the usefulness of the current prototype, and whether and how its functions, particularly those for disaster effects, may need to be modified.

More details on the functions associated with the three major outputs of the tool are described below. For complete details of data elements, functions, and assumptions, see Appendixes C and D.

Computation of Disaster Effects

The computations used to estimate the disaster effect drew inputs from the community characteristics and the disaster attributes. If the user selects a county from the Area Resource File, the majority of the community characteristics are automatically populated from the Area Resource File data. The disaster effects estimated include the number of people displaced, people injured, fatalities, and damaged buildings.

Many of the earthquake and hurricane disaster effects are calculated almost identically to Hazus's calculations. Hazus does not estimate influenza disaster effects. See Appendix D for detailed descriptions of the Hazus disaster effect estimates and a discussion of the few modest simplifying assumptions that RAND has made for purposes of computational feasibility. In general, the Hazus functions include census tract information on population and building type compositions. Using physical models of the effects of earthquakes (e.g., spectral displacement) and hurricanes (e.g., wind speed), the Hazus functions estimate building damage. Subsequently, building damage is translated into numbers of injured people, fatalities, displaced people, etc. The detailed census tract data and physical modeling that Hazus software provides are used directly by the capabilities-based planning tool for the functions that are sourced from Hazus.

Some of the disaster effects were created as scalable functions derived from a few of our sources' point estimates. For estimating the number of companion animals requiring shelter, the TCL states that, given 313,000 people displaced, 193,000 companion animals need to be sheltered. The function was created scalable such that for every person displaced, on average 0.62 (i.e., 193,000/313,000) companion animals need shelter. A more complicated example is the function for the number of people needing evacuation after an earthquake. The NPS earthquake scenario states that 5 percent of the population will need evacuation after an 8.0 earthquake, and the TCL07 states that 3 percent of the population will need evacuation after a 7.2 followed by an 8.0 earthquake. To make a scalable function to estimate any magnitude, RAND anchored a mathematical model (a sigmoid function) to near 0 percent at magnitude 0.0 and 4 percent at magnitude 8.0. The 4 percent is estimated by averaging the 5 percent from the NPS and the 3 percent from the TCL. The 0 percent was chosen by RAND. By design, the mathematical model is bounded by 0 and 100 percent.

Types of Disaster Effects Functions

The disaster effects are the most difficult functions to create. In general, source guidance provides function recommendations for required capabilities and required resources that are scalable with varying community sizes and disaster magnitudes. The source documentation does not propose disaster effect functions that are scalable with respect to disaster magnitudes and community characteristics as we have done in this prototype tool. Our proposed disaster effect functions are a large original contribution to this research area. To create the disaster effect functions, we used source guidance and logical reasoning. These functions are nontrivial and deserve extra explanation that we provide in the following paragraphs.

The disaster effects functions that we created are either taken directly from a disaster planning software (with little to no simplification), created as nonlinear functions, or specified as linear functions. Table 2.1 is a list of functions taken directly from planning software.

As mentioned, some functions are defined as nonlinear functions so that they may be used to interpolate and extrapolate disaster effect estimates. In these cases, either the literature provides or we assumed one or two point estimates of the disaster effects whereby we also assume a nonlinear function structure and fit the function through the literature point estimates. We describe here the four nonlinear disaster effect functions for which we have done this.

We fit a nonlinear function to estimate the percentage of the population that requires evacuation after a hurricane disaster. This estimated percentage is then multiplied by the non-evacuated population to obtain an estimate for the number of people who require evacuation (f_PopE). The literature does not provide estimates of the percentage of population requiring post-hurricane shelter, so we assumed that nearly no one (we assumed 1 percent of the population) will need evacuation when wind speed is 60 mph and nearly everyone (we assumed 99 percent of the population) will need evacuation when the hurricane wind speed is 200 mph. These two wind speeds were selected because 60 mph corresponds to a storm that is less than a Category 1 hurricane and 200 mph corresponds to a Category 5 hurricane (i.e., the largest classification). In light of the lack of published guidance, RAND thought it was reasonable to assume that storms smaller than Category 1 hurricanes will cause little to no evacuation and Category 5 hurricanes will cause nearly complete evacuation. We fit a sigmoid function through these two points. A property of the sigmoid function is that, as wind speed decreases, the estimated percentage of the population needing evacuation asymptotes toward 0 percent. Conversely, as the wind speed increases, the function asymptotes toward 100 percent. Figure 2.2 displays this fitted function with assumed planning factors.

Table 2.1
Planning Software Functions

Variable Name	Function, Software	Disaster[s]
Population Displaced and Not Requiring Shelter	f_PopD, Hazus	Hurricane
Population Displaced and Requiring Shelter	f_PopS, Hazus	Earthquake and hurricane
Buildings Destroyed	f_BldDes, Hazus	Earthquake
Percentage of Buildings with Severe Structural Damage	f_Struct, Hazus	Earthquake and hurricane
Buildings with at Least Moderate Damage	f_BldDam, Hazus	Earthquake
Single-Family Homes Destroyed	f_SFHomDes, Hazus	Earthquake and hurricane
Multi-Family Homes Destroyed	f_MFHomDes, Hazus	Earthquake and hurricane
Population Injured or Ill from Disaster	f_Inj, FluLabSurge	Influenza
Outpatient Visits	f_Outpat, FluLabSurge and Hazus	Influenza and earthquake, respectively
Population Hospitalized	f_Hosp, FluLabSurge	Influenza
Fatalities (Disaster Related)	f_Fatalities, FluLabSurge	Influenza
Number of Lab Samples Needed to Be Tested	f_LabSamp, FluLabSurge 2009	Influenza[a]
Patients Requiring ICU	f_PatICU, Hazus	Hurricane
Number of Hospitalized Patients That Require Transfer Outside of Jurisdiction	f_PatTran, Hazus	Hurricane

[a] FluLabSurge estimates the number of samples over time. For the capabilities-based planning tool, we take the FluLabSurge's maximum estimate over time assuming that 4.26 percent of the population will require four lab tests each.

This model has a desired shape in that, given very small wind speeds, the percentage of the population requiring evacuation is nearly zero. At high wind speeds, nearly all the population requires evacuation. This function is sensitive to the two data points assumed naturally. If, in reality, the data are not valid, the fitted function may not be valid. Given lack of guidance from the literature, we selected these two points as reasonable estimates.

We fit a similar nonlinear model to estimate the fraction of the non-evacuated population injured from the hurricane disaster. This fraction is then multiplied by the number of non-evacuated people to obtain the number of people injured due to the hurricane (f_Inj). In this case, the NPS documentation estimates that 0.06 percent of the population (6 thousand out of a population of 10 million) will be injured in a hurricane with 160 mph wind speeds (i.e., a Category 5 hurricane). RAND then assumes that 0.01 percent of the population will be injured in a hurricane with 115 mph wind speeds (i.e., Category 3 hurricane). Figure 2.3 displays the model fits and the source data used.

This function also has the desired properties that, as wind speed increases, the estimate increases. Naturally, this function is sensitive to the point estimates. The NPS point estimate considers the size of the population and the category of hurricane only. It does not take into account detailed population information such as building stock composition of the community

Figure 2.2
Model Fit of the Percentage of Population Requiring Evacuation

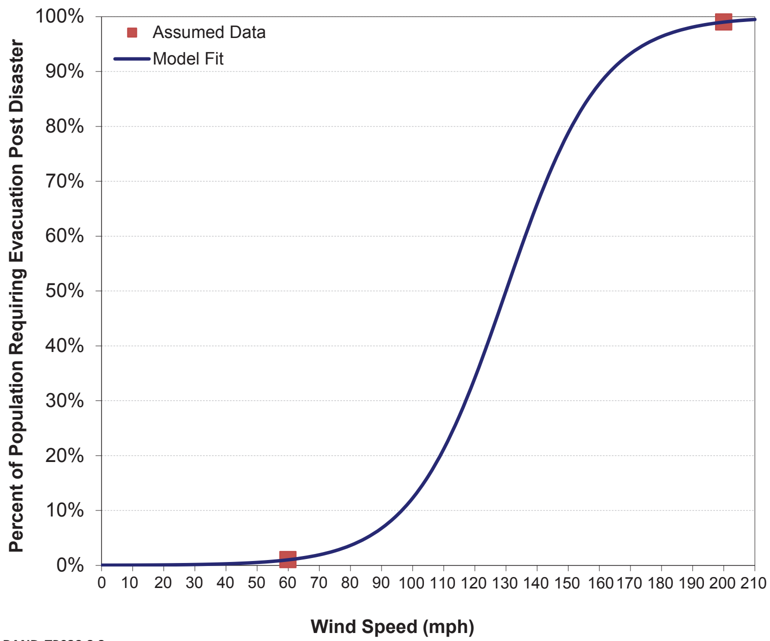

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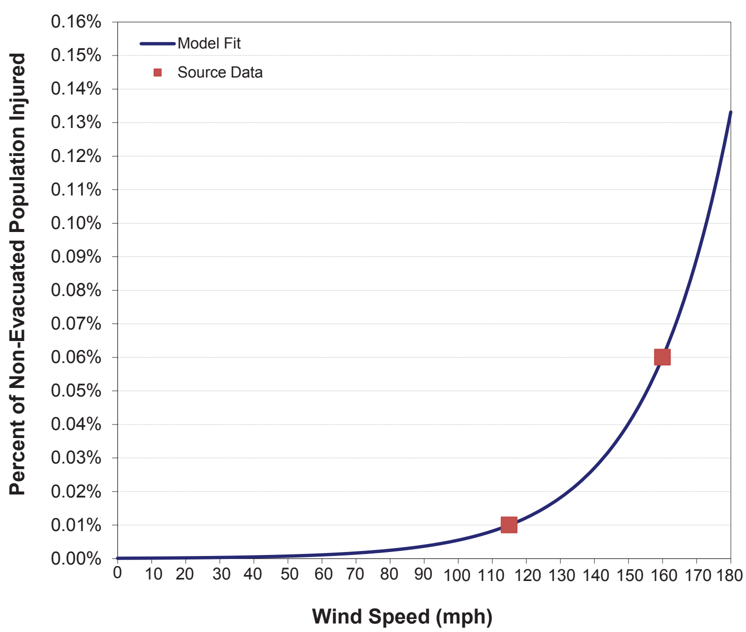
Figure 2.3
Model Fit of the Percentage of Non-Evacuated Population Injured in a Hurricane



RAND *TR928-2.3*

and population demographics. The assumed RAND point estimate was selected as 1/6th of the NPS estimate. RAND felt that, between a Category 3 and Category 5 (i.e., from wind speed of 115 to 160 mph), it was reasonable to assume that the percentage of injuries increases much more rapidly than from no hurricane to a Category 3 (i.e., from wind speed of 0 to 115 mph).

Next, we take a similar approach to define the nonlinear function that estimates the fraction of the non-evacuated population needing hospitalization. We then multiply this fraction by the size of the non-evacuated population to obtain the number of people hospitalized due to disaster (f_Hosp). The NPS estimates that 0.05 percent of a population of 10 million people will be hospitalized given a Category 5 hurricane. For modeling purposes, we interpret the NPS's estimate as 0.05 percent at wind speed of 156 mph. We also assumed that, at wind speed of 74 mph, this fraction is nearly zero (we modeled it as 0.001 percent). Figure 2.4 displays a graphical representation of the model fit to source data.

Similarly this model has the desired properties that, as wind speed increases yet remains relatively small, the fraction of hospitalized is nearly 0 percent and, as wind speed increases to moderate/high speeds, the fraction rises rapidly to the NPS estimate. Naturally, this function is sensitive to the point estimates used. The RAND point estimate was selected because we felt it was reasonable to assume that, for wind speeds up to 74 mph (i.e., the lower bound of a Category 1 hurricane), the percentage of people hospitalized is nearly zero and that wind speeds from 74 to 156 mph (a Category 5 hurricane) will cause significant increases in the percentage of people hospitalized.

Lastly, we assume a nonlinear model to predict the fraction of people that will evacuate after an earthquake (f_PopE). The NPS estimates that 5 percent of the population will evacuate after an 8.0 earthquake, while the TCL estimates that 3 percent of the population will evacuate after an 8.0 earthquake. Because of the logarithmic Richter measure of magnitude, we fit a log-linear (with log base 10) model to 4 percent at magnitude 8.0 and 0 percent when an earthquake does not occur. The 4 percent was selected because it is the average between the two source estimates. Figure 2.5 displays the model fit as a function of earthquake magnitude.

This model fit has the desired property of estimating that no one evacuates if an earthquake does not occur (i.e., magnitude of 0) and of increasing logarithmically through a literature source estimate as magnitude increases.

The disaster effects come from a variety of sources and use a variety of input data. Table 2.2 displays the list of estimated disaster effect functions and qualitative discussion of the input elements used to estimate each. The disaster effects can be grouped into three types depending on their method of creation and the input data used. The first type is the nonlinear functions that are described in detail in the preceding figures and in the surrounding text; the table does not describe these functions further. The second type is functions that are used as defined (sometimes with a few minor approximations) by a source software such as the Hazus, FluSurge, or FluLabSurge software. The Hazus functions use detailed input data including building stock composition, income distribution, age distribution, and ethnicity distribution at the census tract level. Table 2.2 explains qualitatively which inputs are used to estimate each disaster effect. The third type contains functions that are linear approximations of planning factors or assumed constants found in the literature. The linear approximations assume that the disaster effect estimates scale linearly with the magnitude of the disaster, community characteristics, and/or another disaster effect estimate. Each function in Table 2.2 is labeled as one of these function types: Type 1 nonlinear; Type 2 from software; Type 3 linear. Detailed

Figure 2.4
Model Fit of the Percentage of Non-Evacuated Population Hospitalized

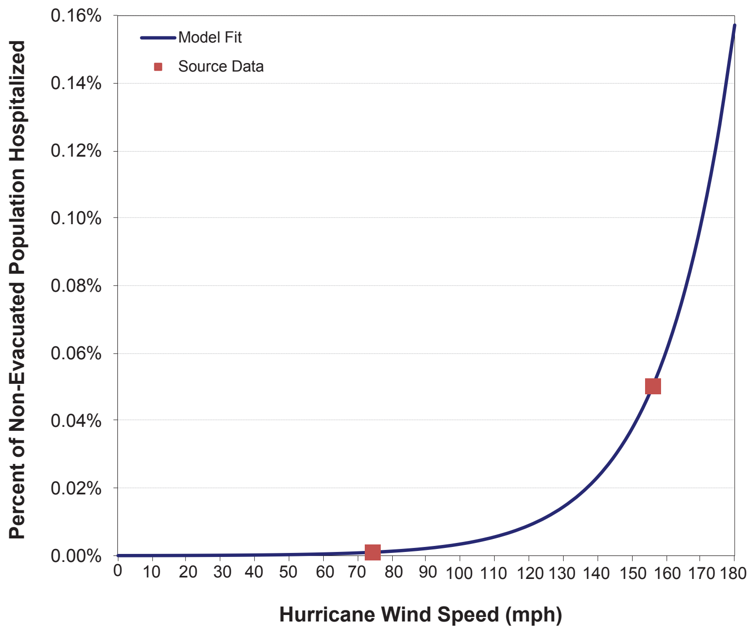


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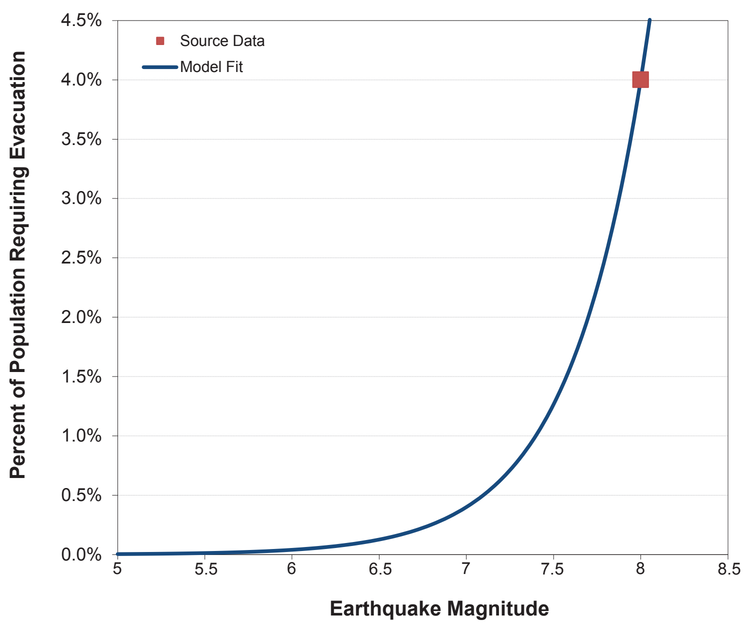
Figure 2.5
Model Fit of the Percentage of Population that Evacuates After an Earthquake



RAND *TR928-2.5*

disaster effect definitions including mathematical formation and sources used can be found in Appendixes A, C, and D.

When interpreting the function output, it is important to consider the context in which the planning factors were defined by our sources. Those taken from sources with well-defined contextual planning factor estimates are arguably more robust to characteristic differences between communities. The disaster effects sourced from software are estimated under a well-defined context. The Hazus software functions, for example, use census tract data that contain building stock distributions and population demographics for any location in the continental United States. Similarly, the CDC FluSurge and FluLabSurge software use detailed input information including influenza attack rate and the percentage of high-risk people.

However, the disaster effect functions not sourced from software are likely less robust because the sources used to build these functions only consider a few community characteristics when defining planning factors. As an example, the TCL defines a scenario where 300,000 people need evacuation after an 8.0 magnitude earthquake in a major metropolitan area of approximately of 10 million people. We used this TCL scenario to define the function that predicts the number of people requiring evacuation after a disaster. In the context where this planning factor was defined in the TCL, there is no mention of building stock composition, population demographics, or income distribution (unlike the Hazus functions). Therefore, this function and others that are not defined from a software package may not be as robust for communities with varying characteristics.

In the non-linear functions we created, we designed them to have sensible asymptotic properties. Using the function displayed in Figure 2.5, we see the percentage of population requiring evacuation as a function of earthquake magnitude. We selected a simple non-linear function to intersect our one data point, that approximately 4 percent of a population would require evacuation for an earthquake of magnitude 8.0. We chose a non-linear function to increase rapidly in the range of magnitudes 7.0 through 9.0, and to decrease toward zero effect when the earthquake has magnitude 0. Since the function approaches zero effect asymptotically, the function will predict a small positive percentage of the population requiring evacuation for earthquakes as small as 1.0 or 2.0 on the Richter scale. It is very likely that precisely 0 percent of the population will require evacuation in these instances, so our function may be inaccurate for earthquakes of small magnitude, where the magnitude is extrapolated far from our data point at magnitude 8.0.

Computation of Capabilities Required

In the majority of the required capabilities functions, the functions are trivial calculations using the disaster effect estimates as inputs. As an example, consider the required capability of sheltering people after a disaster. Given that one million people need shelter after an earthquake (a disaster effect estimate), the required capability is trivially the ability to shelter one million people. A small minority of functions are slightly more complicated and may have prior assumptions.

Computation of Resources Required

The required resource functions consider the disaster effects and required capability estimates as inputs. The majority of the required resource estimates are written more naturally as direct functions of the disaster effects rather than as functions of the required capabilities. The literature sources contain much guidance on scaling resource estimates, unlike the paucity of guid-

Table 2.2
A Listing and Qualitative Description of Disaster Effect Functions and Input Data Elements

Variable Label	Variable Name	Earthquake	Hurricane	Pandemic Influenza
Population displaced and not requiring shelter	O_PopD	(Function Type 2: Software) This function follows the estimate methodology presented by Hazus. This estimate is dependent on the population size, the estimated number of households displaced, age distribution, ethnicity distribution, income level distribution, and the fraction of home ownership as specified by Hazus. This function is also dependent on the building stock composition from the census track data contained in Hazus and earthquake magnitude. This function considers the effects of the physical effects and attenuation as done in Hazus.	(Function Type 2: Software) This function is an approximation of the Hazus estimate and is dependent on the population, wind speed, the population displaced and requiring shelter, the fraction of displaced households by income level, and various census track and Area Resource File data elements including the number of single and multifamily houses, population income distribution, population ethnicity distribution, building stock distribution, distribution of building ownership, and age distribution.	NA
Population displaced and requiring shelter	O_PopS		(Function Type 2: Software) This function is an approximation of the Hazus estimate and is dependent on the population, wind speed, the fraction of displaced households by income level, and various census track and Area Resource File data elements including the number of single and multifamily houses, population income distribution, population ethnicity distribution, building stock distribution, distribution of building ownership, and age distribution.	NA
Population requiring evacuation post disaster	O_PopE	(Function Type 1: Nonlinear) This function is a nonlinear function that is dependent on the population size, the estimate of the fraction of evacuated population before the earthquake, and the earthquake magnitude. It is constructed from estimates of the NPS and TCL. It was described in text above this table.	(Function Type 1: Nonlinear) This function is a nonlinear function that is dependent on the population size, the estimate of the fraction of evacuate population before the hurricane, and wind speed. It was described in text above this table.	NA
Companion animals that need shelter	O_AnimS	(Function Type 3: Linear) This function is dependent on the number of people seeking shelter. It assumes that the average number of companion animals per person sheltered is approximately 0.62 based on a TCL estimate.	(Function Type 3: Linear) This function is dependent on the number of people seeking shelter. It assumes that the average number of companion animals per person sheltered is approximately 0.62 based on a TCL estimate.	NA
Population with mobility disabilities that require pre-disaster evacuation	O_PopEDis	(Function Type 3: Linear) This function estimates that 0.5% of the population has a disability and will require shelter post disaster.	(Function Type 3: Linear) This function is dependent on the estimate for the population displaced and not requiring shelter. It assumes that the proportion of people with disabilities in the population according the Area Resource File is a valid estimate for the proportion of displaced people that have disabilities.	NA
Population injured or ill from disaster	Inj	(Function Type 2: Software) This function is from Hazus and is dependent on the expected occupancy, building types contained in the census track data, the probability of being injured, and the earthquake magnitude. This function also considers the effects of the physical and attenuation as done in Hazus.	(Function Type 1: Nonlinear) This function is a nonlinear function that is dependent on the population size and the wind speed. It is described in the text preceding this table. This function was built using an NPS estimate.	(Function Type 3: Linear) This function is the sum of the number of outpatient visits, hospitalizations, and fatalities from the disaster.
Population hospitalized	Hosp	(Function Type 2: Software) This function is based on the Hazus estimate and is dependent on the expected number of people in each building type contained in the Hazus census track data and the earthquake magnitude. This function also considers the effects of the physical and attenuation as done in Hazus.		(Function Type 2: Software) This function is sourced directly from Flu Surge 2.0. This estimate is a function of attack rate, the population size, and the fraction of the population that is high risk.
Fatalities (disaster related)	Fatalities		(Function Type 1: Nonlinear) This function is dependent on the hurricane category, flood depth, the percentage of the population that evacuated, and the population size. The NPS05 scenario specifies that 0.01% of the population will be killed from a major hurricane assuming a major metropolitan area is a population of 10 million. RAND assumes that at a category 5 hurricane 0.01% of the population will be killed. For categories less than 5, RAND assumes a linear decrease in fatalities. RAND assumes that the flood depth affects fatalities nonlinearly as defined in Jonkman (2007).	

Table 2.2—Continued

Variable Label	Variable Name	Earthquake	Hurricane	Pandemic Influenza
Patients requiring an ICU	PatICU	(Function Type 2: Software) This function is based on the Hazus estimate and is dependent on the expected number of people in each building type contained in the Hazus census track data and the earthquake magnitude. This function also considers the effects of the physical and attenuation as done in Hazus.	(Function Type 3: Linear) This function is dependent on the estimated number of people hospitalized due to the hurricane. RAND assumes that 20% of hospitalizations need intensive care. This assumption was made based on RAND's experience with hospital patient data analysis.	(Function Type 3: Linear) RAND assumed that 20% of hospitalized population require critical care based on RAND's experience with hospitalized patients.
Outpatient visits	Outpatient		(Function Type 3: Linear) This function is estimated as the difference between the estimated number of injuries due to the hurricane minus the estimated number of hospitalizations due to the hurricane.	(Function Type 2: Software) This function is sourced directly from Flu Surge 2.0. This estimate is a function of attack rate, the population size, and the fraction of the population that is high risk.
Patients requiring a ventilator	PatVent	NA	NA	(Function Type 3: Linear) The TCL implies that all ICU patients due to influenza need ventilation.
The number of hospitalized patients who require transfer to outside jurisdiction	PatTran	(Function Type 3: Linear) This function is dependent on the estimate for the number of people severely injured and the available beds in the local hospitals.	(Function Type 3: Linear) RAND assumes that all the people injured from the hurricane require transportation.	NA
Patients with ability to be transferred by commercial (non-medical) means	PatTranCom	(Function Type 3: Linear) RAND assumes that those patients injured that do not require critical care have the ability to transferred by commercial (non-medical) means.	(Function Type 3: Linear) This function is estimated as the estimated number of injured people from the hurricane minus the estimated number of people hospitalized.	NA
The number of transferring patients who require an ambulance and medical assistance	PatTranAmb	(Function Type 3: Linear) RAND assumes that 85% of the number of hospitalized patients who require transfer will need ambulance transportation.	(Function Type 3: Linear) This function assumes that all hospitalized people who are transferred require an ambulance and medical assistance.	NA
Number of lab samples needed to be tested (influenza specific)	LabSamp	NA	NA	(Function Type 3: Linear) This function assumes a constant percentage of the population will require four lab tests each based on guidance from the literature.
Population missing	Missing	(Function Type 3: Linear) This function assumes that 0.2% of the population will be missing as per an NPS estimate.	(Function Type 3: Linear) The assumed default is that nobody will be missing. The user may change this estimate is desired.	NA
Buildings destroyed	BldDes	(Function Type 2: Software) This function is based on the Hazus estimate and is dependent on the building type distribution contained in the Hazus census track data and the earthquake magnitude. This function also considers the effects of the physical and attenuation as done in Hazus.	NE	NA
Buildings with at least moderate damage	BldDam		NE	NA
Percent of buildings with severe structural damage	Struct	(Function Type 2: Software) This function is defined exactly as in Hazus. It is a function of census track level building types and earthquake magnitude.	(Function Type 3: Linear) This function is estimated using Hazus data by considering the number of single and multi-family houses in the community and the building loss ratios which are a function of hurricane wind speed.	NA
Single Family Homes destroyed	SFHomDes		(Function Type 3: Linear) This function is estimated using Hazus methodology as the number of single family homes in the community multiplied by the single family home loss ration which is a function of hurricane wind speed.	NA
Multi-Family Homes destroyed	MFHomDes		(Function Type 3: Linear) This function is estimated using Hazus methodology as the number of multi-family homes in the community multiplied by the multi-family home loss ratio which is a function of hurricane wind speed.	NA
Hospital operating level: percent of beds available post disaster	HospPer	(Function Type 3: Linear) This function uses the NPS estimate that 88% of the hospitals will be destroyed in an earthquake	(Function Type 3: Linear) RAND assumed that all hospitals are operation after the hurricane by default. The tool user may change this input if desired.	(Function Type 3: Linear) RAND assumed that all hospitals are operational after the influenza pandemic by default. The tool user may change this input if desired.
Percent absent workers	Absent	(Function Type 3: Linear) RAND assumed that no workers are absent after the earthquake by default. The tool allows users to edit this input if desired.	(Function Type 3: Linear) RAND assumed that no workers are absent after the hurricane by default. The tool user may change this input if desired.	(Function Type 3: Linear) This function is estimated from the fraction of population that become ill.

NA - Not Applicable; NE - Not Estimated

ance in scaling the disaster effects. Therefore, almost exclusively, the resource functions were written as direct interpretations of our sources. For example, the TCL states that one Type IV Shelter Team is needed for every 250 people sheltered, to provide needed care and assistance. Therefore, the estimate for the number of Type IV Shelter Teams is the estimated number of people needing shelter (a disaster effect estimate) divided by 250 and rounded up to the next integer.

How Uncertainties in Disaster Effect Estimates Affect Uncertainties in Required Resource Estimates

In most instances, the uncertainties in disaster effect estimates will affect uncertainties in required resource estimates. There are some exceptions where the resources are not functions of the disaster effects. For example, CDC's FluSurge model presents a function to estimate the number of vaccinations in an influenza pandemic. This function is not dependent on a disaster effect and is solely dependent on the community age distribution, the fraction of high-risk people in the community, and the number of people not vaccinated already. Some of these key disaster effects are more robust than others. Since planners are primarily interested in estimates of their required capabilities, we discuss this concept from a resource perspective. We identify these key disaster effects here and qualitatively discuss their uncertainties in the following paragraphs.

For the required resources related to fatality management, the estimate for the number of fatalities is a key input. The fatality estimate is derived from the NPS for hurricane and other publications.[2] This estimate does not consider required detailed information such as building stock and population demographics. Therefore, we deem this disaster effect and the required resource estimates as having moderate uncertainty. The fatality estimate for earthquake, however, does consider building stock and population demographics because its source is the Hazus software; we deem these functions as having low uncertainty. The estimate for influenza fatalities is based on the CDC's FluSurge software. Therefore, we deem the influenza fatality estimate and the dependent fatality management resources as having low uncertainty.

The required resources for mass care are mostly dependent on the estimate for the population seeking shelter. The population seeking shelter estimates are from the Hazus software. Therefore, we deem these estimates and the dependent mass care resource functions as having low uncertainty.

The required resources for medical surge are mostly dependent on the estimated number of people hospitalized from the disaster. For influenza and earthquake disasters, the function for the number of people hospitalized is based on the CDC's FluSurge and the Hazus software, respectively. Therefore, we feel that these estimates are valid and have low uncertainty. The disaster effect function for the number of people hospitalized for the hurricane disaster was not taken from a software package. This function is one of the nonlinear functions where published source guidance was used and RAND assumptions were introduced. Because of this, we deem the hurricane medical surge resources as having moderate uncertainty.

The required resources for medical supply and distribution are mainly dependent on the disaster effect estimate of the number of people injured. For earthquake and influenza disasters, this disaster effect estimate is taken directly from disaster planning software. For hurricanes, however, this disaster effect function is one of the nonlinear functions for which pub-

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2 See, e.g., the San Francisco earthquake plan, 2011, and Jonkman, 2007.

lished source guidance was used for construction of the function. Therefore, we deem the medical supply required resources for earthquake and influenza as having low uncertainty and for hurricane as moderate uncertainty.

The required resources for mass prophylaxis are dependent either on estimates from CDC's FluSurge software or on the population of the community. Therefore, we deem these resource requirement functions as fairly robust with low uncertainty.

The required resources for worker health and safety and public health are almost exclusively dependent on estimates of other required resources which, in general, are estimates from published sources and not software. Because of this, we deem these estimates as having moderate uncertainty.

User Interface

We designed a user interface so that the tool is straightforward to use with little instruction. We used forms available in Access to create the interface. These forms allowed us to design an easy-to-understand user interface quickly for the prototype tool. However, if the tool is taken beyond the prototype phase, we recommend that it be designed in an environment that can be run on a range of operating systems. Currently, the prototype can only run on Microsoft Windows. In the following section, we walk readers step-by-step through the key features of the tool.

Key Features of the Prototype Community Preparedness Planning Tool

The planning tool can be used to identify the health-related capabilities and resources needed and determine any resource gaps in planning for three types of disasters, either individually or in combination:

- hurricane
- earthquake
- pandemic influenza.

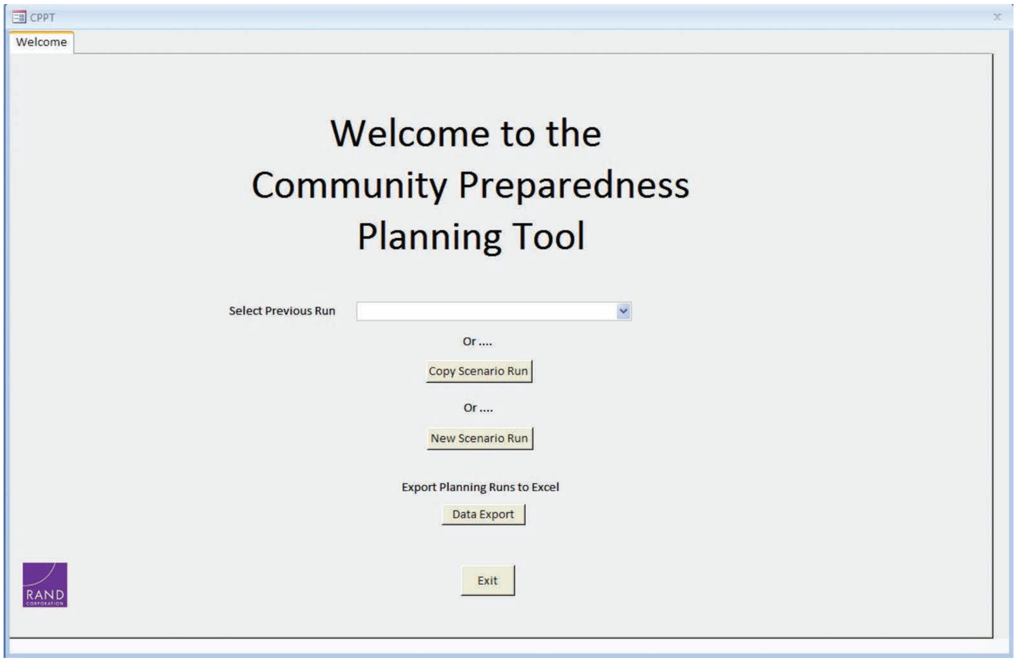
The prototype tool can be used to test several inputs and outputs for only these three disasters, although, in the future, the tool could be expanded to incorporate a broader range of disasters and related capabilities and resources. Most functions that estimate the required capabilities and resources are functions of the disaster effects and are not direct functions of the disaster type. In most cases, the disaster type affects the required capabilities and resources solely through a disaster effect estimate. For example, a terrorist attack bombing will likely cause a different number of injuries than an earthquake. However, the functions that link the number of injuries to the number of clinicians needed (a required resource) are likely valid for both disaster types.

When the tool is activated, the Welcome page opens, as shown in Figure 2.6.

On the Welcome page, users have the option of starting a new planning scenario or selecting a scenario to run that was created earlier. Users can export data from a planning scenario into an Excel file, if desired.

The planning tool uses a modular, building-block approach to preparedness planning, and—based upon local risk assessment—allows users to perform these steps:

Figure 2.6
Welcome Page for the Community Preparedness Planning Tool



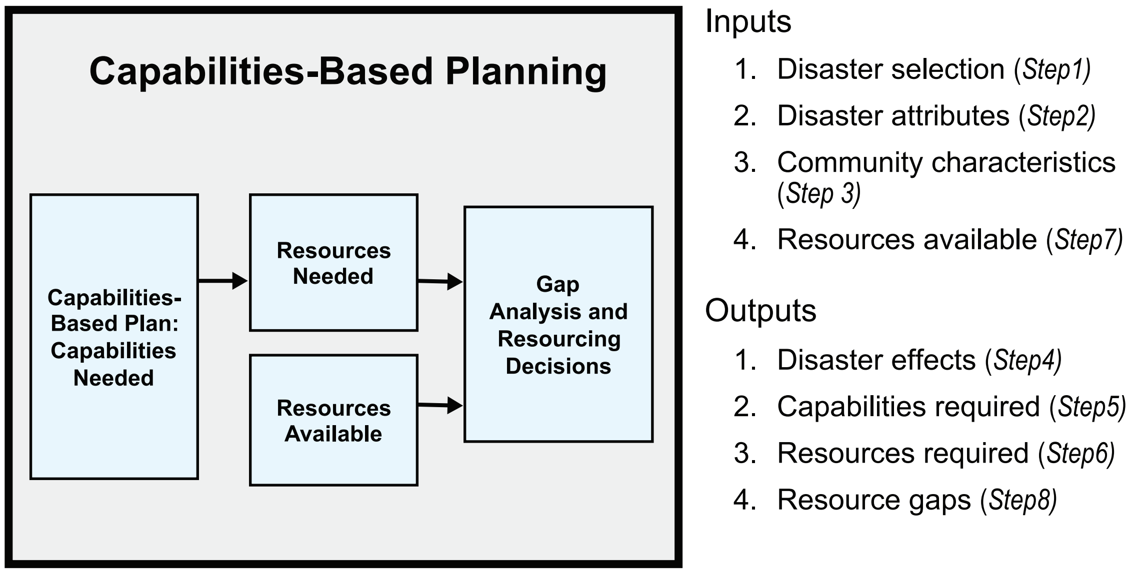
RAND *TR928-2.6*

1. Select the disaster(s) to be included for planning purposes, either individually or in combination (e.g., if a community determines it is at risk for different types of disaster)
2. Select and specify planning assumptions related to disaster attributes
3. Select and specify the community characteristics
4. Review the disaster effects generated by the tool (based on specified planning assumptions) and modify these if or as needed to better reflect local needs
5. Review the tool-generated capabilities needed to address the specified disaster planning scenario
6. Review the required tool-generated resources to address the scenario
7. Specify available resources
8. Review resource gaps as calculated by the tool
9. Generate reports related to capability and resource needs and resource gaps.

Inputs and Outputs

The planning tool includes four types of inputs and generates four main outputs, as shown in Figure 2.7. The three inputs required from the user are: selection of the disaster, disaster attributes, and community characteristics. Users also have the option of inputting available resources. The tool includes pre-populated inputs, as described in the approaches section above and in the various steps below. There are four main outputs from the tool: disaster effects, required capabilities, required resources, and resource gaps. We will discuss each of these inputs and outputs individually, for each step listed above.

Figure 2.7
Inputs and Outputs of the Planning Tool



RAND *TR928-2.7*

Step 1: Select the Disaster (Input 1)

The user selects one or more disasters (hurricane, earthquake, pandemic influenza, or a combination of these) as the basis for planning. The selection of more than one disaster in the tool means that the community is preparing for multiple disasters. However, users should assume that the disasters occur separately.[3]

Step 2: Select and Specify the Disaster Attributes (Input 2)

A list of default disaster attributes, or characteristics, will be automatically generated for each of the selected disasters based on pre-populated data in the tool. For example, if a user checks the hurricane box, the list of attributes will include category of hurricane, wind speed, storm surge, etc., as shown in Figure 2.8. If the user checks earthquake, the list of attributes will include magnitude, proximity, and time of day. If the user selects more than one disaster planning scenario, tabs will appear for each one to allow the user to review and modify the characteristics of each disaster selected. In Figure 2.8, the user has selected all three disasters for the planning scenario, and has tabbed to the hurricane page.

The Community Preparedness Planning Tool includes pre-populated default values for all disaster attributes. These values are either set arbitrarily (e.g., hurricane Category 1 is the default) or based on values found in the literature (e.g., pandemic influenza adult attack rate = 25 percent). All these default settings can be changed by users in order to better tailor planning assumptions to the local setting.

The user reviews and can modify any of the following information, respectively, for each type of disaster:

- **Hurricane:** category, wind speed, storm surge, co-occurrence with flood, depth of flood, percentage of population able to evacuate pre-disaster and not needing shelter post-disaster

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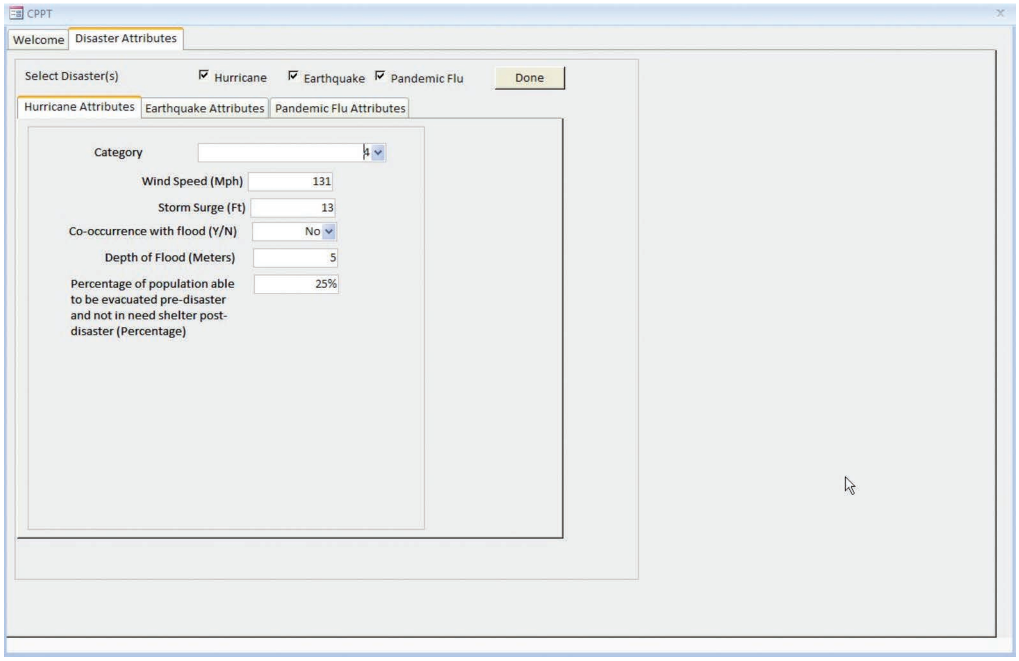
[3] The prototype tool does not capture the interactions of multiple disasters occurring concurrently.

Figure 2.8
Disaster Attributes Page for a Hurricane



RAND *TR928-2.8*

- **Earthquake:** magnitude, proximity, time of day
- **Pandemic influenza:** pandemic scenario (H1N1 or other), untreated disease case-fatality rate, population not seeking medical care, population seeking medical care, potential for multiple events, attack rate in overall population.

Step 3: Select and Specify the Community Characteristics (Input 3)

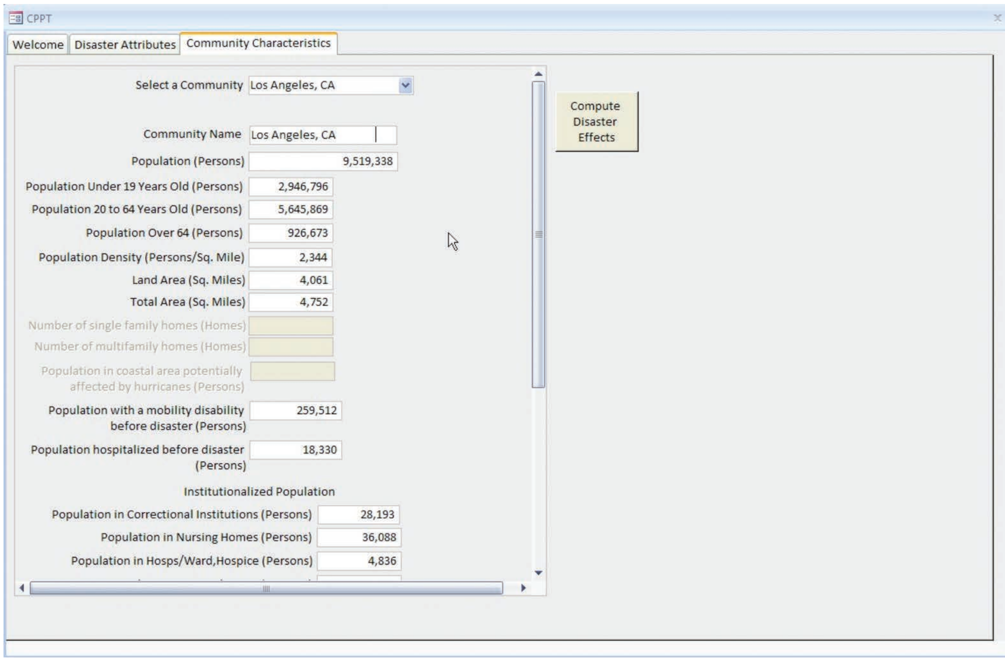
The tool is pre-populated with demographic and population data for all U.S. counties from the 2008 Area Resource File. Users have three options:

- Select a single county
- Combine multiple counties into one "community" for planning purposes
- Create a new, custom community (e.g., by focusing on a specific municipality rather than a county, or by combining sections of multiple counties or several municipalities). The user will need to enter demographic and population data manually for custom communities.

In Figure 2.9, the user has selected Los Angeles County from the drop-down list. After selecting a community for the planning scenario, users have the option of modifying community characteristics, as desired. Community characteristics might focus on different aspects of the population, such as number of persons under 19 years old and population density. Many of the population characteristics focus on identifying the number of people in institutional settings, such as correctional institutions, nursing homes, and hospitals.

Any of the default values can be modified. If the user modifies the default values, these new inputs will be saved automatically for the specified disaster planning scenario run.

Figure 2.9
Community Characteristics for Los Angeles County



RAND *TR928-2.9*

Step 4: Review the Disaster Effects Generated by the Tool (Output 1)

After the user has entered the first three inputs into the tool and clicked on the "Compute Disaster Effects" button on the Community Characteristics tab, the tool generates its first output: estimated disaster effects. The tool uses data on disaster attributes and community characteristics to calculate the effects of the chosen disaster scenario(s) on the community, which will form the basis for capability-based planning. Three types of disaster effects are calculated: population affected, infrastructure affected, the capabilities affected. Disaster effects are calculated based on the characteristics of the specified disaster planning scenario(s) and user-defined community. An example of a Disaster Effects page is shown in Figure 2.10.

Disaster effects are shown individually for each type of disaster selected (i.e., hurricane, earthquake, pandemic influenza). Some disasters do not produce a given type of disaster effect (e.g., pandemic influenza does not cause populations to be displaced or buildings to be destroyed).

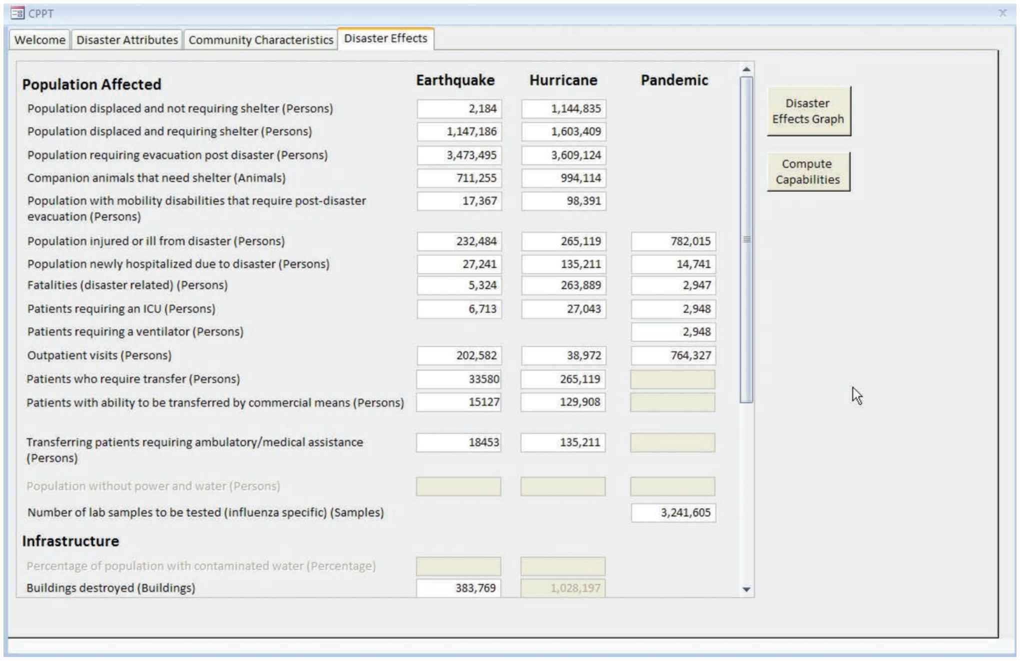
Users can also click on the "View disaster effects" button to see these in graph form, if desired, as shown in Figure 2.11. The graph compares, for each disaster selected, the numbers of displaced persons, persons seeking shelter, injured persons, and fatalities.

Users can modify the disaster effects generated by the tool's functions, if desired. A user might want to modify the disaster effects, for example, if an effect generated by the tool's functions does not correspond to established local planning assumptions. All the disaster effects can be modified by the user.

Step 5: Review the Tool-Generated Capabilities Required (Output 2)

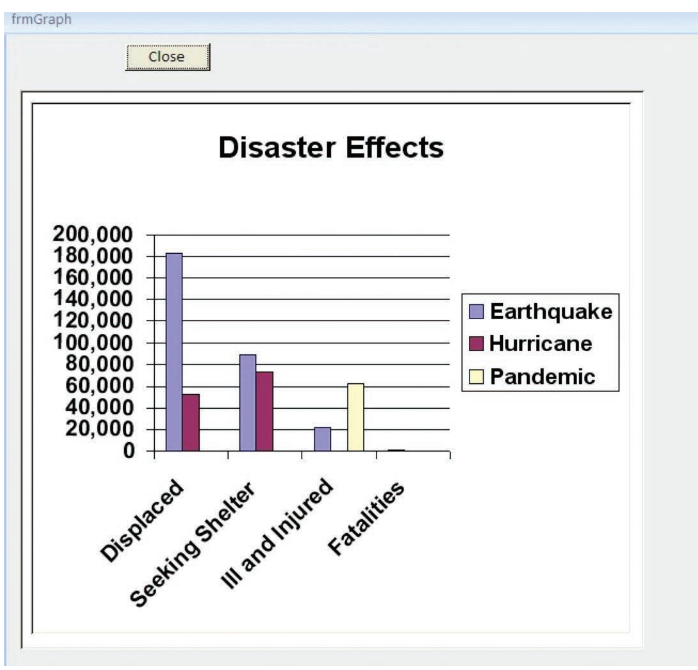
The planning tool uses the results of the disaster effects calculation, along with a set of capability planning factors, to determine the capabilities required to address the effects of the selected disaster. These capabilities are derived from the TCL, FEMA's Resource Typing, CDC's Flu-

Figure 2.10
Disaster Effects Page



RAND *TR928-2.10*

Figure 2.11
Disaster Effects Graph



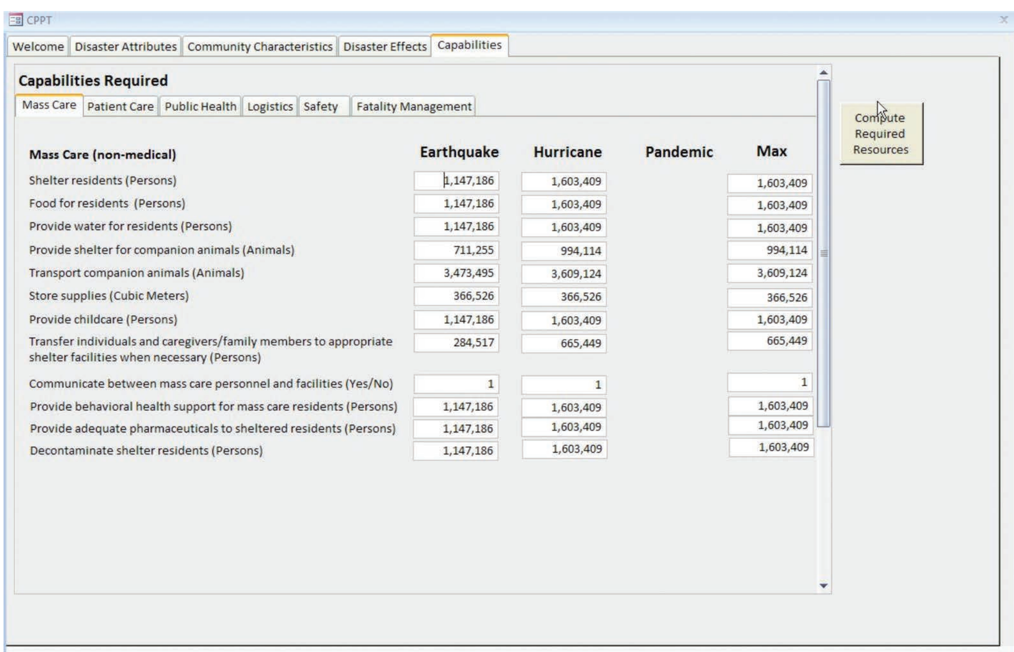
RAND *TR928-2.11*

Surge software, the National Health Security Strategy, the NPS, FEMA's Hazus software, the Veterans Health Administration (VHA) Emergency Management Program Guidebook, journal articles, and published dissertations (DHS, 2007; FEMA, 2005; CDC, 2006; HHS, 2009b; White House, 2005; FEMA, 2009; VHA, 2009).

Figure 2.12 shows an example of the capabilities needed for Mass Care, which relates to emergency sheltering. Required capabilities are shown for two types of disaster: hurricane and earthquake. It also displays six tabs that cover ten major capability areas (listed as bullets):

- Mass Care
  - Mass care (non-medical)
- Patient Care
  - Triage/pre-hospital care and patient transport
  - Medical surge
- Public Health
  - Public health
  - Mass prophylaxis
- Logistics
  - Medical supply and distribution
  - Health communication
- Safety
  - Patient protection
  - Worker health and safety
- Fatality Management
  - Fatality management.

Figure 2.12
Required Capabilities Page for Mass Care



RAND *TR928-2.12*

The tool calculates requirements for 58 specific capabilities in these 10 capability areas. An additional 52 capabilities were identified, but we could find no quantitative data to incorporate them into the functions for the tool's computations. All of the capabilities, organized by capability area, are presented in Appendix B.

For each disaster in the planning scenario, the columns at the right show the number of persons, samples, vehicles, etc., needed for each capability. For example, in the illustration shown, the Earthquake column shows that 1,147,186 persons will require shelter; thus, planning must aim to ensure the resources and capability to provide shelter for this number of displaced persons.

The "Max" column at the right shows the maximum level of each capability which might be required to address any of the selected disasters. This value is equal to the largest value in the corresponding disaster columns.

Step 6: Review Tool-Generated Required Resources (Output 3)

The tool uses a set of pre-populated resource planning factors to calculate the resources required to provide the capabilities needed to address the planning scenario. Resources are calculated in each of the 10 capabilities areas.

This part of the tool focuses mostly on major resources (e.g., not down to number of needles and syringes needed). These resources are derived from the same sources noted above under Step 5, "Review the Tool-Generated Capabilities Required."

Figure 2.13 shows an example of the safety resources required for the three different disasters. The columns at the right show the number of resources required for each item. For example, 405,633 meals would be needed in the case of the specific hurricane scenario (especially the selected hurricane category) used in this planning run.

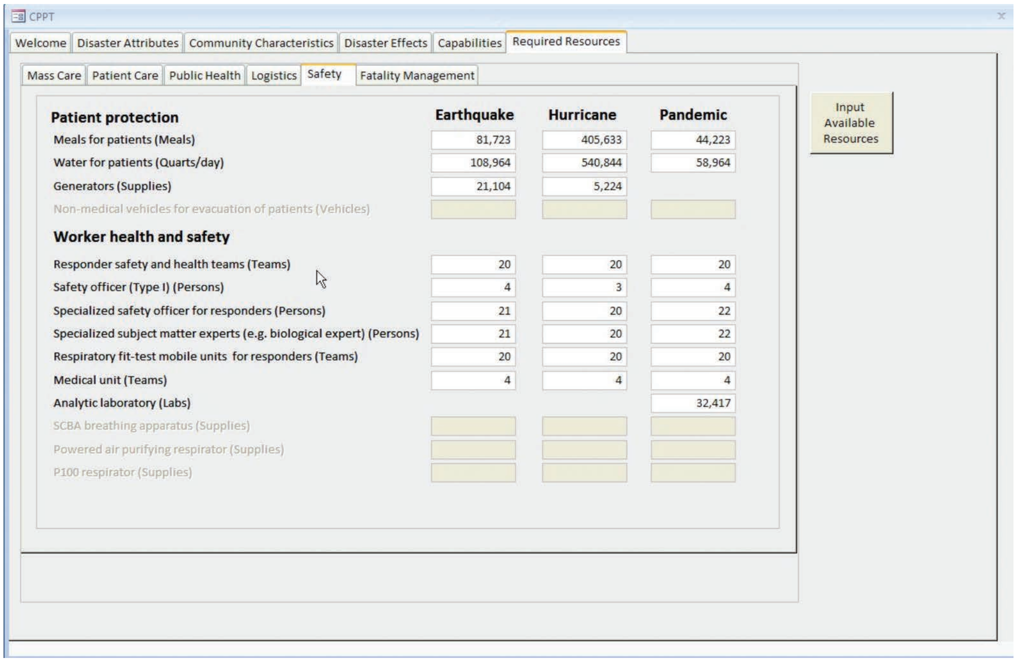
Step 7: Specify the Available Resources (Input 4, Optional)

Users have the option of inputting data about available organizational resources, which can then be used to perform a resource gap analysis. Approximately 200 different resource items can be tracked by the tool (See Table C.5 in Appendix C). These encompass the 10 resource areas shown in the Required Resources step, which also correspond to the 10 capability areas: mass care (non-medical), triage/pre-hospital care and patient transport, medical surge, public health, mass prophylaxis, medical supply and distribution, health communication, patient protection, worker safety and health, and fatality management.

While filling out the fields on this page requires some effort, doing so will allow the user to take advantage of all the features of the tool. Participants at our vetting sessions indicated that identification of resource gaps is particularly useful to them. The tool cannot identify these gaps unless the user inputs available resources.

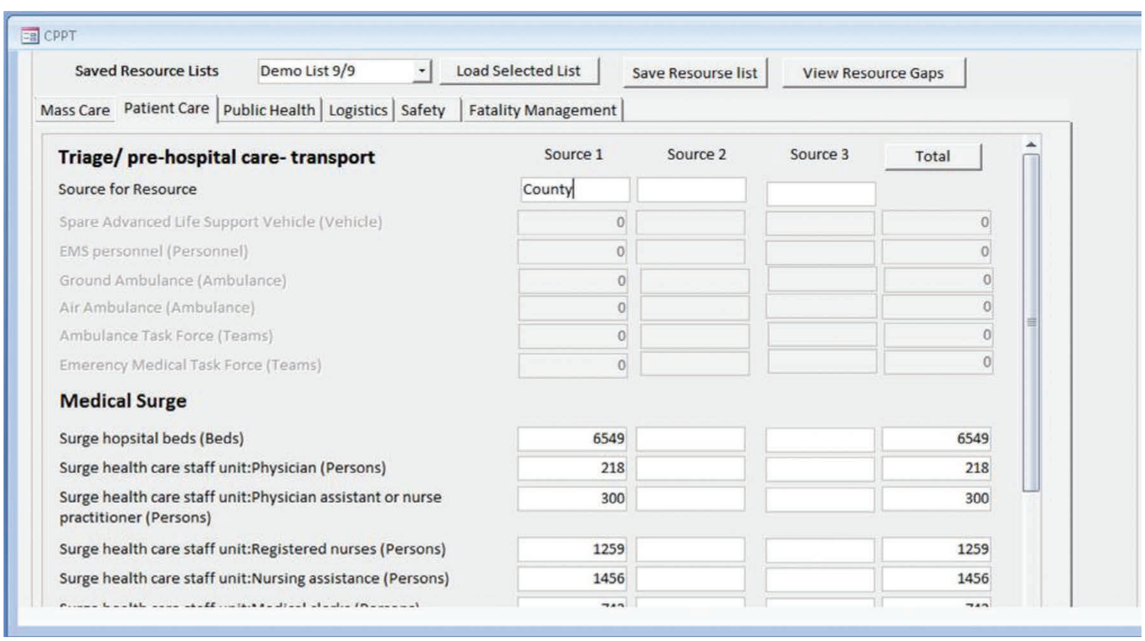
Figure 2.14 shows an example of the Available Resources page for patient care. The user enters available resources into one of three columns, labeled Source 1, Source 2, and Source 3. These columns allow the user to name and distinguish between different groups of resources available from different sources (e.g., the county, the military installation, the VA). The right column sums the total amount of resources entered into the other three columns. If preferred, the user can enter all resources from various sources into one column.

Figure 2.13
Required Resources Page for Safety



RAND *TR928-2.13*

Figure 2.14
Available Resources Page for Patient Care



RAND *TR928-2.14*

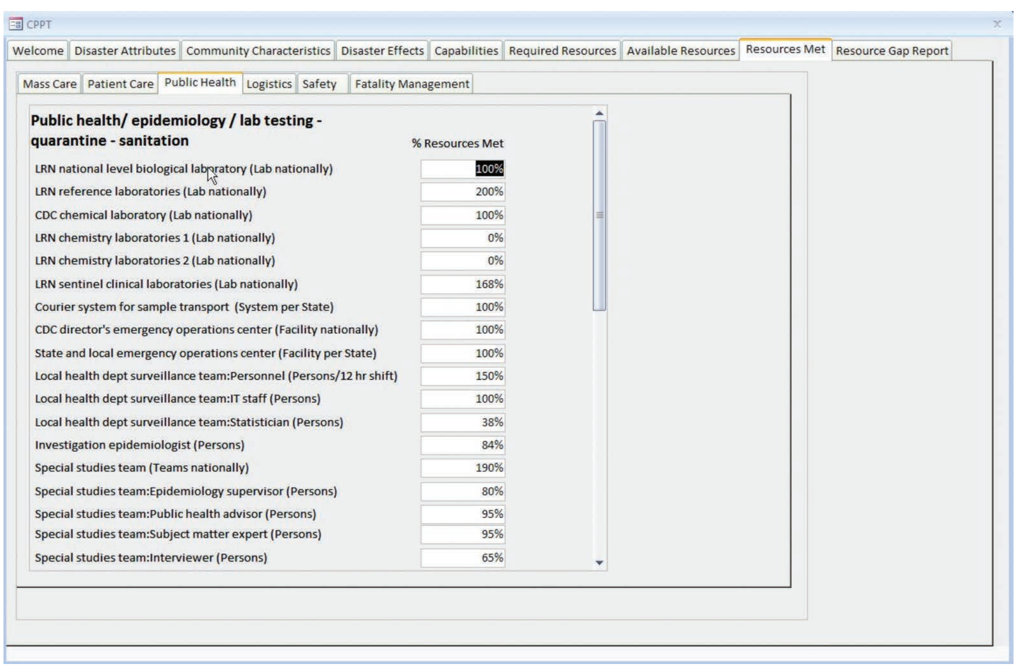
Step 8: Review Resource Gaps (Output 4)

If users enter available resources (from within their own organization exclusively or across local organizations), they will have the option of reviewing the percentage of resources met and generating a resource gap report. The tool compares user-entered available resources with the required resources to determine resource gaps. This information can be used to target resource planning and procurement.

The Resources Met page of the prototype tool lists the same resource items shown on the Available Resources page. An example of a Resources Met page is shown in Figure 2.15. The figure displays the Public Health tab.

The Resources Met page contains only a single column for each item, which displays the percentage of each required resource met in each resource area. The percentages shown are based on the maximum number of resources required across the disasters selected for the planning scenario (the disaster driving the "Max" value for each resource on the Capabilities Required page) and the total available local resources (from one, two, or three local organizational sources included in the Available Resources page). If the user has not filled out the Available Resources page, the value for each item will be 0.00 percent.

Figure 2.15
Resources Met Page for Public Health Capability Area



RAND *TR928-2.15*

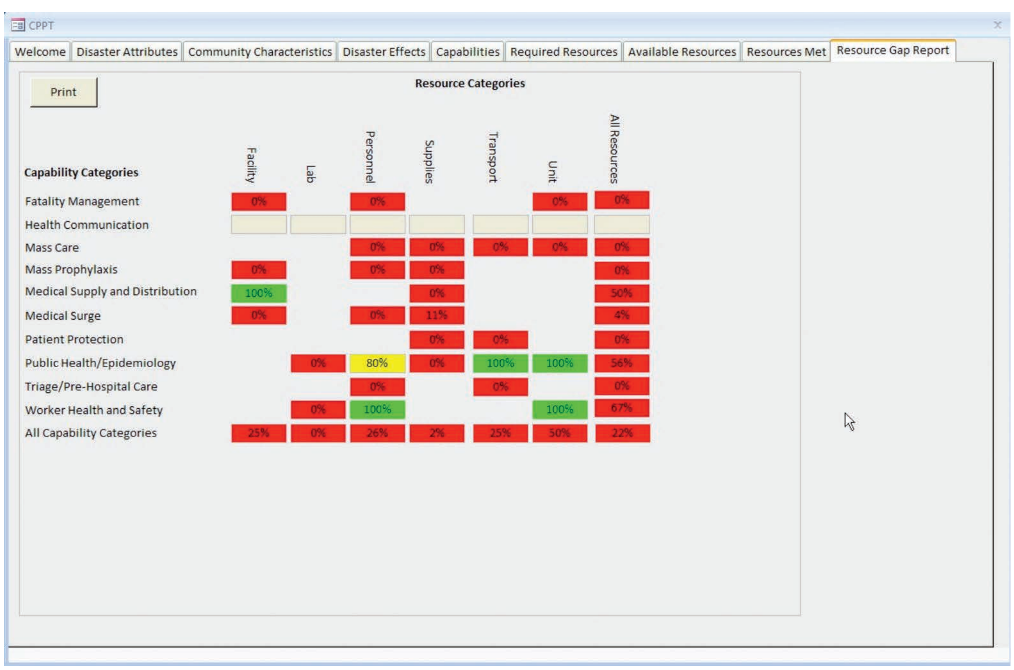
Step 9: Generate Reports

The prototype tool generates two reports. The first report is a spreadsheet export of all tool inputs and outputs for all saved runs. The user can create this report from the Welcome tab of the prototype tool. This export is useful for users who want to create customized reporting or comparisons beyond the current capabilities of the prototype tool.

The second report is a summary of the resource gaps and is described subsequently. The Resource Gap Report is a summary "stoplight" table that provides the user with a high-level overview of resource gaps. An example is shown in Figure 2.16.

The Resource Gap Report allows users to see areas of most critical need that should be considered for improvement or expansion efforts. The 10 capability categories are listed along the left side of the table. Across the top of the table are six categories of functional resource types: facility, lab, personnel, supplies, transport, and unit. The right column provides a rating across all types of resources in a particular capability category. The bottom row provides a rating across all capability categories in a particular type of resource. The bottom right cell provides an overall rating. The ratings are calculated by linking each capability to related resources. This linkage and the score for percentage of resources met are aggregated to each capability category and resource type. A rating of 100 percent or more is shaded green in the tool and indicated by a value of 100 percent in the figure; a rating of 75 percent to 99 percent is shaded yellow in the tool and indicated by values in this range in the figure; and a rating below 75 percent is shaded red in the tool and indicated by values <75 percent in the figure.

Figure 2.16
Resource Gap Report



Capability Categories	Facility	Lab	Personnel	Supplies	Transport	Unit	All Resources
Fatality Management	0%		0%			0%	0%
Health Communication							
Mass Care			0%	0%	0%	0%	0%
Mass Prophylaxis	0%		0%	0%			0%
Medical Supply and Distribution	100%			0%			50%
Medical Surge	0%		0%	11%			4%
Patient Protection				0%	0%		0%
Public Health/Epidemiology		0%	80%	0%	100%	100%	56%
Triage/Pre-Hospital Care			0%		0%		0%
Worker Health and Safety		0%	100%			100%	67%
All Capability Categories	25%	0%	26%	2%	25%	50%	22%

RAND *TR928-2.16*

Feedback on the Planning Tool

As noted earlier, the Community Preparedness Planning Tool is an initial prototype. To understand how planners might use the tool and if there were opportunities for improvement, we sought feedback from civilian and military planners (see Table 1.1 for the list of organizations).

Many were enthusiastic about using the tool, even in its early prototype form. Some communities asked to use the tool immediately and expressed an interest in distributing the tool to community partners. Planners said the tool would be especially useful in orienting new staff, leaders, and organizations. They appreciated the fact that the tool, even as a prototype, allows planners to tailor inputs and resource planning to community needs. Planners felt that the tool would provide visibility into the availability of local resources, which would be helpful at all levels (local to federal). Data generated from the tool would be helpful in justifying resource purchases.

The multiple vetting sessions helped us to improve the presentation of the prototype tool. Below is a list of recommendations and the prototype enhancements associated with each:

- **Recommendation: Clarify the listing of some of the FEMA resource types.** The prototype now clarifies that some FEMA resources are either/or in nature. As an example, a community may need two Type I or four Type II volunteer agency field kitchens. We have used indentation spacing and text in the tool interface to clearly label such instances.
- **Recommendation: Create the ability to export results.** We created the ability to export all inputs and tool calculations for any scenario run. We also implemented the ability to save scenario runs and available resource inputs.
- **Recommendation: In the summary stoplight chart, label the cell shading thresholds (rather than just color coding them and not specifying threshold values for each).** We added a legend to the stoplight chart to indicate that metrics less than 75 percent are shaded red, between 76 and 99 percent are shaded yellow, and 100 percent and greater are shaded green; the actual values are also included in each colored box.

The vetting sessions also produced some recommendations for additional development and programming of the tool beyond the initial prototype described here. Although these were beyond the scope of the current project, we consider them important for further development:

- Expand the tool to include the full range of disasters (e.g., nuclear, radiological, and biological attacks; and chemical attacks and accidents) and capabilities (i.e., beyond health)
- Expand the tool to account for specific populations of relevance to some communities (e.g., tourists, homeless)
- Build an interface between the planning tool and other existing tools (e.g., for risk assessment and event management)
- Add more infrastructure effects (e.g., status of major transportation routes)
- Program the tool to import updated data from other disaster effect tools (e.g., Hazus) and key databases (e.g., Area Resource File)
- Program the tool to display underlying planning factors and functions for capabilities
- Include non-resource elements to generate capabilities (e.g., communications capability area)
- Address resource dependencies

- Automate sensitivity analysis across disaster attributes (expected case/worst-case scenarios)
- Account for disaster response personnel affected by the disaster.

It is important to note that the vetting sessions were not used to test the accuracy of the underlying data and, therefore, the outputs of the planning tool. The sessions were simply to determine if the prototype tool was presented in a clear and user-friendly format and performed functions that would be useful to local community planners.

RAND will gauge the interest of current sponsors and others in developing the tool further. In the near term, RAND is exploring ways to make the prototype tool accessible to local civilian and military planners for purposes of systematically testing it for potential usefulness and for soliciting modifications to inform the tool's further development. We will discuss next steps in Chapter Four.

CHAPTER THREE

Networking Tools

Local all-hazards preparedness and response usually involve multiple agencies—within both the civilian and military sectors—that need to address multiple capabilities across one or more locally relevant disaster planning scenarios. These activities can quickly become complex and challenging to manage. Well-developed social networks can potentially enhance successful local preparedness planning by building familiarity and relationships and facilitating joint activities and collaboration among local response organizations.

RAND developed a community networking framework that makes use of two existing tools, Liferay Social Office, and CI-KNOW (Cyber Infrastructure Knowledge Networks on the Web).[1] These tools can help preparedness planners improve their understanding of local preparedness relationships and networks, build contacts among relevant partners, and enhance the efficiency of risk assessment, planning, and other preparedness activities as well as disaster response and recovery. Social Office is designed to help planners become familiar with other organizations in the local network and to communicate and collaborate more easily and efficiently with each other. CI-KNOW provides ways for planners to assess the structure of the local response network and its individual components.

The tools were selected following extensive research to better understand local emergency planning practices and needs across military and civilian agencies. We adapted them specifically to meet certain needs for local disaster preparedness.

We intend that the prototype tools presented here for demonstration will also give the sense of the possibilities that these tools hold for the future of collaborative work, not only in local emergency preparedness and management but across any number of fields for which collaboration is becoming increasingly important.

In this chapter, we provide an overview of the goals and scope of Social Office and CI-KNOW, then we discuss each tool separately, including the approach used in selecting and adapting the tool and a description of some of its key features.

[1] Social Office is open source collaborative workspace software developed by Liferay, Inc. CI-KNOW was developed by the Science of Networks in Communities research group at Northwestern University. It is a web-based platform that integrates data collection, network analysis, network visualization and recommender system tools for applied network monitoring..

Goal and Scope of the Community Networking Tools

Social Networking with Social Office

Social Office provides tools and practices that can be used to maintain and enhance collaboration among organizations. Social Office is an online social networking tool that allows agencies to create an online forum for their network and to collaborate more efficiently. Social Office can be used to perform the following functions, among others:

- Serve as a common platform to link all three tools created through this project: detailed social networking functions, network monitoring tool, capabilities-based planning tool
- Capture and readily access names and contact information (through user profiles) for organizations involved in emergency preparedness activities
- Store important documents in a central location
- Provide news, announcements, and links to key resources
- Share other relevant information to facilitate local relationships and collaboration, such as key roles and capabilities (through user profiles), readiness exercises and contingency plans, and information to facilitate resource sharing.

Relationship Management and Network Monitoring with CI-KNOW

CI-KNOW is a relationship management/network monitoring tool that allows emergency preparedness organizations to understand the functioning and overall "health" of their network. CI-KNOW provides qualitative and quantitative analyses (visualizations and metrics) to facilitate:

- information sharing regarding roles and responsibilities
- collaborative readiness exercises and contingency planning
- resource sharing
- exploration of how the network (and its individual network members) is performing
  - who is connected or not connected to the network
  - who is connected to whom and how many steps removed
  - the visualizations and metrics suggest potential single points of failure, missing or redundant relationships, and opportunities for more efficient connections.

In employing both these tools, users should work closely with their information technology departments to ensure that the tools are set up appropriately to meet users' needs and to support the efficient functioning of the tools. While the information technology requirements are not especially complicated, information technology support will facilitate efficient distribution and local management of the tools.

In seeking tools to improve collaboration and network monitoring (which in turn supports relationship management), we sought to take advantage of existing open-source or readily available tools, making modifications to make the tools more closely match the needs of the emergency preparedness and planning environment and making them easier for non-experts to use. In the following sections, we describe each of the tools in more detail.

Social Office

Social Office provides an online "portal," a website that integrates a number of functions and provides access to them in a single location (Liferay, 2008). Social Office combines multiple types of technologies, including synchronous communication technologies (chat), asynchronous communication technologies (email, announcements, calendar functions), and content management technologies (document libraries, Really Simple Syndication [RSS] and URL bookmark libraries). All of these technologies can be accessed through a user profile (described below).

Social Office is an open-source Java©-based collaborative web portal that combines the standard portal-based file sharing capabilities with the collaborative tools often included in social networking sites (e.g., user profiles, collaborative calendars, synchronous and asynchronous communication technologies). Social Office provides access to shared document repositories, RSS feeds, private pages for operational and planning activities, important Internet links, and user profiles that specify the key resources and activities that each organization provides.

We envision Social Office as a single entry point to all the tools an emergency preparedness planning network might need. We have attempted to provide enough content in our demonstration site so that interested parties can understand how Social Office can be used. The demonstration site is a simple proof-of-concept site, which highlights the important collaboration enhancing tools provided by Social Office.

Approach for Adapting Social Office

Our team created a Social Office format exclusively tailored to emergency preparedness planning at the local level. The changes we incorporated allow for direct access to the other tools developed or adapted by RAND (CI-KNOW and the community preparedness planning tool). There are links within Social Office that offer users quick access to these other tools.

To facilitate use of the Social Office, we created an illustrative example of a Social Office home page and an operational subgroup, added relevant documents to the repositories and bookmarks, and added some illustrative activities to the calendar. Users can refer to this example home page for ideas about how they might want to set up their own Social Office page.

We also created a custom user's guide to be used in conjunction with already existing documentation for Social Office. Our guide focuses primarily on the key steps for collaboration in the area of emergency management, including emergency preparedness and response. These steps enable the kind of interactions identified as important in our formative research and help simplify the use of the modified collaborative web portal by local emergency management planners.

Key Features of Social Office

Inputs. The main input for Social Office is a user profile generated by each agency. The agency profile should include information about the following:

- Sector: military or civilian (the VA is listed separately within the civilian sector)
- Function: emergency management, security/law enforcement, fire/emergency medical services (EMS), public health, medical services, chemical, biological, radiological, nuclear, explosive (CBRNE)/hazardous materials (HAZMAT)
- Contact information for key personnel (e.g., name, telephone, email)

- Nature and type of partnerships with other local preparedness organizations (e.g., formal or informal information sharing, resource sharing, prior joint drills/exercises/responses).

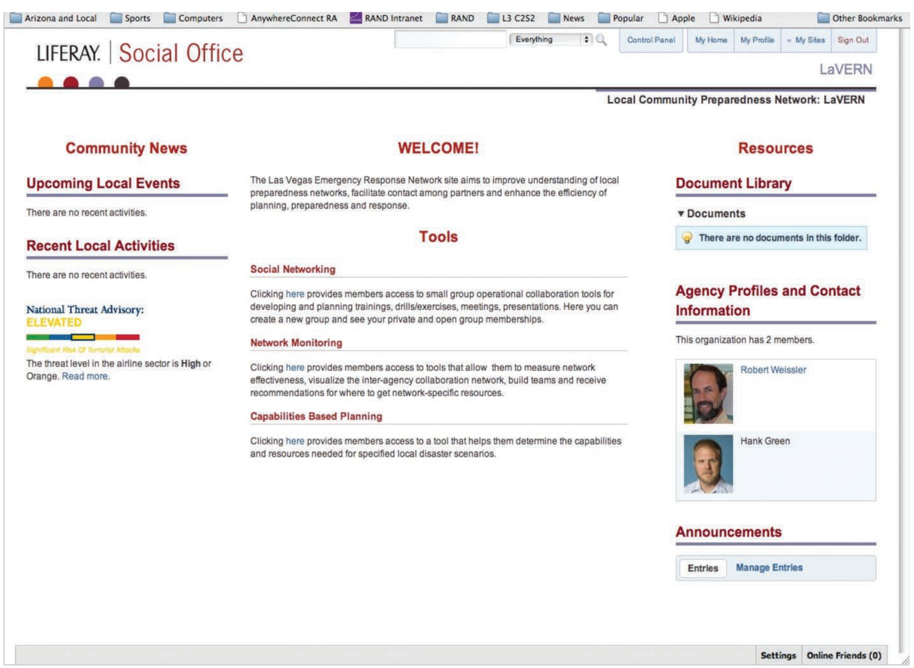
Each user of Social Office will have a profile page detailing this and other information. The completion of a user's profile by all relevant local agencies enables efficient collaboration and networking. The small burden on an organization to input data for the user profile is offset by the efficiencies that can be gained by individual agencies and the local network as a whole, including network continuity in the face of individual staff turnover.

Outputs. The key output of Social Office is the network home page, which provides network members with easy access to collaboration tools and resources. Figure 3.1 shows an example of a Social Office home page. The left column lists upcoming events and activities involving network members. The center column lists tools available to network members (the two networking tools described in this chapter and the planning tool described in the last chapter). The right column lists documents in the network library and provides links to members' profiles. This column also includes announcements of interest to network members.

A home page such as this one is central to Social Office's collaboration functions. Users can access the page to share documents, schedule collaborative events, access each other's profiles, access other network tools, and perform other actions that support community networking.

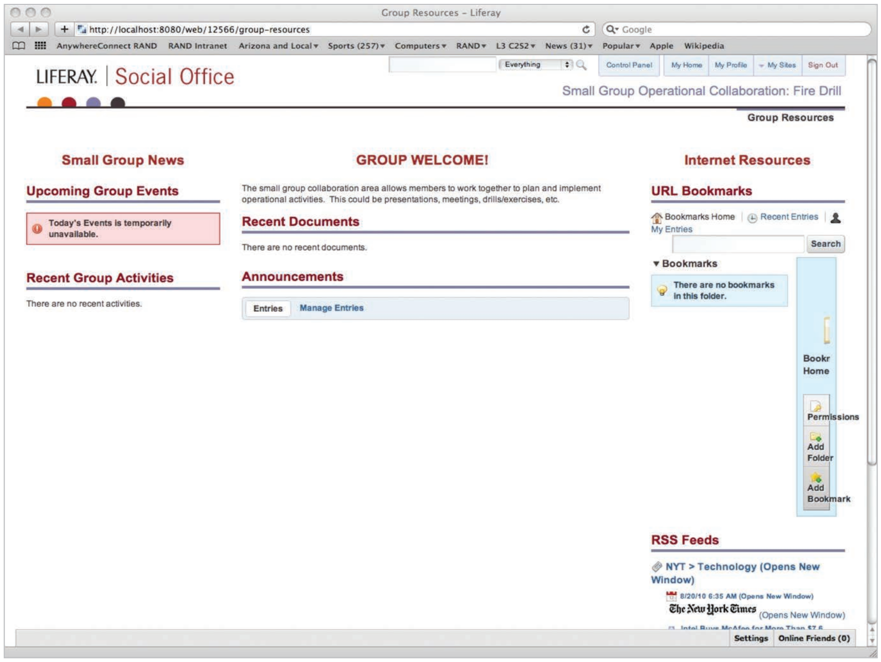
Social Office can also be used to create small group pages focused on a specific issue or activity. An example is shown in Figure 3.2. This type of page facilitates planning by a subset of the larger local preparedness network (e.g., related to a specific function such as public health or medical response, or for a specific activity such as an upcoming local exercise).

Figure 3.1
Home Page for Social Office



RAND *TR928-3.1*

Figure 3.2
Example of Small Group Page



RAND *TR928-3.2*

CI-KNOW

CI-KNOW is a network analysis tool developed by the Science of Networks in Communities (SONIC) research group at Northwestern University (Northwestern, 2010). The tool incorporates basic network metrics with visualization capabilities to enable exploratory analysis of collaborative networks at the level of individual organizations and overall. The tool enables network members to manage their relationships and make strategic decisions regarding planning and collaboration. The tool was initially developed for and targeted to the network research community, but we saw its relevance to emergency preparedness policy and therefore selected it for adaptation and use in this context, especially to help communities:

- determine which organizations in the network have important skills and resources that others might need
- match resource holders with those who need the resources
- determine whether networks are working effectively
- explore how specific organizations are functioning within the network
- understand how to modify the network to improve efficiency and communication.

While an individual organization might employ Social Office or CI-KNOW internally, we assume that a group of organizations will choose to employ these tools to improve interorganizational collaboration. In this context, organizations are members of a collaborative *network* that has chosen to use these new technologies. Network members are likely to be a range of military and civilian organizations, especially local entities such as emergency managers, public health, public and private medical facilities (including local health providers within the

Veterans Health Administration), fire services, emergency medical services, law enforcement, schools (both public and private), other governmental organizations, nonprofits, businesses, and other organizations involved in emergency preparedness activities.

CI-KNOW allows each local network to determine exactly what collaboration means. For some networks, collaboration might consist solely of sharing information. Other local networks might have more formal definitions of collaboration, perhaps involving memorandums of understanding (MOUs) or other types of collaborative agreements. These tools can accommodate each network's own definition of collaboration, and can help facilitate both formal and informal collaboration. For purposes of application to emergency management networks, we use a broad definition of collaboration. Organizations in our example network are considered to be collaborating (or "connected") if they report communicating with each other about emergency preparedness.

Approach for Adapting CI-KNOW

We created and populated an illustrative example of a CI-KNOW network using de-identified data collected from a case study during the formative phase of this project. Then we used the tool to perform the necessary calculations to show how it allows users to create network maps and to identify the most direct pathways connecting organizations.

To make the tool more accessible, our team formatted a series of blank Microsoft Excel© tables that replicate what we believe to be the essential information necessary for initial exploration of network properties, such as what roles organizations play in emergency response planning and which organizations are connected to each other formally or informally (a complete list is provided under the "Inputs" section below). These tables, when completed with data specific to the user's own community network (entered either by a single individual or collaboratively), can be uploaded to an appropriately configured CI-KNOW site to form the basis for all network analyses and visualizations. These blank tables make uploading data and getting started with CI-KNOW easier, which facilitates the collaboration, and network monitoring capabilities that the communities will have at their disposal, such as network visualization tools, user profiles, and the recommendation system.

To make collaboration easier among the members of the network, we created a customized user's guide to point out specific applications of the tool's basic features in the local emergency preparedness context. Local organizations (i.e., network members) can consult the guide to learn how network analysis can be used to facilitate and strengthen information sharing and collaboration. Our user's guide can be used in conjunction with the extensive documentation already available for the tool. That documentation is available continuously from the left-hand-side resource panel within CI-KNOW.[2] Our guide focuses primarily on the key steps for conducting analyses relevant to preparedness planning and simplifying the relevant data import, analysis, and output functions significantly.

Key Features of CI-KNOW

Inputs. As with Social Office, the main input for CI-KNOW is a user (i.e., agency) profile. CI-KNOW includes a survey to gather additional key information about the existence and nature of connections between local agencies. Responses to the survey are also part of the user profile.

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2 The information also can be accessed at http://iknow.northwestern.edu/documentation.html

The CI-KNOW administrator chooses the questions to be included in the survey. These questions can use free text boxes, drop-down lists, rating scales, and other formats. By responding to the survey questions, users provide the data that can be used to create visual displays of community networks and to analyze network relationships.

Survey questions generally fall into two general categories: questions about the organizations themselves, such as member opinions on how important collaboration within an emergency preparedness network is for successful response; and questions about the organization's interactions with other network members, such as which organizations have conducted joint trainings within the past year. The answers to these questions add to the basic information provided in the organizational profile to allow organizations to describe their key functions, important goals, and main areas of operation, and to provide other information that is important in the emergency preparedness context. These questions should be based on the choices made by the network members as to what is important to know in their own local context.

Included in the sample survey in the demonstration version of CI-KNOW are such basic questions as:

- To what degree do you interact with each other network member organization through formal agreements, MOUs, or other similar specific agreements?
- To what degree do you interact with each other network member organization through informal channels, such as seeking advice or sharing information?
- Please tell us what level of operation best describes your organization.
- Are you a military or civilian organization?
- What role does your organization play in emergency response?

Based on answers to the questions, a network administrator can then describe the network "features" of member organizations, for example:

- Popularity—the number of other organizations that name your organization as a partner of theirs
- Number of reported—the number of other organizations that your organization names as partners
- Information—based on network structure
- Unique connections—the number of connections your organization has that others do not have, thus how much access to unique information or resources your organization has
- Cliquishness—based on small group connections, the degree to which you and the organizations you are connected to only interact with each other, i.e., how "clumpy" the network is.

The Excel spreadsheets created by RAND for uploading data into CI-KNOW allow organizations to provide information on several topics of interest for emergency response planning, such as:

- what types of emergency planning and collaboration are taking place in the local area
- which organizations are connected to each other in formal or informal modes of interaction

- what kind of unique relationships are maintained between any two organizations in the local network (e.g., informal communications, formal agreement, prior joint planning or exercises).

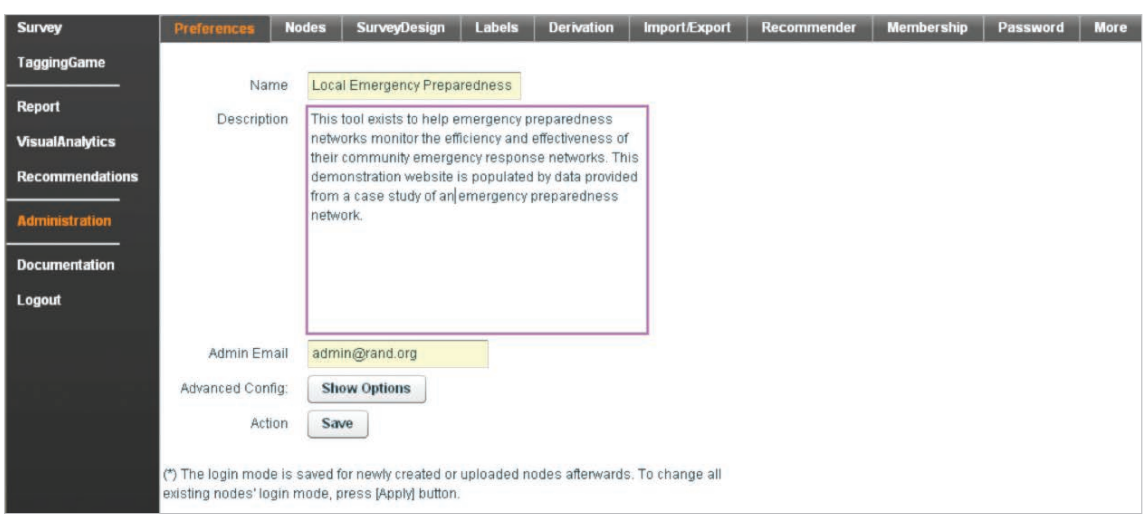
Outputs. A local community preparedness network can be quickly set up in CI-KNOW, as shown in Figure 3.3. The first step is to create a CI-KNOW worksheet for the network, as seen in the figure. The network will include a name for the network, a description of its content, and administrator contact information.

A key output of CI-KNOW is a network map, which we here refer to as a visualization. Network visualizations are used to view and assess network relationships. Visualizations can also be used to determine how the network might be modified to improve efficiency and collaboration.

An example is shown in Figure 3.4. This map shows the network of civilian and military preparedness organizations in a particular county. The map indicates that the county health department (County2HD) plays a key role in linking military and civilian preparedness organizations. However, there are very few other connections between military and civilian organizations. Thus, network members might want to consider strengthening relationships between other organizations in order to improve the efficiency of the network, and to reduce the risk that the network might split if County2HDwere to leave the network. It is not likely that a county health department would leave a local network, but it could temporarily lose connectivity; the figure is intended to show the effects of any organization with similar connections leaving the network, whether temporarily or permanently.

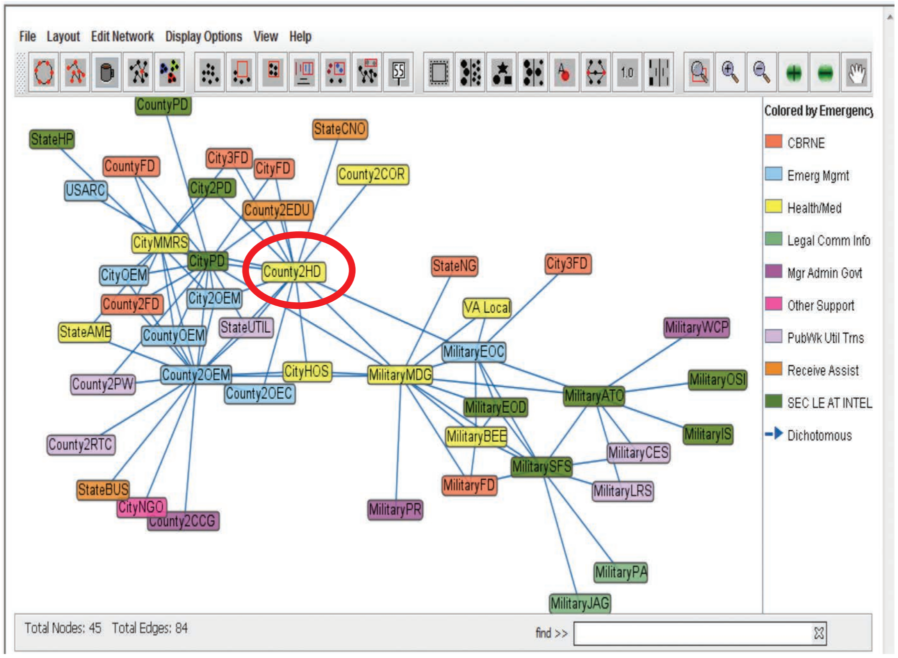
With CI-KNOW, planners can explore and assess network relationships from the perspective of one organization. For example, Figure 3.5 shows the City Office of Emergency Management (OEM) at the center of the network. Planners can see all the current relationships that are within two steps from the City OEM and can identify opportunities to build relationships with other organizations in the network. By clicking on the nodes (boxes) for other organizations, planners can access the organization's profile information and contact information in a

Figure 3.3
Administrator's Set-Up Page in CI-KNOW



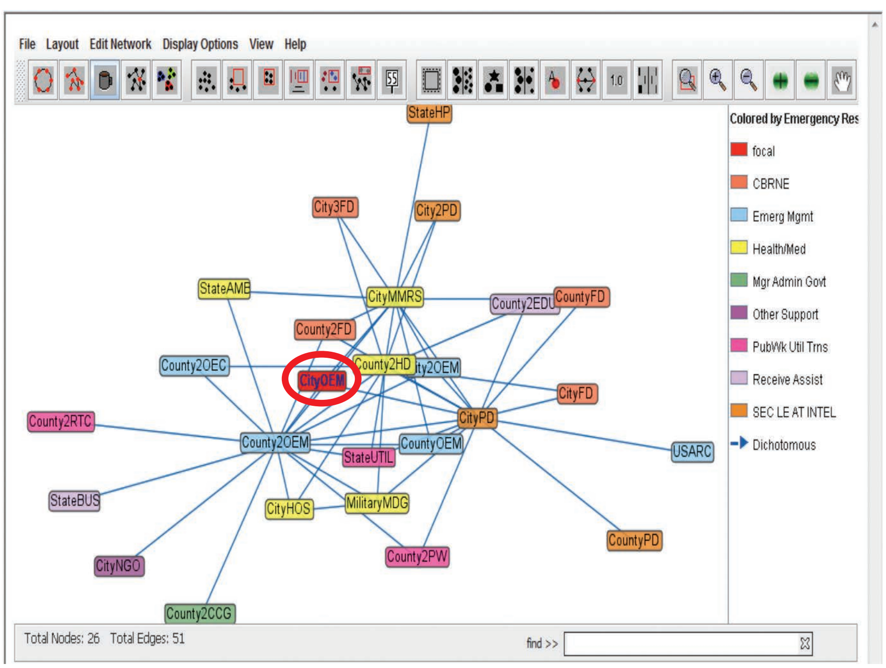
RAND *TR928-3.3*

Figure 3.4
Example of a Local Network Visualization



RAND *TR928-3.4*

Figure 3.5
Example of a Network Focused on an Individual Organization



RAND *TR928-3.5*

separate browser window. Users might also examine resources owned by different members of the network in order to enhance collaboration and resource sharing.

CI-KNOW can also be used to identify options for using existing contacts as a means to develop new relationships. For example, a small non-governmental organization (NGO) might want to establish a relationship with a larger, more prominent organization in the network, such as the local VA. Rather than simply cold-calling the VA, the NGO might prefer to connect to the VA by drawing on existing relationships with other organizations. Figure 3.6 shows the shortest pathway from the "CityNGO" to the local VA via existing contacts.

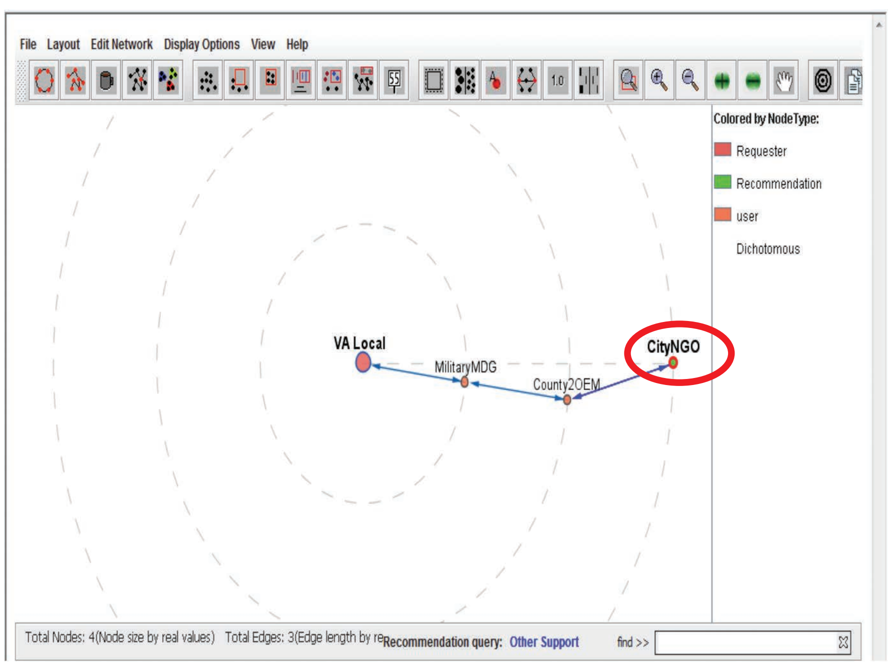
This function allows users to search for recommendations based on community members' names or an attribute that other organizations may have. Users can seek recommendations for making connections between their own organization and any other one in the network.

Users can also obtain recommendations for creating organizational teams that maximize similarity and diversity across a variety of organizational attributes. One could imagine that a user might want to create a number of teams for a preparedness exercise that maximized diversity across emergency response roles, so that each team would have a broad range of skills, and that maximized similarity across locations, so that team members could better understand each other's operational context. If the user did not know much about the organizations, the tool can provide a simple analytic process for creating those teams.

Feedback on the Community Networking Tools

We vetted the community networking tools at several sites (listed in Table 1.1) and received useful feedback.

Figure 3.6
Example of a Recommended Pathway to Connect Organizations



RAND *TR928-3.6*

Social Office provides distinct differences from tools with which our test audiences were already familiar, such as SharePoint, All Partners Access Network (APAN), and Community and Regional Resilience Institute (CARRI) tools (Microsoft SharePoint, 2001; APAN, 2010; CARRI, 2007). Some participants in our vetting sessions noted that Social Office could be used to provide easy access to other important networking and emergency management tools.

However, networking and firewall issues could be problematic for some organizations, especially for military installations. Each local area needs to determine the best local solutions for sharing data in accessing the Social Office site. The ability to export and import data will be critical to both online collaboration through Social Office and network analyses through CI-KNOW.

Participants in the vetting sessions noted several features of CI-KNOW that seemed especially valuable. Some indicated that the network mapping capability might be particularly useful for junior employees or other personnel who are new to an organization and want to understand network relationships. CI-KNOW might also be used to help alleviate the loss of organizational and institutional knowledge.

Some participants noted that the usefulness of CI-KNOW might be extended if it could be used in conjunction with other Web-based tools such as Google Maps, which would display network relationships in geographic space. At the same time, others wanted to be able to use CI-KNOW, if desired, without having to employ other tools.

Participants in the vetting sessions also suggested that CI-KNOW might be simplified by focusing on just a small number (perhaps up to three) of key types of interactions or collaborations among local preparedness organizations. The three we considered were informal interactions (exchanging information and advice), working together on planning and exercising, and engaging in formal interactions, such as a contract or memorandum of understanding.

Participants in the vetting sessions also said that templates would be beneficial to provide an example of an organizational profile and to help organizations upload organizational interaction data. In response to this feedback, we developed the Excel spreadsheets for use with CI-KNOW and are developing a set of instructions for installing CI-KNOW in the same way.

CHAPTER FOUR

Conclusions and Next Steps

The prototype for the capabilities-based planning tool and the two fully functional networking tools developed through this project and described in this report primarily draw from extensive national guidance and other published reports, existing data and existing generic software to provide a new and automated way to perform inherently complex capabilities-based disaster planning and to facilitate networking among local emergency management agencies.

The planning tool, although still an initial prototype, is functional within the scope of its design. We have noted in several places earlier in the report that much of the data used for the tool are in wide circulation and use and were not assessed for accuracy and completeness. We have also noted the specific places where RAND developed estimates (including related assumptions and extrapolations) for certain functions for which data were not readily available or incomplete. The planning tool prototype should undergo robust local testing as well as testing by potential future sponsors and other interested stakeholders, especially for the disaster effects functions, to help inform its further development. Making the prototype available to community users and other stakeholders and systematically assessing user feedback would provide a good opportunity to help determine the extent to which the outputs make sense and reflect planning conditions currently used by emergency planners, if there are significant inaccuracies or other shortcomings in the data and functions used, and whether and how these should be modified in the further development of the tool. In addition, RAND will review any emerging policy, doctrine, and additional scientific evidence to inform that further development.

The initial prototype planning tool can also be expanded in the future to include additional disasters—including but even beyond the current or future National Planning Scenarios, disaster attributes, capabilities needed, and required resources across a broad spectrum of potential risks to communities. Both the planning and networking tools can also be enhanced to make them capable of linking to other tools that may be available to local planners.

As the reader of this report will see, we have used data to provide input to our tools from a variety of sources, particularly from official U.S. government guidance, documents, and tools. As noted throughout the report, the prototype planning tool requires further work to test the inputs and functions already included, especially the functions used to calculate disaster effects. It will also be important to try to develop those functions we considered important conceptually for which we were unable to find credible data to inform their full development. RAND is exploring ways to make the prototype tools accessible to local civilian communities, military installations, and other government agencies that may be interested in testing the tools. Through such a process, we hope to systematically test the data and estimates of the planning tool in particular and thereby inform its further development. We will seek feedback from users on ways that both sets of tools may be improved in any future effort to expand and distribute them more broadly.

The DoD and VA have generously provided the resources necessary to make the original vision for the effort a workable reality. RAND will provide this report, and will make the tools and related user guides available, to other federal agencies that may have interests in the further development of these foundational efforts.

APPENDIX A

List and Description of Source Documents Used in Developing the Community Preparedness Planning Tool

A variety of disaster planning sources drove the creation of the capabilities-based planning prototype tool. These sources were used to construct the tool, list capabilities, and define and create functions and planning factors. We chose primary sources for several reasons. First, the sources that we decided to use are in broad circulation. Some that have been developed in connection with federal government programs are tied to grants provided by federal agencies and in most cases are required to be used by grantees. We believe that it is important to use definitions and a lexicon with which localities are familiar. Although we drew on other documents and an array of literature on the subject matter, we neither relied on the other literature nor made significant attempts to create new "science" in this field.

The following is a list and description of prominent sources used. The descriptions are from the documents themselves or from the proponent's website:

- U.S. Department of Health and Human Services Area Resource File 2008 Release, June 2009 (ARF08)—The basic county-specific Area Resource File (ARF) is the nucleus of the overall ARF System. It is a database containing more than 6,000 variables for each of the nation's counties. ARF contains information on health facilities, health professions, measures of resource scarcity, health status, economic activity, health training programs, and socioeconomic and environmental characteristics. In addition, the basic file contains geographic codes and descriptors which enable it to be linked to many other files and to aggregate counties into various geographic groupings.
- Centers for Disease Control and Prevention's FluLabSurge 2009 (FLS09)—FluLabSurge is designed to assist laboratory directors and public health officials. In the event of an influenza pandemic, both groups are responsible for running influenza-testing laboratories. FluLabSurge is a spreadsheet-based program designed to assist laboratory directors forecast demand for specimen testing during the next influenza pandemic (i.e., the surge in demand), and develop response plans. FluLabSurge produces estimates of: (a) the daily number of specimens that may be delivered to a laboratory for testing; and (b) the testing capacity of that laboratory (e.g., how many samples can be tested per day or work shift) per pandemic transitional day found in each of the pandemic stages. FluLabSurge also helps the user produce a one-page plan showing how capacity will be used to meet user-defined testing goals (e.g., surveillance, strain identification, clinical diagnostics). FluLabSurge comprises three different modules that must be used (i.e., run) in order to produce meaningful results. FluLabSurge allows the user to alter all of the model inputs

and also allows the user to consider 1968-type and 1918-type pandemic scenarios. The three different modules are:

- **Workload Demand Module:** Predicts the daily number of specimens that may be delivered over the course of a pandemic. The number of specimens sent to a lab for testing will depend upon the total number of cases, hospitalizations, and deaths. A user can also choose a scenario representing a 1968-type pandemic or a 1918-type pandemic.
- **Laboratory Capacity Module:** Predicts the average and maximum laboratory testing capacities, using data regarding the number of available personnel and diagnostic machines. The module also allows the user to extensively explore "what if" situations, such as "What if we added more personnel, how many additional tests could we run in a given time period?"
- **Pandemic Planning Module:** Utilizes the data from the other two modules to assist in planning for the next pandemic. The output from this module can be pasted into presentation material and/or reports.

- Centers for Disease Control and Prevention's FluSurge software version 2.0 (FluSurge 2.0)—FluSurge is a spreadsheet-based model that provides hospital administrators and public health officials with estimates of the surge in demand for hospital-based services during the next influenza pandemic. It estimates the number of hospitalizations and deaths of an influenza pandemic (whose length and virulence are determined by the user) and compares the number of persons hospitalized, the number of persons requiring intensive care, and the number of persons requiring ventilator support during a pandemic with existing hospital capacity. With FluSurge 2.0, users can now change variables that affect estimates of the number and duration of influenza-related hospitalizations. Variables that can be altered by the user include the assumed average length of hospital stay for an influenza-related illness, and the percentage of influenza-related hospital admits that will require a bed in an Intensive Care Unit (ICU). The user can also change the total number of persons requiring hospitalization.
- City and County of San Francisco Department of Emergency Management, Catastrophic Earthquake Response Plan 2006 (SFEP06), Appendix B: EOC Checklists, September 2006—This appendix contains 59 separate checklists, one for each likely leadership participant in a catastrophic earthquake response, from the incident commander and EOC manager, through the leaders of all envisioned functional areas. There are numerous tasks to be accomplished by each of these leaders that are detailed in the leader's respective checklist.
- U.S. Department of Homeland Security Target Capabilities List 2007 (TCL07)—The Target Capabilities List describes the capabilities related to the four homeland security mission areas: Prevent, Protect, Respond, and Recover. It defines and provides the basis for assessing preparedness. It also establishes national guidance for preparing the nation for major all-hazards events, such as those defined by the National Planning Scenarios. The 2007 version of the TCL contains 37 core capabilities. A "consensus of the community" approach was used to develop the Target Capabilities List. Stakeholders from federal, state, local, territorial, and tribal governments, the private sector, and nongovernmental organizations came together in four national workshops and capability working groups to define the capabilities.
- Federal Emergency Management Agency Hazus Software 2009 (HAZUS09)—Hazus is a nationally applicable standardized methodology that contains models for estimating

potential losses from earthquakes, floods, and hurricanes. Hazus uses Geographic Information Systems (GIS) technology to estimate physical, economic, and social impacts of disasters. It graphically illustrates the limits of identified high-risk locations due to earthquake, hurricane, and floods.[1] Users can then visualize the spatial relationships between populations and other more permanently fixed geographic assets or resources for the specific hazard being modeled, a crucial function in the pre-disaster planning process. Hazus is used for mitigation and recovery as well as preparedness and response. Government planners, GIS specialists, and emergency managers use Hazus to determine losses and the most beneficial mitigation approaches to take to minimize them. Hazus can be used in the assessment step in the mitigation planning process, which is the foundation for a community's long-term strategy to reduce disaster losses and break the cycle of disaster damage, reconstruction, and repeated damage.[2] Being ready will aid in recovery after a natural disaster.

- Federal Emergency Management Agency Resource Typing 2005 (FEMA05 RT)—Resource typing is categorizing, by capability, the resources requested, deployed, and used in incidents. Measurable standards identifying resource capabilities and performance levels serve as the basis for categories. Resource users at all levels use these standards to identify and inventory resources. Tier 1 Resource Typing Definitions provided by FEMA are:
  - Animal Health Emergency
  - Emergency Medical Services
  - Fire and Hazardous Materials
  - Incident Management
  - Law Enforcement
  - Medical and Public Health
  - Pathfinder Task Forces
  - Public Works
  - Search and Rescue
- National Health Security Strategy 2009 (NHSS09)—This document presents the nation's first National Health Security Strategy (NHSS), which is intended to help galvanize efforts to minimize the health consequences associated with significant health incidents. The NHSS was developed in consultation with a broad range of stakeholders, including representatives from local, state, territorial, tribal, and federal government; community-based organizations; private-sector firms; and academia. The statutory authority and requirements for the NHSS are provided under section 2802 of the Public Health Service Act.
- National Planning Scenarios 2005 (NPS05)—The federal interagency community has developed 15 all-hazards planning scenarios (the National Planning Scenarios) for use in national, federal, state, and local homeland security preparedness activities. They are planning tools and are representative of the range of potential terrorist attacks and natural

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1 FEMA links:
Earthquake: http://www.fema.gov/plan/prevent/earthquake/nehrp.shtm
Hurricane: http://www.fema.gov/hazard/hurricane/index.shtm
Flood: http://www.fema.gov/hazard/flood/index.shtm

2 FEMA multi-hazard mitigation planning: http://www.fema.gov/plan/mitplanning/index.shtm

disasters and the related impacts that face our nation. The objective was to develop a minimum number of credible scenarios in order to establish the range of response requirements to facilitate preparedness planning. Since these scenarios were compiled to be the minimum number necessary to develop the range of response capabilities and resources, other hazards were inevitably omitted. Examples of other potentially high-impact events include nuclear power plant incidents, industrial and transportation accidents, and frequently occurring natural disasters. Entities at all levels of government can use the National Planning Scenarios as a reference to help them identify the potential scope, magnitude, and complexity of potential major events. Entities are not precluded from developing their own scenarios to supplement the National Planning Scenarios, which reflect a rigorous analytical effort by federal homeland security experts, with reviews by state and local homeland security representatives. However, it is recognized that refinement and revision over time will be necessary to ensure the scenarios remain accurate, represent the evolving all-hazards threat picture, and embody the capabilities necessary to respond to domestic incidents.

- Veterans Health Administration Program Guidebook 2009 (VHA)—This 2009 Veterans Health Administration (VHA) Emergency Management Program Guidebook provides updated information and direction to assist VHA facilities in their continuing efforts to meet and maintain optimal readiness for emergencies caused by natural, technological, or human-caused hazards. This Guidebook provides tools that users can apply to develop a comprehensive, effective, and compliant Emergency Management Program. Users will find it contains extensive examples of plans, policies, contingencies, and potential solutions for problems that any facility may face. In addition to the updated emergency management standards crosswalk, sample readiness plans and Standard Operating Procedures have been updated to address the changes in the various standards. This guidance is consistent with the requirements of DHS, the Joint Commission, the Occupational Safety and Health Administration (OSHA), and the National Fire Protection Association (NFPA).

Additional sources that we consulted are shown in the Bibliography.

List of Required Capabilities for the Community Preparedness Planning Tool

We selected a total 110 required capabilities that our sources identified as critical capabilities. We were able to define and create planning factors to quantitatively estimate 58 of the required capabilities (the characteristics and use of which are described further in Appendix C and Appendix D, respectively). The following is a list of these quantitatively estimated 58 capabilities:

Fatality Management

1. Recover and process decedents
2. Identify decedents
3. Support families of decedents
4. Return bodies to next of kin
5. Autopsy remains
6. Store human remains
7. Gather forensic evidence
8. Decontaminate remains
9. Conduct DNA analysis
10. Transport human remains to staging
11. Transfer remains from staging to morgue operations

Mass Care (non-medical)

12. Shelter residents
13. Feed residents
14. Provide water for residents
15. Provide shelter for companion animals
16. Transport companion animals
17. Store supplies
18. Provide childcare
19. Transfer individuals and caregivers/family members to appropriate shelter facilities when necessary
20. Communicate between mass care personnel and facilities
21. Provide behavioral health support for mass care residents

22. Provide adequate pharmaceuticals to sheltered residents
23. Decontaminate shelter residents

Mass Prophylaxis

24. Dispense and administer vaccinations
25. Receive, stage, and store prophylaxis (vaccines, antibiotics, and antivirals)
26. Provide internal and external security to the points of dispense sites
27. Provide transportation for residents to points of dispense

Medical Supply and Distribution

28. Provide receipt, staging, and storage for medical supplies
29. Procure, manage, distribute blood products
30. Generate emergency power for warehouse
31. Provide security for medical distribution

Medical Surge

32. Track patients to and through medical care
33. Set up alternative care sites and overflow emergency medical care facilities to manage hospital surge capacity

Patient Protection

34. Provide care for population in hospitals
35. Feed hospitalized patients
36. Provide water for hospitalized patients
37. Evacuate hospitalized patients
38. Provide medical services of evacuated hospitalized patients
39. Provide care for institutionalized populations
40. Feed institutionalized patients
41. Provide water for institutionalized patients
42. Evacuate institutionalized patients
43. Provide medical services of evacuated institutionalized individuals
44. Provide care for in-home or special-needs patients (e.g., mobility limitations)
45. Feed in-home or special-needs patients
46. Provide water for in-home or special-needs patients
47. Evacuate in-home or special-needs patients
48. Provide medical services of evacuated individuals
49. Decontaminate in-home patients or special-needs evacuees

Public Health/Epidemiology/Lab Testing–Quarantine–Sanitation

50. Investigate human disease cases
51. Conduct abbreviated interviews
52. Test worried well samples
53. Test ill patient samples
54. Provide correct collection, handling, and analysis of laboratory specimens
55. Test environmental samples

Triage/Pre-Hospital Care–Transport

56. Triage, treat, initially stabilize patients for transport
57. Provide ongoing pain management therapy to patients awaiting transport

Worker Health and Safety

58. Supply prophylaxis for first responders and their families, response personnel, and other authorities

From the literature, we identified 52 other important required capabilities but we were unable to define or create quantitative planning factors for them. They are, therefore, defined within the list of functions and planning factors described in Appendix D, but are not actually used by any of the calculations in the current prototype tool. The following is a list of these capabilities:

Fatality Management

1. Provide morgue surge
2. Label victims (search and recovery)

Health Communications

3. Provide timely and accurate information to the public
4. Disseminate public health and safety information to the public to improve provision of home health care
5. Disseminate accurate, timely, and accessible information to the public, media, support agencies, and vendors about mass care services
6. Provide robust information dissemination to public at mass prophylaxis locations
7. Communicate to public and providers about definitions, risk and mitigation, and recommendation for implementation of control measures
8. Make public health recommendations for prophylaxis and other interventions
9. Communicate with providers and hospitals
10. Draft and disseminate initial report of epidemiological investigation

11. Coordinate laboratory activities with laboratory response network
12. Provide consultation to all submitters regarding appropriate collection and shipment of specimens or samples for testing

Mass Care (non-medical)

13. Provide environmental health assessment to mass care

Mass Prophylaxis

14. Track outcomes and adverse events following mass distribution of prophylaxis

Medical Supply and Distribution

15. Distribute, redistribute medical supplies
16. Track inventory
17. Medical supplies and distribution for persons outside health facilities (e.g., homes)

Medical Surge

18. Provide adequate pharmaceuticals to the population
19. Provide mental health treatment
20. Provide mental health treatment–adults
21. Provide mental health treatment—children
22. Communicate between health care facilities and all other responder disciplines
23. Manage/decontaminate contaminated victims
24. Treat different classes of patient

Patient Protection

25. Decontaminate hospitalized evacuees
26. Decontaminate institutionalized evacuees
27. Provide backup power for hospitals
28. Provide backup power for institutionalized medical facilities
29. Provide backup power for in-home patient or special-needs residences

Public Health/Epidemiology/Lab Testing–Quarantine–Sanitation

30. Analyze CBRNE samples
31. Investigate agricultural and food cases

32. Investigate animal disease cases
33. Test initial clinical specimens
34. Deliver medical services to those isolated or quarantined at home
35. Create registries of ill, exposed, and potentially exposed persons
36. Test toxic industrial chemicals and materials

Triage/Pre-Hospital Care–Transport

37. Provide ongoing pain management therapy to acute botulinum intoxication, acute chemical poisoning, and nerve agent exposure patients awaiting transport
38. Triage, treat, initially stabilize patients with burn or trauma
39. Triage, treat, initially stabilize patients with radiation-induced injury—especially bone marrow suppression
40. Triage, treat, initially stabilize patients with negative pressure isolation

Volunteer Management–Health Specific

41. Provide emergency credentialing and privileging procedures
42. Appropriately transport and stage staff
43. Mobilize staff
44. Mobilize mass care staff
45. Mobilize fatality management staff
46. Mobilize behavioral health staff
47. Mobilize medical surge staff
48. Mobilize public health staff

Worker Health and Safety

49. Provide meals to hospital workers
50. Monitor and maintain routine and emergency communications at all times
51. Provide emergency and psychological medical care to health workers and first responders
52. Provide adequate responder personal protective equipment (PPE)

As further information becomes available on these latter capabilities and can be validated to the level of confidence for those that we have used in the initial prototype, they could be added to the tool.

APPENDIX C

Lists of Data Elements Used in the Community Preparedness Planning Tool

This appendix contains five tables that list all data elements—or variables—used in the capabilities-based planning tool as well as descriptions and a list of sources that motivated the inclusion of each variable. The five tables correspond to the tabs in the tool interface. The variables listed in the first two tables, Disaster Attributes and Community Characteristics, are the inputs to the tool. These inputs may be entered by users, or automatically populated by the tool based on the selected community. The last three tables correspond to the output sections of the tool. The variables in the tables for Disaster Effects, Required Capabilities, and Required Resources represent the estimated quantities generated as outputs from the tool, based on application of the relevant functions. The full list of functions is included as Appendix D.

The columns in the tables below are arranged as follows, from left:

- **Variable Number:** This data element is simply an ordinal used to track the total number of variables in the model.
- **Variable Name:** This is the name derived from the nomenclature description of the variable; the variable name is intended to be somewhat intuitive. We used variable names to program the functions in the tool. That is, the tool functions are defined in terms of the tool variables (as specified by variable name, not variable number, so that they can be read directly).
- **Variable Label:** This contains the nomenclature description of the data element.
- **Unit:** This is the unit of measure for each variable. Since the model is focused on medical capabilities, many of the variables are used to calculate a need for patient care, and are measured in terms of persons.
- **Source:** Specifies the source of the variable. When we performed the research, we read many documents that described major disasters in significant detail, especially documents that described planning factors for those disasters. We gathered all the inputs and outputs of the documented planning factors, and compiled them into the list of tool variables. In a few instances, the source is described as "RAND Estimate." These reflect the few variables for which we generated simple approximations, either when we simplified existing complicated planning factors or when our research did not uncover suitable documented planning factors.

Disaster Attributes

Table C.1
Data Elements for Disaster Attributes

Variable Number	Variable Name	Variable Label	Unit	Source
Hurricane				
1	Cat	Category of hurricane	Integer	NPS05
2	Winds	Wind Speed	Miles per hour	NPS05
3	Flood	Co-occurrence with flood	Yes/No	NPS05
4	Flood_Depth	Depth of flood	Meters	Jonkman, 2007. Loss of life estimation in flood risk assessment, PhD thesis, Delft University.
5	PerEvac	Percentage of population able to evacuate pre-disaster and not need shelter post-disaster	Percentage	NPS05
6	Mudslide	Co-occurrence with mudslide?	Yes/No	NPS05
7	Disease	Co-occurrence with disease?	Yes/No	NPS05
8	Storm	Storm surge (for population at elevations)	Feet	NPS05
9	Dist	Distance from shore affected	Miles	NPS05
10	Dia	Diameter	Miles	NPS05
11	Duration	Duration	Days	NPS05
12	EvacT	Evacuation routes, time closed in advance	Hours	NPS05
13	EvacP	Evacuation routes, portion closed post-disaster	Percentage	NPS05
Earthquake				
14	Mag	Magnitude	Richter	NPS05
15	Prox	Proximity	Miles from Epicenter to Population Density Center	NPS05, HAZUS09
16	Time	Time of Day	Time	HAZUS09
17	Multi	Potential for multiple earthquake events (aftershocks) (default = Yes)	Yes/No	NPS05

Table C.1—Continued

Variable Number	Variable Name	Variable Label	Unit	Source
Pandemic Flu				
18	AttRate	Attack rate in overall population	Percentage	Flu Surge 2.0
19	IncuPer	Incubation period	Days	NPS05
20	TransmR	Secondary transmission rate	Percentage	NPS05
21	AttRate1	Attack rate (school age children)	Percentage	NPS05
22	AttRate2	Attack rate (adults)	Percentage	NPS05
23	AttRate3	Attack rate (elderly)	Percentage	Flu Surge 2.0
24	Duration	Duration of single local pandemic wave	Weeks	Flu Surge 2.0
25	PopNSMed	Population not seeking medial care	Percentage	TCL07
26	PopSMed	Population seeking medical care	Percentage	TCL07
27	Multi	Potential for multiple pandemic waves	Yes/No	NPS05
28	Adverse_R	Rates per 1,000 population of adverse health outcomes indexed by age, risk group, scenario outcome, and patient outcome	Percentage	Flu Surge 2.0
29	PerVac_(d,y,r)	Percentages vaccinated by dose number d, age group y, and risk level r	Percentage	Flu Surge 2.0

NOTE: Shaded rows indicate that the variable is important for planning but is not used in the tool.

Community Characteristics

Table C.2
Data Elements for Community Characteristics

Variable Number	Variable Name	Variable Label	Unit	Source
1	Pop_y	Population by age demographic	Persons	ARF08
2	Pop	Population	Persons	ARF08
3	PopDis	Population with a disability	Persons	ARF08
4	Density	Population density	Persons / Sq. mi.	ARF08
5	Land area	Land area	Sq. mi.	ARF08
6	Total area	Total area	Sq. mi.	ARF08
7	HomesSF	Number of single-family homes in the community	Homes	HAZUS09
8	HomesMF	Number of multi-familly homes in the community	Homes	HAZUS09
9	PopAff	Population in coastal area potentially affected by hurricanes	Persons	ARF08
10	InHome	Population with mobility disability before disaster	Persons	ARF08
11	Hosp	Population hospitalized before disaster	Persons	ARF08
12	Inst	Population institutionalized before disaster	Persons	ARF08
13	pc_nICU_beds	Percent non-ICU beds staffed pre-disaster	Percentage	RAND Estimate
14	pc_ICU_beds	Percent ICU beds staffed pre-disaster	Percentage	RAND Estimate
15	HospBeds	Number of hospital beds in community	Beds	ARF08
16	Fire	Quantity of fire response capability	Persons	ARF08
17	EMS	Quantity of emergency response capability	Persons	ARF08
Pandemic Flu Community Characteristics				
18	pc_vent_avail	Percent ventilators available	Percentage	TCL07
19	pc_HR_(y)	Percent high risk by age group y (age 0-17, y=1; 18-64, y=2; 65+, y=3)	Percentage	FluSurge 2.0 Tool
20	Large_Animal	Number of large animals (e.g., horses, cows)	Animals	TCL07

NOTE: Shaded rows indicate that the variable is important for planning but is not used in the tool.

Disaster Effects

Table C.3
Data Elements for Disaster Effects

Variable Number	Variable Name	Variable Label	Unit	Source
Population Affected				
1	O_PopD	Population displaced and not requiring shelter	Persons	TCL07
2	O_PopS	Population displaced and requiring shelter	Persons	TCL07
3	O_PopE	Population requiring post-disaster evacuation	Persons	TCL07
4	O_AnimS	Companion animals that need shelter	Animals	TCL07
5	O_PopEDis	Population with mobility disabilities that require pre-disaster evacuation	Persons	TCL07
6	Inj	Population injured or ill from disaster	Persons	TCL07
7	Hosp	Population hospitalized	Persons	TCL07
8	Fatalities	Fatalities (disaster-related)	Persons	TCL07
9	PatICU	Patients requiring an ICU	Persons	TCL07
10	PatVent	Patients requiring a ventilator	Persons	TCL07
11	Outpatient	Outpatient visits	Persons	TCL07
12	PatTran	The number of hospitalized patients who require transfer to outside jurisdiction	Persons	TCL07
13	PatTranCom	Patients with ability to be transferred by commercial (non-medical) means	Persons	TCL07
14	PatTranAmb	The number of transferring patients who require an ambulance and medical assistance	Persons	TCL07
15	PopPW	Population without power and water	Persons	TCL07
16	LabSamp	Number of lab samples needed to be tested (influenza specific)	Number	RAND Estimate
17	Ambo	Population that require transportation to and between hospitals	Persons	TCL07
18	Missing	Population missing	Persons	TCL07

Table C.3—Continued

Variable Number	Variable Name	Variable Label	Unit	Source
Infrastructure				
19	BldDes	Buildings destroyed	Number	TCL07
20	Struct	Percentage of buildings with severe structural damage	Percentage	HAZUS09
21	BldDam	Buildings with at least moderate damage	Number	TCL07
22	SFHomDes	Single-family homes destroyed	Number	TCL07
23	MFHomDes	Multi-family homes destroyed	Number	TCL07
24	Comm	Percentage of population without communication due to communication systems interruptions	Percentage	RAND Estimate
25	Power	Power systems interrupted	Percentage	RAND Estimate
26	Water	Percent of water systems interrupted	Percentage	RAND Estimate
27	Sewage	Percent of sewage systems interrupted	Percentage	RAND Estimate
28	Contamw	Percent of population with contaminated water	Percentage / Duration	NPS05, TCL07
29	Contamf	Percent of population with contaminated food	Percentage / Duration	SFEP06, NPS05, TCL07
Capabilities				
30	HospAff	Percent of hospitals affected	Percentage	TCL07
31	HospPer	Hospital operating level: percent of beds available post disaster	Percentage	TCL07
32	Absent	Percent absent workers	Percentage	NPS05
33	Fire	Percent of fire stations affected	Percentage	TCL07
34	FirePer	Fire station operating level	Percentage	TCL07
35	FirstResEff	Percent effective first responder	Percentage	RAND
36	EvacR	Percent evacuated pre-disaster	Percentage	RAND Estimate

NOTE: Gray shaded variables indicate that the variable is important for planning but is not used in the tool.

Required Capabilities

Table C.4
Data Elements for Required Capabilities

Variable Number	Variable Name	Variable Label	Unit	Source
Mass Care (non-medical)				
1	y_MC_Shelter	Shelter residents	Persons	TCL07 p.511
2	y_MC_Food	Feed residents	Persons	TCL07 p.511
3	y_MC_Water	Provide water for residents	Persons	TCL07 p.511
4	y_MC_Shelter_A	Provide shelter for companion animals	Animals	TCL07 p.512
5	y_MC_Transport_A	Transport companion animals	Animals	TCL07 p.512
6	y_MC_Storage	Store supplies	Cubic Meters	TCL07 p.466
7	y_MC_Childcare	Provide child care	Persons	TCL07 p.511
8	y_MC_Transport	Transfer individuals and caregivers/family members to appropriate shelter facilities when necessary	Persons	TCL07 p.499
9	y_MC_Comm_MC	Communicate between mass care personnel and facilities	Yes/No	TCL07 p.496,498
10	y_MC_BH_MC	Provide behavioral health support for mass care residents	Persons	TCL07 p.511
11	y_MC_Pharm_MC	Provide adequate pharmaceuticals to sheltered residents	Persons	TCL07 p.511
12	y_MC_Decon_MC	Decontaminate shelter residents	Persons	TCL07 p.449
13	y_EnvHealth	Provide environmental health assessment to mass care	Persons	TCL07 p.498
Triage/Pre-Hospital Care—Transport				
14	y_Triage	Triage, treat, initially stabilize patients for transport	Persons	TCL07 p.462
15	y_Triage_PreHosp_Pain	Provide ongoing pain management therapy to patients awaiting transport	Persons	TCL07 p.442
16	y_Triage_Chem	Acute botulinum intoxication, acute chemical poisoning, and nerve agent exposure	Persons	TCL07 p.462
17	y_Triage_Burn_Trauma	Triage, treat, initially stabilize patients with burn or trauma	Persons	TCL07 p.462
18	y_Triage_Radiation	Triage, treat, initially stabilize patients with radiation-induced injury - especially bone marrow suppression	Persons	TCL07 p.462
19	y_Triage_Neg_Pressure	Triage, treat, initially stabilize patients with negative pressure isolation	Persons	TCL07 p.451
Medical Surge				
20	y_MedSurge_Pharm_MedSurge	Provide adequate pharmaceuticals to the population	Persons	NHSS09 p.25
21	y_MedSurge_Track_MedSurge	Track patients to and through medical care	Persons	TCL07 p.450
22	y_MedSurge_Overflow_MedSurge	Set up alternative care sites and overflow emergency medical care facilities to manage hospital surge capacity	Beds	TCL07 p.451
23	y_MedSurge_Mental_Health	Provide mental health treatment	Persons	NHSS09 p.15
24	y_MedSurge_MH_Adults	Provide mental health treatment - adults	Persons	NHSS09 p.15
25	y_MedSurge_MH_Peds	Provide mental health treatment - children	Persons	NHSS09 p.15
26	y_MedSurge_Comm_MedSurge	Communicate between health care facilities and all other responder disciplines	Yes/No	TCL07 p.451
27	y_MedSurge_Decon_MedSurge	Manage/decontaminate contaminated victims	Persons	TCL07 p.449
28	y_MedSurge_Treat_MedSurge	Treat different classes of patient	Persons	TCL07 p.462

Table C.4—Continued

Variable Number	Variable Name	Variable Label	Unit	Source
Fatality Management				
29	y_Fat_Recover_Dec	Recover and process decedents	Persons	NHSS09 p.26
30	y_Fat_Identify_Dec	Identify decedents	Persons	NHSS09 p.26
31	y_Fat_Support_Dec_Fam	Support families of decedents	Families	NHSS09 p.26
32	y_Fat_Return_Dec	Return bodies to next of kin	Persons	TCL07 p.523
33	y_Fat_Autopsy_Dec	Autopsy remains	Persons	TCL07 p.531
34	y_Fat_Store_Dec	Store human remains	Persons	TCL07 p.523
35	y_Fat_Gather_Forensic	Gather forensic evidence	Sites	TCL07 p.522
36	y_Fat_Decon_Dec	Decontaminate remains	Persons	TCL07 p.522
37	y_Fat_DNA_Analysis	Conduct DNA analysis	Persons	TCL07 p.524
38	y_Fat_Transport_Dec	Transport human remains to staging	Persons	TCL07 p.522
39	y_Fat_Transfer_Dec	Transfer remains from staging to morgue operations	Persons	TCL07 p.522
40	y_Fat_Morgue	Provide morgue surge	Sites	TCL07 p.521
41	y_Fat_Label_Dec	Label victims (search and recovery)	Persons	TCL07 p.522
Medical Supply And Distribution (Function Of Other Capabilities)				
42	y_MedSupply_Stor	Provide receipt, staging, and storage for medical supplies	ft^2	TCL07 p. 476,472
43	y_MedSupply_Distr	Distribute, redistribute medical supplies	ft^3	TCL07 p.465,469
44	y_MedSupply_Track	Track inventory	Yes/No	NHSS09 p.24,25,33,34
45	y_MedSupply_Blood	Procure, manage, distribute blood products	Blood units	TCL07 p.465
46	y_MedSupply_EmerPower	Generate emergency power for warehouse	Sites	TCL07 p.468
47	y_MedSupply_Secure	Provide security for medical distribution	Sites	TCL07 p.468,473
48	y_MedSupply_SpecNeeds	Medical supplies and distribution for persons outside health facilities (e.g., homes)	ft^3	RAND Estimate
Volunteer Management - Health Specific (Function Of Capabilities)				
49	y_Volunteer_Cred	Provide emergency credentialing and privileging procedures	Persons	TCL07 p.453
50	y_Volunteer_Stage	Appropriately transport and stage staff	Persons	TCL07 p.455
51	y_Volunteer_Mob	Mobilize staff	Persons	TCL07 p.497
52	y_Volunteer_Mob_MC	Mobilize mass care staff	Persons	TCL07 p.497
53	y_Volunteer_Mob_Dec	Mobilize fatality management staff	Persons	TCL07 p.522
54	y_Volunteer_Mob_BH	Mobilize behavioral health staff	Persons	RAND Estimate
55	y_Volunteer_Mob_MedSurge	Mobilize medical surge staff	Persons	RAND Estimate
56	y_Volunteer_Mob_PH	Mobilize public health staff	Persons	RAND Estimate

Table C.4—Continued

Variable Number	Variable Name	Variable Label	Unit	Source
Patient Protection				
57	y_Protect_Pat_Hosp	Provide care for population in hospitals	Persons	RAND Estimate
58	y_Protect_Pat_Hosp_Food	Feed hospitalized patients	Persons	NHSS09 p.25
59	y_Protect_Pat_Hosp_Water	Provide water for hospitalized patients	Persons	RAND Estimate
60	y_Protect_Pat_Hosp_Evac	Evacuate hospitalized patients	Persons	TCL07 p.377
61	y_Protect_Pat_Hosp_Med	Provide medical services of evacuated hospitalized patients	Persons	RAND Estimate
62	y_Protect_Pat_Inst_Decon	Decontaminate hospitalized evacuees	Persons	RAND Estimate
63	y_Protect_Pat_Inst	Provide care for institutionalized populations	Persons	RAND Estimate
64	y_Protect_Pat_Inst_Food	Feed institutionalized patients	Persons	RAND Estimate
65	y_Protect_Pat_Inst_Water	Provide water for institutionalized patients	Persons	RAND Estimate
66	y_Protect_Pat_Inst_Evac	Evacuate institutionalized patients	Persons	RAND Estimate
67	y_Protect_Pat_Inst_Med	Provide medical services of evacuated institutionalized individuals	Persons	RAND Estimate
68	y_Protect_Pat_Inst_Decon	Decontaminate institutionalized evacuees	Persons	RAND Estimate
69	y_Protect_Pat_InHome	Provide care for in-home patient or special needs population (e.g. mobility limitations)	Persons	RAND Estimate
70	y_Protect_Pat_InHome_Food	Feed in-home or special needs patients	Persons	RAND Estimate
71	y_Protect_Pat_InHome_Water	Provide water for in-home patient or special needs patients	Persons	RAND Estimate
72	y_Protect_Pat_InHome_Evac	Evacuate in-home patient or special needs patients	Persons	RAND Estimate
73	y_Protect_Pat_InHome_Med	Provide medical services of evacuated individuals	Persons	RAND Estimate
74	y_Protect_Pat_InHome_Decon	Decontaminate in-home patient or special needs evacuees	Persons	RAND Estimate
75	y_Protect_Pat_Hosp_GenPower	Provide backup power for hospitals	Yes/No	VHA 6.2.1.2
76	y_Protect_Pat_Inst_GenPower	Provide backup power for institutionalized medical facilities	Sites	RAND Estimate
77	y_Protect_Pat_InHome_GenPower	Provide backup power for in-home patient or special needs residences	Persons	RAND Estimate

Table C.4—Continued

Variable Number	Variable Name	Variable Label	Unit	Source
Health Communications				
78	y_Comm_Public	Provide timely and accurate information to the public		TCL07 p.482
79	y_Comm_Home	Disseminate public health and safety information to the public to improve provision of home healthcare		TCL07 p.453
80	y_Comm_MC	Disseminate accurate, timely, and accessible information to the public, media, support agencies, and vendors about mass care services		TCL07 p.496
81	y_Comm_MassProphLoc	Robust information dissemination to public on mass prophylaxis locations		TCL07 p.496
82	y_Comm_Risk	Communicate to public and providers about definitions, risk and mitigation, and recommendation for implementation of control measures		TCL07 p.161
83	y_Comm_MassProph	Make public health recommendations for prophylaxis and other interventions		TCL07 p.164
84	y_Comm_ProvHosp	Communicate with providers and hospitals		TCL07 p.451
85	y_Comm_Epid	Draft and disseminate initial report of epidemiological investigation		TCL07 p.165
86	y_Comm_Lab	Coordinate laboratory activities with laboratory response network		TCL07 p.180
87	y_Comm_SpecimenTest	Provide consultation to all submitters regarding appropriate collection and shipment of specimens or samples for testing		TCL07 p.181
Worker Health And Safety (Function Of Other Capabilities)				
88	y_Worker_Proph	Supply prophylaxis for first responders and their families, response personnel, and other authorities	Persons	TCL07 p.450
89	y_Worker_Meals	Provide meals to hospital workers	Persons	inferred from TCL07p.514
90	y_Worker_Comm	Monitor and maintain routine and emergency communications at all times	Yes/No	TCL07p.252
91	y_Worker_Psych	Provide emergency and psychological medical care to health workers and first responders	Persons	TCL07p.254
92	y_Worker_PPE	Provide adequate responder ppe	Persons	TCL07p.249
Mass Prophylaxis				
93	y_MassProph_Vacc	Dispense and administer vaccinations	Persons	TCL07 p.489
94	y_MassProph_StageStore	Receive, stage, and store prophylaxis (vaccines, antibiotics, and antivirals)	ft^2	TCL07 p.490
95	y_MassProph_Secure	Provide internal and external security to the points of dispense sites	Sites	TCL07 p.484
96	y_MassProph_Transport	Provide transportation for residents to points of dispense	Persons	TCL07 p.484
97	y_MassProph_Track	Track outcomes and adverse events following mass distribution of prophylaxis	Events	TCL07 p.484
Public Health / Epidemiology / Lab Testing - Quarantine - Sanitation				
98	y_PhEpidLab_Investigate	Investigate human disease cases	Cases	TCL07 p.170
99	y_PhEpidLab_Interview	Conduct abbreviated interviews	Cases	TCL07 p.170
100	y_PhEpidLab_TestWorried	Test worried well samples	Samples	TCL07 p.188
101	y_PhEpidLab_TestInjured	Test ill patient samples	Samples	TCL07 p.190
102	y_PhEpidLab_CollectSpec	Provide correct collection, handling, and analysis of laboratory specimens	Samples	TCL07 p.181
103	y_PhEpidLab_TestEnvSamples	Test environmental samples	Samples	TCL07 p.183
104	y_PhEpidLab_CBRNE	Analyze cbrne samples	Samples	TCL07 p.260
105	y_PhEpidLab_Investigate_AgFood	Investigate agricultural and food cases	Cases	RAND Estimate
106	y_PhEpidLab_Animal	Investigate animal disease cases	Cases	RAND Estimate
107	y_PhEpidLab_TestSpec	Test initial clinical specimens	Samples	TCL07 p.182
108	y_PhEpidLab_ServicesIsolated	Deliver medical services to those isolated or quarantined at home	Persons	TCL07 p.453
109	y_PhEpidLab_Registries	Create registries of ill, exposed, and potentially exposed persons	Persons	TCL07 p.165
110	y_PhEpidLab_TestEnvSamples_Toxic	Test toxic industrial chemicals and materials	Samples	TCL07 p.183

Note: Gray shaded variables indicate that the variable is important for planning but is not used in the tool.

Required Resources

Table C.5
Data Elements for Required Resources

Variable Number	Variable Name	Variable Label	Secondary Variable Label	Unit	Source
Mass Care (non-medical)					
1	z_MC_Trained_Workers	Trained workers		Persons	TCL07 p.510
2	z_MC_Animal_Workers	Companion animal workers		Persons	TCL07 p.511
3	z_MC_Shelter_Team_IV	Volunteer agency shelter management team	Type iv	Team	TCL07 p.506
4	z_MC_Shelter_Team_III		Type iii	Team	TCL07 p.506
5	z_MC_Shelter_Team_II		Type ii	Team	TCL07 p.506
6	z_MC_Shelter_Team_I		Type i	Team	TCL07 p.506
7	z_MC_Food_Unit	Volunteer food service unit		Units	TCL07 p.511
8	z_MC_Vol_Kitchen_IV	Volunteer agency field kitchen	Type iv	Kitchens	TCL07 p.511
9	z_MC_Vol_Kitchen_III		Type iii	Kitchens	TCL07 p.511
10	z_MC_Vol_Kitchen_II		Type ii	Kitchens	TCL07 p.511
11	z_MC_Vol_Kitchen_I		Type i	Kitchens	TCL07 p.512
12	z_MC_Vol_Mkitchen_I	Voluntary agency mobile kitchen	Type i	Kitchens	TCL07 p.511
13	z_MC_Vol_Support_Team_I	Voluntary agency field support team	Type i	Teams	TCL07 p.511
14	z_MC_Trailer	Voluntary agency drop trailer team		Trailers	TCL07 p.511
15	z_MC_Packaged_Meals	Packaged meals		Meals	TCL07 p.511
16	z_MC_Water	Drinking water		Gallons/Day	RAND Estimate
17	z_MC_Vol_WH_Team_IV	Voluntary agency warehouse team	Type iv	Teams	TCL07 p.511
18	z_MC_Vol_WH_Team_III		Type iii	Teams	TCL07 p.511
19	z_MC_Vol_WH_Team_II		Type ii	Teams	TCL07 p.512
20	z_MC_Vol_WH_Team_I		Type i	Teams	TCL07 p.512
21	z_MC_Childcare_Team_I	Shelter child care team	Type i	Teams	TCL07 p.512
22	z_MC_Small_Animal_Team_I	Small-animal shelter team	Type i	Teams	TCL07 p.512
23	z_MC_Animal_Management_Team	Animal shelter management team		Teams	TCL07 p.512
24	z_MC_Small_Animal_Transport	Small-animal transport team		Teams	TCL07 p.513
25	z_MC_Animal_Incident_Response	Animal incident response team		Teams	TCL07 p.513
26	z_MC_Large_Animal_Rescue	Large-animal rescue team		Teams	FEMA05 RT AHR
27	z_MC_Small_Animal_Rescue	Small-animal rescue team		Teams	FEMA05 RT AHR
28	z_MC_Trans_Vehicles	Transportation vehicles		Vehicles	TCL07 p.392
29	z_MC_Shelter_Manager	Shelter managers		Persons	TCL07 p.506
30	z_MC_Shelter_Assistant_Manager	Shelter assistant manager		Persons	TCL07 p.506
31	z_MC_Shelter_Logistics_Supervisor	Shelter logistics supervisor		Persons	TCL07 p.506
32	z_MC_Feeding_Managers	Shelter feeding managers		Persons	TCL07 p.506
33	z_MC_Shelter_Health_Services_Workers	Shelter health services workers		Persons	TCL07 p.506
34	z_MC_Shelter_Mental_Health_Workers	Shelter mental health services workers		Persons	TCL07 p.506
35	z_MC_Shelter_Safety_Workers	Shelter safety and asset protection workers		Persons	TCL07 p.506
36	z_MC_Food_Drivers	Food service delivery drivers		Persons	TCL07 p.506
37	z_MC_Food_Vehicles	Food service delivery vehicles		Vehicles	TCL07 p.506
38	z_MC_Kitchen_Workers	Food service kitchen workers		Persons	TCL07 p.506
39	z_MC_Kitchen_Meals	Food service kitchen meals		Meals	TCL07 p.506
40	z_MC_Kitchen_generators	Food service kitchen generators		Generators	TCL07 p.506
41	z_MC_Kitchen_Trailers	Food service drop trailers		Trailers	TCL07 p.506
42	z_MC_Pathfinder_Task	Pathfinders task force	Type i	Teams	FEMA05 PTF

Table C.5—Continued

Variable Number	Variable Name	Variable Label	Secondary Variable Label	Unit	Source
Triage/Pre-Hospital Care—Transport (including some patient protection)					
43	z_Triage_Spare_ALS_Vehicle	Spare advanced life support vehicle		Vehicles	TCL07 p.438
44	z_Triage_EMS_Personnel	EMS personnel		Personnel	TCL07 p.446
45	z_Triage_Protect_Pat_Ambulance	Ground ambulance		Ambulance	FEMA05 RT EMS
46	z_Triage_Protect_Pat_Air_Ambulance	Air ambulance		Ambulance	FEMA05 RT EMS
47	z_Triage_Ambulance_TF	Ambulance task force		Teams	FEMA05 RT EMS
48	z_Triage_Emergency TF	Emergency medical task force		Teams	FEMA05 RT EMS
Medical Surge					
49	z_MedSurge_Surge_Beds	Surge beds		Beds	TCL07 2007
		Surge health care staff unit		Unit	TCL07 p.458
50	z_MedSurge_Surge_Physician		Physician	Persons	TCL07 p.458
51	z_MedSurge_Surge_PA		Physician assistant or nurse practitioner	Persons	TCL07 p.458
52	z_MedSurge_Surge_RN		Registered nurses	Persons	TCL07 p.458
53	z_MedSurge_Surge_NA		Nursing assistance	Persons	TCL07 p.458
54	z_MedSurge_Surge_Medical_Clerks		Medical clerks	Persons	TCL07 p.458
55	z_MedSurge_Surge_RT		Respiratory therapist	Persons	TCL07 p.458
56	z_MedSurge_Surge_CM		Case manager	Persons	TCL07 p.458
57	z_MedSurge_Surge_SW		Social worker	Persons	TCL07 p.458
58	z_MedSurge_Surge_Housekeeper		Housekeeper	Persons	TCL07 p.458
59	z_MedSurge_Surge_Patient_Transporter		Patient transporter	Persons	TCL07 p.458
60	z_MedSurge_Pharm_Storage	Regional pharmaceutical cache system		Storage	TCL07 p.458
61	z_MedSurge_Health_Facility	Health care facility		Facility	TCL07 p.451
62	z_MedSurge_Neg_Pressure_Room	Negative-pressure room		Room	TCL07 p.451,458
63	z_MedSurge_ICU_Beds	Licensed ICU beds		Bed	FluSurge 2.0
64	z_MedSurge_nonICU_Beds	Licensed non-ICU beds		Bed	FluSurge 2.0
65	z_MedSurge_Ventilators	Number of ventilators		Ventilators	FluSurge 2.0
66	z_MedSurge_Surge_Beds_Infectious	Surge beds for infectious disease		Bed	TCL07 p.461
67	z_MedSurge_Healthcare_Facility (duplicate of z63; omit this one)	Health care facility, support initial evaluation and treatment of at least 10 total adult and pediatric patients at a time		Facility	TCL07

Table C.5—Continued

Variable Number	Variable Name	Variable Label	Secondary Variable Label	Unit	Source
Fatality management					
68	z_Fat_Interview	Fatality management interview team		Persons	TCL07 p.529,533
69	z_Fat_Interview_Persons	Fatatlity management interview staff		Persons	TCL07 p.529,533
70	z_Fat_Port_Morgue	Portable morgue unit		Units	TCL07 p.527,531
71	z_Fat_Body_Recovery	Body recovery unit		Units	TCL07 p.527,531
72	z_Fat_Field_Investigative	Field investigative unit		Units	TCL07 p.527,531
73	z_Fat_Scene_Logistics	Scene logistics team		Teams	TCL07 p.527,531
74	z_Fat_Escort_Security	Escort security team (provided by esf 13)		Teams	TCL07 p.527,531
75	z_Fat_FM_Staging_Security	Fatality management staging security team		Teams	TCL07 p.527,531
76	z_Fat_Remains_Decon	Remains decontamination team		Teams	TCL07 p.527,531
77	z_Fat_Jur_Med_Examiner	Jurisdictional medical examiner/coroner		Persons	TCL07 p.527,531
78	z_Fat_Fam_Assistance_Center	Family assistance center		Facility	TCL07 p.527,531
79	z_Fat_DNA_Specialist	DNA specialist		Persons	TCL07 p.528,531
80	z_Fat_Data_Entry	Data entry staff		Persons	TCL07 p.528,532
81	z_Fat_Scheduler	Scheduler		Persons	TCL07 p.528,532
82	z_Fat_Med_Records_Specialist	Medical records specialist		Persons	TCL07 p.528,532
83	z_Fat_Interview_Specialist	Interview specialist		Persons	TCL07 p.528,533
84	z_Fat_AM_Comm	Ante mortem IT/communications team		Teams	TCL07 p.528,533
85	z_Fat_Notification	Notification team		Teams	TCL07 p.528,533
86	z_Fat_Embalming	Embalming section		Teams	TCL07 p.528,533
87	z_Fat_Body_Tracker	Body tracker		Persons	TCL07 p.528,533
88	z_Fat_Dental_Section	Dental section		Teams	TCL07 p.528,533
89	z_Fat_Fingerprint	Fingerprint section		Teams	TCL07 p.528,533
90	z_Fat_Radiology	Radiology section (digital equipment)		Teams	TCL07 p.528,533
91	z_Fat_Postmortem_IT_Manager	Postmortem IT manager		Persons	TCL07 p.528,533
92	z_Fat_Postmortem_Data_Clerk	Postmortem data entry clerk		Persons	TCL07 p.528,533
93	z_Fat_Anthropology_Section	Anthropology section		Teams	TCL07 p.528,533
94	z_Fat_DNA	DNA section		Teams	TCL07 p.528,533
95	z_Fat_Pathology	Pathology section		Teams	TCL07 p.528,533
96	z_Fat_PE_Photo	Personal effects and photography section		Teams	TCL07 p.528,534
97	z_Fat_Logistics	Logistics section		Teams	TCL07 p.528,534
98	z_Fat_Safety_Officer	Safety officer		Persons	TCL07 p.528,534
99	z_Fat_Medical_Team	Medical team		Teams	TCL07 p.528,534
100	z_Fat_Incident_Historian	Incident historian		Teams	TCL07 p.527,531
101	z_Fat_Administrative	Fatality management administrative staff		Persons	TCL07 p.528,532
102	z_Fat_DMORT_I	Disaster mortuary operational response team (dmort)	Type i	Teams	FEMA05 HMR, TCL07 p.527
103	z_Fat_PA_Med_Examiner	Medical examiner/coroner public affairs		Persons	TCL07 p.528,531
104	z_Fat_PI_Med_Examiner	Medical examiner/coroner public information officer		Persons	TCL07 p.528,531
105	z_Fat_Storage_Officer	Fatality management storage officer		Persons	TCL07 p.528,531
106	z_Fat_Fam_Assistance_Manager	Family assistance center manager		Persons	TCL07 p.528,531

Table C.5—Continued

Variable Number	Variable Name	Variable Label	Secondary Variable Label	Unit	Source
Medical supply and distribution (function of other capabilities)					
107	z_MedSupply_Instruments_Equipment	Instruments/equipment (bp cuffs, disposable; bp manometer; batteries (aa, aaa, d, c), artificial resuscitator bag, 10 children, 5 percent infant)		Supplies	TCL07 p.473
108	z_MedSupply_Sharps_NCL	Sharps: ncl/syringes (10cc needles syringes, 60cc; 3cc 23 g1 safety syringes; 3cc 23 g1 1/2" safety tb syringes; insulin syringes; blunt plastic cannula, lever lock cannula; 18g 111/2" safety needles; 20g 11/2" safety needles; sharps container; 20g IV start catheter; 18g star catheter; winged infusion set 23ga & 25 ga; bulb syringes; safety syringes- 21, 25; filter needles; catheter tip syringe 60cc; sharps container; lever lock syringes- 20cc, 60cc; syringes-1, 3, 5, 10cc)		Supplies	TCL07 p.473
109	z_MedSupply_Irrigation	Irrigation solutions (normal saline irrigation solution-2000cc; sterile water irrigation solution-2000 cc).		Supplies	TCL07 p.473
110	z_MedSupply_IV_Supplies	IV access/ supplies (lr 1000cc; ns 1000cc; central vein catheter kit; multi-lumen central catheter kit; long arm board; short arm board; stopcock, IV start kits; stopcock; t-connector; IV start catheter-18, 20, 22, 24; arm boards-infant, child; blood administration tubing; IV filters-.22 micron, 1.2 micron; syringe pump tubing; micro drip tubing)		Supplies	TCL07 p.473
111	z_MedSupply_IV_Solutions	IV solutions (lr 1000cc; ns 1000cc; central vein catheter kit; multi-lumen central catheter kit; long arm board; short arm board; stopcock; glucose water; ns 10cc; ns 1000cc).		Supplies	TCL07 p.473
112	z_MedSupply_Hand_Hygiene	Hand hygiene (provodine/iodine scrub brushes; pcmx scrub brushes)		Supplies	TCL07 p.473
113	z_MedSupply_Personal_Care	Patient personal care supplies (bath basin; emesis basin; facial tissues; bedpan; urinal; belonging bag; regular soap; mouth care supplies; cotton swabs; diapers; pacifier; cotton balls)		Supplies	TCL07 p.473
114	z_MedSupply_Respiratory_Supplies	Respiratory system supplies (nasal airways; oral airways; oxygen cannulas; oxygen masks).		Supplies	TCL07 p.473
115	z_MedSupply_ER_Supplies	ER/trauma/surgical supplies (scalpel #11; sutures-to be ordered individually, by box; general instruments tray; facial suture tray; chest drainage system; buretol tubing-60 drops; thoracostomy tray; chest tubes-8, 10, 12, 24, 32; thoracic catheter with tubing and container; sterile towels; sterile sheets; small sterile basins; electrodes; monitoring electrodes).		Supplies	TCL07 p.473
116	z_MedSupply_Dressings	Dressings (bandage scissors; 2x2 dressings; 4x4 dressings; adhesive IV dressing; 4" bandage rolls; 1" paper tape; adhesive bandages).		Supplies	TCL07 p.473
117	z_MedSupply_Linen	Linen (disposable sheets; disposable pillows; disposable pillow covers).		Supplies	TCL07 p.474
118	z_MedSupply_Muscle_Supplies	Muscle/ skeletal supplies (limb restraints).		Supplies	TCL07 p.474
119	z_MedSupply_GI_Supplies	GI system supplies (anti-reflux valve-10, 12, 14; feeding tubes-5,8).		Supplies	TCL07 p.474
120	z_MedSupply_Storage	Storage of medical supplies		12,000ft^2 Warehouse/State	TCL07 p.476
121	z_MedSupply_Pack_Blood	Packed red blood cells		Units	RAND Estimate
122	z_MedSupply_Miscellaneous	Miscellaneous (sterile lubricant; alcohol wipes; alcohol swab sticks; tongue blades; heel warmers; tape measure; body bag; disposable linen savers; safety pins; povodine iodine swab sticks; povodine iodine wipes; hydrogen peroxide; individual bottled drinking water).		Supplies	TCL07 p.474

Table C.5—Continued

Variable Number	Variable Name	Variable Label	Secondary Variable Label	Unit	Source
Volunteer management - health specific (function of capabilities)					
123	z_Volunteer_Center	Volunteer and donation coordination center and phone bank		Operators/Day	TCL07 p.247
124	z_Volunteer_Coordinator	Volunteer/donation coordinator		Persons	TCL07 p.247
125	z_Volunteer_Truck	Trucks		Vehicles	TCL07 p.247
126	z_Volunteer_Drivers	Drivers		Persons	TCL07 p.247
127	z_Volunteer_Wharehouse_Team	Warehouse team		Teams	TCL07 p.247
Patient protection					
128	z_Protect_Pat_Meals	Meals for patients		Meals	RAND Estimate
129	z_Protect_Pat_Water	Water for patients		Water	RAND Estimate
130	z_Protect_Pat_Generators	Generators		Supplies	FEMA05 RT PWR
131	z_Protect_Pat_Vehicles	Non-medical vehicles for evacuation of patients		Vehicles	RAND Estimate
Health communication					
132	z_Comm_Emergency	Emergency alert system		System	TCL07 p.390
133	z_Comm_Public_Warning	Public warning system		System	TCL07 p.390
134	z_Comm_Provider_Comm	Provider communication system		System	RAND Estimate
135	z_Comm_Public_Report_Team	Public report team		System	RAND Estimate
Worker health and safety (function of other capabilities)					
136	z_Worker_Health_Team	Responder safety and health teams		Teams	TCL07 p.259
137	z_Worker_Safety_Officer_TypeI	Safety officer	Type i	Persons	TCL07 p.259
138	z_Worker_Spec_Safety_Officer	Specialized safety officer		Persons	TCL07 p.259
139	z_Worker_Respiratory	Respiratory fit-test mobile units		Teams	TCL07 p.260
140	z_Worker_Medical_Unit	Medical unit		Teams	TCL07 p.260
141	z_Worker_Analytic_Lab	Analytic laboratory		Labs	TCL07 p.260
142	z_Worker_SCBA	SCBA breathing apparatus responders		Supplies/Day	TCL07 p.260
143	z_Worker_PAPR	Powered air purifying respirator responders		Supplies/Day	TCL07 p.260
144	z_Worker_P100	P100 respirator responders		Supplies/Day	TCL07 p.260
145	z_Worker_Spec_SME	Specialized subject matter experts (e.g. biological expert)		Persons	TCL07 p.260
Mass prophylaxis					
146	z_Mass_Proph_Vaccines	Vaccines		Supplies	FluSurge 2.0
147	z_Mass_Proph_Disp_Centers	Dispensing/vaccination centers, points of distribution		Facility	TCL07 p.489
148	z_Mass_Proph_Storage_Facility	Storage facility		ft^2	TCL07 p.490
149	z_Mass_Proph_Tech_Advise_Team	Technical advisory response unit team		Team	TCL07 p.490
150	z_Mass_Proph_Tech_Advise_Persons	Technical advisory response unit persons		Persons	TCL07 p.490

Table C.5—Continued

Variable Number	Variable Name	Variable Label	Secondary Variable Label	Unit	Source
Public health / epidemiology / lab testing - quarantine - sanitation					
151	z_PhEpidLab_LRN_Nat_Bio_Lab	LRN national level biological laboratory		Labs Nationally	TCL07 p.190
152	z_PhEpidLab_LRN_Ref_Lab	LRN reference laboratories		Labs Nationally	TCL07 p.190
153	z_PhEpidLab_CDC_Chem_Lab	Centers for Disease Control and Prevention (CDC) chemical laboratory		Labs Nationally	TCL07 p.192
		LRN chemistry laboratories		Labs per State	
154	z_PhEpidLab_Chem_Lab_1		Level 1	Labs Nationally	TCL07 p.192
155	z_PhEpidLab_Chem_Lab_2		Level 2	Labs Nationally	TCL07 p.192
156	z_PhEpidLab_LRN_Sentinel_Lab	LRN sentinel clinical laboratories		Labs Nationally	TCL07 p.193
157	z_PhEpidLab_Sample_Transport	Courier system for sample transport		Systems per State	TCL07 p.193
158	z_PhEpidLab_Emerg_Op_Center	CDC director's emergency operations center		Facilities Nationally	TCL07 p.193
159	z_PhEpidLab_EOC	State and local emergency operations center		Facilities per State	TCL07 p.193
160	z_Local_Health_Surv_Team	Local health department-based surveillance team		Teams/Location	TCL07 p.169,171
161	z_PhEpidLab_Local_Health_Surv_Person		Personnel	Persons/12-Hour Shift	TCL07 p.169
162	z_PhEpidLab_Local_Health_ITStaff		IT staff	Persons	TCL07 p.169
163	z_PhEpidLab_Local_Health_Stat		Statistician	Persons	TCL07 p.169
164	z_PhEpidLab_Inv_Epid	Investigation epidemiologist		Persons	TCL07 p.169
165	z_Spec_Studies_Team	Special studies team		Teams Nationally	TCL07 p.169
166	z_PhEpidLab_Spec_Studies_Epid_Supervisor		Epidemiology supervisor	Persons	TCL07 p.169
167	z_PhEpidLab_Spec_Studies_PH_Advisor		Public health advisor	Persons	TCL07 p.169
168	z_PhEpidLab_Spec_Studies_SME		Subject matter expert	Persons	TCL07 p.169
169	z_PhEpidLab_Spec_Studies_Interviewer		Interviewer	Persons	TCL07 p.169
170	z_CDC_DEOC_Surge_Team	CDC department emergency operations center surge team		Teams/Location	TCL07 p.169
171	z_PhEpidLab_Sen_Epid_Sup		Senior epidemiology supervisor	Persons	TCL07 p.169
172	z_PhEpidLab_CDC_Surge_Pub_Health_Adv		Public health advisor (PHA)	Persons	TCL07 p.169
173	z_PhEpidLab_CDC_Surge_Data_Entry_Manager		Data entry manager	Persons	TCL07 p.169
174	z_PhEpidLab_CDC_Surge_Data_Entry_Staff		Data entry staff	Persons	TCL07 p.169
175	z_Emerg_Ops_Center_Surge_Team	State/local emergency operations center surge team		Teams/State	TCL07 p.169
176	z_PhEpidLab_StateLocal_Surge_Epid_Commander		Epidemiology incident commander	Persons	TCL07 p.169
177	z_PhEpidLab_StateLocal_Surge_BT_Coord		Bioterrorism coordinator	Persons	TCL07 p.169
178	z_PhEpidLab_StateLocal_Surge_PHA		Pha per 12 hour shift	Persons	TCL07 p.169
179	z_PhEpidLab_StateLocal_Surge_Db_Manager		Database manager	Persons	TCL07 p.169
180	z_PhEpidLab_StateLocal_Surge_Programmer		Programmer	Persons	TCL07 p.169
181	z_PhEpidLab_StateLocal_Surge_Analyst		Analysts	Persons	TCL07 p.169
182	z_PhEpidLab_StateLocal_Surge_Transport		Transport teams (each with 1 driver)	Persons	TCL07 p.169
183	z_PhEpidLab_StateLocal_Surge_Clerical_Staff		Clerical staff member	Persons	TCL07 p.169
		Personal equipment cache		Storage	TCL07 p.169
184	z_PhEpidLab_PE_Cache_Phone		BlackBerry/cell phone	Phones	TCL07 p.169
185	z_PhEpidLab_PE_Cache_PPE		Personal protective equipment	PPE Sets	TCL07 p.169
186	z_PhEpidLab_Computer	Computers	Laptop	Laptops	TCL07 p.169
187	z_PhEpidLab_Printer		Printer	Printers	TCL07 p.169

APPENDIX D

Function Definitions and Planning Factors Used in the Community Preparedness Planning Tool

This appendix contains a description of all functions used to generate the estimates produced as tool outputs. This appendix also contains a list of sources that we used to create or derive the functions. In these descriptions, some functions are shaded gray to denote that the capabilities-based planning tool does not explicitly use this information to generate tailored output for community planning use, but the information may still be important to consider for disaster planning. Some functions are left blank indicating that no suitable function could be found. But, as this tool is a prototype, we considered it possible that we may be able to gather suitable data in future development.

The functions in this appendix are organized into three sections: Disaster Effects, Capabilities, and Resources. These three sections correspond to the three tabs in the tool where outputs are displayed. The functions listed here are used in the tool to generate the outputs displayed on the tool's three tabs.

There are three principal tables:

- Table D.1, Functions for Disaster Effects
- Table D.2, Functions for Required Capabilities
- Table D.3, Functions for Required Resources.

All three tables include six columns, as follows:

- **Function Number:** This is a number associated with each function to keep track of all the functions in the tool.
- **Function Arguments:** This describes the values that are input into a function to produce the output and indicates the disaster for which the function is applicable. This column lists the variable names of the arguments. All the referenced variable names can be found listed in Appendix C. The character following the caret (^) denotes the disasters for which each function is applicable. "^1," "^2," and "^3" denote that the function is applicable to a hurricane, an earthquake, and a pandemic influenza, respectively. "^i" denotes that the function is independent of the disaster selected and is applicable to all disasters.
- **Function Name:** The function name is referenced (sometimes with a modified prefix) in the "function argument" column, where it is defined as the function output.
- **Unit:** This is the unit of measure for the function output.

- **Function Definition:** This is the actual function algebra. Many of the functions are simple, frequently linear, functions. Some of the functions are more complicated. For the very complicated functions, we refer in this column to a later section of the appendix.
- **Sources:** This refers to the source of the function. The vast majority of the functions are simple, taken directly from planning factors found in source documents. For some of the functions, we took complicated planning factors and simplified them. In these instances we include a descriptive note along with the source reference. A few of the functions are RAND Estimates. For these functions, we made very simple assumptions, and explained our logic with notes along the same spreadsheet row as the functions.
- **Explanations and Assumptions:** This column contains notes to explain how we derived some of the functions in the tool. We did not include an explanation for the functions that we considered quite transparent.

Some functions were too complicated to include in the tables. In such cases, further supporting details are included as separate sections of text and tabular information, and provide thorough explanations of those more complicated functions.

Disaster Effects

The content in many of the detailed descriptions that follow is, for the most part, directly from the Hazus software. We note the few instances where other sources were used and where RAND made adjustments and additional assumptions to facilitate computation.

Table D.1
Functions for Disaster Effects

Function Number	Function Arguments	Function Variable Name	Unit	Function Definition	Source	Explanations and Assumptions
	Hurricane					
	Population Affected					
1	f1^1(Pop)=f_PopD	f_PopD	Persons	<<see **Detailed Description 1** following Technical Report Table D.1>>	HAZUS09	
2	f2^1(Windspeed,Pop,PerEvac) =O_PopE	f_PopE	Persons	f2^2(windspeed,Pop, PerEvac)=coef*Pop*(1-PerEvac) = (1/(1+exp(-1*(0.0654645*windspeed-8.55379))))*Pop*(1-PerEvac)	RAND Estimate	RAND assumed that a wind speed of 60mph requires 1 percent of the remaining population to need evacuation and that a wind speed of 200mph causes 99 percent of the remaining population to need evacuation. The sigmoid function (1/(1+exp(-x))) was anchored at these two points and has a range between 0 and 1.
3	f3^1(f_PopS)=O_AnimS	f_AnimS	Animals	f3^2(f_PopS)=(193000/313000)*f_PopS	TCL07 p.512	TCL estimates 193,000 companion animals for 313,000 people that need shelter. RAND assumes that this point estimate found in the source is scalable.
4	f4^1(f_PopS)=f_PopEDis	f_PopEDis	Persons	f4^1(ARF_Employed w/Disability,ARF_Not Employed w/Disability,ARF_Medicare Enrollment Disabled Tot,Pop,f_PopD) = ceiling((ARF_Employed w/Disability+ARF_Not Employed w/Disability+ARF_Medicare Enrollment Disabled Tot)/Pop * f_PopD,1)	RAND Estimate	RAND assumed that the proportion of people displaced with disabilities is equivalent to the proportion of entire population with disabilities.
5	f5^1(Cat,Pop)=O_PopS	f_PopS	Persons	<<see **Detailed Description 1** following Technical Report Table D.1>>	HAZUS09	
6	f6^1(Cat,Pop)=f_Inj	f_Inj	Persons	f6^1(3,Pop) = coef*Pop*(1-PerEvac) = (1/(1+exp(-1*(0.0398279920955501*windspeed-13.7904594579641))))*Pop*(1-PerEvac)	NPS05, RAND Estimate	The NPS05 scenario specifies that 0.06 percent of the population will be injured from a major hurricane assuming a major metropolitan area is a population of 10 million. RAND assumes that at wind speed of 160 mph, 0.06 percent of the population will be injured, and at 115mph, 0.01 percent of population will be injured. The sigmoid function (1/(1+exp(-x))) was anchored at these two points and has a range between 0 and 1.
7	f7^1(Inj-f_Hosp)=f_Outpatient	f_Outpatient	Persons	f7^1= f_Inj-f_Hosp	NPS05, TCL07, RAND Estimate	
8	f8^1(Pop,PerEvac,Windspeed) =f_Hosp	f_Hosp	Persons	f8^1(Pop,PerEvac,Windspeed) = coef*Pop*(1-PerEvac) = (1/(1+exp(-1*(0.0477135747612174*windspeed-15.0437199972503))))*Pop*(1-PerEvac)	NPS05, RAND Estimate	The NPS05 scenario specifies that 0.05 percent of the population will be hospitalized from a major hurricane assuming a major metropolitan area is a population of 10 million. RAND assumes that at wind speed of 156mph, 0.05 percent of the population will be hospitalized, and at 74mph, 0.001 percent of population will be hospitalized. The sigmoid function (1/(1+exp(-x))) was anchored at these two points and has a range between 0 and 1.
9	f9^1()=f_PatVent	f_PatVent	Persons			

Table D.1—Continued

Function Number	Function Arguments	Function Variable Name	Unit	Function Definition	Source	Explanations and Assumptions
	Hurricane					
10	f10^1(Pop,PerEvac)=f_PatICU	f_PatICU	Persons	f10^1(f_Hosp)=ceiling(.2*f_Hosp,1)	RAND Estimate	RAND assumed that 20 percent of hospitalized population require critical care based on RAND's experience with hospitalized patients.
11	f11^1()=f_PatTran	f_PatTran	Persons	f11^1() => f_inj	RAND Estimate	
12	f12^1()=f_Ambo	f_Ambo	Persons			
13	f13^1(f_PatTran)=f_PatTranCom	f_PatTranCom	Decimal	f13^1 => f_inj-f_hosp	RAND Estimate	
14	f14^1()=f_PatTranAmb	f_PatTranAmb	Decimal	f14^1 => f_hosp	RAND Estimate	
15	f15^1(Pop)=f_PopPW	f_PopPW	Persons	<<see **Detailed Description 1** following Technical Report Table D.1>>	HAZUS09	
16	f16^1(Pop)=f_Missing	f_Missing	Persons	default = 0		
17	f17^1(Cat,Pop,FloodDepth)=Fatalities	f_Fatalities	Persons	f17^17(Cat,Pop,FloodDepth) = (.0001*(Cat/5))*Pop+CummulativeStandardNormal((ln(flood_Depth)-5.20)/2.00)*(1-PerEvac)*Pop	NPS05; Jonkman, S.N., 2007. Loss of Life Estimation in Flood Risk Assessment, Dissertation, Civil Engineering and Geosciences, Delft University. p206. 2007.	The NPS05 scenario specifies that 0.01 percent of the population will be killed from a major hurricane assuming a major metropolitan area is a population of 10 million. RAND assumes that in a Category 5 hurricane, 0.01 percent of the population will be killed. For categories less than 5, RAND assumes a linear decrease in fatalities. The "Cumulative Standard Normal" drives the fatalities due to flood as specified in Jonkman (2007).
18	f18^1()=f_LabSamp	f_LabSamp	Number per Day			
	Infrastructure					
19	f19^1()=f_Comm	f_Comm	Decimal	f19^1(Pop)=0.9	NPS05	
20	f20^1()=f_Power	f_Power	Decimal	<<see **Detailed Description 1** following Technical Report Table D.1>>	HAZUS09	
21	f21^1()=f_Water	f_Water	Decimal	<<see **Detailed Description 1** following Technical Report Table D.1>>	HAZUS09	
22	f22^1()=f_Sewage	f_Sewage	Decimal	default = 0	Assumed by RAND	
23	f23^1()=f_Contamw	f_Contamw	Decimal/Duration	default = 0	Assumed by RAND	
24	f24^1()=f_Contamf	f_Contamf	Decimal/Duration	default = 0	Assumed by RAND	
25	f25^1(Buildings)=f_BldDam	f_BldDam	Number			
26	f26^1()=f_Struct	f_Struct	Decimal	<<see **Detailed Description 1** following Technical Report Table D.1>>	HAZUS09	
27	f27^1(Buildings)=f_BldDes	f_BldDes	Number			
28	f28^1(Cat,Pop)=SFHomDes	f_SFHomDes	Number	<<see **Detailed Description 1** following Technical Report Table D.1>>	HAZUS09	
29	f29^1()=MFHomDes	f_MFHomDes	Number	<<see **Detailed Description 1** following Technical Report Table D.1>>	HAZUS09	
	Capabilities Affected					
30	f30^1()=f_HospAff	f_HospAff	Decimal	default = 0	Assumed by RAND	
31	f31^1()=f_HospPer	f_HospPer	Decimal	default = 1	Assumed by RAND	
32	f32^1()=f_Fire	f_Fire	Decimal	default = 0	Assumed by RAND	
33	f33^1()=f_FirePer	f_FirePer	Decimal	default = 1	Assumed by RAND	
34	f34^1(f_Absent,f_EvacR)=f_FirstResEff	f_FirstResEff	Decimal	f34^1(f_Absent,f_EvacR)=(1-f_Absent)*(EvacR)	RAND Estimate	
35	f35^1()=f_Absent	f_Absent	Decimal	default = 0	Assumed by RAND	
36	f36^1()=f_EvacR	f_EvacR	Decimal	default = 0	Assumed by RAND	

Table D.1—Continued

Function Number	Function Arguments	Function Variable Name	Unit	Function Definition	Source	Explanations and Assumptions
	Influenza					
	Population Affected					
1	f1^3(Pop)=f_PopD	f_PopD	Persons			
2	f2^3(Pop)=f_PopE	f_PopE	Persons			
3	f3^3(f_PopS)=O_AnimS	f_AnimS	Animals			
4	f4^3(Pop)=f_PopEDis	f_PopEDis	Persons			
5	f5^3(Pop)=f_PopS	f_PopS	Persons			
6	f6^3(Pop)=f_Inj	f_Inj	Persons	f6^3(Pop)=f_outpat + f_Hosp + f_fatalities	FluSurge 2.0	
7	f7^3(AttRate, Pop_a, pc_HR_a, Adverse_R, ConvF)=f_outpat	f_Outpatient	Persons	<<see **Detailed Description 2** following Technical Report Table D.1>>	FluSurge 2.0	
8	f8^3(AttRate, Pop_a, pc_HR_a, Adverse_R, ConvF)=f_Hosp	f_Hosp	Persons	<<see **Detailed Description 2** following Technical Report Table D.1>>	FluSurge 2.0	
9	f9^3(f_PatICU)=f_PatVent	f_PatVent	Persons	f9^3(f_PatICU)=1*f_PatICU	TCL07 p.460	
10	f10^3(f_Hosp)=f_PatICU	f_PatICU	Persons	f10^3(f_Hosp)=0.2*f_Hosp	TCL07 p.460	RAND assumed that 20 percent of the hospitalized population would require critical care based on RAND's experience with hospitalized patients.
11	f11^3()=f_PatTran	f_PatTran	Persons			
12	f12^3()=f_Ambo	f_Ambo	Persons			
13	f13^3()=f_PatTranCom	f_PatTranCom	Decimal			
14	f14^3()=f_PatTranAmb	f_PatTranAmb	Decimal			
15	f15^3(Pop)=f_PopPW	f_PopPW	Persons			
16	f16^3(Pop)=f_Missing	f_Missing	Persons			
17	f17^3(AttRate, Pop_a, pc_HR_a, Adverse_R, ConvF)=f_Fatalities	f_Fatalities	Persons	<<see **Detailed Description 2** following Technical Report Table D.1>>	FluSurge 2.0	
18	f18^3(Pop)=f_LabSamp	f_LabSamp	Number per Day	f18^3(Pop)=0.0426*4*Pop	FLS09; Ferguson, N. M. et al. Strategies for Mitigating an Influenza Pandemic, Nature 2006, Figure 4c, High Transmissibility, No Interventions, Nature, 2006, 442:448-452.	This is an approximation of the peak number of lab per day as specified in the sources. RAND assumes the 4.26 percent of the population will require 4 lab tests each.

Table D.1—Continued

Function Number	Function Arguments	Function Variable Name	Unit	Function Definition	Source	Explanations and Assumptions
	Influenza					
	Infrastructure					
19	f19^3()=f_Comm	f_Comm	Decimal			
20	f20^3()=f_Power	f_Power	Decimal			
21	f21^3()=f_Water	f_Water	Decimal			
22	f22^3()=f_Sewage	f_Sewage	Decimal			
23	f23^3()=f_Contamw	f_Contamw	Decimal/Duration			
24	f24^3()=f_Contamf	f_Contamf	Decimal/Duration			
25	f25^3(Buildings)=f_BldDam	f_BldDam	Number			
26	f26^3()=f_Struct	f_Struct	Decimal			
27	f27^3(Buildings)=f_BldDes	f_BldDes	Number			
28	f28^3()=f_SFHomDes	f_SFHomDes	Number			
29	f29^3()=f_MFHomDes	f_MFHomDes	Number			
	Capabilities Affected					
30	f30^3()=f_HospAff	f_HospAff	Decimal			
31	f31^3()=f_HospPer	f_HospPer	Decimal	default = 1	Assumed by RAND	
32	f32^3()=f_Fire	f_Fire	Decimal			
33	f33^3()=f_FirePer	f_FirePer	Decimal			
34	f34^3()=f_FirstResEff	f_FirstResEff	Decimal			
35	f35^3()=f_Absent	f_Absent	Decimal	f34^3()=f_Inj/Pop	TCL07 p.192, RAND Estimate	

Table D.1—Continued

Function Number	Function Arguments	Function Variable Name	Unit	Function Definition	Source	Explanations and Assumptions
	Earthquake					
	Population Affected					
1	f1^2(Pop)=f_PopD	f_PopD	Persons	<<see **Detailed Description 3** following Technical Report Table D.1>>	NPS05; TCL07; HAZUS09	
2	f2^2(Pop)=f_PopE	f_PopE	Persons	f2^2(Pop) => coef*Pop*(1-PerEvac) = 4.000095999904E-10*(10^(magnitude))*Pop*(1-PerEvac)	NPS05; TCL07; RAND Estimate	NPS05 states that 5 percent of the population will need evacuation after a magnitude 8.0 earthquake and the TCL07 states that 3 percent of the population will need evacuation after a magnitude 8.0 earthquake. Therefore, we fit a model that predicts 4 percent (i.e., the average of the two source estimates) after a magnitude 8.0 earthquake and 0 percent when no earthquake occurs. Since the Richter scale is logrithmic, we assumed a logrithmic model.
3	f3^2(f_PopS)=O_AnimS	f_AnimS	Animals	f3^2(f_AnimS)=(193000/313000)*f_PopS	TCL07	TCL estimates 193,000 companion animals for 313,000 people that need shelter. RAND assumes that this point estimate found in the source is scalable.
4	f4^2(Pop)=f_PopEDis	f_PopEDis	Persons	f4^2(Pop)=0.005*Pop	SFEP06	
5	f5^2(Pop)=f_PopS	f_PopS	Persons	<<see **Detailed Description 3** following Technical Report Table D.1>>	HAZUS09	
6	f6^2(Pop)=f_Inj	f_Inj	Persons	<<see **Detailed Description 6** following Technical Report Table D.1>>	NPS05; SFEP06	
7	f7^2()=f_Outpatient	f_Outpatient	Persons	<<see **Detailed Description 6** following Technical Report Table D.1>>	HAZUS09	
8	f8^2(Pop)=f_Hosp	f_Hosp	Persons	<<see **Detailed Description 6** following Technical Report Table D.1>>	HAZUS09	
9	f9^2()=f_PatVent	f_PatVent	Persons			
10	f10^2()=f_PatICU	f_PatICU	Persons	<<see **Detailed Description 6** following Technical Report Table D.1>>	HAZUS09	
11	f11^2()=f_PatTran	f_PatTran	Persons	<<see **Detailed Description 7** following Technical Report Table D.1>>	HAZUS09	
12	f12^2()=f_Ambo	f_Ambo	Persons			
13	f13^2()=f_PatTranCom	f_PatTranCom	Persons	(1-(b_Hosp + PatICU) / (b_Hosp + Hosp)) * Pat_Trans	RAND Estimate	RAND assumes that those patients injured that do not require critical care have the ability to transferred by commercial (non-medical) means.
14	f14^2()=f_PatTranAmb	f_PatTranAmb	Persons	.85*(1-HosPer)*Pat_Trans	RAND Estimate	
15	f15^2(Pop)=f_PopPW	f_PopPW	Persons	f15^2(Pop)=0.1*Pop	NPS05	
16	f16^2(Pop)=f_Missing	f_Missing	Persons	f16^2(Pop)=0.002*Pop	NPS05	
17	f17^2(Pop)=f_Fatalities	f_Fatalities	Persons	<<see **Detailed Description 6** following Technical Report Table D.1>>	HAZUS09	
18	f18^2()=f_LabSamp	f_LabSamp	Number per Day			

Table D.1—Continued

Function Number	Function Arguments	Function Variable Name	Unit	Function Definition	Source	Explanations and Assumptions
	Earthquake					
	Infrastructure					
19	f19^2()=f_Comm	f_Comm	Decimal			
20	f20^2()=f_Power	f_Power	Decimal			
21	f21^2()=f_Water	f_Water	Decimal			
22	f22^2()=f_Sewage	f_Sewage	Decimal			
23	f23^2()=f_Contamw	f_Contamw	Decimal/Duration			
24	f24^2()=f_Contamf	f_Contamf	Decimal/Duration	default = 0	Assumed By RAND	
25	f25^2(Buildings)=f_BldDam	f_BldDam	Number	<<see **Detailed Description 6** following Technical Report Table D.1>>	HAZUS09	
26	f26^2()=f_Struct	f_Struct	Decimal	<<See HAZUS09 model documentation>>	HAZUS09	
27	f27^2(Buildings)=f_BldDes	f_BldDes	Number	<<see **Detailed Description 6** following Technical Report Table D.1>>	HAZUS09	
28	f28^2()=f_SFHomDes	f_SFHomDes	Number	<<See HAZUS09 model documentation>> RES1 + RES2 homes destroyed	HAZUS09	See HAZUS09 model documentation of residence type 1 (RES1) and residence type 2 (RES2)
29	f28.5^2()=f_MFHomDes	f_MFHomDes	Number	<<See HAZUS09 model documentation>> RES3	HAZUS09	See HAZUS09 model documentation of residence type 3 (RES3)
	Capabilities Affected					
30	f29^2()=f_HospAff	f_HospAff	Decimal			
31	f30^2()=f_HospPer	f_HospPer	Decimal	f30^2()=0.12	NPS05	
32	f31^2()=f_Fire	f_Fire	Decimal	f31^2()=0	HAZUS09	
33	f32^2()=f_FirePer	f_FirePer	Decimal	f32^2()=0.17	NPS05	
34	f33^1(f_Absent,f_EvacR)=f_FirstResEff	f_FirstResEff	Decimal	f33^1(f_Absent,f_EvacR)=(1-f_Absent)*(EvacR)	RAND Estimate	

Detailed Description 1: Functions for Hurricane Population and Structure Damage Disaster Effects

This appendix subsection details the hurricane functions #1 f_PopD, #5 f_PopS, #15 f_PopPW, #20 f_Power, #21 f_Water, #26 f_Struct, #28 f_SFHomDes, and #29 f_MFHomDes listed in Table D.1. Default values for weighting factors are listed in Table D.1.1; default fractional values for displaced households are listed in Table D.2.2.

Functions

The population displaced not requiring shelter (f_PopD) is the population requiring shelter subtracted from the number of displaced people.

$$\text{f\_PopD} = \frac{D \cdot P}{H} - \text{f\_PopS}$$

The population displaced and requiring shelter (f_PopS) estimate is dependent on the number of displaced households and the distribution of income, ethnicity, building ownership type, and age. P is the population of the community.

$$\text{f\_PopS} = \frac{D \cdot P}{H} \sum_{i=1}^{5} \sum_{j=1}^{5} \sum_{k=1}^{2} \sum_{l=1}^{3} \left(\alpha_{ijkl} I_i E_j O_k A_l \right)$$

α is a weighting factor used in the f_PopS function to weight income, ethnicity, ownership type, and age.

$$\alpha_{ijkl} = w_I(F_I) + w_E(F_E)_j + w_O(F_O)_k + w_A(F_A)_l$$

Table D.1.1
Default Values for Weighting Factors

Symbol	Description	Default Value
w_I	Income factor weighting	0.73
w_E	Ethnic factor weighting	0.27
w_O	Ownership factor weighting	0.00
w_A	Age factor weighting	0.00
$(w_I + w_E + w_O + w_A)$	Total	1.00

SOURCE: Hazus.

The population without power or water (f_PopPW) estimate is dependent on the population, the number of uninhabitable housing units due to power or water loss, and wind speed. *P* is the population of the community.

$$\text{f\_PopPW} = P \cdot \frac{U_b}{H}$$

The percentage of power systems interrupted (f_Power) estimate is the fraction of uninhabitable housing units due to power loss and is dependent on the wind speed.

$$\text{f\_Power} = \frac{U_b}{(S + M)}$$

The percentage of water systems interrupted (f_Water) is the fraction of uninhabitable housing units due to water loss and is dependent on the wind speed.

$$\text{f\_Water} = \frac{U_b}{(S + M)}$$

The percentage of buildings with severe structural damage (f_Struct) estimate is dependent on the wind speed and the number of uninhabitable housing units due to damage.

$$\text{f\_Struct} = \frac{U_a}{(S + M)}$$

The number of single-family homes destroyed (f_SFHomDes) is the number of single-family homes in the community multiplied by the single-family building loss ratio.

$$\text{f\_SFHomDes} = S \cdot F_S(X_S)$$

The number of multi-family homes destroyed (f_MFHomDes) is the number of multi-family homes in the community multiplied by the multi-family building loss ratio.

$$\text{f\_MFHomDes} = M \cdot F_M(X_M)$$

The form of the displaced households model is:

$$D = (U_a + \beta U_b)\frac{H}{S + M}$$

where
D = Number of households with displaced residents
U_a = Number of uninhabitable units due to damage
U_b = Number of uninhabitable units due to loss of water or power
H = Total number of households, from Area Resource File “Households”
S = Total number of single-family dwelling units, from Hazus county data
M = Total number of dwelling units in multi-family buildings, from Hazus county data
β = Adjustment factor. RAND assumes this is equal to 1.

Table D.1.2
Default Fractional Values

Symbol	Description	Default Value
Income		
$(F_I)_1$	Fraction of displaced households given household income < $10,000	0.62
$(F_I)_2$	Fraction of displaced households given $10,000 < household income < $20,000	0.42
$(F_I)_3$	Fraction of displaced households given $20,000 < household income < $30,000	0.29
$(F_I)_4$	Fraction of displaced households given $30,000 < household income < $40,000	0.22
$(F_I)_5$	Fraction of displaced households given household income > $40,000	0.13
Ethnicity		
$(F_E)_1$	Fraction of displaced households given household ethnicity is white	0.24
$(F_E)_2$	Fraction of displaced households given household ethnicity is black	0.48
$(F_E)_3$	Fraction of displaced households given household ethnicity is Hispanic	0.47
$(F_E)_4$	Fraction of displaced households given household ethnicity is Asian	0.26
$(F_E)_5$	Fraction of displaced households given household ethnicity is Native American	0.26
Ownership		
$(F_O)_1$	Fraction of displaced households given dwelling unit is owned by household	0.40
$(F_O)_2$	Fraction of displaced households given dwelling unit is rented by household	0.40
Age		
$(F_A)_1$	Fraction of displaced households for population under 16 years old	0.40
$(F_A)_2$	Fraction of displaced households for population 16–65 years old	0.40
$(F_A)_3$	Fraction of displaced households for population over 65 years old	0.40

SOURCE: Hazus.

NOTE: I_i = Percentage of population in the i^{th} income class, from Area Resource File household incomes; E_j = Percentage of population in the j^{th} ethnic class, from Area Resource File of white, black, Hispanic, Asian, and American Indian; O_k = Percentage of population in the k^{th} ownership class, assumed 50 percent own, 50 percent rent; A_l = Percentage of population in the l^{th} age class, approximate from Area Resource File.

$$U_a = S \cdot F_S(X_S) + M \cdot F_M(X_M)$$

$$U_b = R_u[(S+M)-U_a]$$

R_u is the damage ratio to power and water facilities. The R_u below is RAND's approximation of Hazus's calculation. The RAND calculation estimates R_u as 0 when wind speed is less than 60 mph, as 1 when wind speed is greater than 200 mph, and a linear interpolation between 60 and 200 mph.

R_u =

- 0 if wind speed < 60 mph
- (wind speed–60) / (200-60) if 60 mph ≤ wind speed ≤ 200mph
- 1 if wind speed > 200 mph.

$F_S(X_S)$ is the single-family building loss ratio; $F_M(X_M)$ is the multi-family building loss ratio.

X is the mean building loss ratio. The function for X below is RAND's approximation using Hazus as a guide:

X_S = mean building loss ratio for single-family

X_M = mean building loss ratio for multi-family

$$F_S(X_S) = \frac{2X_S^{1.6}}{1 + X_S^{2.6}}$$

$$F_M(X_M) = \frac{2X_M^{1.3}}{1 + X_M^{2.2}}$$

X_S =

- X_M = 0 if wind speed < 60mph
- (wind speed–60) / (200–60) if 60mph ≤ wind speed ≤ 200mph
- 1 if wind speed > 200mph.

The RAND calculation estimates X_M and X_S as 0 when wind speed is less than 60 mph, as 1 when wind speed is greater than 200 mph, and a linear interpolation between 60 and 200 mph.

Detailed Description 2: Functions for Influenza Disaster Effects

This appendix subsection details the influenza functions #7 f_Outpat, #8 f_Hosp, and #17 f_Fatalities listed in Table D.1.

Sources

These functions are from the CDC's FluSurge model.

Functions

The number of fatalities (f_Fatalities) estimate due to illness severity type *s* is dependent on the influenza attack rate, the percentage of the population that is at high risk (typically due to age), and the rate of adverse health outcomes that affect fatalities.

$$\text{f\_Fatalities} = \sum_{y=1}^{3}\left(\text{AttRate}\cdot\left(\left(\frac{Pop_y\cdot(1-\%HR_y)}{1000}\right)\cdot\left(\frac{\rho_{2,1,y}}{\phi_{2,y}}\right)+\left(\frac{Pop_y\cdot\%HR_y}{1000}\right)\cdot\left(\frac{\rho_{1,1,y}}{\phi_{1,y}}\right)\right)\right).$$

The population hospitalized (f_Hosp) estimate due to illness severity type *s* is dependent on the influenza attack rate, the percentage of the population that is at high risk (typically due to age), and the rate of adverse health outcomes that affect the number hospitalized.

$$\text{f\_Hosp} = \sum_{y=1}^{3}\left(\text{AttRate}\cdot\left(\left(\frac{Pop_y\cdot(1-\%HR_y)}{1000}\right)\cdot\left(\frac{\rho_{2,2,y}}{\phi_{2,y}}\right)+\left(\frac{Pop_y\cdot\%HR_y}{1000}\right)\cdot\left(\frac{\rho_{1,2,y}}{\phi_{1,y}}\right)\right)\right).$$

The number of outpatient visits (f_Outpat) estimate due to illness severity type *s* is dependent on the influenza attack rate, the percentage of the population that is at high risk (typically due to age), and the rate of adverse health outcomes that affect the number of outpatient visits.

$$\text{f\_Outpat} = \sum_{y=1}^{3}\left(\text{AttRate}\cdot\left(\left(\frac{Pop_y\cdot\left(1-\%HR_y\right)}{1000}\right)\cdot\left(\frac{\rho_{2,3,y}}{\phi_{2,y}}\right)+\left(\frac{Pop_y\cdot\%HR_y}{1000}\right)\cdot\left(\frac{\rho_{1,3,y}}{\phi_{1,y}}\right)\right)\right).$$

Indexes

- y = Year (age) group (1: 0–17; 2: 18–64; 3: 65+)
- s = Severity of outcomes (1: low severity; 2: high severity)
- r = Risk group (1: high risk; 2: non–high risk)
- o = Patient outcomes (1: deaths; 2: hospitalizations; 3: outpatient visits) = corresponding to functions #17 (f_fatalities), #8 (f_hosp), and #7 (f_outpat) in "Functions—Disaster Effects" sheet.

Inputs

- Pop_y = Population indexed by year (age) group
- $\phi_{s,y}$ = Conversion factor indexed by year (age) group and severity (See Table D.1.3).

Assumptions

- $\%HR_y$ = Percentage considered at "high risk" for adverse health outcomes indexed by year (age) group %HRy = pc_HR_(y) in the community characteristics list (See Table D.1.4).
- $\rho_{r,o,y}$ = Rate per 1,000 population of adverse health outcomes by risk group (r), patient outcome (o), and age group (y) (See Table D.1.5).

In Table D.1.5, RAND simplifies the calculation by only using the "most likely (or mean)" values. CDC's FluSurge software allows the user to select a minimum, maximum, or a most likely scenario that alters the quantities in Table D.1.5. RAND has omitted the option to select minimum or maximum scenarios to facilitate computations.

Table D.1.3
Conversion Factor $\phi_{y,s}$

	Conversion factor $\phi_{y,s}$	
Age Group (y)	**Severity (*s*)**	
	High Severity	**Low Severity**
0–17 years	0.35	0.42
18–64 years	0.12	0.23
65+ years	0.12	0.19

SOURCE: CDC FluSurge.

Table D.1.4
$\%HR_y$—Percentage Considered "High Risk"

Age Group	0–17 years	18–64 years	65+ years
Percentage of high-risk population	6.4	14.4	40.0

SOURCE: CDC FluSurge.

Detailed Description 3: Functions for Earthquake Direct Social Losses Disaster Effects

This appendix subsection details the earthquake functions #1 f_PopD and #5 f_PopS in Table D.1. The content in this subsection is directly from the Hazus software. We denote the few instances where RAND made adjustments and additional assumptions to facilitate computation.

Sources

These functions are derived in large part from the Hazus software; RAND made assumptions to facilitate calculations as denoted below.

Assumptions

- Total number of households is sum of number of single- and multiple-family units
- Residents are displaced only from structures with moderate, extensive, or complete structural damage.
- The number of displaced persons estimate is based on weighting by degree of structural damage, age group, ethnicity group, income group, and home ownership status.

Functions

The population displaced and not requiring shelter (f_PopD) estimate is dependent on the number of displaced households, the community population (Pop), and the population displaced and requiring shelter.

$$\text{f\_PopD} = \frac{\# DH \cdot POP}{\# HH} - \text{f\_O\_PopS} \; .$$

The population displaced and requiring shelter (f_PopS) estimate is dependent on the number of displaced households and the distribution of income, ethnicity, housing ownership type, and age.

$$\text{f\_PopS} = \sum_{i=1}^{5}\sum_{j=1}^{5}\sum_{k=1}^{2}\sum_{l=1}^{3} \alpha_{ijkl} \cdot \left(\frac{\# DH \cdot POP}{\# HH} \right) \cdot HI_i \cdot HE_j \cdot HO_k \cdot HA_l \; .$$

α is a weighting factor used in the f_PopS function to weight income, ethnicity, ownership housing type, and age.

$$\alpha_{ijkl} = \left(IW \cdot IM_i\right) + \left(EW \cdot EM_j\right) + \left(OW \cdot OM_k\right) + \left(AW \cdot AM_l\right) \; .$$

Table D.1.5
Rate per 1,000 Population of Adverse Health Outcomes $\rho_{r,o,y}$

o = 1 = FATALITIES

Set rates per 1,000 population of adverse health outcomes, by age and risk groups

		Most likely (or mean)
Rates per 1,000	**"High risk" (r = 1)**	
	0–17 years	0.22
	18–64 years	2.91
	65+ years	4.195
	"Non–high risk" (r = 2)	
	0–17 years	0.024
	18–64 years	0.037
	65+ years	0.42

o = 2 = HOSPITALIZATIONS

Set rates per 1,000 population of adverse health outcomes, by age and risk groups

		Most likely (or mean)
Rates per 1,000	**"High risk" (r = 1)**	
	0–17 years	2.9
	18–64 years	2.99
	65+ years	8.5
	"Non–high risk" (r = 2)	
	0–17 years	0.5
	18–64 years	1.465
	65+ years	2.25

o = 3 = OUTPATIENT VISITS

Set rates per 1,000 population of adverse health outcomes, by age and risk groups

		Most likely (or mean)
Rates per 1,000	**"High risk" (r = 1)**	
	0–17 years	346
	18–64 years	109.5
	65+ years	104.5
	"Non–high risk" (r = 2)	
	0–17 years	197.5
	18–64 years	62.5
	65+ years	59.5

SOURCE: CDC FluSurge.

The total number of households with displaced residents (*#DH*) estimate is dependent on the number of single- and multi-family dwelling units, the predicted moderate, extreme, and complete structural damage, and the number of households.

$$\# DH = \left(\# SFU \times \%SF + \# MFU \times \%MF\right) \cdot \left(\frac{\# HH}{\# SFU + \# MFU}\right)$$
$$\%SF = w_{SFM} \times \%SFM + w_{SFE} \times \%SFE + w_{SFC} \times \%SFC$$
$$\%MF = w_{MFM} \times \%MFM + w_{MFE} \times \%MFE + w_{MFC} \times \%MFC \quad .$$

Definitions

Input variables contained in the census tract data in Hazus:

POP = Number of people in county
#HH = Total number of households
#SFU = Total number of single-family dwelling units
#MFU = Total number of multi-family dwelling units
HA_1 = Percentage of population under 16 years old
HA_2 = Percentage of population between 16 and 65 years old
HA_3 = Percentage of population over 65 years old
HE_1 = Percentage of white households
HE_2 = Percentage of black households
HE_3 = Percentage of Hispanic households
HE_4 = Percentage of Native American households
HE_5 = Percentage of Asian households
HI_1 = Percentage of households whose income is under $10,000
HI_2 = Percentage of households whose income is $10,001 to $15,000
HI_3 = Percentage of households whose income is $15,001 to $25,000
HI_4 = Percentage of households whose income is $25,001 to $35,000
HI_5 = Percentage of households whose income is over $35,000
HO_1 = Percentage of households owned by householder
HO_2 = Percentage of households rented by householder

Input variables from Hazus:

%SF = Total percentage of single-family units with residents displaced
%MF = Total percentage of multi-family units with residents displaced
%SFM = Probability for moderate structural damage in the single-family residential occupancy class (Computed by building damage module)
%SFE = Probability for extensive structural damage in the single-family residential occupancy class (Computed by building damage module)
%SFC = Probability for complete structural damage in the single-family residential occupancy class (Computed by building damage module)
%MFM = Probability for moderate structural damage in the multi-family residential occupancy class (Computed by building damage module)
%MFE = Damage state probability for extensive structural damage in the multi-family residential occupancy class (Computed by building damage module)
%MFC = Damage state probability for complete structural damage in the multi-family residential occupancy class (Computed by building damage module)
w_{SFM} = Weighting factor to adjust for single-family units of moderate damage that are perceived to be uninhabitable
w_{SFE} = Weighting factor to adjust for single-family units of extensive damage that are perceived to be uninhabitable
w_{SFC} = Weighting factor to adjust for single-family units of complete damage that are perceived to be uninhabitable
w_{MFM} = Weighting factor to adjust for multi-family units of moderate damage that are perceived to be uninhabitable
w_{MFE} = Weighting factor to adjust for multi-family units of extensive damage that are perceived to be uninhabitable
w_{MFC} = Weighting factor to adjust for multi-family units of complete damage that are perceived to be uninhabitable

Tables D.1.6, D.1.7, and D.1.8 display the default values specified by Hazus. The Hazus software allows the selection of non-default values; however, RAND omitted this capability to facilitate computation and, therefore, assumed that these default values are always appropriate.

Table D.1.6
Weight Factors for Single and Multi-Family Residence Damage

Weight Factor	Default Value
w_{SFM}	0.0
w_{SFE}	0.0
w_{SFC}	1.0
w_{MFM}	0.0
w_{MFE}	0.9
w_{MFC}	1.0

SOURCE: Hazus.

Table D.1.7
Weight Factors for Income, Ethnicity, Ownership, and Age to Estimate the Population Seeking Shelter and Displaced

Class	Description	Default
IW	Income Weighting Factor	0.73
EW	Ethnic Weighting Factor	0.27
OW	Ownership Weighting Factor	0.00
AW	Age Weighting Factor	0.00

SOURCE: Hazus.

NOTE: IW = Shelter weighting factor for income; EW = Shelter weighting factor for ethnicity; OW = Shelter weighting factor for ownership; AW = Shelter weighting factor for age group.

The relative modification factors below are used to calculate the α_{ijkl} weighting factor above. See Table D.1.8 below for the default estimates.

IM_1 = Relative modification factor for estimating the percentage of households with income less than $10,000. Used for estimating the percentage of each category that will seek shelter.

IM_2 = Relative modification factor for estimating the percentage of households with income $10,000–$14,999. Used for estimating the percentage of each category that will seek shelter.

IM_3 = Relative modification factor for estimating the percentage of households with income $15,000–$24,999. Used for estimating the percentage of each category that will seek shelter.

IM_4 = Relative modification factor for estimating the percentage of households with income $25,000–$34,999. Used for estimating the percentage of each category that will seek shelter.

IM_5 = Relative modification factor for estimating the percentage of households with income greater than $35,000. Used for estimating the percentage of each category that will seek shelter.

EM_1 = Relative modification factor for estimating the percentage of white households. Used for estimating the percentage of each category that will seek shelter.

EM_2 = Relative modification factor for estimating the percentage of black households. Used for estimating the percentage of each category that will seek shelter.

EM_3 = Relative modification factor for estimating the percentage of Hispanic households. Used for estimating the percentage of each category that will seek shelter.

EM_4 = Relative modification factor for estimating the percentage of Asian households. Used for estimating the percentage of each category that will seek shelter.

EM_5 = Relative modification factor for estimating the percentage of Native American households. Used for estimating the percentage of each category that will seek shelter.

OM_1 = Relative modification factor for estimating the percentage of families who own their dwelling unit. Used for estimating the percentage of each category that will seek shelter.

OM_2 = Relative modification factor for estimating the percentage of families who rent their dwelling unit. Used for estimating the percentage of each category that will seek shelter.

AM_1 = Relative modification factor for estimating the percentage of population under 16 years old. Used for estimating the percentage of each category that will seek shelter.

AM_2 = Relative modification factor for estimating the percentage of population ages 16–65 years old. Used for estimating the percentage of each category that will seek shelter.

AM_3 = Relative modification factor for estimating the percentage of population over 65 years old. Used for estimating the percentage of each category that will seek shelter.

Table D.1.8
Default Values for the Fraction of Displaced Households Given Income, Ethnicity, Ownership, and Age Used to Estimate the Number of Displaced People

Symbol	Description	Default Value
Income		
IM_1	Fraction of Displaced Households Given Household Income < $10,000	0.62
IM_2	Fraction of Displaced Households Given $10,000 < Household Income < $20,000	0.42
IM_3	Fraction of Displaced Households Given $20,000 < Household Income < $30,000	0.29
IM_4	Fraction of Displaced Households Given $30,000 < Household Income < $40,000	0.22
IM_5	Fraction of Displaced Households Given Household Income > $40,000	0.13
Ethnicity		
EM_1	Fraction of Displaced Households Given Household Ethnicity Is White	0.24
EM_2	Fraction of Displaced Households Given Household Ethnicity Is Black	0.48
EM_3	Fraction of Displaced Households Given Household Ethnicity Is Hispanic	0.47
EM_4	Fraction of Displaced Households Given Household Ethnicity Is Asian	0.26
EM_5	Fraction of Displaced Households Given Household Ethnicity Is Native American	0.26
Ownership		
OM_1	Fraction of Displaced Households Given Dwelling Unit Is Owned by Household	0.40
OM_2	Fraction of Displaced Households Given Dwelling Unit Is Rented by Household	0.40
Age		
AM_1	Fraction of Displaced Households for the Population Is Under 16 Years Old	0.40
AM_2	Fraction of Displaced Households for the Population Between 16 and 65 Years Old	0.40
AM_3	Fraction of Displaced Households for the Population Over 65 Years Old	0.40

SOURCE: Hazus.

Detailed Description 4: Functions for Earthquake Physical and Attenuation Disaster Effects

This appendix subsection details the estimation of earthquake spectral acceleration and spectral displacement considering attenuation. The estimate of spectral displacement is an input to the damage probability estimate in Detailed Description 5: Functions for Earthquake Damage Disaster Effects.

Sources

These functions are specified directly from the ground motion attenuation relationship described in Collins et al. (2006) and the spectral acceleration to spectral displacement relationship specified by Hazus (FEMA, 2009). RAND denotes assumptions made to facilitate calculations.

Functions

Given a moment magnitude of the earthquake and the earthquake's proximity, we calculate the spectral acceleration (Sa) using the correlations found in Collins et al. (2006) for the 1.0 second period.

$$Sa = \exp\left(C_1 + C_2 \cdot M_w + C_3 \cdot \ln\left(Rc_{rup}\right) + C_4 \cdot M_w \cdot \ln\left(Rc_{rup}\right) \right.$$
$$\left. + C_5 \cdot R_{rup} + C_6 \cdot \left(8.5 - M_w\right)^2 + C_7 \cdot HW \cdot \left(8.5 - M_w\right)\right)$$

$$Rc_{rup} = \sqrt{R_{rup}^2 + 6.5^2}$$

C_1 = 6.594
C_2 = –0.758
C_3 = –1.48
C_4 = 0.0954
C_5 = –0.0055
C_6 = –0.351
C_7 = 0.212
HW =

$R_{rup}/5$	if $R_{rup} < 5$
1	if $5 \le R_{rup} < 15$
$1 - (R_{rup} - 15)20 - 15$	if $15 \le R_{rup} < 20$
0	if $R_{rup} > 20$

M_w = Moment magnitude of earthquake
R_{rup} = Distance to fault rupture in kilometers
Sa = Spectral acceleration units (g).

This results in a relationship where the spectral acceleration attenuates with proximity to earthquake. Using the relationship between spectral acceleration and spectral displacement described in the Hazus-MH earthquake documentation, we calculate spectral displacement (Sd) as:

$$Sd = 9.8 \cdot Sa \cdot T^2 .$$

RAND assumes that T^2 = 1.0 (i.e., the period T is assumed to be 1.0 second).

With spectral displacement estimates, we are able to use the Hazus relationships between spectral displacement and construction type to determine probability of structural failure given a particular building construction type described in the section that follows.

Detailed Description 5: Functions for Earthquake Damage Disaster Effects

This appendix subsection details the building damage probability estimation. This section uses the spectral displacement estimate specified in Detailed Description 4 as an input. The building damage probability estimate in this section is used to estimate the disaster effect functions specified in Detailed Description 6: Functions for Earthquake Casualty Disaster Effects.

Source

Hazus Software.

Functions

Buildings were defined in two dimensions, by construction type and by occupancy type. Construction type designations are specified by Hazus to indicate the construction characteristics of the building (steel 3 stories, masonry 2 stories, wood, etc.). The occupancy type describes the use for the building (industrial, residency duplex, commercial, etc.). We used Hazus data that contain the number of buildings of each occupancy class by census tract. In addition, the Hazus data contained the percentage of each construction type by occupancy class and location. Using this, we were able to translate the occupancy building totals to construction building totals.

$$P_j = P(DS = j) = P(DS \le j) - P(DS \le j-1) = \Phi\left[\frac{1}{\beta_j}\cdot\ln\left(\frac{Sd}{\overline{Sd}_j}\right)\right] - \Phi\left[\frac{1}{\beta_{j-1}}\cdot\ln\left(\frac{Sd}{\overline{Sd}_{j-1}}\right)\right]$$

Damage to buildings is categorized in six damage states specified by Hazus and denoted here by *DS*: no damage (*DS* = *D0*), slight damage (*DS* = *D1*), moderate damage (*DS* = *D2*), extensive damage (*DS* = *D3*), complete damage (*DS* = *D4*), and collapsed (*DS* = *C*). The probability of being in or exceeding a particular damage state was modeled by Hazus using a log normal distribution based on tables of values for the median and variance of spectral displacement for these damage states based on construction type. Using Hazus's estimation approach, the probability that a building is in damage state *j* is

where *j*–1 denotes the previous damage state (e.g., if *j* = *D2*, then *j*–1 = *D1*) and P(*DS* ≤ –1) = 0.

The following are definitions for the variables and operators in the damage probability equation:

β_j = Standard deviation of the natural logarithm of spectral displacement of damage state *j* for a particular construction type. These estimates are listed in the Hazus Earthquake model manuals.

$\overline{Sd}_j$ = Median value of spectral displacement where a building reaches the damage state *j* for a particular construction type. These estimates are listed in the Hazus Earthquake model manuals.

Φ = Standard cumulative normal distribution function

To calculate the expected number of damaged buildings in a given damage state and a building type, Hazus multiplies the probability of damage by the number of buildings of the given building type. The number of casualties estimate is a function of the estimated building damage as detailed in the section above.

Detailed Description 6: Functions for Earthquake Casualty Disaster Effects

This appendix subsection details earthquake disaster effect functions #6 f_Inj, #7 f_Outpatient, #8 f_Hosp, #10 f_PatICU, #17 f_Fatalities, #25 f_BldDam, and #27 f_BldDes listed in Table D.1. The building damage probability estimate in Detailed Description 5 is an input to the functions specified in this section.

Sources

Primarily Hazus Software, with a few RAND approximations.

Injury Severity Definitions

Following the methodology specified by FEMA in their Hazus-MH software package, we grouped the types of injuries into the following four severity levels:

- Typically injuries that might be treated with basic medical aid administered by para professionals
- Require a higher level of medical care than Severity Type 1. Typically require the use of medical technology such as x-rays or surgery. These injuries do not normally progress to life-threatening.
- Life-threatening if not treated quickly or correctly
- Instantaneously fatal.

Functions

The expected number of injuries given building type and injury severity ($EN_{\beta,\Sigma}$) is dependent on the probability of injury severity (P_Σ) and the number of people in the specified building type (N_β).

$$EN_{\beta,\Sigma} = N_\beta \cdot P_\Sigma \ .$$

The probability of an injury severity category (P_Σ) is dependent on the probabilities of slight, moderate, extensive, and complete building damage, the probability of injury severity, and the probability of building collapse.

$$P_\Sigma = P_{D1} \cdot P_{D1,\Sigma} + P_{D2} \cdot P_{D2,\Sigma} + P_{D3} \cdot P_{D3,\Sigma} + P_{D4} \cdot \left(P_{NC} \cdot P_{NC,\Sigma} + P_C \cdot P_{C,\Sigma}\right)$$

where *D1*, *D2, D3, D4, C,* and *NC* designate building damage states of slight, moderate, extensive, complete, collapse, and no collapse, respectively. The probability of no collapse (P_{NC}) equals one minus the probability of collapse (P_C).

The number of buildings with damage (f_BldDam) is the sum of the probability of slight, moderate, extensive, and complete damage multiplied by the number of buildings.

$$\text{f\_BldDam} = (P_{D1} + P_{D2} + P_{D3} + P_{D4}) \cdot (\text{\# of buildings}).$$

The number of buildings destroyed (f_BldDes) is the probability of complete damage (P_{D4}) multiplied by the number of buildings.

$$\text{f\_BldDes} = (\text{P}_{\text{D4}}) \cdot (\text{\# of buildings}).$$

The number of people in each building type (N_β) was based on census data and estimated population distributions by occupancy type and time of day from the Hazus software package. The data contained number of residents and visitors, information on vacant buildings, number of workers by sector (commercial, education, industrial, etc.), and hotel population. For all occupancy types other than residential, the associated time-based populations were distributed evenly among those occupancy types as specified by Hazus. For example, the number of commercial workers expected to be working at 2 p.m. was distributed evenly across the 10 types of commercial buildings.

For residential locations, Hazus first adjusts the pool of buildings for vacant buildings to establish the number of occupied buildings. Then the probability of being in either a single-family unit, mobile home, or multi-family unit is calculated based on the number of owners and renters of those residency types as specified in the census tract data. Hazus then adjusts for the average number of units in each residential type and calculates the expected number of residents by residency type based on the population distribution over the time of day. Hazus then divides this by the number of occupied residencies to estimate the expected number of residents per residential building type dependent upon the time of day. This was multiplied by the number of residencies in each damage state to determine N_β for all residential occupancy classes as specified by Hazus.

The population injured or ill from disaster (f_Inj) estimate is dependent on the expected number of injured people (including those instantaneously killed or mortally injured severity S4). It accounts for the community's mix of building types, typical occupancy numbers by building type, and the probability of being injured given a particular level of structural damage.

$$\text{f\_Inj} = \sum_{\Sigma=1}^{4} \sum_{\forall\beta} EN_{\beta,\Sigma} \; .$$

The number of outpatient visits (f_Outpatient) is the number of severity 1 plus one-half the number of severity 2 injuries considering the building type mixture of the community. Due to the types of injuries falling into severity 1 and severity 2, we assumed that all severity 1 injuries would be outpatient visits and only half of severity 2 injuries would be outpatient visits.

$$\text{f\_Outpatient} = \text{f\_PatTranCom} = \sum_{\forall\beta} \left[EN_{\beta,1} + \frac{1}{2} \cdot EN_{\beta,2} \right] .$$

The number of patients newly hospitalized was the remaining severity 2 injuries not considered to be outpatient visits plus all severity 3 injuries and half of the severity 4 injuries. We assumed only half of the severity 4 injuries would be hospitalized as many would be presumably taken directly to a morgue facility.

$$\text{f\_Hosp} = \sum_{\forall\beta} \left[EN_{\beta,3} + \frac{1}{2} \cdot \left(EN_{\beta,2} + EN_{\beta,4} \right) \right] .$$

The number of patients requiring an ICU (f_PatICU) is the total number of patients with severity type 3 and half the severity type 4 injuries considering the mix of building types in the community.

$$\text{f\_PatICU} = \sum_{\forall\beta}\left[EN_{\beta,3} + \frac{1}{2}\cdot EN_{\beta,4}\right]$$

Fatalities (f_Fatalities) is calculated as the sum of the expected number of severity type 3 and type 4 injuries. This may overestimate the actual number as it counts all patients in type 3 as fatalities even though some type 3 patients may survive. Further research on the effects of hospital functionality on the case fatality rate could improve this estimate.

$$\text{f\_Fatalities} = \sum_{\Sigma=3}^{4}\sum_{\forall\beta} EN_{\beta,\Sigma}$$

Definitions (estimates are from the Hazus model):

P_{Σ} = Probability of severity category Σ (1, 2, …, 4)

Σ = Severity categories, reflecting degree of severity (S1, S2, S3, S4).

Details of injury severity:

- **S1:** Injuries requiring basic medical aid that could be administered by paraprofessionals. These types of injuries would require bandages or observation. Some examples are: a sprain, a severe cut requiring stitches, a minor burn (first-degree or second-degree on a small part of the body), or a bump on the head without loss of consciousness. Injuries of lesser severity that could be self-treated are not estimated by Hazus.
- **S2:** Injuries requiring a greater degree of medical care and use of medical technology such as X-rays or surgery, but not expected to progress to a life-threatening status. Some examples are small areas of third-degree burns or second-degree burns over large parts of the body, a bump on the head that causes loss of consciousness, fractured bone, dehydration or exposure.
- **S3:** Injuries that pose an immediate life-threatening condition if not treated adequately and expeditiously. Some examples are: uncontrolled bleeding, punctured organ, other internal injuries, spinal column injuries, or crush syndrome.
- **S4:** Instantaneously killed or mortally injured.

$EN_{\beta,\Sigma}$ = Expected number of occupants of building type β who have suffered injury type Σ
N_{β} = Number of occupants in building type β
P_{D1} = Probability of slight structural damage to building
P_{D2} = Probability of moderate structural damage to building
P_{D3} = Probability of extensive structural damage to building
P_{D4} = Probability of complete structural damage to building
$P_{D1,\Sigma}$ = Probability of severity Σ type injury given slight structural damage to building
$P_{D2,\Sigma}$ = Probability of severity Σ type injury given moderate structural damage to building
$P_{D3,\Sigma}$ = Probability of severity Σ type injury given extensive structural damage to building
$P_{NC,\Sigma}$ = Probability of severity Σ type injury given complete structural damage to building without collapse
$P_{C,\Sigma}$ = Probability of severity Σ type injury given complete structural damage to building with collapse.

Detailed Description 7: Functions for Patient Transfer Disaster Effects

This appendix subsection details the earthquake disaster effect function #11 f_PatTran listed in Table D.1. We found that estimates of patient transfer were not present in the source literature. Therefore, we created informed functions that use community characteristics and estimates from Hazus.

Sources

The functions were created by RAND, the estimates for the number of injuries is from Hazus, and the estimates of the total number of hospital beds and the number of available hospital beds are from the Area Resource File.

Functions

The number of hospitalized patients that require transfer to outside jurisdiction (f_PatTran) is dependent on the number of available hospital beds in the community and the estimated number of injuries.

$$\text{f\_PatTran} =$$

$$\sum_{i=1}^{\#\,Hospitals} Max\left(0, -Avail\_Beds_i\right) + \left(Severity3 + Severity4 - Max\left(0, \sum_{i=1}^{\#\,Hospitals} Avail\_Beds_i\right)\right).$$

The number of available hospital beds for a given hospital i ($Avail\_Beds_i$) is dependent on the hospital functionality and the number of unoccupied beds pre-disaster.

$$Avail\_Beds_i = (Hosp\_Functionality_i) \cdot (Beds_i) - (Pre\text{-}Disaster\_Beds_i).$$

Definitions

$Avail\_Beds_i$ = number of available beds in hospital i within the community

$Hosp\_Functionality_i$ = level of functionality of the hospital immediately after the disaster

$Beds_i$ = total number of beds in hospital i from the Area Resource File

$Pre\text{-}Disaster\_Beds_i$ = Number of beds occupied prior to disaster/outbreak

Severity3 = Total number disaster victims with severity 3 type injuries

Severity4 = Total number of disaster victims with severity 4 type injuries.

Required Capabilities

Table D.2
Functions for Required Capabilities

Function Number	Function Arguments	Function Variable Name	Unit	Function Definition	Source	Explanations and Assumptions
	Fatality Management					
1	g1^i(f_Fatalities)=g_Recover	g_Recover	persons	g1^i(f_Fatalities)=1*f_Fatalities	TCL07 p.519	
2	g2^i(f_Fatalities)=g_Identify	g_Identify	persons	g2^i(f_Fatalities)=1*f_Fatalities	TCL07 p.519	
3	g3^i(f_Fatalities)=g_FamilySupoprt	g_FamilySupoprt	persons	g3^i(f_Fatalities)=1*f_Fatalities	TCL07 p.519	
4	g4^i(f_Fatalities)=g_Return	g_Return	persons	g4^i(f_Fatalities)=1*f_Fatalities	TCL07 p.519	
5	g5^i(f_Fatalities)=g_Autopsy	g_Autopsy	persons	g5^i(f_Fatalities)=1*f_Fatalities	TCL07 p.519	
6	g6^i(f_Fatalities)=g_MorgueSurge	g_MorgueSurge	persons	g6^i(f_Fatalities)=1*f_Fatalities	TCL07 p.519	
7	g7^i(f_Fatalities)=g_Fat_Store_Dec	g_Fat_Store_Dec	persons	g7^i(f_Fatalities)=1*f_Fatalities	TCL07 p.519	
8	g8^i(f_Fatalities)=g_Fat_Decon_Dec	g_Fat_Decon_Dec	persons	g8^i(f_Fatalities)=1*f_Fatalities	TCL07 p.519	
9	g9^i(f_Fatalities)=g_Fat_DNA_Analysis	g_Fat_DNA_Analysis	persons	g9^i(f_Fatalities)=1*f_Fatalities	TCL07 p.519	
10	g10^i(f_Fatalities)=g_Fat_Transport_Dec	g_Fat_Transport_Dec	persons	g10^i(f_Fatalities)=1*f_Fatalities	TCL07 p.519	
11	g11^i(f_Fatalities)=g_Fat_Transfer_Dec	g_Fat_Transfer_Dec	persons	g11^i(f_Fatalities)=1*f_Fatalities	TCL07 p.519	
12	g12^i(f_Fatalities)=g_Fat_Label_Dec	g_Fat_Label_Dec	persons	g12^i(f_Fatalities)=1*f_Fatalities	TCL07 p.519	
	Mass Care					
13	g13^(1,2)(f_O_PopS)=g_MC_Shelter	g_MC_Shelter	Persons	g13^(1,2)(f_O_PopS)=1*f_O_PopS	TCL07	
14	g14^(1,2)(f_O_PopD)=g_MC_Food	g_MC_Food	Persons	g14^(1,2)(f_O_PopS)=1*f_O_PopS	TCL07	
15	g15^(1,2)(f_O_PopS)=g_MC_Water	g_MC_Water	Persons	g15^(1,2)(f_O_PopS)=1*f_O_PopS	TCL07	
16	g16^(1,2)(f_O_AnimS)=g_MC_Shelter_A	g_MC_Shelter_A	Animals	g16^(1,2)(f_O_AnimS)=1*f_O_AnimS	TCL07 p.512	
17	g17^(1,2)(f_O_PopEAnim)=g_MC_Transport_A	g_MC_Transport_A	Animals	g17^(1,2)(f_O_PopEAnim)=1*f_O_PopEAnim	TCL07	
18	g18^(1,2)(f_O_PopS)=g_MC_Storage	g_MC_Storage	Cubic Feet	g18^(1,2)(f_O_PopS)=.3195*f_O_PopS	TCL07 p.511	RAND assumes that this point estimate found in the source is scalable.
19	g19^(1,2)(f_O_PopS)=g_MC_Childcare	g_MC_Childcare	Persons	g19^(1,2)(f_O_PopS)=f_O_PopS	TCL07 p.512	
20	g20^(1,2)(f_O_PopS)=g_MC_BH_MC	g_MC_BH_MC	Persons	g20^(1,2)(f_O_PopS)=1*f_O_PopS	RAND Estimate	Required for all those sheltered.
21	g21^(1,2)(f_O_PopD)=g_MC_Pharm_MC	g_MC_Pharm_MC	Persons	g21^(1,2)(f_O_PopS)=1*f_O_PopS	RAND Estimate	Required for all those sheltered.
22	g22^(1,2)(f_O_PopD)=g_MC_Decon_MC	g_MC_Decon_MC	Persons	g22^(1,2)(f_O_PopS)=1*f_O_PopS	RAND Estimate	Required for all those sheltered.
23	g23^(1,2)(f_Inj,f_PatTran,f_PatTranAmb)=g_MC_Transport	g_MC_Transport	Persons	g23^(1,2)(f_Inj,f_PatTran,f_PatTranAmb)=celing(f_Inj+f_PatTran+f_PatTranAmb,1)	RAND Estimate	The number of people requiring transport to shelter facilities are assumed to be the sum of those injured, the number of hospitalized that require transport, and the number of transferring patients that require ambulance transport.
24	g24^(1,2)()=g_MC_Comm_MC	g_MC_Comm_MC	System	g24^(1,2)()=1	RAND Estimate	Mass care communication is needed.
	Triage/Pre-Hospital Care-Transport					
25	g25^i(f_Inj)=g_Triage	g_Triage	Persons	g25^i(f_Inj)=1*f_Inj	RAND Estimate	RAND assumes that all injured people need to be triaged, treated, initially stabilized.
26	g26^i()=g_Triage_Chem	g_Triage_Chem	Persons	g26^(1,2)()=0	RAND Estimate	Chemical spill is not part of the prototype tool's capability yet.
27	g27^i()=g_Triage_Burn_Trauma	g_Triage_Burn_Trauma	Persons	g27^(1,2)()=0	RAND Estimate	Fire is not part of the prototype tool's capability yet.
28	g28^i()=g_Triage_Radiation	g_Triage_Radiation	Persons	g28^(1,2)()=0	RAND Estimate	Radiation preparedness is not part of the prototype tool's capability yet.
29	g29^i()=g_Triage_Neg_Pressure	g_Triage_Neg_Pressure	Persons	g29^(1,2)(f_PatVent)=f_PatVent	RAND Estimate	RAND assumes that all patients that need to be ventilated require negative pressure room capability.
						RAND assumes that all patients that

Table D.2—Continued

Function Number	Function Arguments	Function Variable Name	Unit	Function Definition	Source	Explanations and Assumptions
	Medical Surge					
31	g31^i()=g_MedSurge_Mental_Health	g_MedSurge_Mental_Health	Persons	g31^i(g_MedSurge_MH_Adults,)=1*g_MedSurge_MH_Adults+g_MedSurge_MH_Peds	RAND Estimate	Provide mental health to all adult and pediatric patients.
32	g32^i()=g_MedSurge_MH_Adults	g_MedSurge_MH_Adults	Persons	g32^i(Adult_Population)=0.262*Adult_Population	Kessler et al., Prevalence, Severity, and Comorbidity of 12-month DSM-IV Disorders in the National Comorbidity Survey Replication. Archives of General Psychiatry. 2005. 62(6):617-627.	RAND assumes that this point estimate found in the source is scalable.
33	g33^i()=g_MedSurge_MH_Peds	g_MedSurge_MH_Peds	Persons	g33^i(Child_Population)=0.262*Child_Population	Kessler et al. Prevalence, Severity, and Comorbidity of…. AGP. 2005	RAND assumes that this point estimate found in the source is scalable.
34	g34^i(Pop)=g_MedSurge_Pharm_MedSurge	g_MedSurge_Pharm_MedSurge	Persons	g34^i(Pop)=1*Pop	NHSS Dec 2009 p.25	
35	g35^i(f_Outpatient,f_HospPer)=g_MedSurge_Track_MedSurge	g_MedSurge_Track_MedSurge	Persons	g35^i(f_Outpatient,f_Hosp)=1*(f_Outpatient+f_Hosp)	TCL07 p.450	
36	g36^i()=g_MedSurge_Comm_MedSurge	g_MedSurge_Comm_MedSurge	boolean	default = 1	RAND Estimate	RAND assumes that communication between medical facilities is required.
37	g37^i()=g_MedSurge_Decon_MedSurge	g_MedSurge_Decon_MedSurge	Persons			
38	g38^i(f_HospPer,f_Outpatient,NumHospBeds,f_Hosp,f_Inj)=g_MedSurge_Overflow_MedSurge	g_MedSurge_Overflow_MedSurge	Beds	g38^i(f_HospPer,f_Outpatient,NumHospBeds,f_Hosp,f_Inj)=f_Outpatient-(NumHospBeds*f_HospPer)*.85	RAND Estimate	RAND assumes that hospitals have 85 percent of their beds occupied. This assumption was made from RAND's experience with hospital utilization levels.
39	g39^i(f_Inj,f_outpatient)=g_MedSurge_Treat_MedSurge	g_MedSurge_Treat_MedSurge	Persons	g39^i(f_Inj,f_outpatient)=f_Inj+f_outpatient	RAND Estimate	RAND assumes a community needs medical surge capability to treat those people injured, ill, or requiring outpatient services.
	Medical Supply and Distribution (function of other capabilities)					
40	g40^i()=g_MedSupplg_Stor	g_MedSupplg_Stor	ft^2/state	g40^i()=24,000	TCL07 p.476	
41	g41^i()=g_MedSupplg_Distr	g_MedSupplg_Distr	ft^3			
42	g42^i()=g_MedSupplg_Track	g_MedSupplg_Track				
43	g43^i(z_MedSupply_Pack_Blood)=g_MedSupply_Blood	g_MedSupply_Blood	blood units	g43^i(z_MedSupply_Pack_Blood)=z_MedSupply_Pack_Blood	RAND Estimate	This is a function of the number of blood units needed (z_MedSupply_Pack_Blood). The number of blood units needed is a required resource.
44	g44^i(z_MedSupply_Storage)=g_MedSupplg_EmerPower	g_MedSupplg_EmerPower		g44^i(z_MedSupply_Storage)=z_MedSupply_Storage	RAND Estimate	This is a function of the amount of storage needed. The amount of storage needed is a required resource.
45	g45^i(z_MedSupply_Storage)=g_MedSupply_Secure	g_MedSupply_Secure	Sites	g45^i(z_MedSupply_Storage)=z_MedSupply_Storage	RAND Estimate	This is a function of the amount of storage needed. The amount of storage needed is a required resource.

Table D.2—Continued

Function Number	Function Arguments	Function Variable Name	Unit	Function Definition	Source	Explanations and Assumptions
	Volunteer Management—Health specific (function of capabilities)					
47	g47^i(Trained Workers,Companion Animal Workers,Shelter Managers,Shelter Assistant Manager,Shelter Logistics Supervisor,Shelter Feeding Managers,Shelter Health Services Workers,Shelter Mental Health Services Workers,Shelter Safety And Asset Protection Workers,Food Service Delivery Drivers,Food Service Kitchen Workers,z_Volunteer_Coordinator)=g_Volunteer_Cred	g_Volunteer_Cred	Persons	g47^i(z_MC_Shelter_Manager,z_MC_Shelter_Assistant_Manager,z_MC_Shelter_Logistics_Supervisor,z_MC_Feeding_Managers,z_MC_Shelter_Health_Services_Workers,z_MC_Shelter_Mental_Health_Workers,z_MC_Shelter_Safety_Workers,z_MS_Food_Drivers,z_MS_Kitchen_Workers,z_Volunteer_Coordinator)=z_MC_Shelter_Manager+z_MC_Shelter_Assistant_Manager+z_MC_Shelter_Logistics_Supervisor+z_MC_Feeding_Managers+z_MC_Shelter_Health_Services_Workers+z_MC_Shelter_Mental_Health_Workers+z_MC_Shelter_Safety_Workers+z_MS_Food_Drivers+z_MS_Kitchen_Workers+z_Volunteer_Coordinator	TCL07 p.238,506	
48	g48^i(Trained Workers,Companion Animal Workers,Shelter Managers,Shelter Assistant Manager,Shelter Logistics Supervisor,Shelter Feeding Managers,Shelter Health Services Workers,Shelter Mental Health Services Workers,Shelter Safety And Asset Protection Workers,Food Service Delivery Drivers,Food Service Kitchen Workers,z_Volunteer_Coordinator)=g_Volunteer_Stage	g_Volunteer_Stage	Persons	g48^i(z_MC_Shelter_Manager,z_MC_Shelter_Assistant_Manager,z_MC_Shelter_Logistics_Supervisor,z_MC_Feeding_Managers,z_MC_Shelter_Health_Services_Workers,z_MC_Shelter_Mental_Health_Workers,z_MC_Shelter_Safety_Workers,z_MS_Food_Drivers,z_MS_Kitchen_Workers,z_Volunteer_Coordinator)=z_MC_Shelter_Manager+z_MC_Shelter_Assistant_Manager+z_MC_Shelter_Logistics_Supervisor+z_MC_Feeding_Managers+z_MC_Shelter_Health_Services_Workers+z_MC_Shelter_Mental_Health_Workers+z_MC_Shelter_Safety_Workers+z_MS_Food_Drivers+z_MS_Kitchen_Workers+z_Volunteer_Coordinator	TCL07 p.506	
49	g49^i(g_Volunteer_Mob_MC,g_Volunteer_Mob_Dec,g_Volunteer_Mob_BH,g_Volunteer_Mob_MedSurge,g_Volunteer_Mob_PH,z_Volunteer_Coordinator)=g_Volunteer_Mob	g_Volunteer_Mob	Persons	g49^i(g_Volunteer_Mob_MC,g_Volunteer_Mob_Dec,g_Volunteer_Mob_BH,g_Volunteer_Mob_MedSurge,g_Volunteer_Mob_PH)=g_Volunteer_Mob_MC+g_Volunteer_Mob_Dec+g_Volunteer_Mob_BH+g_Volunteer_Mob_MedSurge+g_Volunteer_Mob_PH	TCL07 p.506	
50	g50^i(z_MC_Shelter_Manager,z_MC_Shelter_Assistant_Manager,z_MC_Shelter_Logistics_Supervisor,z_MC_Feeding_Managers,z_MC_Shelter_Health_Services_Workers,z_MC_Shelter_Mental_Health_Workers,z_MC_Shelter_Safety_Workers,z_MS_Food_Drivers,z_MS_Kitchen_Workers")=g_Volunteer_Mob_MC	g_Volunteer_Mob_MC	Persons	g50^i(z_MC_Shelter_Manager,z_MC_Shelter_Assistant_Manager,z_MC_Shelter_Logistics_Supervisor,z_MC_Feeding_Managers,z_MC_Shelter_Health_Services_Workers,z_MC_Shelter_Mental_Health_Workers,z_MC_Shelter_Safety_Workers,z_MS_Food_Drivers,z_MS_Kitchen_Workers)=z_MC_Shelter_Manager+z_MC_Shelter_Assistant_Manager+z_MC_Shelter_Logistics_Supervisor+z_MC_Feeding_Managers+z_MC_Shelter_Health_Services_Workers+z_MC_Shelter_Mental_Health_Workers+z_MC_Shelter_Safety_Workers+z_MS_Food_Drivers+z_MS_Kitchen_Workers	TCL07 p.506	
51	g51^i()=g_Volunteer_Mob_Dec	g_Volunteer_Mob_Dec	Persons			
52	g52^i()=g_Volunteer_Mob_BH	g_Volunteer_Mob_BH	Persons			
53	g53^i()=g_Volunteer_Mob_MedSurge	g_Volunteer_Mob_MedSurge	Persons			
54	g54^i()=g_Volunteer_Mob_PH	g_Volunteer_Mob_PH	Persons			

Table D.2—Continued

Function Number	Function Arguments	Function Variable Name	Unit	Function Definition	Source	Explanations and Assumptions
	Patient Protection					
55	g55^i(b_Hosp,f_Hosp)=g_Protect_Pat_Hosp	g_Protect_Pat_Hosp	Persons	g55^i(b_Hosp,f_Hosp)=1*(b_Hosp+f_Hosp)	RAND Estimate	Provide hospital care for all pre-disaster hospitalized patients and newly hospitalized patients due to disaster.
56	g56^i(b_Hosp,f_Hosp)=g_Protect_Pat_Hosp_Food	g_Protect_Pat_Hosp_Food	Persons	g56^i(b_Hosp,f_Hosp)=1*(b_Hosp+f_Hosp)	RAND Estimate	Provide hospital care for all pre-disaster hospitalized patients and newly hospitalized patients due to disaster.
57	g57^i(b_Hosp,f_Hosp)=g_Protect_Pat_Hosp_Water	g_Protect_Pat_Hosp_Water	Persons	g57^i(b_Hosp,f_Hosp)=1*(b_Hosp+f_Hosp)	RAND Estimate	Provide hospital care for all pre-disaster hospitalized patients and newly hospitalized patients due to disaster.
58	g58^i(b_Hosp,f_Hosp)=g_Protect_Pat_Hosp_Evac	g_Protect_Pat_Hosp_Evac	Persons	g58^i(b_Hosp,f_Hosp)=1*(b_Hosp+f_Hosp)	RAND Estimate	Provide hospital care for all pre-disaster hospitalized patients and newly hospitalized patients due to disaster.
59	g59^i(b_Hosp,f_Hosp)=g_Protect_Pat_Hosp_GenPower	g_Protect_Pat_Hosp_GenPower	Yes/No	g59^i(b_Hosp,f_Hosp)=1*(b_Hosp+f_Hosp)	RAND Estimate	RAND assumes power must be supplied to all hospitalized patients.
60	g60^i(b_Hosp,f_Hosp)=g_Protect_Pat_Hosp_Med	g_Protect_Pat_Hosp_Med	Persons	g60^i(b_Hosp,f_Hosp)=1*(b_Hosp+f_Hosp)	RAND Estimate	Provide hospital care for all pre-disaster hospitalized patients and newly hospitalized patients due to disaster.
61	g61*(b_Hosp,f_Hosp)=g_Protect_Pat_Inst_Decon	g_Protect_Pat_Inst_Decon	Persons	g61^i(b_Hosp,f_Hosp)=1*(b_Hosp+f_Hosp)	RAND Estimate	RAND assumes that the decontamination capability is needed for all hospitalized patients.
62	g62^i(b_Inst)=g_Protect_Pat_Inst	g_Protect_Pat_Inst	Persons	g62^i(b_Inst)=1*b_Inst	RAND Estimate	Provide care for all those institutionalized
63	g63^i(b_Inst)=g_Protect_Pat_Inst_Food	g_Protect_Pat_Inst_Food	Persons	g63^i(b_Inst)=1*b_Inst	RAND Estimate	Provide care for all those institutionalized
64	g64^i(b_Inst)=g_Protect_Pat_Inst_Water	g_Protect_Pat_Inst_Water	Persons	g64^i(b_Inst)=1*b_Inst	RAND Estimate	Provide care for all those institutionalized
65	g65^i(b_Inst)=g_Protect_Pat_Inst_Evac	g_Protect_Pat_Inst_Evac	Persons	g65^i(b_Inst)=1*b_Inst	RAND Estimate	Provide care for all those institutionalized
66	g66^i(b_Inst)=g_Protect_Pat_Inst_GenPower	g_Protect_Pat_Inst_GenPower	Yes/No	g66^i(b_Inst)=1*b_Inst	RAND Estimate	RAND assumes that power must be supplied to all institutionalized people.
67	g67^i(b_Inst)=g_Protect_Pat_Inst_Med	g_Protect_Pat_Inst_Med	Persons	g67^i(b_Inst)=1*b_Inst	RAND Estimate	Provide care for all those institutionalized
68	g68^i(b_Inst)=g_Protect_Pat_Inst_Decon	g_Protect_Pat_Inst_Decon	Persons	g68^i(b_Inst)=1*b_Inst	RAND Estimate	RAND assumes that the decontamination capability is needed for all institutionalized people.
69	g69^i(b_InHome)=g_Protect_Pat_InHome	g_Protect_Pat_InHome	Persons	g69^i(b_InHome)=1*b_InHome	RAND Estimate	Provide care for all in-home or special-needs people
70	g70^i(b_InHome)=g_Protect_Pat_InHome_Food	g_Protect_Pat_InHome_Food	Persons	g70^i(b_InHome)=1*b_InHome	RAND Estimate	Provide care for all in-home or special-needs people
71	g71^i(b_InHome)=g_Protect_Pat_InHome_Water	g_Protect_Pat_InHome_Water	Persons	g71^i(b_InHome)=1*b_InHome	RAND Estimate	Provide care for all in-home or special-needs people
72	g72^i(b_InHome)=g_Protect_Pat_InHome_Evac	g_Protect_Pat_InHome_Evac	Persons	g72^i(b_InHome)=1*b_InHome	RAND Estimate	Provide care for all in-home or special-needs people
73	g73^i(b_InHome)=g_Protect_Pat_InHome_GenPower	g_Protect_Pat_InHome_GenPower	Persons	g73^i(b_InHome)=1*b_InHome	RAND Estimate	RAND assumes that power must be supplied to all in-home and special-needs people.
74	g74^i(b_InHome)=g_Protect_Pat_InHome_Med	g_Protect_Pat_InHome_Med	Persons	g74^i(b_InHome)=1*b_InHome	RAND Estimate	Provide care for all in-home or special-needs people
75	g75^i(b_InHome)=g_Protect_Pat_InHome_Decon	g_Protect_Pat_InHome_Decon	Persons	g75^i(b_InHome)=1*b_InHome	RAND Estimate	RAND assumes that the decontamination capability is needed for all in-home and special-needs people.

Table D.2—Continued

Function Number	Function Arguments	Function Variable Name	Unit	Function Definition	Source	Explanations and Assumptions
	Health Communications					
76	g76^i()=g_Comm_Public	g_Comm_Public				
77	g77^i()=g_Comm_Home	g_Comm_Home				
78	g78^i()=g_Comm_MC	g_Comm_MC				
79	g79^i()=g_Comm_MassProphLoc	g_Comm_MassProphLoc				
80	g80^i()=g_Comm_Risk	g_Comm_Risk				
81	g81^i()=g_Comm_MassProph	g_Comm_MassProph				
82	g82^i()=g_Comm_ProvHosp	g_Comm_ProvHosp				
83	g83^i()=g_Comm_Epid	g_Comm_Epid				
84	g84^i()=g_Comm_Lab	g_Comm_Lab				
85	g85^i()=g_Comm_SpecimenTest	g_Comm_SpecimenTest				
	Worker Health and Safety (function of other capabilities)					
87	g87^i(Num_Responders)=g_Worker_Proph	g_Worker_Proph	Persons	g87^2(Num_Responders)=1*Num_Responders	RAND Estimate	Provide prophylaxis for all emergency responders.
88	g88^i(Num_Responders)=g_Worker_Meals	g_Worker_Meals	Persons	g88^2(Num_Responders)=1*Num_Responders	RAND Estimate	RAND assumes that all disaster responders need meals.
89	g89^i(Num_Responders)=g_Worker_Comm	g_Worker_Comm				
90	g90^i(Num_Responders)=g_Worker_Psych	g_Worker_Psych	Persons	g90^2(Num_Responders)=1*Num_Responders	RAND Estimate	RAND assumes a community needs the capability of supplying emergency and psychological care to disaster responders.
91	g91^i(Num_Responders)=g_Worker_PPE	g_Worker_PPE	Persons	g91^2(Num_Responders)=1*Num_Responders	RAND Estimate	RAND assumes a community needs the capability of supplying personal protective equipment to disaster responders.
	Mass Prophylaxis					
92	g93^3(Pop)=g_MassProph_Vacc	g_MassProph_Vacc	Persons	g92^3(Pop)=1*Pop	TCL07 p.490	
93	g94^3()=g_MassProph_StageStore	g_MassProph_StageStore	ft^2	g93^3(Pop)=ceiling(6*10^-3*Pop,1)	TCL07 p.490	RAND assumes that this point estimate found in the source is scalable.
94	g95^3(z_Mass_Proph_Disp_Centers)=g_MassProph_Secure	g_MassProph_Secure	Sites	g94^3(z_Mass_Proph_Disp_Centers)=1*z_Mass_Proph_Disp_Centers	TCL07 p.489	
95	g96^3(Pop,f_PatTran)=g_MassProph_Transport	g_MassProph_Transport	Persons	g95^3(Pop,f_PatTran)=ceiling(Pop*f_PatTran,1)	RAND Estimate	RAND assumes that all hospitalized patients that require transport will need transportation to prophylaxis locations.
96	g97^3()=g_MassProph_Track	g_MassProph_Track				
	Public Health/Epidemiology/Lab Testing—Quarantine—Sanitation					
97	g97^3()=g_PhEpidLab_CBRNE	g_PhEpidLab_CBRNE	Samples	g97^3(LabSamp)=LabSamp	FLS09	
98	g98^3(g_PhEpidLab_Investigate_AgFood,g_PhEpidLab_Animal)=g_PhEpidLab_Investigate	g_PhEpidLab_Investigate	Cases			
99	g99^3()=g_PhEpidLab_Investigate_AgFood	g_PhEpidLab_Investigate_AgFood	Cases			
100	g100^3()=g_PhEpidLab_Animal	g_PhEpidLab_Animal	Cases			
101	g101^3(LabSamp)=g_PhEpidLab_Interview	g_PhEpidLab_Interview	Cases	g101^3(LabSamp)=LabSamp/2	TCL07 p.190	
102	g102^3(LabSamp)=g_PhEpidLab_TestSpec	g_PhEpidLab_TestSpec	Samples	g102^3(LabSamp)=LabSamp	RAND Estimate	RAND assumes that a community needs the capability of testing all laboratory samples.
103	g103^3(LabSamp)=g_PhEpidLab_TestWorried	g_PhEpidLab_TestWorried	Samples	g103^3(LabSamp)=LabSamp*0.8*0.25	TCL07 p.188,190	RAND assumes that this point estimate found in the source is scalable.
104	g104^3(LabSamp)=g_PhEpidLab_TestInjured	g_PhEpidLab_TestInjured	Samples	g104^3(LabSamp)=LabSamp*0.2	TCL07 p.188,190	RAND assumes that this point estimate found in the source is scalable.
105	g105^3()=g_PhEpidLab_ServicesIsolated	g_PhEpidLab_ServicesIsolated	Persons			
106	g106^3()=g_PhEpidLab_CollectSpec	g_PhEpidLab_CollectSpec	Samples	g106^3(LabSamp)=LabSamp	RAND Estimate	RAND assumes that all lab samples require collection.
107	g107^3()=g_PhEpidLab_Registries	g_PhEpidLab_Registries	Registries			
108	g108^3(LabSamp)=g_PhEpidLab_TestEnvSamples	g_PhEpidLab_TestEnvSamples	Samples	g108^3(LabSamp)=LabSamp	RAND Estimate	RAND assumes that all lab samples require testing.
109	g109^3(LabSamp)=g_PhEpidLab_TestEnvSamples_Toxic	g_PhEpidLab_TestEnvSamples_Toxic	Samples	g109^3(LabSamp)=LabSamp	RAND Estimate	RAND assumes that a community needs the capability of testing all

Required Resources

Table D.3
Functions for Required Resources

Function Number	Function Arguments	Function Variable Names	Variable	Unit	Function Definition	Source	Explanations and Assumptions
	Fatality Management						
1	h1^i(f_Fatalities)=z_Fat_Interview	z_Fat_Interview	z_Fat_Interview	Teams	h1^i(f_Fatalities)=ceiling((2*100/229270)*f_Fatalities,1)	TCL07 p.529,533	TCL scenario specifies 100 teams per shift for 229,270 fatalities. RAND assumed two shifts per day. RAND assumes that this point estimate found in the source is scalable.
2	h2^i(f_Fatalities,f_Absent)=z_Fat_Interview_Persons	z_Fat_Interview_Persons	z_Fat_Interview_Persons	Persons	h2^i(f_Fatalities,f_Absent)=ceiling(ceiling((1/(1-f_Absent))*2,1))	TCL07 p.529,533	
3	h3^i(f_Fatalities)=z_Fat_Port_Morgue	z_Fat_Port_Morgue	z_Fat_Port_Morgue	Morgues	h3^i(f_Fatalities)=ceiling((2/229270)*f_Fatalities*(1/(1-f_Absent)),1)	TCL07 p.527,531	TCL scenario specifies 2 portable morgues for 229,270 fatalities. RAND assumes that this point estimate found in the source is scalable.
4	h4^i(f_Fatalities)=z_Fat_Body_Recovery	z_Fat_Body_Recovery	z_Fat_Body_Recovery	Units/12-Hour Shift	h4^i(f_Fatalities)=ceiling((15/229270)*f_Fatalities,1)	TCL07 p.527,531	TCL scenario specifies 15 units for 229,270 fatalities. RAND assumes that this point estimate found in the source is scalable.
5	h5^i(f_Fatalities)=z_Fat_Field_Investigative	z_Fat_Field_Investigative	z_Fat_Field_Investigative	Units/12-Hour Shift	h5^i(f_Fatalities)=ceiling((15/229270)*f_Fatalities,1)	TCL07 p.527,531	TCL scenario specifies 15 units for 229,270 fatalities. RAND assumes that this point estimate found in the source is scalable.
6	h6^i()=z_Fat_Scene_Logistics	z_Fat_Scene_Logistics	z_Fat_Scene_Logistics	Teams	h6^i()=ceiling(1*(1/(1-f_Absent)),1)	TCL07 p.527,531	
7	h7^i(z_Fat_Field_Investigative,z_Fat_Body_Recovery)=z_Fat_Escort_Security	z_Fat_Escort_Security	z_Fat_Escort_Security	Teams	h7^i(z_Fat_Field_Investigative,z_Fat_Body_Recovery)=(ceiling(z_Fat_Field_Investigative/3,1)+ceiling(z_Fat_Body_Recovery/3,1))*1	TCL07 p.527,531	TCL scenario specifies 5 teams per 15 field investigative unit and 5 teams per 15 body recovery units. RAND assumes that this point estimate found in the source is scalable.
8	h8^i()=z_FM_Staging_Security	z_Fat_FM_Staging_Security	z_FM_Staging_Security	Teams	h8^i()=ceiling(2*(1/(1-f_Absent)),1)	TCL07 p.527,531	
9	h9^i(f_Absent)=z_Incident_Historian	z_Fat_Incident_Historian	z_Incident_Historian	Persons	h9^i(f_Absent)=ceiling((1/(1-f_Absent))*1,1)	TCL07 p.527,531	
10	h10^i(f_Fatalities)=z_Remains_Decon	z_Fat_Remains_Decon	z_Remains_Decon	Teams	h10^i(f_Fatalities)=ceiling((16/229270)*f_Fatalities,1)	TCL07 p.527,531	TCL scenario specifies 16 teams for 229,270 fatalities. RAND assumes that this point estimate found in the source is scalable.
11	h11^i(f_Absent)=z_Fat_Jur_Med_Examiner	z_Fat_Jur_Med_Examiner	z_Fat_Jur_Med_Examiner	Persons/Jurisdiction	h11^i(f_Absent)=ceiling((1/(1-f_Absent))*1,1)	TCL07 p.527,531	
12	h12^i(f_Fatalities)=z_Fat_Fam_Assistance_Center	z_Fat_Fam_Assistance_Center	z_Fat_Fam_Assistance_Center	Center/Jurisdiction	h12^i(f_Fatalities)=ceiling((2/229270)*f_Fatalities,1)	TCL07 p.528,531	TCL scenario specifies 3 centers for 229,270 fatalities. RAND assumes that this point estimate found in the source is scalable.

Table D.3—Continued

Function Number	Function Arguments	Function Variable Names	Variable	Unit	Function Definition	Source	Explanations and Assumptions
	Fatality Management—Cont.						
13	h13^i(f_Absent)=z_Fat_PA_Med_Examiner	z_Fat_PA_Med_Examiner	z_Fat_PA_Med_Examiner	Persons/Day	h13^i(f_Absent)=ceiling((1/(1-f_Absent))*2,1)	TCL07 p.528,531	
14	h14^i(f_Absent)=z_Fat_PI_Med_Examiner	z_Fat_PI_Med_Examiner	z_Fat_PI_Med_Examiner	Persons	h14^i(f_Absent)=ceiling((1/(1-f_Absent))*1,1)	TCL07 p.528,531	
15	h15^i(f_Absent)=z_Fat_Storage_Officer	z_Fat_Storage_Officer	z_Fat_Storage_Officer	Persons	h15^i(f_Absent)=ceiling((1/(1-f_Absent))*1,1)	TCL07 p.528,531	
16	h16^i(z_Fat_Fam_Assistance_Center,f_Absent)=z_Fat_Fam_Assistance_Manager	z_Fat_Fam_Assistance_Manager	z_Fat_Fam_Assistance_Manager	Persons	h16^i(z_Fat_Fam_Assistance_Center,f_Absent)=ceiling((1/(1-f_Absent))*z_Fat_Fam_Assistance_Center,1)	TCL07 p.528,531	
17	h17^i(z_Fat_Fam_Assistance_Center,f_Absent)=z_Fat_DNA_Specialist	z_Fat_DNA_Specialist	z_Fat_DNA_Specialist	Persons/Day	h17^i(z_Fat_Fam_Assistance_Center,f_Absent)=ceiling((1/(1-f_Absent))*40*z_Fat_Fam_Assistance_Center,1)	TCL07 p.528,531	TCL specifies 40 specialists per family assistance center.
18	h18^i(z_Fat_Fam_Assistance_Center,f_Absent)=z_Fat_Data_Entry	z_Fat_Data_Entry	z_Fat_Data_Entry	Persons/Day	h18^i(z_Fat_Fam_Assistance_Center,f_Absent)=ceiling((1/(1-f_Absent))*120*z_Fat_Fam_Assistance_Center,1)	TCL07 p.528,532	TCL specifies 120 specialists per family assistance center.
19	h19^i(z_Fat_Fam_Assistance_Center,f_Absent)=z_Fat_Administrative	z_Fat_Administrative	z_Fat_Administrative	Persons/Day	h19^i(z_Fat_Fam_Assistance_Center,f_Absent)=ceiling((1/(1-f_Absent))*10*z_Fat_Fam_Assistance_Center,1)	TCL07 p.528,532	TCL specifies 10 people per family assistance center.
20	h20^i(z_Fat_Fam_Assistance_Center,f_Absent)=z_Fat_Scheduler	z_Fat_Scheduler	z_Fat_Scheduler	Persons/Day	h20^i(z_Fat_Fam_Assistance_Center,f_Absent)=ceiling((1/(1-f_Absent))*4*z_Fat_Fam_Assistance_Center,1)	TCL07 p.528,532	TCL specifies 4 people per family assistance center.
21	h21^i(z_Fat_Fam_Assistance_Center,f_Absent)=z_Fat_Med_Records_Specialist	z_Fat_Med_Records_Specialist	z_Fat_Med_Records_Specialist	Persons/Day	h21^i(z_Fat_Fam_Assistance_Center,f_Absent)=ceiling((1/(1-f_Absent))*20*z_Fat_Fam_Assistance_Center,1)	TCL07 p.528,532	TCL specifies 20 people per family assistance center.
22	h22^i(z_Fat_Fam_Assistance_Center,f_Absent)=z_Fat_Interview_Specialist	z_Fat_Interview_Specialist	z_Fat_Interview_Specialist	Persons/Day	h22^i(z_Fat_Fam_Assistance_Center,f_Absent)=ceiling((1/(1-f_Absent))*200*z_Fat_Fam_Assistance_Center,1)	TCL07 p.528,533	TCL specifies 200 people per family assistance center.
23	h23^i(z_Fat_Fam_Assistance_Center,f_Absent)=z_Fat_AM_Comm	z_Fat_AM_Comm	z_Fat_AM_Comm	Persons/Day	h23^i(z_Fat_Fam_Assistance_Center,f_Absent)=ceiling((1/(1-f_Absent))*10*z_Fat_Fam_Assistance_Center,1)	TCL07 p.528,533	TCL specifies 10 people per family assistance center.
24	h24^i(z_Fat_Fam_Assistance_Center,f_Absent)=z_Fat_Notification	z_Fat_Notification	z_Fat_Notification	Persons/Day	h24^i(z_Fat_Fam_Assistance_Center,f_Absent)=ceiling((1/(1-f_Absent))*10*z_Fat_Fam_Assistance_Center,1)0	TCL07 p.528,533	TCL specifies 10 people per family assistance center.

Table D.3—Continued

Function Number	Function Arguments	Function Variable Names	Variable	Unit	Function Definition	Source	Explanations and Assumptions
	Fatality Management—Cont.						
25	h25^i(f_Fatalities,f_Absent)=z_Fat_Embalming	z_Fat_Embalming	z_Fat_Embalming	Persons/Day	h25^i(f_Fatalities,f_Absent)=ceiling((1/(1-f_Absent))*(48/229270)*f_Fatalities,4)	TCL07 p.528,533	TCL scenario specifies 48 people for 229,270 fatalities. RAND assumes that this point estimate found in the source is scalable.
26	h26^i(f_Fatalities,f_Absent)=z_Fat_Body_Tracker	z_Fat_Body_Tracker	z_Fat_Body_Tracker	Persons/Day	h26^i(f_Fatalities,f_Absent)=ceiling((1/(1-f_Absent))*(16/229270)*f_Fatalities,8)	TCL07 p.528,533	TCL scenario specifies 16 people for 229,270 fatalities. RAND assumes that this point estimate found in the source is scalable.
27	h27^i(f_Fatalities,f_Absent)=z_Fat_Dental_Section	z_Fat_Dental_Section	z_Fat_Dental_Section	Persons/Day	h27^i(f_Fatalities,f_Absent)=ceiling((1/(1-f_Absent))*(10/229270)*f_Fatalities,5)	TCL07 p.528,533	TCL scenario specifies 10 people for 229,270 fatalities. RAND assumes that this point estimate found in the source is scalable.
28	h28^i(f_Fatalities,f_Absent)=z_Fat_Fingerprint	z_Fat_Fingerprint	z_Fat_Fingerprint	Persons/Day	h28^i(f_Fatalities,f_Absent)=ceiling((1/(1-f_Absent))*(4/229270)*f_Fatalities,2)	TCL07 p.528,533	TCL scenario specifies 4 people for 229,270 fatalities. RAND assumes that this point estimate found in the source is scalable.
29	h29^i(f_Fatalities,f_Absent)=z_Fat_Radiology	z_Fat_Radiology	z_Fat_Radiology	Persons/Day	h29^i(f_Fatalities,f_Absent)=ceiling((1/(1-f_Absent))*(4/229270)*f_Fatalities,2)	TCL07 p.528,533	TCL scenario specifies 4 people for 229,270 fatalities. RAND assumes that this point estimate found in the source is scalable.
30	h30^i(z_Fat_Embaling,f_Absent)=z_Fat_Postmortem_IT_Ma nager	z_Fat_Postmortem_IT_Manager	z_Fat_Postmortem_IT_Manager	Persons/Day	h30^i(z_Fat_Embalming,f_Absent)=ceiling((1/(1-f_Absent))*2*z_Fat_Embalming,1)	TCL07 p.528,533	TCL scenario specifies 2 people per embalming section.
31	h31^i(f_Fatalities,f_Absent)=z_Fat_Postmortem_Data_Clerk	z_Fat_Postmortem_Data_Clerk	z_Fat_Postmortem_Data_Clerk	Persons/Day	h31^i(f_Fatalities,f_Absent)=ceiling((1/(1-f_Absent))*(6/229270)*f_Fatalities,3)	TCL07 p.528,533	TCL scenario specifies 6 people for 229,270 fatalities. RAND assumes that this point estimate found in the source is scalable.
32	h32^i(f_Fatalities,f_Absent)=z_Fat_Anthropology_Section	z_Fat_Anthropology_Section	z_Fat_Anthropology_Section	Persons/Day	h32^i(f_Fatalities,f_Absent)=ceiling((1/(1-f_Absent))*(4/229270)*f_Fatalities,2)	TCL07 p.528,533	TCL scenario specifies 4 people for 229,270 fatalities. RAND assumes that this point estimate found in the source is scalable.
33	h33^i(f_Fatalities,f_Absent)=z_Fat_DNA	z_Fat_DNA	z_Fat_DNA	Persons/Day	h33^i(f_Fatalities,f_Absent)=ceiling((1/(1-f_Absent))*(4/229270)*f_Fatalities,2)	TCL07 p.528,533	TCL scenario specifies 4 people for 229,270 fatalities. RAND assumes that this point estimate found in the source is scalable.
34	h34^i(f_Fatalities,f_Absent)=z_Fat_Pathology	z_Fat_Pathology	z_Fat_Pathology	Persons/Day	h34^i(f_Fatalities,f_Absent)=ceiling((1/(1-f_Absent))*(6/229270)*f_Fatalities,3)	TCL07 p.528,533	TCL scenario specifies 6 people for 229,270 fatalities. RAND assumes that this point estimate found in the source is scalable.
35	h35^i(f_Fatalities,f_Absent)=z_Fat_PE_Photo	z_Fat_PE_Photo	z_Fat_PE_Photo	Persons/Day	h35^i(f_Fatalities,f_Absent)=ceiling((1/(1-f_Absent))*(8/229270)*f_Fatalities,4)	TCL07 p.528,534	TCL scenario specifies 8 people for 229,270 fatalities. RAND assumes that this point estimate found in the source is scalable.
36	h36^i(f_Fatalities,f_Absent)=z_Fat_Logistics	z_Fat_Logistics	z_Fat_Logistics	Persons/Day	h36^i(f_Fatalities,f_Absent)=ceiling((1/(1-f_Absent))*(4/229270)*f_Fatalities,2)	TCL07 p.528,534	TCL scenario specifies 4 people for 229,270 fatalities. RAND assumes that this point estimate found in the source is scalable.
37	h37^i(f_Absent)=z_Fat_Safety_Officer	z_Fat_Safety_Officer	z_Fat_Safety_Officer	Persons/Day	h37^i(f_Absent)=ceiling((1/(1-f_Absent))*2,1)	TCL07 p.528,534	
38	h38^i(z_Fat_Port_Morgue)=z_Fat_Medical_Team	z_Fat_Medical_Team	z_Fat_Medical_Team	Teams	h38^i(z_Fat_Port_Morgue)=z_Fat_Port_Morgue*1	TCL07 p.528,534	

Table D.3—Continued

Function Number	Function Arguments	Function Variable Names	Variable	Unit	Function Definition	Source	Explanations and Assumptions
	Mass Care						
39	h39^(1,2)(z_MC_Animal_Workers,z_MC_Shelter_Manager,z_MC_Shelter_Assistant_Manager,z_MC_Shelter_Logistics_Supervisor,z_MC_Feeding_Managers,z_MC_Shelter_Health_Services_Workers,z_MC_Shelter_Mental_Health_Workers,z_MC_Shelter_Safety_Workers,z_MS_Food_Drivers,z_MS_Kitchen_Workers,f_Absent)=z_MC_Trained_Workers	z_MC_Trained_Workers	z_MC_Trained_Workers	Persons	h39^(1,2)(z_MC_Animal_Workers,z_MC_Shelter_Manager,z_MC_Shelter_Assistant_Manager,z_MC_Shelter_Logistics_Supervisor,z_MC_Feeding_Managers,z_MC_Shelter_Health_Services_Workers,z_MC_Shelter_Mental_Health_Workers,z_MC_Shelter_Safety_Workers,z_MS_Food_Drivers,z_MS_Kitchen_Workers,f_Absent)=(1/(1-f_Absent))*(z_MC_Animal_Workers+z_MC_Shelter_Manager+z_MC_Shelter_Assistant_Manager+z_MC_Shelter_Logistics_Supervisor+z_MC_Feeding_Managers+z_MC_Shelter_Health_Services_Workers+z_MC_Shelter_Mental_Health_Workers+z_MC_Shelter_Safety_Workers+z_MS_Food_Drivers+z_MS_Kitchen_Workers)	TCL07 p.510	
40	h40^(1,2)(f_O_AnimS,f_Absent)=z_MC_Animal_Workers	z_MC_Animal_Workers	z_MC_Animal_Workers	Persons	h40^(1,2)(f_O_AnimS,f_Absent)=ceiling((1/(1-f_Absent))*f_O_AnimS*.07254,1)	TCL07 p.510	TCL scenario specifies 14,000 animal workers for sheltering 193,000 companion animals. RAND assumes that this point estimate found in the source is scalable.
41	h41^(1,2)(f_O_PopS)=z_MC_Shelter_Team_IV	z_MC_Shelter_Team_IV	z_MC_Shelter_Team_IV	Teams	h41^(1,2)(f_O_PopS)=ceiling(f_O_PopS/250,1)	TCL07 p.506,511	TCL scenario specifies 1 team per 250 sheltered people. RAND assumes that this point estimate found in the source is scalable.
42	h42^(1,2)(f_O_PopS)=z_MC_Shelter_Team_III	z_MC_Shelter_Team_III	z_MC_Shelter_Team_III	Teams	h42^(1,2)(f_O_PopS)=ceiling(f_O_PopS/500,1)	TCL07 p.506,511	TCL scenario specifies 1 team per 500 sheltered people. RAND assumes that this point estimate found in the source is scalable.
43	h43^(1,2)(f_O_PopS)=z_MC_Shelter_Team_II	z_MC_Shelter_Team_II	z_MC_Shelter_Team_II	Teams	h43^(1,2)(f_O_PopS)=ceiling(f_O_PopS/750,1)	TCL07 p.506,511	TCL scenario specifies 1 team per 750 sheltered people. RAND assumes that this point estimate found in the source is scalable.
44	h44^(1,2)(f_O_PopS)=z_MC_Shelter_Team_I	z_MC_Shelter_Team_I	z_MC_Shelter_Team_I	Teams	h44^(1,2)(f_O_PopS)=ceiling(f_O_PopS/1000,1)	TCL07 p.506,511	TCL scenario specifies 1 team per 1,000 sheltered people. RAND assumes that this point estimate found in the source is scalable.
45	h45^(1,2)(f_O_PopS)=z_MC_Food_Unit	z_MC_Food_Unit	z_MC_Food_Unit	Units	h45^(1,2)(f_O_PopS)=ceiling((f_O_PopS*(1500000/313000)/1500),1)	TCL07 p.511	TCL scenario specifies that 1,000 units are needed to provide 1,500,000 meals to 313,000 being sheltered. Each unit can produce 1,500 meals per day. RAND assumes that this point estimate found in the source is scalable.
46	h46^(1,2)(f_O_PopS)=z_MC_Vol_Kitchen_IV	z_MC_Vol_Kitchen_IV	z_MC_Vol_Kitchen_IV	Kitchens	h46^(1,2)(f_O_PopS)=ceiling(f_O_PopS*(1500000/313000)/5000,1)	TCL07 p.511	TCL scenario specifies that 300 kitchens are needed to provide 1,500,000 meals to 313,000 being sheltered. Each unit can produce 5,000 meals per day. RAND assumes that this point estimate found in the source is scalable.
47	h47^(1,2)(f_O_PopS)=z_MC_Vol_Kitchen_III	z_MC_Vol_Kitchen_III	z_MC_Vol_Kitchen_III	Kitchens	h47^(1,2)(f_O_PopS)=ceiling(f_O_PopS*(1500000/313000)/10000,1,1)	TCL07 p.511	TCL scenario specifies that 150 kitchens are needed to provide 1,500,000 meals to 313,000 being sheltered. Each unit can produce 10,000 meals per day. RAND assumes that this point estimate found in the source is scalable.
48	h48^(1,2)(f_O_PopS)=z_MC_Vol_Kitchen_II	z_MC_Vol_Kitchen_II	z_MC_Vol_Kitchen_II	Kitchens	h48^(1,2)(f_O_PopS)=ceiling(f_O_PopS*(1500000/313000)/10000,1)	TCL07 p.512	TCL scenario specifies that 75 kitchens are needed to provide 1,500,000 meals to 313,000 being sheltered. Each unit can produce 20,000 meals per day. RAND assumes that this point estimate found in the source is scalable.
49	h49^(1,2)(f_O_PopS)=z_MC_Vol_Kitchen_I	z_MC_Vol_Kitchen_I	z_MC_Vol_Kitchen_I	Kitchens	h49^(1,2)(f_O_PopS)=ceiling(f_O_PopS*(1500000/313000)/30000,1)	TCL07 p.512	TCL scenario specifies that 50 kitchens are needed to provide 1,500,000 meals to 313,000 being sheltered. Each unit can produce 30,000 meals per day. RAND assumes that this point estimate found in the source is scalable.
50	h50^(1,2)(f_O_PopS)=z_MC_Vol_Mkitchen_I	z_MC_Vol_Mkitchen_I	z_MC_Vol_Mkitchen_I	Kitchens	h50^(1,2)(f_O_PopS)=ceiling(f_O_PopS*(1500000/313000)/800,1)	TCL07 p.512	TCL scenario specifies that 1,875 mobile kitchens are needed to provide 1,500,000 meals to 313,000 being sheltered. Each unit can produce 800 meals per day. RAND assumes that this point estimate found in the source is scalable.

Table D.3—Continued

Function Number	Function Arguments	Function Variable Names	Variable	Unit	Function Definition	Source	Explanations and Assumptions
	Mass Care—Cont.						
51	h51^(1,2)(z_MC_Vol_Kitchen_IV,z_MC_Vol_Kitchen_III,z_MC_Vol_Kitchen_II,z_MC_Vol_Kitchen_I)=z_MC_Vol_Support_Team_I	z_MC_Vol_Support_Team_I	z_MC_Vol_Support_Team_I	Teams	h51^(1,2)(z_MC_Vol_Kitchen_IV,z_MC_Vol_Kitchen_III,z_MC_Vol_Kitchen_II,z_MC_Vol_Kitchen_I)=300*z_MC_Vol_Kitchen_IV + 300*z_MC_Vol_Kitchen_III + 225*z_MC_Vol_Kitchen_II + 200*z_MC_Vol_Kitchen_I	TCL07 p.512	
52	h52^(1,2)(z_MC_Vol_Kitchen_IV,z_MC_Vol_Kitchen_III,z_MC_Vol_Kitchen_II,z_MC_Vol_Kitchen_I)=z_MC_Trailer	z_MC_Trailer	z_MC_Trailer	Trailers	h52^(1,2)(z_MC_Vol_Kitchen_IV,z_MC_Vol_Kitchen_III,z_MC_Vol_Kitchen_II,z_MC_Vol_Kitchen_I)=2*(z_MC_Vol_Kitchen_IV + z_MC_Vol_Kitchen_III + z_MC_Vol_Kitchen_II + z_MC_Vol_Kitchen_I)	TCL07 p.512	
53	h53^(1,2)(f_O_PopS,f_Contamf)=z_MC_Packaged_Meals	z_MC_Packaged_Meals	z_MC_Packaged_Meals	Meals	h53^(1,2)(f_O_PopS,f_Contamf)=ceiling((1500000/313000)*f_O_PopS*1/(1-f_Contamf))	TCL07 p.512	TCL scenario specifies that 1,500,000 meals are needed to shelter 313,000 people. RAND assumes that this point estimate found in the source is scalable.
54	h54^(1,2)(f_O_PopS,f_Contamw)=z_MC_Water	z_MC_Water	z_MC_Water	Gallons/Day	h54^(1,2)(f_O_PopS,f_Contamw)=0.75*f_O_PopS/(1-f_Contamw)	RAND Estimate	RAND assumes that each sheltered person needs 0.75 gallons of drinking water per day. RAND assumes that this point estimate found in the source is scalable.
55	h55^(1,2)(f_O_PopS)=z_MC_Vol_WH_Team_IV	z_MC_Vol_WH_Team_IV	z_MC_Vol_WH_Team_IV	Teams	h55^(1,2)(f_O_PopS)=ceiling(f_O_PopS*(100000/313000)/100000*10,1)	TCL07 p.511	TCL scenario specifies that 10 teams are needed for the 100,000 square feet of warehouse space require for 313,000 people sheltered. RAND assumes that this point estimate found in the source is scalable.
56	h56^(1,2)(f_O_PopS)=z_MC_Vol_WH_Team_III	z_MC_Vol_WH_Team_III	z_MC_Vol_WH_Team_III	Teams	h56^(1,2)(f_O_PopS)=ceiling(f_O_PopS*(100000/313000)/100000*7,1)	TCL07 p.511	TCL scenario specifies that 7 teams are needed for the 100,000 square feet of warehouse space require for 313,000 people sheltered. RAND assumes that this point estimate found in the source is scalable.
57	h57^(1,2)(f_O_PopS)=z_MC_Vol_WH_Team_II	z_MC_Vol_WH_Team_II	z_MC_Vol_WH_Team_II	Teams	h57^(1,2)(f_O_PopS)=ceiling(f_O_PopS*(100000/313000)/100000*4,1)	TCL07 p.512	TCL scenario specifies that 4 teams are needed for the 100,000 square feet of warehouse space require for 313,000 people sheltered. RAND assumes that this point estimate found in the source is scalable.
58	h58^(1,2)(f_O_PopS)=z_MC_Vol_WH_Team_I	z_MC_Vol_WH_Team_I	z_MC_Vol_WH_Team_I	Teams	h58^(1,2)(f_O_PopS)=ceiling(f_O_PopS*(100000/313000)/100000*1,1)	TCL07 p.512	TCL scenario specifies that 1 team is needed for the 100,000 square feet of warehouse space require for 313,000 people sheltered. RAND assumes that this point estimate found in the source is scalable.
59	h59^(1,2)(f_O_PopS)=z_MC_Childcare_Team_I	z_MC_Childcare_Team_I	z_MC_Childcare_Team_I	Teams	h59^(1,2)(f_O_PopS)=ceiling(f_O_PopS*(1252/313000),1)	TCL07 p.512	TCL scenario specifies that 1,252 teams are needed when sheltering 313,000 people. RAND assumes that this point estimate found in the source is scalable.

Table D.3—Continued

Function Number	Function Arguments	Function Variable Names	Variable	Unit	Function Definition	Source	Explanations and Assumptions
	Mass Care—Cont.						
60	h60^(1,2)(f_O_AnimS)=z_MC_Small_Animal_Team_I	z_MC_Small_Animal_Team_I	z_MC_Small_Animal_Team_I	Teams	h60^(1,2)(f_O_AnimS)=ceiling(f_O_AnimS*(643/193000),1)	TCL07 p.512	TCL scenario specifies that 643 teams are needed for 193,000 companion animals sheltered. RAND assumes that this point estimate found in the source is scalable.
61	h61^(1,2)(f_O_AnimS)=z_MC_Animal_Management_Team	z_MC_Animal_Management_Team	z_MC_Animal_Management_Team	Teams	h61^(1,2)(f_O_AnimS)=ceiling(f_O_AnimS*(130/193000),1)	TCL07 p.512	TCL scenario specifies that 130 teams are needed for 193,000 companion animals sheltered. RAND assumes that this point estimate found in the source is scalable.
62	h62^(1,2)(f_O_AnimS)=z_MC_Small_Animal_Transport	z_MC_Small_Animal_Transport	z_MC_Small_Animal_Transport	Teams	h62^(1,2)(f_O_AnimS)=ceiling(f_O_AnimS*(1286/193000),1)	TCL07 p.513	TCL scenario specifies that 1,286 teams are needed for 193,000 companion animals sheltered. RAND assumes that this point estimate found in the source is scalable.
63	h63^(1,2)(f_O_AnimS)=z_MC_Animal_Incident_Response	z_MC_Animal_Incident_Response	z_MC_Animal_Incident_Response	Teams	h63^(1,2)(f_O_AnimS)=ceiling(f_O_AnimS*(2725/193000),1)	TCL07 p.513	TCL scenario specifies that 2,725 teams are needed for 193,000 companion animals sheltered. RAND assumes that this point estimate found in the source is scalable.
64	h64^(1,2)(f_O_AnimS)=z_MC_Large_Animal_Rescue	z_MC_Large_Animal_Rescue	z_MC_Large_Animal_Rescue	Teams			
65	h65^(1,2)(f_O_AnimS)=z_MC_Small_Animal_Rescue	z_MC_Small_Animal_Rescue	z_MC_Small_Animal_Rescue	Teams			
66	h66^(1,2)(Pop,f_EvacR)=z_MC_Trans_Vehicles	z_MC_Trans_Vehicles	z_MC_Trans_Vehicles	50-Person Bus Vehicles	h66^(1,2)(Pop,f_EvacR)=ceiling((1-f_EvacR)*Pop*(17/100000),1)	TCL07 p.392	TCL scenario specifies that 17 vehicles are needed per 100,000 population. RAND assumes that this point estimate found in the source is scalable.
67	h67^(1,2)()=z_MC_Pathfinder_Task	z_MC_Pathfinder_Task	z_MC_Pathfinder_Task	Teams			
68	h68^(1,2)(z_MC_Shelter_Team_IV,z_MC_Shelter_Team_III,z_MC_Shelter_Team_II,z_MC_Shelter_Team_I,f_Absent)=z_MC_Shelter_Manager	z_MC_Shelter_Manager	z_MC_Shelter_Manager	Persons	h68^(1,2)(z_MC_Shelter_Team_IV,z_MC_Shelter_Team_III,z_MC_Shelter_Team_II,z_MC_Shelter_Team_I,f_Absent)=ceiling((1/(1-f_Absent))*(2*z_MC_Shelter_Team_IV or 4*z_MC_Shelter_Team_III or 6*z_MC_Shelter_Team_II or 8*z_MC_Shelter_Team_I),1)	TCL07 p.506,511	
69	h69^(1,2)(z_MC_Shelter_Team_IV,z_MC_Shelter_Team_III,z_MC_Shelter_Team_II,z_MC_Shelter_Team_I,f_Absent)=z_MC_Shelter_Assistant_Manager	z_MC_Shelter_Assistant_Manager	z_MC_Shelter_Assistant_Manager	Persons	h69^(1,2)(z_MC_Shelter_Team_IV,z_MC_Shelter_Team_III,z_MC_Shelter_Team_II,z_MC_Shelter_Team_I,f_Absent)=ceiling((1/(1-f_Absent))*(4*z_MC_Shelter_Team_IV or 8*z_MC_Shelter_Team_III or 12*z_MC_Shelter_Team_II or 16*z_MC_Shelter_Team_I,1)	TCL07 p.506,511	
70	h70^(1,2)(z_MC_Shelter_Team_IV,z_MC_Shelter_Team_III,z_MC_Shelter_Team_II,z_MC_Shelter_Team_I,f_Absent)=z_MC_Shelter_Logistics_Supervisor	z_MC_Shelter_Logistics_Supervisor	z_MC_Shelter_Logistics_Supervisor	Persons	h70^(1,2)(z_MC_Shelter_Team_IV,z_MC_Shelter_Team_III,z_MC_Shelter_Team_II,z_MC_Shelter_Team_I,f_Absent)=ceiling((1/(1-f_Absent))*(2*z_MC_Shelter_Team_IV or 4*z_MC_Shelter_Team_III or 6*z_MC_Shelter_Team_II or 8*z_MC_Shelter_Team_I),1)	TCL07 p.506,511	

Table D.3—Continued

Function Number	Function Arguments	Function Variable Names	Variable	Unit	Function Definition	Source	Explanations and Assumptions
	Mass Care—Cont.						
71	h71^(1,2)(z_MC_Shelter_Team_IV,z_MC_Shelter_Team_III,z_MC_Shelter_Team_II,z_MC_Shelter_Team_I,f_Absent)=z_MC_Feeding_Managers	z_MC_Feeding_Managers	z_MC_Feeding_Managers	Persons	h71^(1,2)(z_MC_Shelter_Team_IV,z_MC_Shelter_Team_III,z_MC_Shelter_Team_II,z_MC_Shelter_Team_I,f_Absent)=ceiling((1/(1-f_Absent))*(2*z_MC_Shelter_Team_IV or 4*z_MC_Shelter_Team_III or 6*z_MC_Shelter_Team_II or 8*z_MC_Shelter_Team_I),1)	TCL07 p.506,511	
72	h72^(1,2)(z_MC_Shelter_Team_IV,z_MC_Shelter_Team_III,z_MC_Shelter_Team_II,z_MC_Shelter_Team_I,f_Absent)=z_MC_Shelter_Health_Services_Workers	z_MC_Shelter_Health_Services_Workers	z_MC_Shelter_Health_Services_Workers	Persons	h72^(1,2)(z_MC_Shelter_Team_IV,z_MC_Shelter_Team_III,z_MC_Shelter_Team_II,z_MC_Shelter_Team_I,f_Absent)=ceiling((1/(1-f_Absent))*(3*z_MC_Shelter_Team_IV or 6*z_MC_Shelter_Team_III or 9*z_MC_Shelter_Team_II or 12*z_MC_Shelter_Team_I),1)	TCL07 p.506,511	
73	h73^(1,2)(z_MC_Shelter_Team_IV,z_MC_Shelter_Team_III,z_MC_Shelter_Team_II,z_MC_Shelter_Team_I,f_Absent)=z_MC_Shelter_Mental_Health_Workers	z_MC_Shelter_Mental_Health_Workers	z_MC_Shelter_Mental_Health_Workers	Persons	h73^(1,2)(z_MC_Shelter_Team_IV,z_MC_Shelter_Team_III,z_MC_Shelter_Team_II,z_MC_Shelter_Team_I,f_Absent)=ceiling((1/(1-f_Absent))*(3*z_MC_Shelter_Team_IV or 6*z_MC_Shelter_Team_III or 9*z_MC_Shelter_Team_II or 12*z_MC_Shelter_Team_I),1)	TCL07 p.506,511	
74	h74^(1,2)(z_MC_Shelter_Team_IV,z_MC_Shelter_Team_III,z_MC_Shelter_Team_II,z_MC_Shelter_Team_I,f_Absent)=z_MC_Shelter_Safety_Workers	z_MC_Shelter_Safety_Workers	z_MC_Shelter_Safety_Workers	Persons	h74^(1,2)(z_MC_Shelter_Team_IV,z_MC_Shelter_Team_III,z_MC_Shelter_Team_II,z_MC_Shelter_Team_I,f_Absent)=ceiling((1/(1-f_Absent))*(3*z_MC_Shelter_Team_IV or 6*z_MC_Shelter_Team_III or 9*z_MC_Shelter_Team_II or 12*z_MC_Shelter_Team_I),1)	TCL07 p.506,511	
75	h75^(1,2)(z_MC_Food_Unit,z_MC_Vol_Support_Team_I,f_Absent)=z_MC_Food_Drivers	z_MC_Food_Drivers	z_MC_Food_Drivers	Persons	h75^(1,2)(z_MC_Food_Unit,z_MC_Vol_Support_Team_I,f_Absent)=ceiling((1/(1-f_Absent))*(2*z_MC_Food_Unit+2*z_MC_Vol_Support_Team_I),1)	TCL07 p.507,508	
76	h76^(1,2)(z_MC_Food_Unit,z_MC_Vol_Support_Team_I,EvacR)=z_MC_Food_Vehicles	z_MC_Food_Vehicles	z_MC_Food_Vehicles	Vehicles	h76^(1,2)(z_MC_Food_Unit,z_MC_Vol_Support_Team_I,EvacR)=ceiling((1*z_MC_Food_Unit+1*z_MC_Vol_Support_Team_I),1)	TCL07 p.507,508	
77	h77^(1,2)(z_MC_Vol_Kitchen_IV,z_MC_Vol_Kitchen_III,z_MC_Vol_Kitchen_II,z_MC_Vol_Kitchen_I,f_Absent)=z_MC_Kitchen_Workers	z_MC_Kitchen_Workers	z_MC_Kitchen_Workers	Persons	h77^(1,2)(z_MC_Vol_Kitchen_IV,z_MC_Vol_Kitchen_III,z_MC_Vol_Kitchen_II,z_MC_Vol_Kitchen_I,f_Absent)=ceiling((1/(1-f_Absent))*(15*z_MC_Vol_Kitchen_IV or 20*z_MC_Vol_Kitchen_III or 30*z_MC_Vol_Kitchen_II or 40*z_MC_Vol_Kitchen_I),1)	TCL07 p.507,508	
78	h78^(1,2)(f_O_PopS,f_Contamf)=z_MC_Kitchen_Meals	z_MC_Kitchen_Meals	z_MC_Kitchen_Meals	Meals/Day	h78^(1,2)(f_O_PopS,(f_Contamf)=2.43*f_O_PopS*2/(1-f_Contamf)	TCL07 p.507,508	
79	h79^(1,2)(z_MC_Vol_Kitchen_IV,z_MC_Vol_Kitchen_III,z_MC_Vol_Kitchen_II,z_MC_Vol_Kitchen_I)=z_MC_Kitchen_Generators	z_MC_Kitchen_Generators	z_MC_Kitchen_Generators	Generators	h79^(1,2)(z_MC_Vol_Kitchen_IV,z_MC_Vol_Kitchen_III,z_MC_Vol_Kitchen_II,z_MC_Vol_Kitchen_I)=1*z_MC_Vol_Kitchen_IV or 1*z_MC_Vol_Kitchen_III or 1*z_MC_Vol_Kitchen_II or 1*z_MC_Vol_Kitchen_I	TCL07 p.507,508	
80	h80^(1,2)()=z_MC_Kitchen_Trailers	z_MC_Kitchen_Trailers	z_MC_Kitchen_Trailers	Trailers	h80^(1,2)(z_MC_Vol_Kitchen_IV,z_MC_Vol_Kitchen_III,z_MC_Vol_Kitchen_II,z_MC_Vol_Kitchen_I)=1*z_MC_Vol_Kitchen_IV or 1*z_MC_Vol_Kitchen_III or 1*z_MC_Vol_Kitchen_II or 1*z_MC_Vol_Kitchen_I	TCL07 p.507,508	

Table D.3—Continued

Function Number	Function Arguments	Function Variable Names	Variable	Unit	Function Definition	Source	Explanations and Assumptions
	Triage / Pre-hospital Care - Transport						
81	h81^i(Pop,f_EvacR)=z_Triage_Spare_ALS_Vehicle	z_Triage_Spare_ALS_Vehicle	z_Triage_Spare_ALS_Vehicle	Vehicles			
82	h82^i(z_Triage_Ambulance,FirstResEff)=z_Triage_EMS_Personnel	z_Triage_EMS_Personnel	z_Triage_EMS_Personnel	Personnel	h82^i(z_Triage_Ambulance,f_Absent)=ceiling((1/FirstResEff)*2*z_Triage_Ambulance,1)	TCL07 p.446	
83	h83^i(f_PatICU,f_PatTran)=z_Triage_Protect_Pat_Ambulance	z_Triage_Protect_Pat_Ambulance	z_Triage_Protect_Pat_Ambulance	Ambulance	h83^i(f_PatICU,f_PatTran)=f_PatICU + 0.15*f_PatTran	RAND Estimate	RAND assumes that all patients requiring critical care due to disaster and 15 percent of the hospitalized patients that need transport require ambulances. RAND assumes that this point estimate found in the source is scalable.
84	h84^i(z_Triage_Protect_Pat_Ambulance)=z_Triage_Protect_Pat_Air_Ambulance	z_Triage_Protect_Pat_Air_Ambulance	z_Triage_Protect_Pat_Air_Ambulance	Ambulance	h84^i(z_Triage_Protect_Pat_Ambulance)=ceiling(0.1*z_Triage_Protect_Pat_Ambulance,1)	RAND Estimate	RAND assumes that 1 air ambulance is needed per 10 vehicle ambulances. RAND assumes that this point estimate found in the source is scalable.
85	h85^i(z_Triage_Protect_Pat_Ambulance)=z_Triage_Ambulance_TF	z_Triage_Ambulance_TF	z_Triage_Ambulance_TF	Teams	h85^i(z_Triage_Protect_Pat_Ambulance)=ceiling(z_Triage_Protect_Pat_Ambulance/5,1)	RAND Estimate, FEMA05	RAND assumes that 1 task force can operate 5 ambulances. RAND assumes that this point estimate found in the source is scalable.
86	h86^i(z_Triage_Protect_Pat_Ambulance)=z_Triage_Emergency TF	z_Triage_Emergency TF	z_Triage_Emergency TF	Teams	h86^i(z_Triage_Protect_Pat_Ambulance)=ceiling(z_Triage_Protect_Pat_Ambulance/5,1)	RAND Estimate, FEMA05	RAND assumes that 1 task force can operate 5 ambulances. RAND assumes that this point estimate found in the source is scalable.

Table D.3—Continued

Function Number	Function Arguments	Function Variable Names	Variable	Unit	Function Definition	Source	Explanations and Assumptions
	Medical Surge						
87	h87^i(f_Hosp,HospPer,NumBeds,Pop)=z_MedSurge_Surge_Beds	z_MedSurge_Surge_Beds	z_MedSurge_Surge_Beds	Beds	h87^(i)(f_Hosp,HospPer,NumBeds,Pop)=ceiling(f_Hosp-(NumBeds*(1-BedUtil)),1) <<Bed utilization from ARF or assumed to be 85 percent>>	TCL07 p.450	
88	h88^i()=z_MedSurge_Health_Care_Facility	z_MedSurge_Health_Care_Facility	z_MedSurge_Health_Care_Facility	Facility			
89	h89^i(f_Absent)=z_MedSurge_Surge_Physician	z_MedSurge_Surge_Physician	z_MedSurge_Surge_Physician	Persons/12-Hour Shift	h89^i(z_MedSurge_Surge_Beds,f_Absent)=ceiling((1/(1-f_Absent))*1/50*z_MedSurge_Surge_Beds,1)	TCL07 p.458	TCL scenario states that 1 physician is needed for 50 surge beds. RAND assumes that this point estimate found in the source is scalable.
90	h90^i(f_Absent)=z_MedSurge_Surge_PA	z_MedSurge_Surge_PA	z_MedSurge_Surge_PA	Persons/12-Hour Shift	h90^i(z_MedSurge_Surge_Beds,f_Absent)=ceiling((1/(1-f_Absent))*1/50*z_MedSurge_Surge_Beds,1)	TCL07 p.458	TCL scenario states that 1 physician assistant is needed for 50 surge beds. RAND assumes that this point estimate found in the source is scalable.
91	h91^i(f_Absent)=z_MedSurge_Surge_RN	z_MedSurge_Surge_RN	z_MedSurge_Surge_RN	Persons/12-Hour Shift	h91^i(z_MedSurge_Surge_Beds,f_Absent)=ceiling((1/(1-f_Absent))*6/50*z_MedSurge_Surge_Beds,1)	TCL07 p.458	TCL scenario states that 6 registered nurses are needed for 50 surge beds. RAND assumes that this point estimate found in the source is scalable.
92	h92^i(f_Absent)=z_MedSurge_Surge_NA	z_MedSurge_Surge_NA	z_MedSurge_Surge_NA	Persons/12-Hour Shift	h92^i(z_MedSurge_Surge_Beds,f_Absent)=ceiling((1/(1-f_Absent))*4/50*z_MedSurge_Surge_Beds,1)	TCL07 p.458	TCL scenario states that 4 nursing assistants are needed for 50 surge beds. RAND assumes that this point estimate found in the source is scalable.
93	h93^i(f_Absent)=z_MedSurge_Surge_Medical_Clerks	z_MedSurge_Surge_Medical_Clerks	z_MedSurge_Surge_Medical_Clerks	Persons/12-Hour Shift	h93^i(z_MedSurge_Surge_Beds,f_Absent)=ceiling((1/(1-f_Absent))*2/50*z_MedSurge_Surge_Beds,1)	TCL07 p.458	TCL scenario states that 2 medical clerks are needed for 50 surge beds. RAND assumes that this point estimate found in the source is scalable.
94	h94^i(f_Absent)=z_MedSurge_Surge_RT	z_MedSurge_Surge_RT	z_MedSurge_Surge_RT	Persons/12-Hour Shift	h94^i(z_MedSurge_Surge_Beds,f_Absent)=ceiling((1/(1-f_Absent))*1/50*z_MedSurge_Surge_Beds,1)	TCL07 p.458	TCL scenario states that 1 respiratory therapist is needed for 50 surge beds. RAND assumes that this point estimate found in the source is scalable.
95	h95^i(f_Absent)=z_MedSurge_Surge_CM	z_MedSurge_Surge_CM	z_MedSurge_Surge_CM	Persons/12-Hour Shift	h95^i(z_MedSurge_Surge_Beds,f_Absent)=ceiling((1/(1-f_Absent))*1/50*z_MedSurge_Surge_Beds,1)	TCL07 p.458	TCL scenario states that 1 case manager is needed for 50 surge beds. RAND assumes that this point estimate found in the source is scalable.
96	h96^i(f_Absent)=z_MedSurge_Surge_SW	z_MedSurge_Surge_SW	z_MedSurge_Surge_SW	Persons/12-Hour Shift	h96^i(z_MedSurge_Surge_Beds,f_Absent)=ceiling((1/(1-f_Absent))*1/50*z_MedSurge_Surge_Beds,1)	TCL07 p.458	TCL scenario states that 1 social worker is needed for 50 surge beds. RAND assumes that this point estimate found in the source is scalable.
97	h97^i(f_Absent)=z_MedSurge_Surge_Housekeeper	z_MedSurge_Surge_Housekeeper	z_MedSurge_Surge_Housekeeper	Persons/12-Hour Shift	h97^i(z_MedSurge_Surge_Beds,f_Absent)=ceiling((1/(1-f_Absent))*1/50*z_MedSurge_Surge_Beds,1)	TCL07 p.458	TCL scenario states that 1 housekeeper is needed for 50 surge beds. RAND assumes that this point estimate found in the source is scalable.
98	h98^i(f_Absent)=z_MedSurge_Surge_Patient_Transporter	z_MedSurge_Surge_Patient_Transporter	z_MedSurge_Surge_Patient_Transporter	Persons/12-Hour Shift	h98^i(z_MedSurge_Surge_Beds,f_Absent)=ceiling(`*1/50*z_MedSurge_Surge_Beds,1)	TCL07 p.458	TCL scenario states that 1 patient transporter is needed for 50 surge beds. RAND assumes that this point estimate found in the source is scalable.
99	h99^i()=z_MedSurge_Pharm_Storage	z_MedSurge_Pharm_Storage	z_MedSurge_Pharm_Storage	Storage	h99^i()=1	TCL07 p.458	
100	h100^i()=z_MedSurge_Health_Facility	z_MedSurge_Health_Facility	z_MedSurge_Health_Facility	Facility			
101	h101^i()=z_MedSurge_Neg_Pressure_Room	z_MedSurge_Neg_Pressure_Room	z_MedSurge_Neg_Pressure_Room	Room	h101^i(z_MedSurge_Health_Facility)=1*z_MedSurge_Health_Facility	TCL07 p.451,458	
102	h102^i(f_PatICU)=z_MedSurge_ICU_Beds	z_MedSurge_ICU_Beds	z_MedSurge_ICU_Beds	Bed	h102^i(f_PatICU)=1*f_PatICU	FluSurge 2.0,TCL07 p.460	
103	h103^i(f_PatICU,f_Hosp)=z_MedSurge_Non-ICU_Beds	z_MedSurge_Non-ICU_Beds	z_MedSurge_Non-ICU_Beds	Bed	h103^i(f_PatICU,f_Hosp)=1*(f_Hosp-f_PatICU)	FluSurge 2.0,TCL07 p.460	
104	h104^i(f_PatVent)=z_MedSurge_Ventilators	z_MedSurge_Ventilators	z_MedSurge_Ventilators	Ventilators	h104^i(f_PatVent)=1*f_PatVent	FluSurge 2.0,TCL07 p.460	

Table D.3—Continued

Function Number	Function Arguments	Function Variable Names	Variable	Unit	Function Definition	Source	Explanations and Assumptions
	Medical Supply and Distribution (function of other capabilities)						
105	h105^i(f_Inj,FractAdult)=z_MedSupply_Instruments_Equipment	z_MedSupply_Instruments_Equipment	z_MedSupply_Instruments_Equipment	Supplies	h105^i(f_Inj,FractAdult)=1*f_Inj*FractAdult	TCL07 p.473	
106	h106^i(f_Inj,FractAdult)=z_MedSupply_Sharps_NCL	z_MedSupply_Sharps_NCL	z_MedSupply_Sharps_NCL	Supplies	h106^i(f_Inj,FractAdult)=1*f_Inj*FractAdult	TCL07 p.473	
107	h107^i(f_Inj,FractAdult)=z_MedSupply_Irrigation	z_MedSupply_Irrigation	z_MedSupply_Irrigation	Supplies	h107^i(f_Inj,FractAdult)=1*f_Inj*FractAdult	TCL07 p.473	
108	h108^(1,2)(f_Hosp)=z_MedSupply_Pack_Blood	z_MedSupply_Pack_Blood	z_MedSupply_Pack_Blood	Units	h108^(1,2)(f_Hosp)=1.1*f_Hosp	Beekley, Mass Casualties in Combat: Lessons Learned, Journal of Trauma-Injury, Infection, and Critical Care, 2007, 62:pp. S39-S40	
109	h109^i(f_Inj,FractAdult)=z_MedSupply_IV_Supplies	z_MedSupply_IV_Supplies	z_MedSupply_IV_Supplies	Supplies	h109^i(f_Inj,FractAdult)=1*f_Inj*FractAdult	TCL07 p.473	
110	h110^i(f_Inj,FractAdult)=z_MedSupply_IV_Solutions	z_MedSupply_IV_Solutions	z_MedSupply_IV_Solutions	Supplies	h110^i(f_Inj,FractAdult)=1*f_Inj*FractAdult	TCL07 p.473	
111	h111^i(f_Inj,FractAdult)=z_MedSupply_Hand_Hygiene	z_MedSupply_Hand_Hygiene	z_MedSupply_Hand_Hygiene	Supplies	h111^i(f_Inj,FractAdult)=1*f_Inj*FractAdult	TCL07 p.473	
112	h112^i(f_Inj,FractAdult)=z_MedSupply_Personal_Care	z_MedSupply_Personal_Care	z_MedSupply_Personal_Care	Supplies	h112^i(f_Inj,FractAdult)=1*f_Inj*FractAdult	TCL07 p.473	
113	h113^i(f_Inj,FractPed)=z_MedSupply_Respiratory_Supplies	z_MedSupply_Respiratory_Supplies	z_MedSupply_Respiratory_Supplies	Supplies	h113^i(f_Inj,FractPed)=1*f_Inj*FractPed	TCL07 p.473	
114	h114^i(f_Inj,FractPed)=z_MedSupply_ER_Supplies	z_MedSupply_ER_Supplies	z_MedSupply_ER_Supplies	Supplies	h114^i(f_Inj,FractPed)=1*f_Inj*FractPed	TCL07 p.473	
115	h115^i(f_Inj,FractPed)=z_MedSupply_Dressings	z_MedSupply_Dressings	z_MedSupply_Dressings	Supplies	h115^i(f_Inj,FractPed)=1*f_Inj*FractPed	TCL07 p.473	
116	h116^i(f_Inj,FractPed)=z_MedSupply_Linen	z_MedSupply_Linen	z_MedSupply_Linen	Supplies	h116^i(f_Inj,FractPed)=1*f_Inj*FractPed	TCL07 p.473	
117	h117^i(f_Inj,FractPed)=z_MedSupply_Muscle_Supplies	z_MedSupply_Muscle_Supplies	z_MedSupply_Muscle_Supplies	Supplies	h117^i(f_Inj,FractPed)=1*f_Inj*FractPed	TCL07 p.473	
118	h118^i(f_Inj,FractPed)=z_MedSupply_GI_Supplies	z_MedSupply_GI_Supplies	z_MedSupply_GI_Supplies	Supplies	h118^i(f_Inj,FractPed)=1*f_Inj*FractPed	TCL07 p.473	
119	h119^i(f_Inj,FractPed)=z_MedSupply_Miscellaneous	z_MedSupply_Miscellaneous	z_MedSupply_Miscellaneous	Supplies	h119^i(f_Inj,FractPed)=1*f_Inj*FractPed	TCL07 p.473	
120	h120^i()=z_MedSupply_Storage	z_MedSupply_Storage	z_MedSupply_Storage	12,000ft^2 Warehouse/State	h120^i()=2	TCL07 p.476	
	Volunteer Management - Health specific (function of capabilities)						
121	h121^i(f_PopD)=z_Volunteer_Center	z_Volunteer_Center	z_Volunteer_Center	Operators/Day	h121^i(f_PopD)=ceiling((120/2500000)*f_PopD,1)	TCL07 p.247	TCL scenario specifies that 120 operators/day are needed for 2,500,000 people displaced. RAND assumes that this point estimate found in the source is scalable.
122	h122^i(f_PopD,f_Absent)=z_Volunteer_Coordinator	z_Volunteer_Coordinator	z_Volunteer_Coordinator	Persons	h122^i(f_PopD,f_Absent)=ceiling((1/(1-f_Absent))*(4/1000000)*f_PopD,1)	TCL07 p.247	TCL scenario specifies that 4 people are needed for 1,000,000 people displaced. RAND assumes that this point estimate found in the source is scalable.
123	h123^i(f_PopD,EvacR)=z_Volunteer_Truck	z_Volunteer_Truck	z_Volunteer_Truck	Vehicles	h123^i(f_PopD,EvacR)=ceiling((1/EvacR)*(1250/1000000)*f_PopD,1)	TCL07 p.247	TCL scenario specifies that 1,250 vehicles are needed for 1,000,000 people displaced. RAND assumes that this point estimate found in the source is scalable.
124	h124^i(f_PopD,f_Absent)=z_Volunteer_Drivers	z_Volunteer_Drivers	z_Volunteer_Drivers	Persons	h124^i(f_PopD,f_Absent)=ceiling((1/(1-f_Absent))*(1250/1000000)*f_PopD,1)	TCL07 p.247	TCL scenario specifies that 1,250 drivers are needed for 1,000,000 people displaced. RAND assumes that this point estimate found in the source is scalable.
125	h125^i(f_PopD)=z_Volunteer_Wharehouse_Team	z_Volunteer_Wharehouse_Team	z_Volunteer_Wharehouse_Team	Teams	h125^i(f_PopD)=ceiling((100000/1000000)*f_PopD,1)	TCL07 p.247	TCL scenario specifies that 100,000 teams are needed for 1,000,000 people displaced. RAND assumes that this point estimate found in the source is scalable.

Table D.3—Continued

Function Number	Function Arguments	Function Variable Names	Variable	Unit	Function Definition	Source	Explanations and Assumptions
	Patient Protection						
126	h126^i(b_Hosp,f_Contamf)=z_Protect_Pat_Meals	z_Protect_Pat_Meals	z_Protect_Pat_Meals	Meals/Day	h126^i(b_Hosp,f_Contamf)=3*b_Hosp/(1-f_Contamf)	RAND Estimate	RAND assumes that hospitalized patients need 3 meals a day.
127	h127^i(b_Hosp,f_Contamw)=z_Protect_Pat_Water	z_Protect_Pat_Water	z_Protect_Pat_Water	Quarts/Day	h127^(1,2)(f_O_PopS,f_Contamw)=3*f_O_PopS/(1-f_Contamw)	RAND Estimate;equivalent for mass care water http://www.nationalterroralert.com/safewater/	RAND assumes that sheltered individuals need 3 quarts of drinking water a day.
128	h128^i(b_Hosp)=z_Protect_Pat_Generators	z_Protect_Pat_Generators	z_Protect_Pat_Generators	Supplies	h128^(1,2)(b_Hosp)=b_Hosp*(1-f_HospPer)*2	FEMA05 RT; RAND Estimate assumed 2/hospital without power	RAND assumes that 2 backup generators are needed for each hospital without power.
129	h129^i(f_Ambo,EvacR)=z_Protect_Pat_Vehicles	z_Protect_Pat_Vehicles	z_Protect_Pat_Vehicles	Vehicles			
	Health Communications						
130	h130^i()=z_Comm_Emergency	z_Comm_Emergency	z_Comm_Emergency	System	h130^i()=1	TCL07 p.390	
131	h131^i()=z_Comm_Public_Warning	z_Comm_Public_Warning	z_Comm_Public_Warning	System	h131^i()=1	TCL07 p.390	
132	h132^i()=z_Comm_Provider_Comm	z_Comm_Provider_Comm	z_Comm_Provider_Comm	System	h132^i()=1	RAND Estimate	
133	h133^i()=z_Comm_Public_Report_Team	z_Comm_Public_Report_Team	z_Comm_Public_Report_Team	System	h133^i()=1	RAND Estimate	
	Worker Health and Safety (function of other capabilities)						
134	h134^AA()=z_Worker_Health_Team	z_Worker_Health_Team	z_Worker_Health_Team	Teams	h134^AA()=20	TCL07 p.259	
135	h135^AA(f_Absent)=z_Worker_Safety_Officer_TypeI	z_Worker_Safety_Officer_TypeI	z_Worker_Safety_Officer_TypeI	Persons/Day	h135^AA(f_Absent)=ceiling((1/(1-f_Absent))*3,1)	TC07 p.259	
136	h136^AA(z_Worker_Health_Team,f_Absent)=z_Worker_Spec_Safety_Officer	z_Worker_Spec_Safety_Officer	z_Worker_Spec_Safety_Officer	Persons	h136^AA(z_Worker_Health_Team,f_Absent)=ceiling((1/(1-f_Absent))*1*z_Worker_Health_Team,1)	TC07 p.259	
137	h137^AA(f_Absent)=z_Worker_Spec_SME	z_Worker_Spec_SME	z_Worker_Spec_SME	Persons	h137^AA(z_Worker_Health_Team,f_Absent)=ceiling((1/(1-f_Absent))*1*z_Worker_Health_Team,1)	TC07 p.260	
138	h138^AA()=z_Worker_Respiratory	z_Worker_Respiratory	z_Worker_Respiratory	Teams	h138^AA(z_Worker_Health_Team)=1*z_Worker_Health_Team	TC07 p.260	
139	h139^AA()=z_Worker_Medical_Unit	z_Worker_Medical_Unit	z_Worker_Medical_Unit	Teams	h139^AA(z_Worker_Health_Team)=ceiling((4/20)*z_Worker_Health_Team,1)	TC07 p.260	TCL scenario specifies that 4 teams are needed for every 20 responder safety and health teams. RAND assumes that this point estimate found in the source is scalable.
140	h140^AA(f_LabSamp)=z_Worker_Analytic_Lab	z_Worker_Analytic_Lab	z_Worker_Analytic_Lab	Labs	h140^AA(f_LabSamp)=ceiling(f_LabSamp/100,1)	TCL07 p.260	TCL scenario specifies that each lab can process 100 samples per day. RAND assumes that this point estimate found in the source is scalable.
141	h141^AA(Num_Responders)=z_Worker_SCBA	z_Worker_SCBA	z_Worker_SCBA	Supplies/Day	h141^AA(Num_Responders)=3*Num_Responders	TC07 p.260	
142	h142^AA(Num_Responders)=z_Worker_PAPR	z_Worker_PAPR	z_Worker_PAPR	Supplies/Day	h142^AA(Num_Responders)=3*Num_Responders	TC07 p.260	
143	h143^AA(Num_Responders)=z_Worker_P100	z_Worker_P100	z_Worker_P100	Supplies/Day	h143^AA(Num_Responders)=3*Num_Responders	TC07 p.260	
	Mass Prophylaxis						
144	h144^3(Pop)=z_Mass_Proph_Vaccines	z_Mass_Proph_Vaccines	z_Mass_Proph_Vaccines		<<See **Detailed Explanation 8** following Table D.3>>	FluSurge 2.0	
145	h145^3(Pop)=z_Mass_Proph_Disp_Centers	z_Mass_Proph_Disp_Centers	z_Mass_Proph_Disp_Centers	Facility	h144^3(Pop)=ceiling((1/42554)*Pop,1)	TCL07 p.489	TCL scenario specifies that 1 facility is needed per population of 42,554. RAND assumes that this point estimate found in the source is scalable.
146	h146^3(Pop)=z_Mass_Proph_Storage_Facility	z_Mass_Proph_Storage_Facility	z_Mass_Proph_Storage_Facility	ft^2	h145^3(Pop)=ceiling((12000/2000000)*Pop,1)	TCL07 p.490	TCL scenario specifies that 12,000 square feet is needed per 2,000,000 population. RAND assumes that this point estimate found in the source is scalable.
147	h147^3()=z_Mass_Proph_Tech_Advise_Team	z_Mass_Proph_Tech_Advise_Team	z_Mass_Proph_Tech_Advise_Team	Team	h146^3()=1	TCL07 p.490	
148	h148^3(z_Mass_Proph_Tech_Advise_Team,f_Absent)=z_Mass_Proph_Tech_Advise_Persons	z_Mass_Proph_Tech_Advise_Persons	z_Mass_Proph_Tech_Advise_Persons	Persons	h147^3(z_Mass_Proph_Tech_Advise_Team,f_Absent)=ceiling((1/(1-f_Absent))* 7 to 9,1)	TCL07 p.490	

Table D.3—Continued

Function Number	Function Arguments	Function Variable Names	Variable	Unit	Function Definition	Source	Explanations and Assumptions
	Public Health / Epidemiology / Lab Testing - Quarantine - Sanitation						
149	h149^i()=z_PhEpidLab_LRN_Nat_Bio_Lab	z_PhEpidLab_LRN_Nat_Bio_Lab	z_PhEpidLab_LRN_Nat_Bio_Lab	Lab Nationally	h148^i()=1	TCL07 p.190	
150	h150^i()=z_PhEpidLab_LRN_Ref_Lab	z_PhEpidLab_LRN_Ref_Lab	z_PhEpidLab_LRN_Ref_Lab	Lab Nationally	h149^i()= at least 1	TCL07 p.190	
151	h151^i()=z_PhEpidLab_CDC_Chem_Lab	z_PhEpidLab_CDC_Chem_Lab	z_PhEpidLab_CDC_Chem_Lab	Lab Nationally	h150^i()=1	TCL07 p.192	
152	h152^i()=z_PhEpidLab_Chem_Lab_1	z_PhEpidLab_Chem_Lab_1	z_PhEpidLab_Chem_Lab_1	Lab Nationally	h152^i()=10	TCL07 p.192	
153	h153^i()=z_PhEpidLab_Chem_Lab_2	z_PhEpidLab_Chem_Lab_2	z_PhEpidLab_Chem_Lab_2	Lab Nationally	h153^i()=36	TCL07 p.192	
154	h154^i()=z_PhEpidLab_LRN_Sentinel_Lab	z_PhEpidLab_LRN_Sentinel_Lab	z_PhEpidLab_LRN_Sentinel_Lab	Lab Nationally	h154^i()=4000	TCL07 p.193	
155	h155^i()=z_PhEpidLab_Sample_Transport	z_PhEpidLab_Sample_Transport	z_PhEpidLab_Sample_Transport	System per State	h155^i()=1	TCL07 p.193	
156	h156^i()=z_PhEpidLab_Emerg_Op_Center	z_PhEpidLab_Emerg_Op_Center	z_PhEpidLab_Emerg_Op_Center	Facility Nationally	h156^i()=1	TCL07 p.193	
157	h157^i()=z_PhEpidLab_EOC	z_PhEpidLab_EOC	z_PhEpidLab_EOC	Facility per State	h157^i()=1	TCL07 p.193	
158	h158^i()=z_Local_Health_Surv_Team	z_Local_Health_Surv_Team	z_Local_Health_Surv_Team	Teams/Location	h158^i()=2	TCL07 p.169,171	
159	h159^i(f_Absent)=z_PhEpidLab_Local_Health_Surv_Person	z_PhEpidLab_Local_Health_Surv_Person	z_PhEpidLab_Local_Health_Surv_Person	Persons			
160	h160^i(f_Absent)=z_PhEpidLab_Local_Health_ITStaff	z_PhEpidLab_Local_Health_ITStaff	z_PhEpidLab_Local_Health_ITStaff	Persons	h160^i(z_Local_Health_Surv_Team,z_Emerg_Ops_Center_Surge_Team,f_Absent)=ceiling((1/(1-f_Absent))*(1*z_Local_Health_Surv_Team + 1*z_Emerg_Ops_Center_Surge_Team,1))	TCL07 p.169,171	
161	h161^i(f_Absent)=z_PhEpidLab_Local_Health_Stat	z_PhEpidLab_Local_Health_Stat	z_PhEpidLab_Local_Health_Stat	Persons	h161^i(z_Local_Health_Surv_Team,z_Spec_Studies_Team,f_Absent)=ceiling((1/(1-f_Absent))*1*z_Local_Health_Surv_Team + 1*z_Spec_Studies_Team,1)	TCL07 p.169,171	
162	h162^i(f_Absent)=z_PhEpidLab_Inv_Epid	z_PhEpidLab_Inv_Epid	z_PhEpidLab_Inv_Epid	Persons	h162^i(Num_Hospitals,z_Local_Health_Surv_Team,z_Spec_Studies_Team,z_Local_Health_Surv_Team,z_CDC_DEOC_Surge_Team,z_Emerg_Ops_Center_Surge_Team,f_Absent)=ceiling((1/(1-f_Absent))*(1*Num_Hospitals + 2*z_Local_Health_Surv_Team + 1 + 5*z_Spec_Studies_Team + 2*z_Local_Health_Surv_Team + 5*z_CDC_DEOC_Surge_Team + 1*z_Emerg_Ops_Center_Surge_Team),1)	TCL07 p.169,171	
163	h163^i()=z_Spec_Studies_Team	z_Spec_Studies_Team	z_Spec_Studies_Team	teams nationally	h163^i()=10	TCL07 p.169,171	
164	h164^i(z_Spec_Studies_Team,f_Absent)=z_PhEpidLab_Spec_Studies_Epid_Supervisor	z_PhEpidLab_Spec_Studies_Epid_Supervisor	z_PhEpidLab_Spec_Studies_Epid_Supervisor	Persons	h164^i(z_Spec_Studies_Team,f_Absent)=ceiling((1/(1-f_Absent))*(1*z_Spec_Studies_Team),1)	TCL07 p.169,171	
165	h165^i(z_Spec_Studies_Team,f_Absent)=z_PhEpidLab_Spec_Studies_PH_Advisor	z_PhEpidLab_Spec_Studies_PH_Advisor	z_PhEpidLab_Spec_Studies_PH_Advisor	Persons	h165^i(z_Spec_Studies_Team,f_Absent)=ceiling((1/(1-f_Absent))*(1*z_Spec_Studies_Team),1)	TCL07 p.169,171	
166	h166^i(z_Spec_Studies_Team,f_Absent)=z_PhEpidLab_Spec_Studies_SME	z_PhEpidLab_Spec_Studies_SME	z_PhEpidLab_Spec_Studies_SME	Persons	h166^i(z_Spec_Studies_Team,f_Absent)=ceiling((1/(1-f_Absent))*(1*z_Spec_Studies_Team),1)	TCL07 p.169,171	
167	h167^i(z_Spec_Studies_Team,f_Absent)=z_PhEpidLab_Spec_Studies_Interviewer	z_PhEpidLab_Spec_Studies_Interviewer	z_PhEpidLab_Spec_Studies_Interviewer	Persons	h167^i(z_Spec_Studies_Team,f_Absent)=ceiling((1/(1-f_Absent))*5*z_Spec_Studies_Team,1)	TCL07 p.169,171	
168	h168^i()=z_CDC_DEOC_Surge_Team	z_CDC_DEOC_Surge_Team	z_CDC_DEOC_Surge_Team	teams/location	h168^i()=1	TCL07 p.169,171	
169	h169^i(z_CDC_DEOC_Surge_Team,z_Emerg_Ops_Center_Surge_Team,f_Absent)=z_PhEpidLab_Sen_Epid_Sup	z_PhEpidLab_Sen_Epid_Sup	z_PhEpidLab_Sen_Epid_Sup	Persons	h169^i(z_CDC_DEOC_Surge_Team,f_Absent)=ceiling((1/(1-f_Absent))*(1*z_CDC_DEOC_Surge_Team + 1*z_Emerg_Ops_Center_Surge_Team),1)	TCL07 p.169,171	
170	h170^i(z_CDC_DEOC_Surge_Team,f_Absent)=z_PhEpidLab_CDC_Surge_Pub_Health_Adv	z_PhEpidLab_CDC_Surge_Pub_Health_Adv	z_PhEpidLab_CDC_Surge_Pub_Health_Adv	Persons	h170^i(z_CDC_DEOC_Surge_Team,f_Absent)=ceiling((1/(1-f_Absent))*1*z_CDC_DEOC_Surge_Team,1)	TCL07 p.169,171	

Table D.3—Continued

Function Number	Function Arguments	Function Variable Names	Variable	Unit	Function Definition	Source	Explanations and Assumptions
	Public Health / Epidemiology / Lab Testing - Quarantine - Sanitation—Cont.						
171	h171^i(z_CDC_DEOC_Surge_Team,f_Absent)=z_PhEpidLab_CDC_Surge_Data_Entry_Manager	z_PhEpidLab_CDC_Surge_Data_Entry_Manager	z_PhEpidLab_CDC_Surge_Data_Entry_Manager	Persons	h171^i(z_CDC_DEOC_Surge_Team,f_Absent)=ceiling((1/(1-f_Absent))*1*z_CDC_DEOC_Surge_Team,1)	TCL07 p.169,171	
172	h172^i(z_CDC_DEOC_Surge_Team,f_Absent)=z_PhEpidLab_CDC_Surge_Data_Entry_Staff	z_PhEpidLab_CDC_Surge_Data_Entry_Staff	z_PhEpidLab_CDC_Surge_Data_Entry_Staff	Persons	h172^i(z_CDC_DEOC_Surge_Team,f_Absent)=ceiling((1/(1-f_Absent))*1,10*z_CDC_DEOC_Surge_Team)	TCL07 p.169,171	
173	h173^i()=z_Emerg_Ops_Center_Surge_Team	z_Emerg_Ops_Center_Surge_Team	z_Emerg_Ops_Center_Surge_Team	Teams/State	h173^i()=2	TCL07 p.169,171	
174	h174^i(z_Emerg_Ops_Center_Surge_Team,f_Absent)=z_PhEpidLab_StateLocal_Surge_Epid_Commander	z_PhEpidLab_StateLocal_Surge_Epid_Commander	z_PhEpidLab_StateLocal_Surge_Epid_Commander	Persons	h174^i(z_Emerg_Ops_Center_Surge_Team,f_Absent)=ceiling((1/(1-f_Absent))*1*z_Emerg_Ops_Center_Surge_Team,1)	TCL07 p.169,171	
175	h175^i(z_Emerg_Ops_Center_Surge_Team,f_Absent)=z_PhEpidLab_StateLocal_Surge_BT_Coord	z_PhEpidLab_StateLocal_Surge_BT_Coord	z_PhEpidLab_StateLocal_Surge_BT_Coord	Persons	h175^i(z_Emerg_Ops_Center_Surge_Team,f_Absent)=ceiling((1/(1-f_Absent))*1*z_Emerg_Ops_Center_Surge_Team,1)	TCL07 p.169,171	
176	h176^i(z_Emerg_Ops_Center_Surge_Team,f_Absent)=z_PhEpidLab_StateLocal_Surge_Epid_Support	z_PhEpidLab_StateLocal_Surge_Epid_Support	z_PhEpidLab_StateLocal_Surge_Epid_Support	Persons	h176^i(z_Emerg_Ops_Center_Surge_Team,f_Absent)=ceiling((1/(1-f_Absent))*5*z_Emerg_Ops_Center_Surge_Team,1)	TCL07 p.169,171	
177	h177^i(z_Emerg_Ops_Center_Surge_Team,f_Absent)=z_PhEpidLab_StateLocal_Surge_PHA	z_PhEpidLab_StateLocal_Surge_PHA	z_PhEpidLab_StateLocal_Surge_PHA	Persons	h177^i(z_Emerg_Ops_Center_Surge_Team,f_Absent)=ceiling((1/(1-f_Absent))*1*z_Emerg_Ops_Center_Surge_Team,1)	TCL07 p.169,171	
178	h178^i(z_Emerg_Ops_Center_Surge_Team,f_Absent)=z_PhEpidLab_StateLocal_Surge_Db_Manager	z_PhEpidLab_StateLocal_Surge_Db_Manager	z_PhEpidLab_StateLocal_Surge_Db_Manager	Persons	h178^i(z_Emerg_Ops_Center_Surge_Team,f_Absent)=ceiling((1/(1-f_Absent))*1*z_Emerg_Ops_Center_Surge_Team,1)	TCL07 p.169,171	
179	h179^i(z_Emerg_Ops_Center_Surge_Team,f_Absent)=z_PhEpidLab_StateLocal_Surge_Programmer	z_PhEpidLab_StateLocal_Surge_Programmer	z_PhEpidLab_StateLocal_Surge_Programmer	Persons	h179^i(z_Emerg_Ops_Center_Surge_Team,f_Absent)=ceiling((1/(1-f_Absent))*1*z_Emerg_Ops_Center_Surge_Team,1)	TCL07 p.169,171	
180	h180^i(z_Emerg_Ops_Center_Surge_Team,f_Absent)=z_PhEpidLab_StateLocal_Surge_Analyst	z_PhEpidLab_StateLocal_Surge_Analyst	z_PhEpidLab_StateLocal_Surge_Analyst	Persons	h180^i(z_Emerg_Ops_Center_Surge_Team,f_Absent)=ceiling((1/(1-f_Absent))*2*z_Emerg_Ops_Center_Surge_Team,1)	TCL07 p.169,171	
181	h181^i(z_Emerg_Ops_Center_Surge_Team,f_Absent)=z_PhEpidLab_StateLocal_Surge_Transport	z_PhEpidLab_StateLocal_Surge_Transport	z_PhEpidLab_StateLocal_Surge_Transport	Persons	h181^i(z_Emerg_Ops_Center_Surge_Team,f_Absent)=ceiling((1/(1-f_Absent))*2*z_Emerg_Ops_Center_Surge_Team,1)	TCL07 p.169,171	
182	h182^i(z_Emerg_Ops_Center_Surge_Team,f_Absent)=z_PhEpidLab_StateLocal_Surge_Clerical_Staff	z_PhEpidLab_StateLocal_Surge_Clerical_Staff	z_PhEpidLab_StateLocal_Surge_Clerical_Staff	Persons	h182^i(z_Emerg_Ops_Center_Surge_Team,f_Absent)=ceiling((1/(1-f_Absent))*1*z_Emerg_Ops_Center_Surge_Team,1)	TCL07 p.169,171	
183	h183^i(<<All_PhEpidLab_Persons>>)=z_PhEpidLab_PE_Cache_Phone	z_PhEpidLab_PE_Cache_Phone	z_PhEpidLab_PE_Cache_Phone	Phones	h183^i(<<All_PhEpidLab_Persons>>)=1*<<All_PhEpidLab_Persons>>	TCL07 p.169,171	
184	h184^i(<<All_PhEpidLab_Persons>>)=z_PhEpidLab_PE_Cache_PPE	z_PhEpidLab_PE_Cache_PPE	z_PhEpidLab_PE_Cache_PPE	PPE Sets	h184^i(<<All_PhEpidLab_Persons>>)=1*<<All_PhEpidLab_Persons>>	TCL07 p.169,171	
185	h185^i(<<All_PhEpidLab_Persons>>)=z_PhEpidLab_Computer	z_PhEpidLab_Computer	z_PhEpidLab_Computer	Laptops	h185^i(<<All_PhEpidLab_Persons>>)=1*<<All_PhEpidLab_Persons>>*(1/2)	TCL07 p.169,171	
186	h186^i(<<All_PhEpidLab_Persons>>)=z_PhEpidLab_Printer	z_PhEpidLab_Printer	z_PhEpidLab_Printer	Printers	h186^i(<<All_PhEpidLab_Persons>>)=ceiling(z_PhEpidLab_Computer/10,1)	TCL07 p.169,171	

Notes:

Gray denotes functions not included/used in tool

<<All_PhEpidLab_Persons>> is the sum of all persons in the public health/epidemiology/lab

--- More specifically:

<<All_PhEpidLab_Persons>> = z_Local_Health_Surv_Team + z_PhEpidLab_Local_Health_Surv_Person + z_PhEpidLab_Local_Health_ITStaff + z_PhEpidLab_Local_Health_Stat + z_PhEpidLab_Inv_Epid + z_Spec_Studies_Team + z_PhEpidLab_Spec_Studies_Epid_Supervisor + z_PhEpidLab_Spec_Studies_PH_Advisor + z_PhEpidLab_Spec_Studies_SME + z_PhEpidLab_Spec_Studies_Interviewer + z_CDC_DEOC_Surge_Team + z_PhEpidLab_Sen_Epid_Sup + z_PhEpidLab_CDC_Surge_Pub_Health_Adv + z_PhEpidLab_CDC_Surge_Data_Entry_Manager + z_PhEpidLab_CDC_Surge_Data_Entry_Staff + z_Emerg_Ops_Center_Surge_Team + z_PhEpidLab_StateLocal_Surge_Epid_Commander + z_PhEpidLab_StateLocal_Surge_BT_Coord + z_PhEpidLab_StateLocal_Surge_PHA + z_PhEpidLab_StateLocal_Surge_Db_Manager + z_PhEpidLab_StateLocal_Surge_Programmer + z_PhEpidLab_StateLocal_Surge_Analyst + z_PhEpidLab_StateLocal_Surge_Transport + z_PhEpidLab_StateLocal_Surge_Clerical_Staff

Detailed Description 8: Function for Vaccine Dosages, Required Resources

This appendix subsection details the required resource function #144 z_Mass_Proph_Vaccines listed in Table D.3.

Sources

This function is from the CDC's FluSurge model and uses data from the Area Resource File.

Functions

The number of vaccines required (z_Mass_Proph_Vaccines) is dependent on the population age distribution, the fraction of high-risk population, and the fraction of the population that is not already vaccinated.

z_Mass_Proph_Vaccines =

$$\sum_{d=1}^{2}\left(\sum_{y=1}^{3} Pop_y\left(1-\%HR_y\right)PNV_{d,y,r=2}+\sum_{y=1}^{3} Pop_y \%HR_y PNV_{d,y,r=1}\right)$$

Definitions

Pop_y = Population of age group y (y = 1 for age group 0–17 years; y = 2 for age group 18–64 years; y = 3 for age group 65+)

$\%HR_y$ = Percentage high risk where y is age group (see Table D.3.1).

$PNV_{d,y,r}$ = Percentage not vaccinated where r = 1 is high risk and r = 2 is non-high risk, y is age group, and d is vaccine dosage number (see Table D.3.2).

Table D.3.1
$\%HR_y$—Percentage Considered at "High Risk"

Age group	0–17 years	18–64 years	65+ years
Percentage of high-risk population	6.4	14.4	40.0

SOURCE: CDC FluSurge.

Table D.3.2
$PNV_{d,y,r}$—Percentage Not Vaccinated

"At High Risk"	% 1st dose	% 2nd dose
0–17 years	50	45
18–64 years	50	45
65+ years	50	45
"Non-High Risk"		
0–17 years	20	10
18–64 years	20	10
65+ years	20	10

SOURCE: CDC FluSurge.

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