NISTIR 8231

Implementation of the NIST Community Resilience Planning Guide for Buildings and Infrastructure Systems

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National Institute of Standards and Technology
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Abstract

The National Institute of Standards and Technology (NIST) published the Community Resilience Planning Guide for Buildings and Infrastructure Systems (NIST SP 1190) in October 2015. The Guide describes a six-step process to develop a community resilience plan. The Guide was intended to be flexible, so that it could be used to create a standalone plan or to complement other planning processes by integrating resilience measures into long-term community plans. Since the Guide's release, communities have begun to use it to develop resilience plans. This report documents uses data from implementation evaluation surveys and direct interaction with communities using the Guide to understand how it is being implemented and how resilience planning is being integrated with other existing planning processes. The report also documents practices that can be replicated in other locations and identifies gaps where additional guidance or tools would be helpful to facilitate resilience planning.

Key Words

Buildings, community, hazards, infrastructure, planning, recovery, resilience

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Glossary

AHA	All-Hazards Knowledge Framework
ARA	Applied Research Associates
BNSF	Burlington Northern Santa Fe
CDBG-DR	Community Development Block Grants Disaster Recovery Program
CDC	Centers for Disease Control and Prevention
CPT	Collaborative Planning Team
DelDOT	Delaware Department of Transportation
DHS	Department of Homeland Security
EDG	Economic Decision Guide
EPA	Environmental Protection Agency
FEMA	Federal Emergency Management Agency
Guide	Community Resilience Planning Guide for Buildings and Infrastructure Systems
Hazus	Hazards-United States (Methodology and Software)
Hazus-MH	Hazards-United States Multi-Hazard (Methodology and Software)
INL	Idaho National Lab
IRB	Institutional Review Board
MOU	Memoranda of Understanding
NESEC	Northeast States Emergency Consortium
NIST	National Institute of Standards and Technology
NLC	National League of Cities
NOAA	National Oceanic and Atmospheric Administration
OMB	Office of Management and Budget
OSSPAC	Oregon Seismic Safety Policy Advisory Commission
PRA	Paperwork Reduction Act
RRAP	Regional Resilience Assessment Program
SPUR	San Francisco Bay Area Planning and Urban Research Association
SR 1	State Route 1

1. Introduction

In October 2015, the National Institute of Standards and Technology (NIST) released the *Community Resilience Planning Guide for Buildings and Infrastructure Systems* (Guide) (1, 2). This was the first major deliverable under the NIST Community Resilience Program and an important document for guiding research under the Community Resilience Program. The Guide describes a six-step process for resilience planning that can be used to develop a standalone resilience plan for a community or to develop community resilience goals that are integrated into existing community plans. The Guide is being used by several communities around the United States and has received international attention and interest. The implementations described in this report provide data about the effectiveness of the Guide, as well as any gaps or shortcomings. The later implementations of the Guide (i.e., Nashua, NH and Bozeman, MT) demonstrate the use of a workshop format to initiate the planning process and how other tools can be employed to support resilience planning as described in the Guide. Data from the survey instrument supplements the direct observations with information from these communities and others that have used the Guide for their planning.

NIST released the Community Resilience Economic Decision Guide for Buildings and Infrastructure Systems (EDG) in 2016 as a companion to the Guide (3). The EDG is intended to help communities evaluate project options to support resilience improvements. It recognizes that communities want to make efficient use of resources and that often communities will attempt to address multiple priorities. The EDG methodology therefore considers resilience and non-resilience benefits and costs.

This report provides an overview of the Guide and Economic Decision Guide, case studies of Guide use, and survey instruments for evaluating NIST resilience guidance and tools. Case study data for the report was collected by NIST through direct interactions with five communities using the Guide. A detailed review of each case study and what was learned about the process of resilience planning is documented and assessed. A survey instrument was also developed to conduct a formal evaluation of community use of NIST resilience planning guidance and tools, including the Guide, EDG, and the Economic Decision Guide Software (EDGe$) Tool. For this evaluation, the survey was used to collect data from users of the Guide, both those who NIST has worked with directly and others who have used the Guide for their planning efforts without direct NIST involvement. These data are used to extend the findings obtained through direct engagement with communities. Ultimately, both data types and the corresponding discussion are used to identify practices that can be replicated to facilitate the use of the Guide by other communities. The results of this study are useful input to future guidance documents and provide insights for tools that facilitate their implementation.

1.1. NIST Community Resilience Planning Guide

The Guide focuses on the role of the built environment in supporting social and economic activities in a community, and how to improve community resilience by identifying goals for recovery of physical systems services and social and economic functions. One of the goals of the Guide development effort was to develop a process that could be applied to resilience planning given any hazard, whether natural, technological, or human-caused. The Guide

process also had to be flexible such that it could be applied to communities of any size and accommodate differences in complexity.

NIST referred to two previous community resilience planning efforts, both specific to given geographic areas, as it began development of the Guide. The first was the Resilient City Study, undertaken by the San Francisco Bay Area Planning and Urban Research Association (SPUR) (4). The second was the Oregon Resilience Plan produced by the Oregon Seismic Safety Policy Advisory Commission (OSSPAC) (5). Both the SPUR study and the Oregon Resilience Plan focused on the built environment and its role in supporting response and recovery following a disruptive seismic event. The SPUR study focused on the impact and recovery within San Francisco following an earthquake that can reasonably be expected to occur once during the lifetime of a structure or system. For San Francisco, this corresponds to a magnitude 7.2 earthquake located on the peninsula segment of the San Andreas Fault. The Oregon Resilience Plan examined the impacts on the state from a Cascadia Subduction Zone earthquake and tsunami that would directly affect a relatively small part of the state but would have cascading consequences that would impact and disrupt social and economic activity throughout the state. Both studies linked the importance of developing and implementing resilience plans to ensure that when a disruptive event occurs, the affected areas can recover in a way that does not result in economic decline or loss of residents and businesses.

These efforts considered resilience at a local (i.e., city) and state level. NIST research focuses on the community scale (e.g., city, county); the Guide defines a community as having: 1) a governance structure and 2) a defined geographic boundary. The Guide process is flexible and can be applied in other settings where these two conditions are met, such as a university campus or military base. Local government is a logical convener, able to bring together relevant stakeholders at the local, regional, state, and federal level as needed for resilience planning. Finally, local government can either make decisions regarding resilience actions or influence decisions for assets and systems that are either municipally or investor-owned (e.g., utilities), privately owned, or owned and operated by state agencies (e.g., roads, bridges).

The six-step Guide process is depicted in Figure 1-1. Step 1 describes the formation of the collaborative planning team: selecting a leader, bringing together a diverse set of team members, and developing a stakeholder network to represent each of the social dimensions in the community. One of the key features of the Guide process is the explicit characterization of the social and economic dimensions of the community in Step 2. This allows the community to identify those dimensions that are critical to its initial response and longer-term recovery and to establish priorities. Understanding the social and economic priorities enables the community to map these priorities onto building clusters[1] and establish resilience goals (expressed in terms of time to recover function) for the building clusters. The building clusters' dependency on infrastructure systems are also established. In Step 3, resilient performance goals for recovery of function (desired performance) are set independent of hazards. When the hazards are considered for determining anticipated performance of the built environment, gaps between the anticipated performance of a building cluster or infrastructure system and the desired performance represent opportunities to improve resilience. A template for the performance goals tables is shown in Appendix A. This process allows communities to identify areas where they may not have capacity to recover as desired following disruption and to consider alternatives to reduce vulnerabilities in Step 4. Improvements could include administrative actions such as land use planning or buyback programs to reduce risk, mutual aid agreements to accelerate restoration of services, temporary measures to meet community needs following a hazard event, and construction or rehabilitation projects to improve the capacity of the built environment to withstand hazards. The Guide also considers the long-term plans of the community, so that resilience can be built over time and support community goals. The Guide can be used to create a standalone resilience plan or integrate resilience into existing community plans. The Guide, along with supporting materials including Guide Briefs are available on the NIST website at: https://www.nist.gov/topics/community-resilience.

Figure 1-1. NIST Resilience Planning Process

[1] The term "building cluster" denotes a group of buildings serving a common function. Buildings within the cluster are not necessarily geographically co-located. Examples include residential housing, schools, or healthcare facilities. The clusters serve community social institutions and should have similar performance goals.

1.2. NIST Economic Decision Guide

The Community Resilience Economic Decision Guide for Buildings and Infrastructure (EDG) is a companion to the resilience planning process described in the Guide. The seven-step EDG process is mapped in relation to the six-step Guide Process in Figure 1-2. Relevant use of the EDG as a companion to the Guide starts at Step 4 of the Guide process. For this reason, implementation use of the EDG is not reported upon in this interim use report -- the majority of communities discussed in the present report have not yet reached Step 4 of the Guide. The EDG describes an economic decision process that identifies and compares present and future streams of costs and benefits to the community, allowing for comparison of competing project options to each other and to the status quo. The EDG considers direct resilience benefits by calculating the cost of losses avoided as well as calculating the economic and non-economic benefits that accrue to the community from the investment. These non-disaster economic benefits include direct and indirect benefits, externalities (costs or benefits affecting a third party), and non-market considerations.

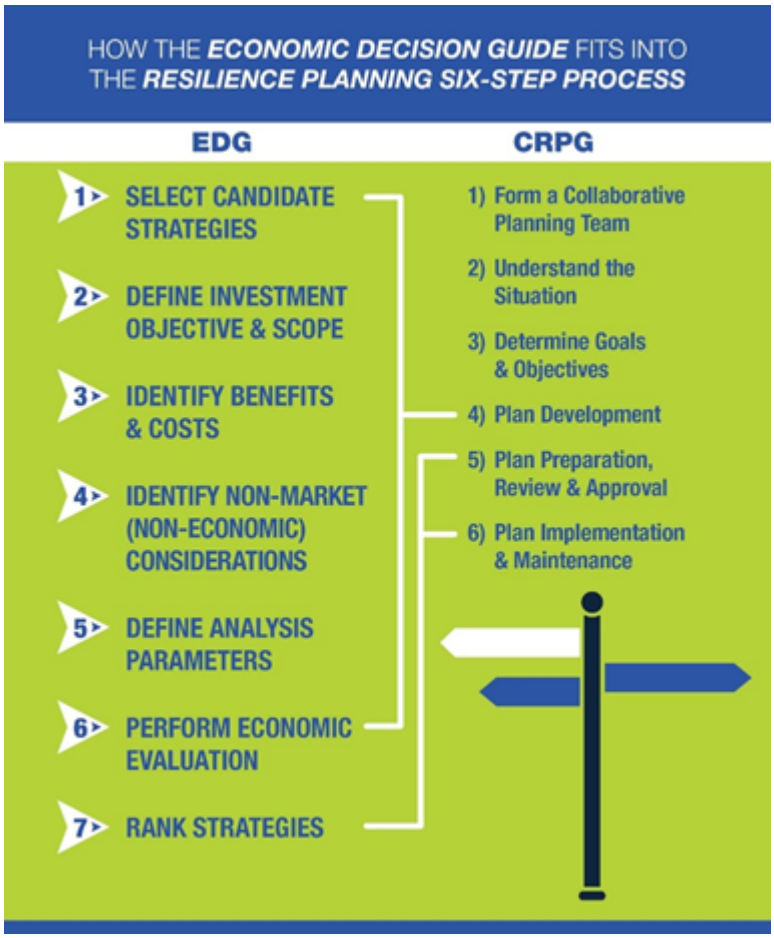

Figure 1-2. Economic Decision Guide Process

While the EDG is intended to be used in combination with the Guide, it is possible to implement the methodology independently to evaluate resilience options. NIST has developed a software-based tool, the Economic Decision Guide Software (EDGe$), which is available on the NIST Community Resilience Program website: https://www.nist.gov/services-resources/software/edge-economic-decision-guide-software-tool.

2. Guide Use by Communities

Guide use has occurred in two phases. The first phase of implementation, coming shortly after the publication of the Guide, is defined by communities tailoring their use of the Guide to achieve their resilience objectives. Use of the Guide in Fort Collins, Colorado, Howard County, Maryland, and by the Delaware Department of Transportation (DelDOT) falls within this type of use. This type of use continues and NIST is not always aware of communities

electing to use the Guide. More recently, a second phase was started, where NIST has signed Memoranda of Understanding (MOUs) with three communities to provide a more formal setting for studying Guide use. This collaboration is ongoing, and Guide use to date by Nashua, NH and Bozeman, MT are presented.

The Fort Collins example demonstrates how the Guide can be applied in a municipal setting. The resilience assessment focused on the City of Fort Collins, but since Fort Collins is the county seat for Larimer County, some county facilities located within the city limits were included in the assessment. Similarly, the Poudre School District serves several communities, including Fort Collins, so the function of the entire school district was considered.

Howard County was beginning work on a resilience plan and wanted to learn from NIST's work. In 2016, Howard County was in the process of developing a recovery plan for the county that used the NIST Guide as a reference. Following the flash flood in Ellicott City in July of 2016, members of the county's economic development, planning, and emergency management staff worked closely with businesses and residents in the affected area to recover quickly from the flood.

The DelDOT project centered around a highway corridor and its role to ensure that the communities along the corridor can function and the extent to which function can be disrupted when the highway is not available. DelDOT used the Guide to encourage engagement of the four towns along the SR 1 corridor and to approach the corridor assessment from a broader resilience perspective. The state has also used the Guide as a reference in the development of statewide transportation strategic plan.

During 2018, NIST established MOUs with three communities as part of its research program, provided technical support and guidance on Guide use for community resilience planning. The purpose of these engagements was twofold. First, formal engagement with the local planning teams allowed NIST to provide guidance to teams as they used the Guide 6-step process and to support them as they established performance goals and determined anticipated performance for buildings and infrastructure and identified priorities for projects to build resilience. Second, formal, sustained engagement allowed NIST to learn from the implementation of the Guide process, identify other tools that can inform resilience planning, and identify any gaps where additional guidance or tools would further facilitate the use of the Guide. These implementations began after NIST had learned from the initial phase of implementations and published additional guidance, in the form of Guide Briefs. Based on interest from: Nashua, New Hampshire, Bozeman, Montana, and Salt Lake County, Utah, NIST entered into agreements to provide technical support to the three communities and to collect data on the implementation process to inform development of tools or additional guidance. Technical support followed a similar formula in each of these three engagements:

1. An initial coordination meeting was held by teleconference to identify stakeholders to participate in a one-day initial planning meeting, set the agenda for that meeting, and to review the community's long-term goals, hazard concerns, and understand the community's scope and objectives for the resilience planning process.

2. An in-person planning was held with each community. The planning meeting began with the community reviewing its long-term goals for development and growth (master plan) and updates to the hazard mitigation plan. NIST introduced the Guide process and facilitated a working session to help the community establish performance goals for buildings and infrastructure.

3. NIST continued to provide technical support and guidance through e-mail and telephone conversations during as the community estimated anticipated performance for buildings and infrastructure.

4. A second meeting in-person was held with the collaborative planning team and stakeholder group to review the completed performance tables and the next steps in the process.

The MOU engagements with the communities allowed NIST to carefully work through the Guide process with the users, understand how other resources or studies might be combined with the Guide process to meet local objectives, and how projects might be time-phased to fit with available resources.

3. Implementation Evaluation Surveys to Assess Guide Use

NIST researchers designed an assessment of community use of NIST resilience planning guidance and tools to: 1) inform the next generation of guidance on community resilience planning and accompanying tool development, 2) better understand the process of resilience planning, and 3) identify additional resources that communities need for resilience planning. Through an implementation or process evaluation approach (6; 7), the survey instruments are used to:

- identify and maximize strengths in development;
- identify and minimize barriers to implementing activities;
- determine if project goals match target population needs;
- assess whether available resources can sustain project activities;
- measure the community's perceptions of the Guide and related resources for resilience planning;
- document systemic change in the planning process; and
- monitor clients' and other stakeholders' experiences with resilience planning.

The survey instruments were developed to provide a formative evaluation of the implementation phase of the Guide and associated products with the intent of generating information to guide program improvement (7). Examples of implementation or process evaluations within other federal programs were used to inform the development of the surveys (e.g., 8). Survey questions align to each of six steps of the Guide as well as a general background module and a question module related to the use of the Economic Decision Guide. A subsequent outcome evaluation can be later used to provide NIST information about the impact of the Guide on communities. However, at this stage in the NIST Community Resilience Program understanding why a resilience planning effort is successful is far more important than just knowing that it is successful.

The remainder of this section provides an overview of the methods used to develop the sampling frame for this research. It overviews the question sections and response types developed to obtain data from those community representatives surveyed. The evaluation research is being conducted in phases. Phase 1 includes modules through Guide Step 2 and Phase 2 consists of modules for Guide Steps 3-6. Results of data collected as part of Phase 1 are presented in this report. It should be noted that the methodology presented in this report and the associated survey questions were approved by the Office of Management and Budget (OMB) under Paperwork Reduction Act (PRA) (9). Additionally, the NIST Institutional Review Board (IRB) made a thorough review of the survey protocol and questions and NIST researchers engaged in IRB-related online training. The IRB is an administrative body established to protect the rights and welfare of human research subjects recruited to participate in research activities conducted under the auspices of the institution with which it is affiliated, in this case, NIST.

3.1. Sample Development

Communities presently using the Guide have self-identified through contact with NIST, as outlined in Section 3 and further explained in Section 5. Respondents for the survey are identified through their ongoing relationship with NIST. In the course of working with community representatives to provide support for resilience planning activities and other uses of NIST guidance on community resilience, NIST has developed strong relationships with communities that are engaged in resilience activities. As a result, the members of this research team have awareness of where the Guide is already being used. This knowledge allows respondents to be identified and selected based on their role as community champions or conveners of Guide implementation.

Using the existing primary contacts as a starting point, NIST requested the names and contact information for additional representatives from the collaborative planning team in each community. In this manner, a purposive sampling strategy was employed. Purposive sampling is non-probability sampling where respondents are selected for a study based on specified characteristics based on the study objective(s) (10).

3.2. Survey Data Collection Modes

A range of survey modes were available for data collection in this study. For each respondent, data was collected through the most efficient and effective means for the community and its representative(s). Most respondents used the web-interface survey, which was scripted in a commercial web-based survey tool. However, the survey was also made available through face-to-face and telephone modes. This multi-modal approach was provided to minimize respondent burden.

3.3. Types of Guide Usage

There are two general types of Guide use observed across the population of usage: 1. Conventional Guide use and 2. Unconventional Guide use. These Guide types are defined below and the structure of surveys are informed by the specific type of use made by the community.

3.3.1. **Conventional Guide Use**

Respondents classified under conventional Guide use are from those communities using the Guide for resilience planning. Specifically, these communities demonstrate the intention to work through the six-step process presented in the Guide. These users are applying the Guide in a prescriptive manner.

3.3.2. **Unconventional Guide Use**

Respondents classified under unconventional Guide use are from those communities using the Guide as a reference to support or assess another resilience effort (e.g., to evaluate existing plans, incorporate resilience into other capital and social plans, or to prioritize investments). In some cases, unconventional guide use may reflect that a given community has initiated resilience planning in a different manner than prescribed in the Guide and may select to follow one or more (but not all) of the six-steps in the Guide.

3.4. Respondent Recruitment

Through existing contact with community representatives and/or through the resilience planning process convener, the NIST identified representatives from a given community's collaborative planning team.

NIST investigators invited participation in this study through a standardized email invitation and via follow-up emails or phone calls, as required. If a respondent affirmed that (s)he was willing to respond to the survey and returned the completed consent form, NIST researchers initiated the survey by sending an initial link and a unique identification code generated for the individual respondent. The respondent was classified according to how the community (s)he represents is using the Guide; the classification determined the survey modules the respondent was asked to complete.

3.5. Survey Structure

Upon successful recruitment, consent, and classification, the respondent received an initial, background survey module with questions about the respondent and their community. The survey questions and associated modules differ between Guide user types as outlined, below.

For this study, NIST has and will continue to collect data on background of respondent and community, strengths in resilience planning process, barriers to implementing activities, match of project goals to target population needs, match between available resources and project activities, perceptions of the Guide and related resources for resilience planning, systemic change in the community's planning process, and experiences with each of the six

steps of resilience planning. The source of these data are representatives of the communities who have used or are currently using the Guide. The survey instruments allow systematic measurement of the same information across representatives and communities.

3.5.1. General Question Module

The first section of questions is asked of both conventional and unconventional users of the Guide. It deals primarily with characteristics of the community and the respondent's role within the community. The survey additionally seeks to understand the community's motivation for community planning and the extent to which financial assistance was/is available. The next group of questions deals with the types of hazards the community has experienced in the past (e.g., flooding, earthquake) and the other types of stressors experienced by the community (e.g., crime, unreliable public transportation). Finally, the survey asks about other types of community plans in place in the community (e.g., transportation plan, comprehensive plan).

3.5.2. Unconventional Guide Use Survey Questions

For the unconventional Guide users, the survey is relatively brief. It consists of the general module, described above, as well as a single survey module that seeks to obtain a description of and insight as to how the community is using the Guide to assist in other resilience-related planning activities. In particular, this module seeks to determine if the community was in the process of resilience planning when finding out about the Guide and whether additions/changes were made based on the information in the Guide.

A copy of the survey for unconventional guide use can be found in Appendix A.

3.5.3. Conventional Guide Use Survey Differences

Conventional Guide users start by responding to the general survey module. The remainder of the survey is spread across a series of standalone modules. The individual six steps of the Guide require some time for a community to complete – this can be months or years – thus, it makes sense to ask a respondent to provide relevant data on a step once it has been completed. The modules accord with the steps in the Guide (e.g., Step 1 performance is reviewed in Survey Module 1, Step 2 in Survey Module 2, etc.). After each module there is a brief general process evaluation, which asks is there are tools and/or support from NIST or other organizations that could have enabled more effective or efficient completion of the related Guide step.

For purposes of the data presented in this report, conventional guide users completed up to Module 2 in the survey sequence.

The Step 1 "Form a Collaborative Planning Team" survey module (i.e., survey module 1) is focused on understanding the genesis of the collaborative planning team for the community and representativeness of team membership.

The Step 2 "Understand the Situation" survey module (i.e., survey module 2) seeks to gather information about the processes used to characterize the population and identify social institutions in the community, as well as their dependencies. Additionally, questions are asked about identification of the links between social institutions and the built environment in the community.

A copy of the survey for conventional Guide use can be found in Appendix A.

Information on each community classified as a conventional user will be collected at regular intervals during the guide implementation process. NIST researchers will continue to contact respondents quarterly to assess which step(s) from the Guide have been completed by a given community and the appropriate survey module will be provided for completion. At the point in the future when the Step 6 Survey Module has been completed, the survey will be terminated for that respondent.

3.6. Respondents

The present sample includes a total of nine respondents representing seven communities; the sample includes one to two community representatives per community. As the evaluation is ongoing, the results presented here are preliminary and account for a portion of those expected in the final assessment. NIST will continue to recruit respondents to enhance the assessment of the experience of resilience planning or related resilience activity in each community.

4. Community Overview

Table 4-1 summarizes the communities studied in this report based on data collected through survey responses, direct interactions, or both. Section 5 provides case studies for communities where NIST has provided guidance on Guide use. Section 6 documents the survey responses from representatives of communities who have or are presently using NIST guidance on resilience planning. Table 4-1 summarizes the locations studied in this report based on data collected through survey responses, direct interactions, or both.

Table 4-1: Locations, characteristics, and hazards.

Location	Population	Governance Structure	Planning Focus
Fort Collins, CO	143 986 (2010 Census)	Council-Manager	Flooding, wildland-urban interface fire, hazardous chemical release, long-term power outage
Howard County, MD	287 085 (2010 Census)	County Council; County Executive	Recovery plan
Delaware State Route 1	Fenwick Island, DE: 379; South Bethany, DE: 449; Bethany Beach, DE: 1060; Dewey, DE: 341. Year-round residents. (2010 Census)	All have council-mayor governments	Coastal flooding
Boulder County, CO	294 572 (2010 Census)	Board of County Commissioners	Flooding
Nashua, NH	86 492 (2010 Census)	Mayor-Board of Aldermen	Flooding, hurricane, earthquake, winter storm
Bozeman, MT	37 286 (2010 Census)	Mayor-Commission/City Manager	Adaptation to changing climate, flood, drought
San Diego, CA & Tijuana, Mexico	1 406 630 (2010 Census) 1 641 570 (2015 INEGI)	Common Council, Mayor (San Diego) Mayor (Tijuana)	Earthquake, flooding
Larimer County, CO	299 630 (2010 Census)	Board of County Commissioners	Flooding, severe storms, tornado, wildland-urban interface fire
Salt Lake County, UT	1 029 655 (2010 Census)	County Mayor	Flooding, earthquake, wildland-urban interface fire
San Francisco, CA	805 235 (2010 Census)	Mayor and Board of Supervisors	Earthquake, severe storms, wildland-urban interface fire

5. Case Studies

Section 5 documents case studies for communities that used the Guide and where NIST was able to collect data on the Guide use through direct interaction with the communities. In each of these cases, the collaborative planning team was a relatively small working group of no more than five individuals. In most cases, larger networks of stakeholders representing social or economic functions (e.g., healthcare, education, businesses) were also engaged to inform the planning effort. The following sections document five communities where the Guide was used to support resilience planning.

5.1. Case Study 1: Fort Collins, Colorado

5.1.1. Description of the Community

Fort Collins, Colorado (Figure 5-1) is located on the Cache La Poudre River along the Front Range of the Colorado Rocky Mountains, approximately 65 miles (105 km) north of Denver. The population according to the 2010 census was 143 986; the estimated population in 2016 was 164 207. Fort Collins has a diversified economy which includes higher education, technology, healthcare, retail, and manufacturing. The largest employer in Fort Collins is Colorado State University.

Table 5-1: Population Breakdown of Fort Collins, Colorado by Race (Source: U.S. Census Bureau)

White alone, percent	88.6 %
Black or African American alone, percent	1.5 %
American Indian and Alaska Native alone, percent	0.6 %
Asian alone, percent	3.1 %
Native Hawaiian and Other Pacific Islander alone, percent	0.1 %
Two or More Races, percent	4.0 %
Hispanic or Latino, percent	11.4 %
White alone, not Hispanic or Latino, percent	80.8 %

Table 5-2: Income and Poverty Data for Fort Collins, Colorado. (Source: U.S. Census Bureau).

Median household income (in 2016 dollars) (2012-2016)	$57,831
Per capita income in past 12 months (in 2016 dollars) 2012-2016)	$30,680
Persons in poverty, percent	17.8 %

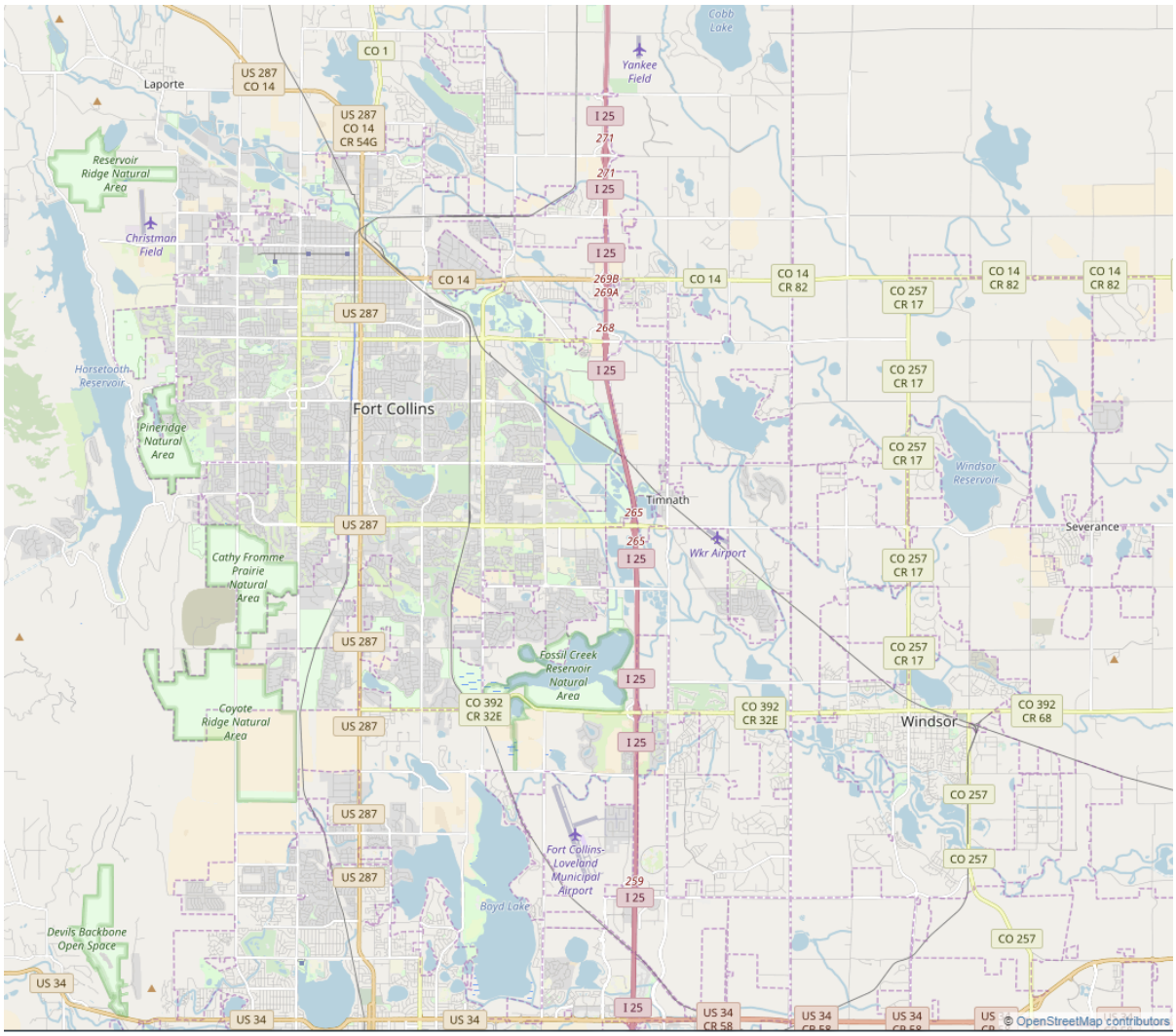

Figure 5-1. Map of Fort Collins, Colorado (©OpenStreetMaps contributors).

Fort Collins has a council-manager form of city government. The mayor is elected to a two-year term in elections held in odd numbered years. There are six city council members, each elected to four-year terms. Elections for the city council members are held every two years, staggered between even- and odd-numbered districts. The City Manager has overall responsibility for city operations and the council establishes policy direction. In addition to the City Government, Fort Collins is the county seat of Larimer County and houses county government facilities.

The information for Fort Collins was obtained through direct interaction with the users of the Guide. In Fort Collins, NIST participated in several on-site meetings of the collaborative planning team (CPT), accompanied the local lead (an emergency manager from Larimer County), Department of Homeland Security (DHS) Protective Security Advisor, and Idaho National Laboratory (INL) technical support staff on visits to key stakeholders in the city. The collaborative planning team was led by an emergency manager from Larimer County, working in coordination with the emergency manager from Fort Collins. Idaho National

Laboratory provide technical analysis and support to the CPT. DHS also provided technical support to the CPT.

5.1.2. **Major Hazards for Fort Collins**

The City of Fort Collins and Larimer County have a long history of dealing with flash flooding. In 1864, a major flood on the Cache La Poudre River led to the relocation of Camp Collins from its original location near what is now Laporte to a new location near the historic downtown. The camp was renamed Fort Collins. In 1904, major flooding was experienced along the Poudre River due to heavy rains near Livermore. Other, lesser floods occurred through the years until another major flood on the Big Thompson River in 1976. In 1997, Fort Collins received 25 to 36 cm (10 to 14 in.) of rain during a 31-hour period, leading to five deaths and over $ 200 million in damages. The campus of Colorado State University sustained over $ 140 million in damages to buildings. The experience from this storm led the city to be proactive in removing structures from flood prone areas and to take steps to reduce the risk that flooding posed to the city, such as creating park areas that can flood during periods of heavy precipitation and channels to direct water to retention areas. The result is that during the September 9 to 16, 2013 rainfall event, little damage to structures occurred in Fort Collins despite up to 30 cm (12 in.) of rain (11).

While flooding is the hazard of greatest concern to the city, wildland-urban interface fires also pose a risk to the city. The High Park Fire in June of 2013 burned in Larimer County northwest of Fort Collins (12). This was the second largest wildfire in Colorado history based on the area burned 353 km^2 (87 284 acres). The High Park Fire destroyed 259 buildings and there was one fatality, although Fort Collins was not directly affected. Wildfire scarring can also exacerbate flood risks since rainfall is not easily absorbed into the soil and quickly flows into streams (13).

Fort Collins can also experience tornadoes, although these are relatively rare along the front range of the Rocky Mountains. Since 1954, seven tornadoes have been recorded in Fort Collins, none more intense than EF 1[2]. A 2008 tornado rated EF 3 struck Windsor, Colorado, just east of Fort Collins causing $ 147 million in damages, one fatality, and 78 injuries. There were 850 homes damaged and approximately 300 either damaged or unable to be occupied along the path of the storm. Given the infrequent nature of the tornado hazard in Fort Collins, the hazard was not considered in detail for this study (14).

Fort Collins is also at risk of technological hazards. Three rail lines run either in downtown or within the city limits. Both BNSF and Union Pacific operate trains on tracks that pass

[2] The Enhanced Fujita Scale is used to rate the intensity of tornadoes. Trained National Weather Service personnel use a series of damage indicators (buildings and other structures) to estimate the intensity of a tornado. The scale is shown in the table below:

EF Rating	3-second Gust km/h (mi/h)
0	105-137 (65-85)
1	138-177 (86-110)
2	179-217 (111-135)
3	219-266 (136-165)
4	267-322 (166-200)
5	over 322 (over 200)

through downtown Fort Collins. OmniTrax Great Western operates 129 km (80 miles) of track along the front range and provides interchange services with the Union Pacific and BNSF railroads. Some of the Great Western track is located within the city limits of Fort Collins. Given the rail traffic through the city, a scenario of a train derailment resulting in the release of a chemical inhalation hazard was considered as a possible hazard. The third hazard scenario considered was a long-term power outage. This was included in the study since long-term power outage and the resulting consequences were a priority for FEMA during the assessment period.

5.1.3. **Current State of Planning in the Community**

The City of Fort Collins has an active planning program. The city maintains a strategic plan (15), which is updated on a two-year cycle. Fort Collins maintains a City Plan (comprehensive plan) (16), which has a 20-year planning horizon. It also has plans for economic development, transportation, and other elements that align with the City Plan (17). The Northern Colorado Regional Hazard Mitigation Plan (18), which covers Fort Collins, Larimer County, City of Loveland, Town of Estes Park, Town of Wellington, and the Town of Berthoud was updated in 2013. Several continuity of operation plans were also reviewed and were important to help the team establish resilience performance goals for the building clusters and infrastructure sectors of interest. These plans included the following:

- The City of Fort Collins Continuity of Operations Plan
- The Larimer County Continuity of Operations Plan
- The Larimer County Sheriff's Office Continuity of Operations Plan

In addition to the city and regional plans, the State of Colorado developed the Colorado Resilience Framework (19). The Colorado Resilience Framework was published in 2015, following the 2013 floods that severely impacted Boulder County. The Framework is intended to look holistically at the shocks and chronic stresses faced by the state, identify problems and set strategies and goals for addressing those problems. It also establishes the role of the state and communities in building resilience.

5.1.4. **Process Description**

The City of Fort Collins was proposed by the DHS Protective Security Advisor for Colorado for the Regional Resilience Assessment Program (RRAP) and the city was selected by the RRAP program for a start in 2016 (20). The DHS RRAP team made the decision to use the Community Resilience Planning Guide at the during the 2016 RRAP kickoff meeting in 2015. Since this was the first application of the Guide to a resilience assessment, there was a learning curve associated with the application of the process in Fort Collins. For example, engagement of stakeholders took longer than expected due to the need to make a compelling case for why resilience planning was important for their operations. Also, considering multiple dependency paths between systems rather than for single infrastructure systems led INL to develop tools to support the analysis. Further, since the project was being conducted as a DHS Regional Resilience Assessment, the Guide process was modified somewhat to

both meet the objectives of the RRAP while at the same time provide recommendations for resilience improvements to the city's infrastructure.

Step 1. The first step in the Guide process is the formation of the Collaborative Planning Team (CPT). The team was led by an Emergency Management Coordinator from Larimer County and supported by the Emergency Management Director from Fort Collins. The CPT was composed of representatives from the following:

- Larimer County Emergency Management
- Fort Collins Emergency Management
- Fort Collins Department of Planning, Development, and Transportation
- Fort Collins Utilities – Water and Power & Light
- Fort Collins Office of Social Sustainability

The CPT held an initial meeting to introduce the Guide process and the plans for the resilience assessment. The CPT leader developed an outreach plan to work with stakeholder groups to foster their support for the effort and to collect data that would be important to Steps 2 and 3 of the Guide process. These stakeholder interactions allowed the CPT to identify additional members who would support the process to completion. (Appendix B provides an example of questions asked of stakeholder groups).

Step 2. Step 2 of the Guide process, Understanding the Situation, is intended to develop an understanding of the local values, goals, and priorities. It also identifies social and economic institutions of the community and their dependence on buildings and infrastructure to perform their intended functions, particularly in times of disruption due to hazards. The CPT identified 27 plans produced by the city that were reviewed to understand the city's long-term goals for development and inform the resilience planning process.[3] The CPT also reviewed continuity of operations plans (listed in Section 2.3) to understand the desired performance for these facilities in an emergency.

Step 2 involves identification of the building stock and the infrastructure systems that support the operation and functionality of buildings. This part of the task was accomplished using open source documentation as well as information gathered from meetings with stakeholder groups. The INL team used this information to map dependencies using an automated tool developed by the Laboratory. The dependency maps developed for the project allowed the team to identify the possible cascading consequences of failures and their impact on resilience of the city and supported recommendations to address gaps that could lead to improved performance. The team used the dependency maps as a basis for follow-up meetings with stakeholders to refine their dependency assessments and verify that the dependency maps accurately reflected conditions.

Step 3. As the assessment entered Step 3 of the Guide process, the collaborative planning team worked with stakeholders in the four functions (government, healthcare, education, and

[3] Adopted Fort Collins plans are available online at: https://www.fcgov.com/planning/documents.php. Note that not all plans developed by the city were reviewed as part of the RRAP. Only those plans that were most relevant for resilience planning were reviewed.

service organizations providing emergency shelter) and with the utility providers to define performance objectives for buildings and infrastructure.

The RRAP team evaluated flooding and wildland-urban interface fire as the primary hazards of concern, based on a review of the Larimer County Hazard Mitigation Plan. The team also considered a train derailment and hazmat release on the BNSF rail line that runs through the city and a long-term power outage. The team developed performance goals tables based on the approach described in the Community Resilience Planning Guide and tailored the performance goal tables to reflect the functional requirements and dependencies for the four community functions of interest. The INL team supported this effort and the analysis to determine anticipated performance by developing detailed dependency maps. These maps allowed the team to evaluate system level response and identify areas where there were gaps that if addressed could lead to improved performance.

Step 4. The Fort Collins assessment ended at Step 4 of the Guide process, in which the identified performance gaps are evaluated, prioritized, and solutions determined that can be part of an implementation strategy. The team provided the city with a set of options to improve resilience. Since Fort Collins is active in planning, these options were presented such that they can be incorporated into other plans for implementation. The RRAP team also provided the city with a dependency mapping tool, implemented in ArcGIS, that will allow the city to consider dependencies when considering future projects. The tool has currently been delivered only to DHS and the City of Fort Collins.

5.1.5. **Assessment**

The Fort Collins use of the Guide process was tailored to address the requirements of the Regional Resilience Assessment Program, focusing on the role of infrastructure and critical buildings in the four social dimensions: governance, education, health and community serving organizations providing sheltering services. The experience in Fort Collins provided useful insights as to how the process works and opportunities to provide additional guidance that would be helpful to future users. The following observations were obtained from working with the collaborative planning team and stakeholders.

Step 1: Form a Collaborative Planning Team

The collaborative planning team should consist of local representatives who understand and accept the value of community resilience planning, are committed to the process, and are able to champion resilience and engage the relevant stakeholders. Resilience planning is inherently a local issue and must reflect local customs, priorities, practices and capabilities. Even though this implementation was initiated under a DHS-led national program, committed local leadership was an essential element of its success.

Resilience planning requires the engagement of the collaborative planning team and a larger group of stakeholders, it is important to socialize the resilience planning concept ahead of time to build support and understanding ahead of initiating the planning effort. Since this effort started before stakeholder buy-in had been received, there was some initial hesitance

by stakeholders to engage in the project. While this hesitance was overcome, it did require additional time early in the project to work with stakeholder groups and ensure their engagement and support of the effort.

Endorsement by elected leadership is essential. Elected leadership is able to communicate the goals and objectives of the resilience planning effort to community members, businesses, and other stakeholders and encourage their support and participation in the planning effort and eventual implementation. Further, elected leadership can act on recommendations or influence actions that lead to greater resilience.

In some cases, external organizations may perform resilience assessments on behalf of the local government. In the case of Fort Collins, the INL team conducted the resilience assessment. Where external organizations are performing analyses and informing the collaborative planning team, it is important for the collaborative planning team to receive periodic updates on the analysis. These updates are important not only for keeping the collaborative planning team and stakeholders informed of progress and findings but also for confirming the analysis organizations' understanding of the buildings and infrastructure dependency relationships. Regular interaction can lead to better analysis outcomes and ultimately a well-informed resilience plan. In Fort Collins, regular meetings between the collaborative planning team and stakeholder groups allowed for dependency models to be refined based on experience and stakeholder understanding of systems.

Step 2: Understand the Situation

As soon as possible after the start of the project, it is important to identify the lifeline service providers and contacts for the region. If there is not an established cooperative arrangement in place, the CPT should work with the service providers to address concerns about information exchange and security. To the extent possible, sensitive infrastructure information should remain with the owner and the information exchange limited to what is needed to establish goals and priorities, determine anticipated performance, and agree on possible solutions to meet resilience goals.

For each of the social functions identified in the Community Resilience Planning Guide, a point of contact should be identified who can assist the CPT with detailed understanding of that function and the associated local attributes and dependencies. The Fort Collins CPT developed a relatively short questionnaire that facilitated information collection about recovery time objectives, dependencies, and existing practices for continuity of service and allowed the CPT to have more focused discussions with stakeholders to better inform the study. The team also found it helpful to develop a simple spreadsheet that included all the functional categories within each social function (e.g., the government function would include emergency services, information technology, emergency communications, public safety, judicial, criminal justice, municipally-owned utilities, transportation services/traffic management, and governance). This helped the stakeholder groups identify buildings and infrastructure that were required for the specific social function to provide services to the community and to identify contacts and plans that would be relevant to the resilience planning process.

Step 3: Determine Goals and Objectives

In a city such as Fort Collins that does short-term, long-term, and strategic planning, there is a wealth of existing data and information that can be used to determine priorities for building and infrastructure performance, based on the culture, history, plans for future development, growth, and adaptation. Plans such as the hazard mitigation plan, master plan, and capital improvement plans are also the logical vehicles for implementation of resilience projects and for alignment of such projects with other community goals. The assessment included a review of 27 separate plans, which helped the team understand the city's priorities, plans for development, and assess preparedness, particularly for critical facilities and infrastructure. However, the review did not include a comparison of policies to identify conflicts or opportunities to integrate planning to include resilience. An opportunity exists to provide additional guidance on a uniform method for review and integration of resilience goals with local and regional plans. For example, the hazard mitigation plan and any hazard or risk assessments are useful for defining the hazards of concern that should be included in the resilience approach.

Local GIS resources can be especially helpful to resilience planning efforts. These resources may include data on the location of buildings (by type or function), location of infrastructure systems and assets, and hazard data. Local GIS personnel can assist the planning team to understand and interpret data. Engaging these resources early in the resilience process facilitates the resilience analysis process by providing detailed information on buildings and infrastructure assets, geographic location (which can affect vulnerability), and dependency relationships.

INL used a dependency mapping tool, called the All-Hazards Knowledge Framework (AHA) to identify the dependencies among buildings, infrastructure, and social systems. *The results of this analysis provided a visual depiction of the dependencies and the consequences of failure that allowed stakeholders to see and understand how these dependencies could affect their ability to deliver services following hazard events.* This experience points to the need for validated tools to evaluate the resilience of a community as a system, assess the impact of failures (or loss of capacity) and identify and evaluate possible solutions. Map-based, visual tools will be especially important to meeting this need.

Step 4: Plan Development

Prioritized actions were proposed such that they can be incorporated into existing city planning processes for implementation. The CPT used the performance goals tables to identify gaps in performance and develop an implementation strategy. The gaps and their potential to disrupt critical community functions were documented along with proposed actions to improve performance and enhance resilience. As noted previously, INL also delivered a dependency analysis tool to Fort Collins and DHS. The tool can be used by the city to consider dependencies when planning infrastructure projects.

5.2. Case Study 2: Howard County, Maryland

5.2.1. Description of the Community

Howard County, Maryland is a large, diverse county located south and west of the city of Baltimore. The eastern part of the county is suburban and heavily developed, while the western part of the county is more rural. The county has a population of 287 085 according to the 2010 census and covers an area of 655 km^2 (253 mi^2). The county seat is Ellicott City, with a population of 65 834 as of the 2010 census and having an area of 77.9 km^2 (30.1 mi^2). The county is governed by a county council, composed of elected representatives from the five districts in the county and an elected county executive (21).

Table 5-3: Population Breakdown of Howard County, Maryland by Race. (Source: U.S. Census Bureau)

White alone, percent	57.3 %
Black or African American alone, percent	19.5 %
American Indian and Alaska Native alone, percent	0.4 %
Asian alone, percent	18.9 %
Native Hawaiian and Other Pacific Islander alone, percent	0.1 %
Two or More Races, percent	3.7 %
Hispanic or Latino, percent	6.8 %
White alone, not Hispanic or Latino, percent	52.1 %

Table 5-4: Income and Poverty Data for Howard County, Maryland. (Source: U.S. Census Bureau)

Median household income (in 2016 dollars) (2012-2016)	$113 800
Per capita income in past 12 months (in 2016 dollars) 2012-2016)	$49 667
Persons in poverty, percent	5.2 %

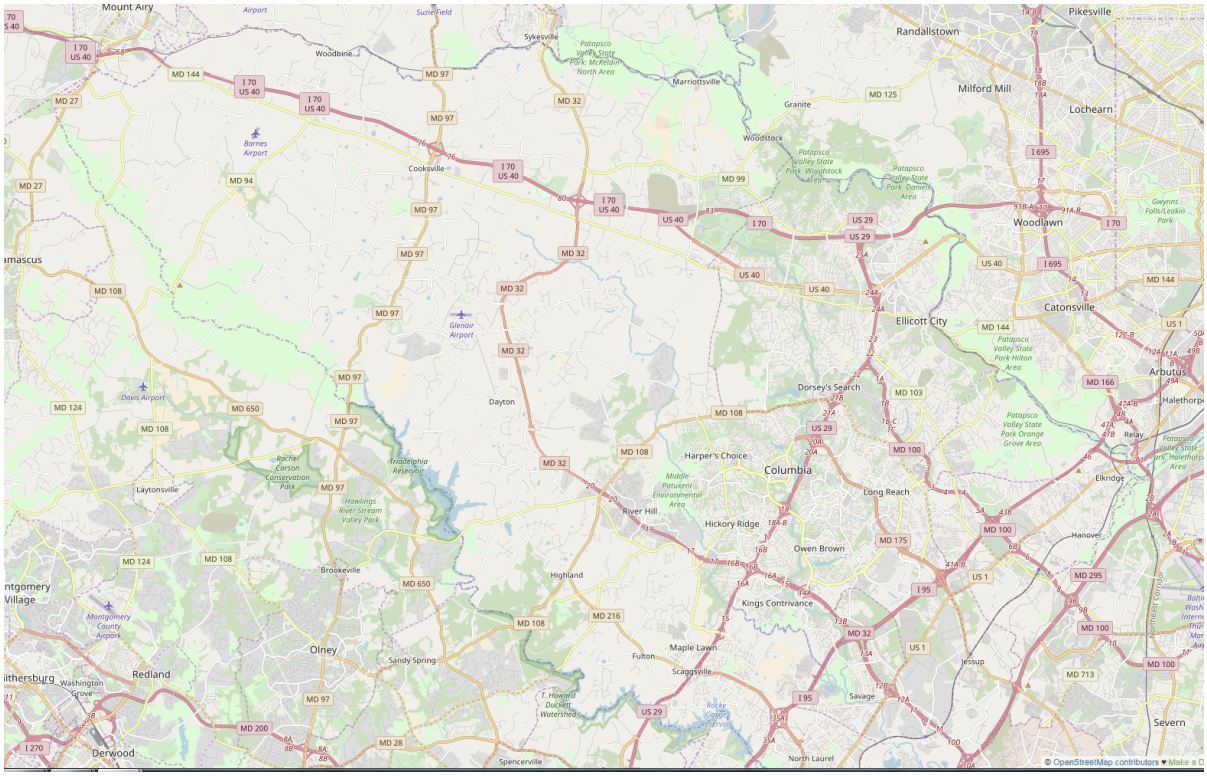

Figure 5-1. Map of Howard County, MD and surrounding areas. (©OpenStreetMaps contributors)

This case study focused on Ellicott City. When the city was founded, it was built along a fall line where water could be used to power mills. The historic district of Ellicott City is susceptible to flooding, either from the Patapsco River that runs along the eastern end of the historic district or from the streams that flow into and through the historic district. In 2016, a thunderstorm that produced 15 cm (6 in.) of rain in approximately 2 hours, caused the streams to overflow their banks, and the resulting flash flood significantly damaged buildings and infrastructure on Main Street. The County's Emergency Management Office was developing a recovery plan at the time of the flood and while the plan had not been completed, the County had the opportunity to test the recovery plan and use the experience to further refine the plan. The Guide was one of several resources the County had used to develop its recovery plan and thus provided an opportunity to derive lessons that could further advance resilience planning.

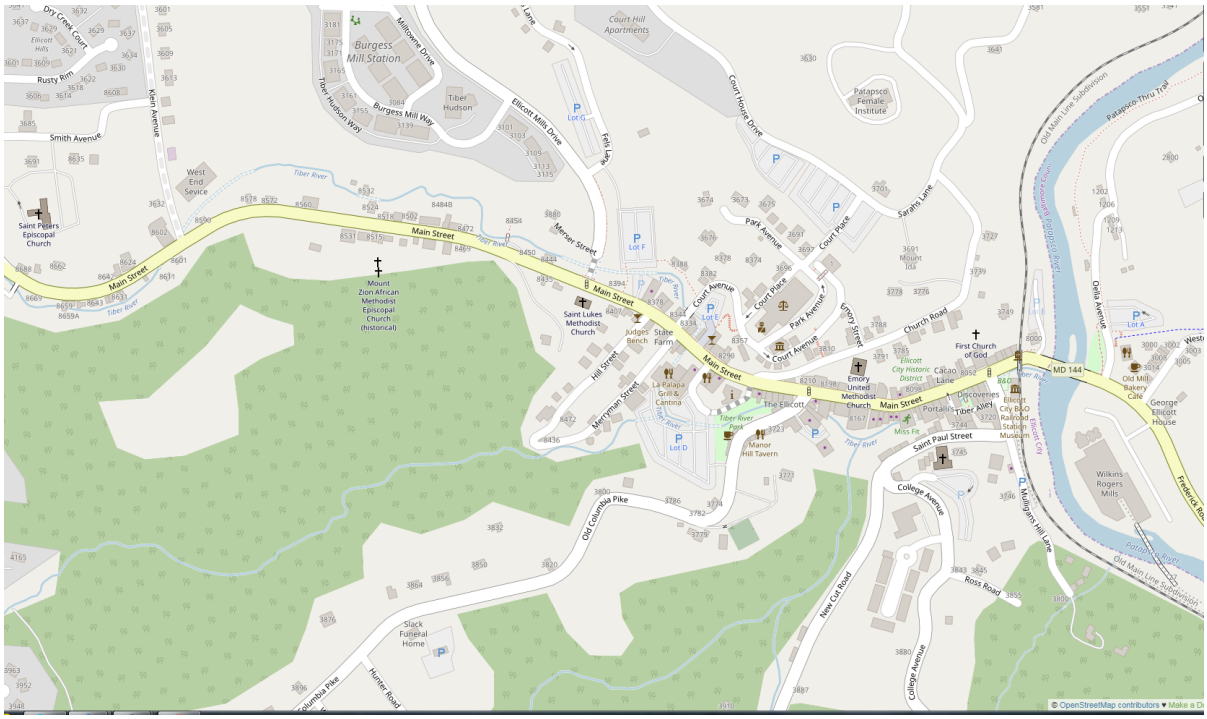

Figure 5-2. Ellicott City, MD Historic District (©OpenStreetMap contributors).

5.2.2. **Hazards for Howard County, Maryland**

Howard County has conducted several hazard assessments and has identified significant hazards, characterized their likelihood and consequence, and communicated this information to the public as a part of preparedness efforts. Given the importance of Ellicott City to Howard County, both as the seat of county government and the significance of the historic downtown area to the county economy, this section focuses on resilience planning by Howard County for Ellicott City.

Given its location, the historic district is prone to flooding, both from the Patapsco River immediately east of the historic district and the Tiber River that flows through the historic district, passing under Main Street and several buildings. The city suffered a significant flash flood event in July 2016, that damaged many buildings and caused damage to streets, sidewalks, and other infrastructure. Two people died during the 2016 flash flood.

5.2.3. **Current State of Planning in Community**

Howard County maintains a proactive planning process. The county released Plan Howard 2030 in July of 2012 and amended the plan in February 2018 (22). In addition, the county maintains up-to-date plans for, emergency management (23), and economic development (24), as well as detailed plans to implement the goals of the master plan (25). The hazard mitigation plan is developed and maintained by the State of Maryland and was updated in 2016 (26). At the time of the 2016 flood, the county was in the process of preparing a recovery plan.

5.2.4. **Process Description**

Howard County was developing a recovery plan at the time the 2016 flood struck Ellicott City. The County used the Guide to inform the development process. The 2016 flood occurred during the recovery plan development and gave the County an opportunity to test the recovery plan and work toward building resilience as a part of the recovery process. While Howard County's approach to recovery did not follow the Guide process step-by-step, it is possible to identify steps the county took that are consistent with the Guide process and to derive lessons that support the Guide process or identify areas where additional guidance would be useful. Unlike the Fort Collins and DelDOT projects, Howard County was recovering from the 2016 flash flood disaster, which provided a different perspective on planning.

Step 1. Howard County did not formally establish a CPT. As the County transitioned from response to recovery, the need for a dedicated recovery manager was recognized and staffed. The recovery manager effectively functioned as the CPT lead. Representatives from the Emergency Operations Department, which was responsible for leading the recovery plan development, the County's Office of Economic Development, Office of Planning and Zoning, and the Deputy City Administrator for Ellicott City participated in planning and implementing actions to help the historic district of Ellicott City recover quickly.

Step 2: Following the flood, Howard County assessed the conditions of buildings and infrastructure within the historic district affected by the flash flood. Maintaining the historic fabric was an overarching consideration of the recovery. Because the historic district was a significant economic contributor in the County, it was important to retain as many businesses as possible and to help them reopen. These considerations were central to the planning and implementation of actions to improve resilience during recovery.

Step 3: Howard County undertook their own process for developing a recovery plan and the Guide served as a useful reference. During the recovery, the County identified some priorities, such as improving underground utilities and moving some electric distribution lines underground to improve resilience to future hazards.

5.2.5. **Assessment**

Howard County was developing its recovery plan before the 2016 flood in Ellicott City. The flash flood presented an opportunity to implement the plan and to learn from the experience. The response and recovery to the flood have identified several points that are relevant not only for post-disaster recovery, but also for planning to reduce risk in future events. The following points made by Howard County Emergency Management and County Government staff are organized by the steps in the Guide.

Step 1: Form a Collaborative Planning Team

An integrated planning approach for recovery was important. Even before the 2016 flood, Howard County recognized the importance of bringing together stakeholders within the

county government and from outside to inform their planning. In addition to the Emergency Operations Department, which was responsible for leading the recovery plan development, the team included participation from the County's Office of Economic Development, Office of Planning and Zoning, and the Deputy City Administrator for Ellicott City.

A dedicated recovery manager needs to be identified, whose sole responsibility was to work with all the necessary organizations to ensure that recovery proceeded. In Howard County, recovery manager coordinated all the stakeholders working to help the city recover from the floods and worked with the Office of Emergency Management and other county officials to ensure that all efforts were aligned to make the recovery as efficient as possible. The recovery manager operated as a CPT lead working with all of the stakeholders and balancing interests during recovery.

Step 2: Understand the Situation

Historic communities value maintaining the historic character of the built environment, while working to improve resilience. The 2016 flood affected a relatively small part of the city; however, this affected area is the historic heart of Ellicott City and a significant economic engine for the County (27). So, there was a desire to restore the historic district as much as possible to its pre-flood condition as well as to assist residents and business owners with their recovery. As the historic district began its recovery, the County, businesses and homeowners, utilities and other stakeholders worked to maintain the historic fabric of the area while incorporating changes that would improve resilience to future floods.

Resilience planning requires coordination of all planning documents. The county noted that their plans (i.e., Master Plan, Hazard Mitigation Plan, Economic Development Plan, etc.) have historically been isolated from each other. One change that has resulted from the 2016 flood is that county has now integrated their planning processes so that everything flows into the county master plan. The master plan contains priority projects that meet county objectives and include measures to enhance resilience to future hazard events. As part of the effort to harmonize planning processes, the county has also seen the value of linking planning and zoning to ensure that land use and development plans are consistent with the hazards present.

Step 3: Determine Goals and Objectives

The County identified gaps and planned actions that were consistent with the historic fabric of the affected area while improving resilience to future hazards. Howard County developed a recovery plan using the Guide as a reference (28). The County was able to implement many of the concepts contained in the Guide. Exercising the recovery plan following the 2016 Ellicott City Flood either confirmed or identified practices that enabled the County to recover rapidly and to incorporate measures that improve resilience. The result was that two years after that flood, most of the businesses in the historic district had reopened. Further, the County had taken concrete steps to integrate resilience into the County's master plan, which provides an implementation vehicle and time-phased means to build resilience over time.

5.3. Case Study 3: Delaware Department of Transportation

5.3.1. Description of the Community

The Delaware Department of Transportation (DelDOT) had a highway corridor assessment planned as a part of their normal operations and used the Guide to support their resilience studies. DelDOT evaluated the impact of road closures due increased frequency of flooding and to assist in identifying projects where nature-based solutions could reduce coastal flooding impacts. The highway corridor considered was State Route 1 from Dewey Beach to Fenwick. DelDOT also used the Guide as a reference for the development of their Strategic Implementation Plan for Climate Change, Sustainability, and Resilience for Transportation (29).

The SR 1 corridor is the main route along the coast from Fenwick Island, Delaware to Dewey Beach, Delaware and includes the towns of Bethany and South Bethany. The year-round populations in the towns are relatively small, but the summertime populations are significantly greater with tourists and seasonal residents going to the beaches. The four communities along the corridor are a significant contributor to Delaware's tourism industry. SR 1 is owned, operated, and maintained by the state, while surface streets in the towns are municipally maintained. The four cities are spread out along the corridor, with a state park separating Dewey Beach and Bethany and another state park separating South Bethany and Fenwick Island. Year-round (permanent) populations range from about 350 residents to 1000 whereas the summertime (tourist) population along the corridor can exceed 20 000.

Table 5-5: Population Breakdown of Sussex County*, Delaware by Race. (Source: U.S. Census Bureau)

White alone, percent	82.7 %
Black or African American alone, percent	12.5 %
American Indian and Alaska Native alone, percent	1.1 %
Asian alone, percent	1.3 %
Native Hawaiian and Other Pacific Islander alone, percent	0.1 %
Two or More Races, percent	2.1 %
Hispanic or Latino, percent	9.4 %
White alone, not Hispanic or Latino, percent	75.0 %

Table 5-6: Income and Poverty Data for Sussex County*, Delaware. (Source: U.S. Census Bureau)

Median household income (in 2016 dollars) (2012-2016)	$54 218
Per capita income in past 12 months (in 2016 dollars) 2012-2016)	$29 630
Persons in poverty, percent	11.6 %

* Note that data shown is for Sussex County, since the four cities along the SR 1 corridor have year-round populations of less than 5 000 residents. Census data is only available for cities and towns with populations greater than 5 000.

Delaware SR 1 is a coastal highway between Fenwick Island in the south and Dewey Beach to the north. There are only three east-west routes that intersect with SR 1: US 9 in the north, SR 26 at Bethany Beach and SR 54 at the southern end of the SR 1 corridor, making the corridor a critical transportation asset for the cities along the corridor. Much of the corridor crosses narrow strips of land with the Atlantic Ocean to the east and inland bays to the west. Due to the soil conditions, elevating the roadway is not possible in all locations, so SR1 is subject to flooding, usually from the bay side during nor'easters, tropical storms, and hurricanes when the winds tend to cause storm surge from the west. On the east, the highway is protected by dunes over much of its length, reducing the risk of flooding from the ocean side.

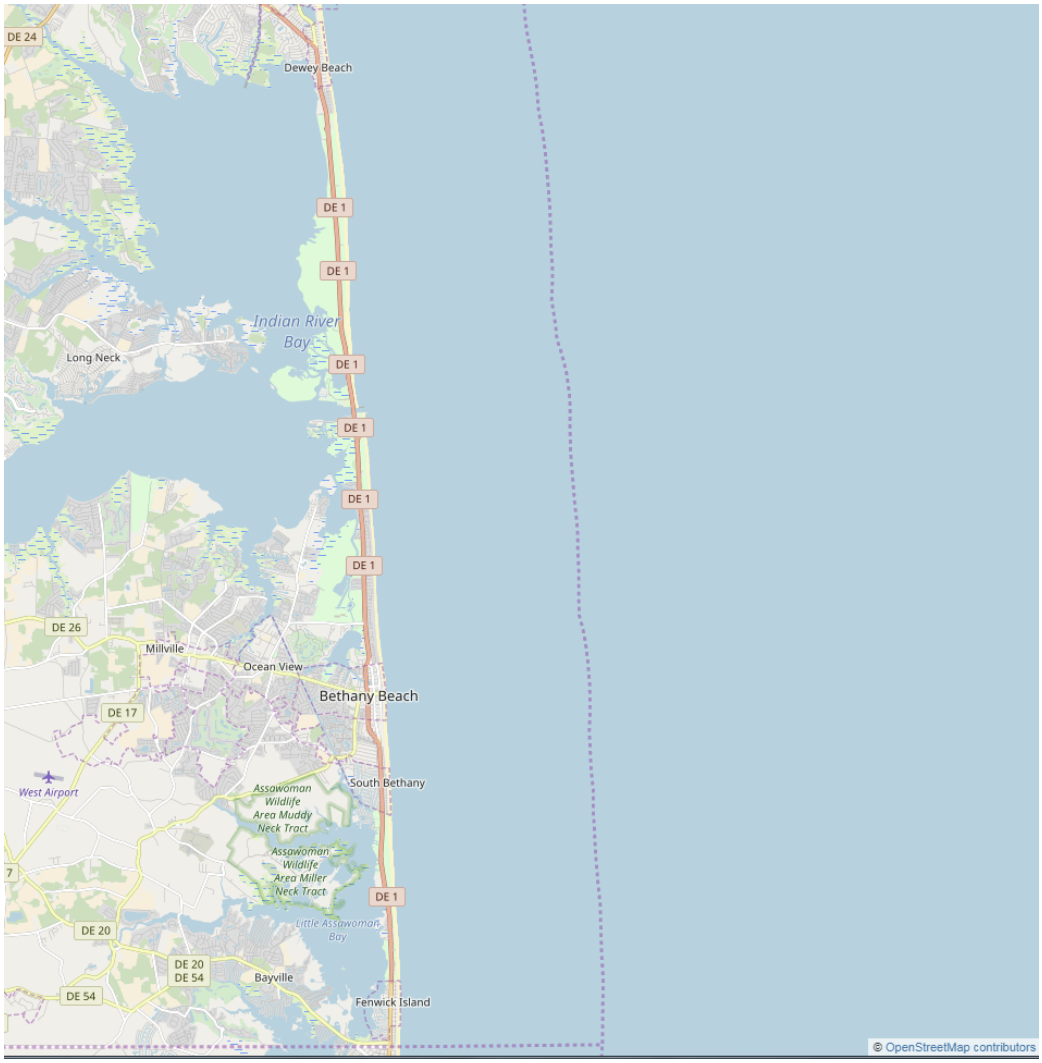

Figure 5-3. Delaware State Route 1 Corridor. (©OpenStreetMaps contributors).

5.3.2. **Current State of Planning in Community**

All the communities maintain and update master plans (30, 31, 32, 33). Sussex County maintains an up-to-date hazard mitigation plan (34) that includes the cities along the SR 1 corridor. DelDOT prepared a Strategic Implementation Plan for Climate Change, Sustainability, and Resilience for Transportation for all the state's transportation systems, including highway infrastructure. DelDOT conducts assessments of highway corridors to evaluate conditions, usage, and threats such as changes to environmental conditions that affect the corridor's availability. Since Delaware is a coastal state and there are projected changes in sea level rise and other climate factors that could impact the state's transportation, DelDOT addresses future conditions in its long-term planning.

5.3.3. **Process Description**

The SR 1 corridor assessment was selected by DelDOT to address frequent flooding of the roadway in multiple locations. It was initially thought that sediment was impeding water drainage from the roadway. However, it was determined that sea level rise was the cause for more frequent flooding. The SR 1 study sought to develop an understanding of the problem and to identify solutions to reduce the frequency and severity of flooding, improving the resilience of the communities along the corridor.

Step 1: The CPT was led by a DelDOT engineer, supported by other DelDOT technical staff, The Delaware Center for the Inland Bays, and a contractor. The CPT engaged elected officials and staff in the four communities along the corridor to collect information on their priorities, dependencies on the corridor, and relevant plans.

Step 2: NIST met with the DelDOT team at their headquarters to review the two corridor assessments and the goals that DelDOT had for each assessment, the approach that would be taken to implement the Guide, and to discuss plans for a stakeholder meeting with the towns along the SR1 corridor.

The stakeholder meeting was an opportunity to introduce the Guide to officials in three of the four cities along the SR 1 corridor. Since DelDOT had worked with the cities previously, there was an existing relationship that allowed for the meeting to elicit information about the importance of the corridor. This discussion was facilitated by NIST and centered on Step 2 of the Guide, specifically characterizing the social and economic dimensions along the corridor and their dependencies on each other and the built environment. The discussion also touched briefly on Step 3 of the Guide by probing the types of hazards that the towns are most concerned about and the observed disruptions that result from those hazards. The five questions that were used for this discussion are the following:

- What are major social and economic functions (e.g., business, housing, etc.) along the Route 1 Corridor? How are these functions dependent on each other?
- How are these major social and economic functions dependent on buildings and infrastructure systems (e.g., power, water/wastewater, communications,

transportation)? What infrastructure is most important in the community in the return of social and economic functions to 'normal'?

- How are the other infrastructure systems dependent on the Route 1 Corridor?
- When disruptions occur to the built infrastructure what is the extent of economic consequences? How are the social and economic consequences of interruptions linked to the recovery time?
- Are there other stakeholders who should be involved?

Each of the four cities have active planning efforts and all had up-to-date master plans or were in the process of updating their master plan. Further, Sussex County maintains an up-to-date hazard mitigation plan that includes the four shore communities.

Step 3: The facilitated meeting also provided information that assisted in understanding the community impacts that result when portions of the highway are inundated. The participants in the meeting described the role of the highway corridor in the region and the significant connection to the economic viability of the towns along the corridor. There was discussion of limitations on solutions that DelDOT faces given the location, soil conditions, and other factors.

The Guide provided the DelDOT team and local stakeholders a useful process for approaching the highway corridor assessment in terms of its role connecting the beach communities and as a right-of-way along which other infrastructure is located, and its importance to the local economy. The Guide supported a broader assessment of the consequences of flooding along the SR1 corridor. DelDOT and the cities along the SR 1 corridor did not complete the performance goals tables for Step 3 in the Guide process. However, the work that was performed using the Guide has led to the formation of a Resilience Council involving the cities and the county. The council is working to identify and address resilience issues that are common to the coastal cities. The Center for the Inland Bays continues to work on bioretention projects along the corridor to relieve flooding impacts due to coastal storms. DelDOT has identified specific projects including elevation of a section of the highway to further alleviate flood impacts. One of the issues that was brought up during the meeting with the cities was reliability of broadband service, which affected their ability to attract new businesses and could impact the ability to communicate with residents during an emergency. The collaboration of the cities enabled them to begin conversations with the broadband provider to improve the reliability of service to the cities.

Work on solutions to reduce the impact of flooding along the corridor is continuing. DelDOT plans to elevate a section of SR1. DelDOT is also working with the town of Dewey Beach to reduce flooding impacts. The Center for the Inland Bays had worked with the towns on storm water management and is now working on bioretention along the corridor to reduce the severity of floods.

5.3.4. **Assessment**

The SR 1 study used the Guide process to direct the corridor assessment, considering the dependencies of social and physical systems on the highway corridor. The Guide supported the formation of a collaboration of the four communities to more broadly work together to consider and address resilience concerns, including initiating discussions with the broadband service provider regarding reliability.

Step 1: Form a Collaborative Planning Team

A collaborative planning team supported by engagement of key stakeholders (officials from the four communities) supported the resilience assessment effort. A DelDOT team of engineers supports the corridor assessments and updates to the transportation strategic plan. For the SR 1 corridor, DelDOT worked with the Center for the Inland Bays and the local elected leadership and key senior permanent staff from three of the four towns along the corridor. An initial meeting was held with this group to facilitate a start to their planning process. While the Guide provided a useful framing for this and subsequent meetings between DelDOT, the four communities, and the Center for the Inland Bays.

Step 2: Understand the Situation

Resilience planning helped the participants to think more comprehensively about the importance of the highway corridor and dependencies on the highway and other infrastructure along the corridor. It also helped them to make connections between economic development or other objectives and the reliability of infrastructure during normal operation and during storm events. For example, the discussion with the cities, which focused on the transportation corridor, led to a broader discussion about infrastructure constraints to economic development (e.g., reliable broadband internet access).

Step 3: Determine Goals and Objectives

The DelDOT application of the Guide for a highway corridor assessment was a useful test of the Guide's flexibility. While the process was useful to elicit information from the affected communities that informed the highway corridor assessment, the time and budget constraints of such a study proved a challenge to fully implement a resilience plan for the corridor, gradually building resilience as capital projects are undertaken. However, the resilience council that did result from the engagement of the four cities may lead to further resilience building efforts in the future.

There has been an effort by the four communities to engage with the broadband provider to reduce the frequency of outages due to storms. More reliable broadband internet service was noted by the local government representatives as important to attracting businesses to the region.

Greater participation in the initial meeting with the towns would have been desirable. This might have led to greater engagement and closer adherence to the Guide process.

5.4. Case Study 4: Nashua, New Hampshire

5.4.1. Description of the Community

Nashua, New Hampshire is a city of 86 494 people (2010 Census) located just north of the Massachusetts/New Hampshire border. The city is bounded to the east by the Merrimack River and the Nashua River flows through the downtown to its confluence with the Merrimack River. The city's economy was originally built around the mills that are located along the riverfronts. Today the economy is diversified and includes defense, technology, financial, healthcare firms as major employers. Nashua is the location for the Federal Aviation Administration Boston Air Route Traffic Control Center. Nashua also has a large retail sector and attracts shoppers from across the region since there is no sales tax in New Hampshire. Nashua is governed by a mayor and a board of fifteen alderman. There are six at-large aldermen, elected three at a time to four-year terms during each municipal election. There are also 9 ward aldermen who are elected to two-year terms during municipal elections. The mayor serves four-year terms.

Table 5-7: Population Breakdown of Nashua, New Hampshire by Race (Source: U.S. Census Bureau)

White alone, percent	84.6 %
Black or African American alone, percent	3.1 %
American Indian and Alaska Native alone, percent	0.1 %
Asian alone, percent	7.3 %
Native Hawaiian and Other Pacific Islander alone, percent	0.0 %
Two or More Races, percent	3.4 %
Hispanic or Latino, percent	12.3 %
White alone, not Hispanic or Latino, percent	75.2 %

Table 5-8: Income and Poverty Data for Nashua, New Hampshire. (Source: U.S. Census Bureau).

Median household income (in 2016 dollars) (2012-2016)	$68 844
Per capita income in past 12 months (in 2016 dollars) 2012-2016)	$33 896
Persons in poverty, percent	11.0 %

5.4.2. Major Hazards for Nashua, Hampshire

Nashua's major hazard concerns include flooding, hurricane, and winter storms. In 1936, a combination of a severe winter that kept snowpack water equivalents significantly higher than average, combined with heavy rainfall associated with two storms that affected the region within a few days of each other caused significant melting of snow and ice jams on rivers. The result was significant flooding throughout New England and significant swaths of downtown Nashua inundated. A third storm also struck the area but prolonged the inundation

rather than appreciably adding to it. This flood event continues to be the flood of record for the city of Nashua.

In 1938, an unnamed hurricane made landfall on Long Island. The storm traversed across Connecticut, Massachusetts, and Vermont before dissipating in Canada. The storm did significant damage throughout New England resulting in 564 deaths and over 1 700 injuries across the affected region. Buildings and infrastructure in Nashua were damaged due to both wind and flooding, even though the city was well east of the storm track.

Of lesser concern in Nashua is risk of earthquake. In 1638, an earthquake with an estimated magnitude of 6.5 occurred. This is the largest known earthquake to have been centered in New Hampshire. Since then, 320 earthquakes strong enough to be felt have occurred in New Hampshire. Two earthquakes in 1940, both with an estimated magnitude of 5.6, are the strongest to have occurred in the state since the 1638 earthquake. Only minor damage, such as fractures in walls and pipes and fallen or damaged chimneys was reported.

Nashua is subject to frequent winter storms sometimes accompanied by heavy snowfall. Winter storms can cause isolated damage to structures and disrupt transportation, power, and communications. The city has well-established plans for responding to winter storms. City residents also have plans for temporary relocation should extended power outages require then to move to the houses of family or friends in the event that they cannot remain in their home due to a loss of heat during a winter storm.

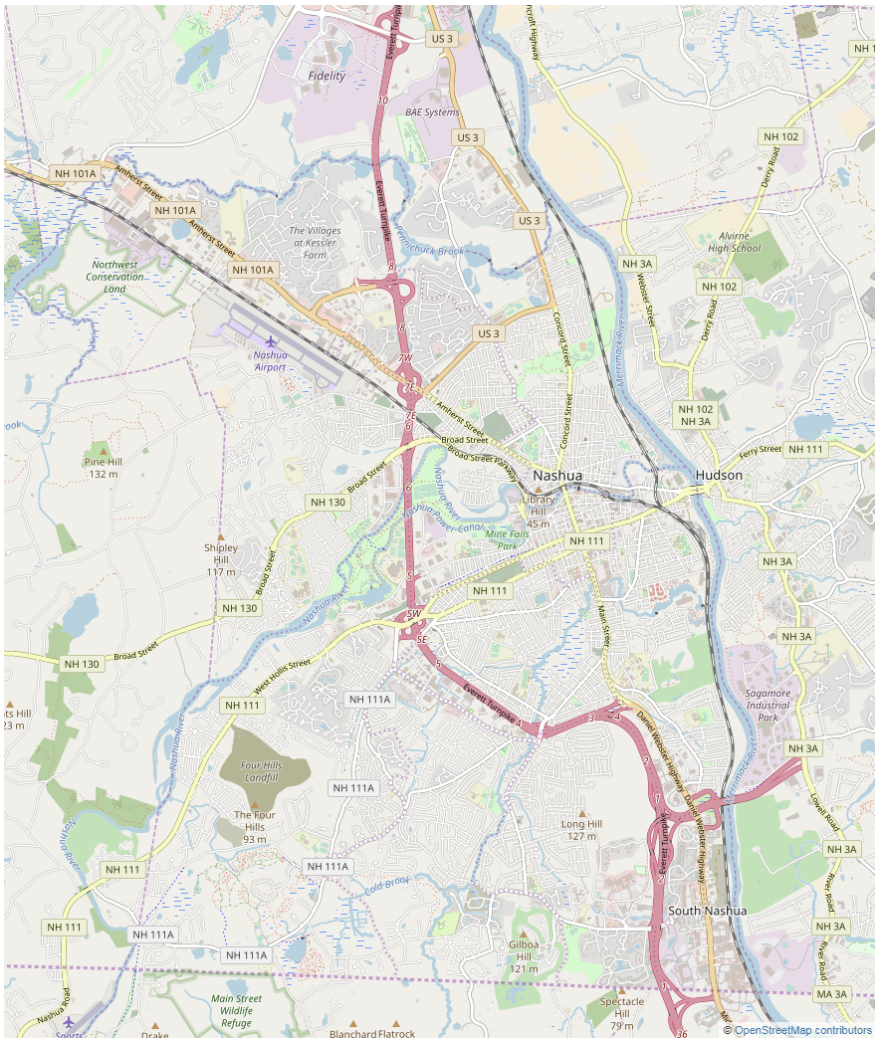

Figure 5-4. City of Nashua, New Hampshire and surrounding areas. (©OpenStreetMaps contributors)

5.4.3. **Current State of Planning in Community**

The City of Nashua has an integrated planning program, that includes a Master Plan (35), and several connected plans, including:

- Riverfront Master Plan
- Downtown Master Plan
- The Nashua Urban Trails Network and The Nashua Trails Plan
- East Hollis Street Plan
- Nashua River Trail
- Nashua Riverwalk Plan

- Nashua Shoreland Urban Exemption
- Tree Streets Neighborhood Analysis and Overview 2012
- Water Supply Protection Map

The Nashua Hazard Mitigation Plan was last updated in 2013 (36) and is due for an update in 2018. The Hazard Mitigation Plan update will be informed by the resilience planning and assessment. The city is also expecting to update the Master Plan in the next year and the resilience plan will also inform updates to the Master Plan.

5.4.4. **Process Description**

The Nashua project was the first where NIST provided limited technical support through an MOU as the city implemented the Guide. As noted in Section 2, this project followed a specific pattern of engagement to help the city with their implementation of the Guide. This implementation served as a good example for how the process can be structured, using data from other sources to inform the resilience planning process. Since the Nashua project is ongoing, their Guide use will be documented up through the middle of Step 3.

Step 1: Form a Collaborative Planning Team

Nashua's collaborative planning team was led by the Director of Emergency Management for the city. He assembled a large stakeholder group that included representatives from city departments and programs, including:

- Mayor's Office
- Board of Aldermen
- Community Development
- Economic Development
- Urban Programs
- Waterways Program
- Building Safety
- Public Health and Emergency Management
- Public Schools
- Housing Authority
- Utilities
- Public Works

The stakeholder group also included representatives from social services and religious organizations operating in the city, regional and state representatives, and federal agency

representatives from the U.S. Army Corps of Engineers, DHS, and EPA (EPA Healthy Cities Initiative funding supported the planning effort).

Step 2: Understand the Situation

During a one-day workshop for the stakeholder group, the city's plans for economic development, riverfront development, master plan update, and hazard mitigation plan update were all reviewed. This gave all participants an understanding of the long-term goals for the city.

Prior to the meeting, the CPT lead developed a spreadsheet with the city's buildings associated with the relevant building cluster from the resilient performance goals tables template provided by NIST (See Appendix C). The spreadsheet allowed the stakeholders to identify specific buildings that contributed to the delivery of a specific service or function delivered by a building cluster.

Step 3: Determine Goals and Objectives

At the first stakeholder meeting, NIST facilitated a working session during which the participants self-selected for breakout groups to set resilient performance goals for the building clusters. The breakout groups were organized by the four building cluster categories: (1) critical facilities, (2) emergency housing, (3) housing/neighborhoods/businesses, and (4) community recovery.

The breakout groups identified some facilities that did not fit neatly into building clusters in the template, so in two cases, new clusters were created to capture these facilities. Also, since the city has frequent winter storms that are often accompanied by power outages, a cluster for self-help housing was created to reflect that residents will often relocate for short periods of time until power is restored and they are able to return to their primary residence. The groups also redefined some clusters, separating out functions that they deemed to be critical following a disruptive event. Following the work of the stakeholder group to establish the performance goals for the building clusters, the CPT worked with the infrastructure service providers to complete the tables for those sectors.

The city received funding through a National League of Cities (NLC) grant to implement the Plan Integration for Resilience Scorecard (PIRS) (37, 38), which allows the user to spatially evaluate community plans, identify where there are conflicts between plans that can increase vulnerability to hazards, based both on current conditions and expected future conditions. PIRS allows the user to assess physical and social vulnerability based on the spatial analysis of the plans and identify where plan integration and alignment of policies can reduce vulnerability. The plan analysis will inform the updates to the Master Plan, Hazard Mitigation Plan, and other city plans and complement the broader resilience assessment.

Nashua worked with the Northeast States Emergency Consortium (NESEC) to provide the hazard analysis needed to support the determination of anticipated performance for buildings and infrastructure. NESEC used Hazus-MH, developed by FEMA, to analyze the impact of earthquake, flood, and hurricane, on buildings and infrastructure given the following return intervals and scenarios:

- Earthquake: Central New Hampshire 6.5 (scenario) and 500, 1000, and 2500-year probabilistic events.

- Hurricane: 1938 Hurricane (scenario) and 10, 20, 50, 100, 200, 500, and 1000-year probabilistic events.

- Flood: 10, 25, 50, 100, and 500-year probabilistic events. (The 1936 flood corresponds to a 500-year flood event.

Nashua is currently reviewing the data from the Hazus-MH. These data will provide the basis for determining anticipated performance of buildings and infrastructure. In addition to determining performance gaps for buildings and infrastructure based on the Guide process, the data from the Hazus-MH runs will identify where buildings are impacted, allowing the city to develop tailored plans to address priority gaps to increase resilience.

5.4.5. **Assessment**

Step 1: Form a Collaborative Planning Team

The CPT should engage with stakeholders representing social dimensions and infrastructure owners to inform the resilience planning process. As noted in the previous section, Nashua engaged a large network of stakeholders in their planning process. An initial meeting with this group was held in February 2018 to begin the planning process. To limit the time commitment for the broader group of stakeholders, a facilitated meeting format with a working session to establish performance goals for building clusters worked well and almost all participants remained engaged for the duration of the two meetings held with the larger group. The second meeting, held in June 2018, was an opportunity to review progress with the stakeholders, describe the plan review using PIRS, and describe how the CPT would complete the analysis and assemble a prioritized list of possible actions to improve resilience. Between meetings, the collaborative planning team was able to work directly with infrastructure owners/operators to complete the performance goal tables.

Engagement of residents to inform them of the planning process and goals and to gather input to inform the resilience planning process is valuable. The CPT held meetings with city residents to socialize the resilience planning process and to collect input that could be used to support the planning process. The city held two such meetings following the first meeting of the stakeholder group.

Support of the elected leadership is important to bring credibility to the planning process and encourage participation by stakeholders. The CPT had the support of the Mayor's Office and the Board of Alderman to undertake the resilience planning process and representatives from the Mayor's Office and the Board of Alderman were part of the larger stakeholder group. Support for the process by elected leadership also helped encourage the participation of a large group of public and private sector stakeholders.

Step 2: Understand the Situation

Developing a spreadsheet to organize the building inventory by building cluster helped the stakeholder group establish performance goals. Before the first meeting of the CPT and broader stakeholder group, the CPT assembled a spreadsheet that mapped the building inventory for the city within the appropriate building clusters, using the performance goals tables template provided by NIST. This simplified the definition of performance goals since the stakeholders could quickly reference the buildings that made up each cluster. It also supported decisions by the CPT to define new clusters or move clusters from one functional category to another based on their importance to the city, to develop a performance goals table that reflected the building stock and the priorities of the city. Once the performance goals were established, it was possible for the CPT to work with the infrastructure owners/operators to define performance goals for those systems and to review and compare priorities and identify possible gaps.

Step 3: Determine Goals and Objectives

The creation of a spreadsheet linking buildings to clusters and the facilitated working session to established resilience performance goals for building clusters are practices that should be repeated in future implementations. The facilitated working session at the first meeting was an efficient way to establish the building clusters and resilience performance goals. Having a spreadsheet with the building inventory grouped by the appropriate building cluster simplified this working session.

The Plan Integration for Resilience Scorecard (PIRS) fills a gap in the Guide process by evaluating and scoring relevant community plans, identifying where the policies contained in those plans conflict to create vulnerabilities, and bringing those plans into alignment. The use of the PIRS adds an important component to resilience planning, particularly the integration of resilience into community plans.

The use of a tool such as Hazus-MH informs the completion of the resilience performance goals tables, which determines where gaps in the ability to deliver a service occur and helps the community prioritize those gaps. The Nashua implementation is also demonstrating the use of Hazus-MH to analyze the impact of earthquake, hurricane, and flood on the built environment to determine the anticipated performance of buildings clusters and infrastructure systems. It also provides details as to which buildings or infrastructure assets are likely to be affected by a hazard and the extent of the loss of function, which helps the community decide where actions are needed and the type of actions that are available to build resilience.

5.5. Case Study 5: Bozeman, MT

5.5.1. Description of the Community

Bozeman, Montana is a city of 37 280 (2010 Census) located in south-central part of the state. The City is the county seat of Gallatin County. The city occupies 49.60 km^2 (19.15 mi^2). Major employers include Montana State University, the state's land-grant university,

high-tech companies researching or producing lasers and optics, software companies, and bio-technology companies. Tourism is also important to Bozeman given its relative proximity to Yellowstone National Park and other outdoor recreation areas.

Table 5-9: Population Breakdown of Bozeman, Montana by Race. (Source: U.S. Census Bureau)

White alone, percent	92.6 %
Black or African American alone, percent	0.6 %
American Indian and Alaska Native alone, percent	1.5 %
Asian alone, percent	2.5 %
Native Hawaiian and Other Pacific Islander alone, percent	0.0 %
Two or More Races, percent	2.2 %
Hispanic or Latino, percent	3.0 %
White alone, not Hispanic or Latino, percent	90.5 %

Table 5-10: Income and Poverty Data for Bozeman, Montana. (Source: U.S. Census Bureau)

Median household income (in 2016 dollars) (2012-2016)	$48,612
Per capita income in past 12 months (in 2016 dollars) 2012-2016)	$28,748
Persons in poverty, percent	20.7 %

5.5.2. **Major Hazards for Bozeman, Montana**

The major concern for Bozeman and the driver for the resilience assessment is adaptation to changing climate conditions. Expected increases in average annual temperatures will create strains since many buildings are not air-conditioned. The city relies on snowpack for much of its water supply and the increase in average annual temperatures and changes in precipitation patterns are reducing the extent of snowpack, which limits water supply, especially during the dry summer months. As Bozeman grows, the changes in the water supply could constrain the ability of the city to expand to meet the demand for additional housing and businesses. From a hazard perspective, Bozeman is at some risk for flooding and although the risk is limited, flood is included in the study. Bozeman also experiences some seismic activity and is near the Yellowstone Caldera, but seismic risk is not a focus of this planning effort.

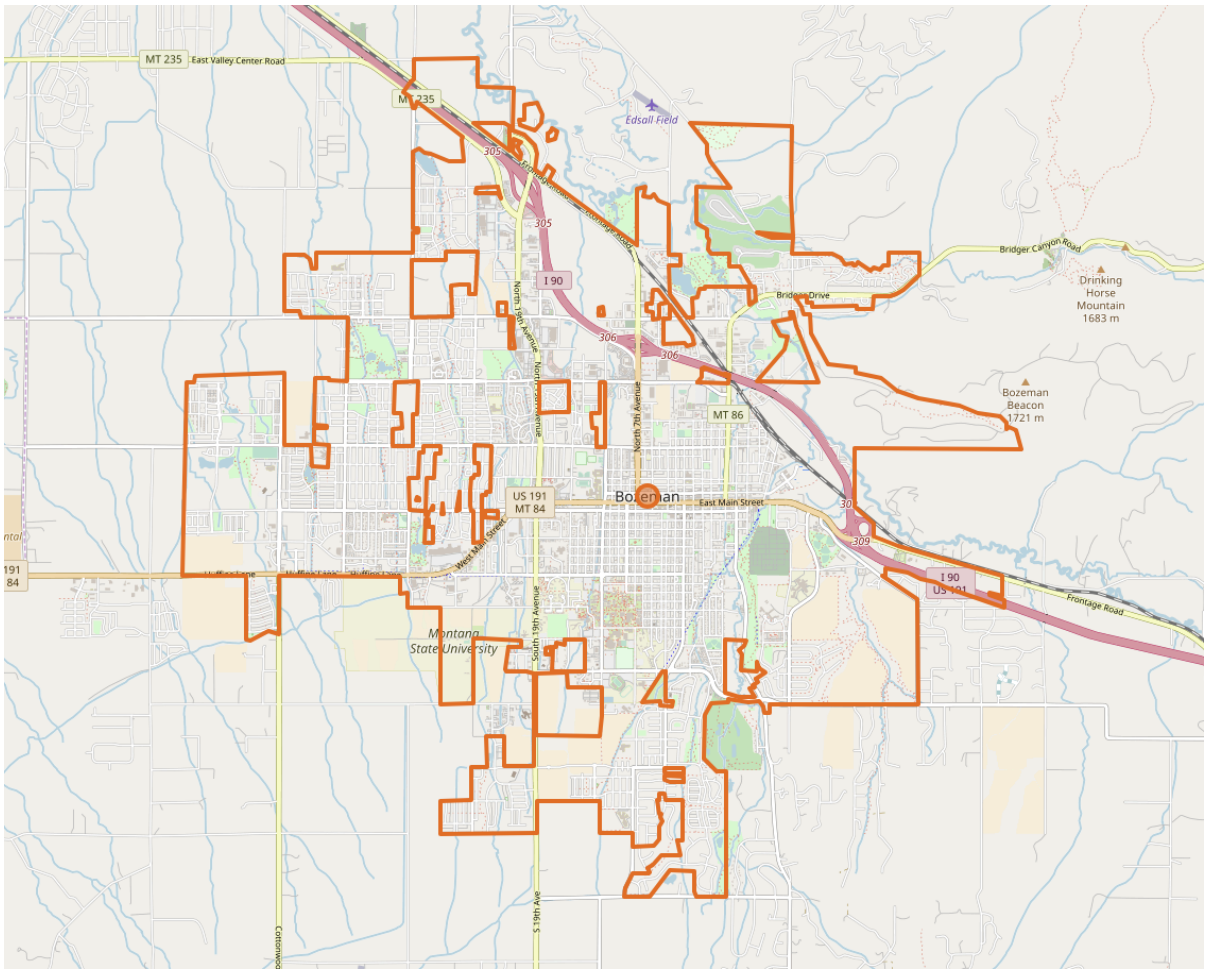

Figure 5-5. City of Bozeman, Montana and surrounding areas. (©OpenStreetMaps contributors)

5.5.3. **Current State of Planning in Community**

The City of Bozeman has an active planning program. The city's community plan (comprehensive plan) (39) and economic development (40) were both prepared in 2009. It is currently being updated and the new community plan is scheduled to be released in 2019. The city maintains a current inventory of buildings and land use and has in-house GIS capability.

The Gallatin County Hazard Mitigation Plan (41), which covers Bozeman, was updated in 2012. It is currently in the update cycle. The resilience planning process will provide input to the updates of the community and hazard mitigation plans.

5.5.4. **Process Description**

The Bozeman project is following a similar process as the project in Nashua, with some important differences. First, the primary impetus for Bozeman's resilience assessment is adaptation to changing climate conditions, which includes changes in average annual

temperature and changes in extremes, changes in precipitation patterns, changes in snowpack and melting, and drought. Climate changes and population growth are expected to place increasing stress on buildings and infrastructure that were not originally designed for forecast conditions. Flood is a concern and was included as a hazard. Given the emphasis on adaptation, seismic hazards were not a priority.

A second difference was that the city hired an engineering consulting firm to assist in the development of the climate action plan. In planning for the work with the city, NIST and the contractor have worked together with city staff to develop a process that utilizes the strengths of the contractor and NIST to meet the city's needs.

The Bozeman study was limited to an assessment of city-owned buildings. The objective was to conduct a resilience assessment and develop a set of recommendations to address performance gaps for city-owned facilities and the infrastructure on which they depend for operation first, then expand the process to address all buildings and infrastructure. This approach was generally followed, although the performance goals tables included building clusters that are not city-owned and operated.

Step 1: Form a Collaborative Planning Team

Bozeman's CPT is led by the Sustainability Director for the city. It includes other city staff and is supported by the Brendle Group (consultant). The Sustainability Director assembled a large stakeholder group that included representatives from a number of city and county departments and programs, including:

- City Commission
- City Manager
- Gallatin County Commission
- Community Development
- Economic Development
- Building Division
- City Police
- City Fire Department
- Parks and Recreation
- Human Resources
- Public Health
- County Emergency Management
- Utilities

- Public Works

The stakeholder group also includes a representative from Northwest Energy (electric power). The National League of Cities is providing funding to support the resilience planning effort through Leadership in Resilience Program and is also involved in the planning effort.

Step 2: Understand the Situation

A one-day workshop was held with the broad stakeholder group. Similar to the process followed in Nashua, a spreadsheet was developed that grouped individual buildings within the appropriate building cluster to provide background to the stakeholder group.

Several plans and documents were reviewed prior to the workshop. In addition to the Community Plan and Hazard Mitigation Plan, the Montana Climate Adaptation Plan and local climate assessment were also reviewed.

Step 3: Determine Goals and Objectives

At the first stakeholder meeting, NIST and the Brendle Group facilitated a workshop. Following the approach used in Nashua, NIST facilitated a session during which the participants worked in breakout groups to set resilient performance goals for the building clusters. The breakout groups were organized by the four building cluster categories: (1) critical facilities, (2) emergency housing, (3) housing/neighborhoods/businesses, and (4) community recovery. The breakout groups were asked to review the building list and the building clusters and then assign desired performance goals, in terms of time to restore functionality.

The emphasis of the resilience assessment is on city-owned and operated buildings, however, the performance goals tables were completed for all building clusters, since city operations will have dependencies on other functions and building clusters beyond just city facilities (e.g., housing, fuel supplier). With the building cluster table and performance goals completed, the full group then worked to establish performance goals for the infrastructure systems. As a final exercise, the stakeholders attempted to establish an anticipated performance for one building cluster given an expected 100-year flood event.

Brendle Group is working with the city to determine the adaptive capacity of city facilities to expected changes in climate. They have developed a vulnerability assessment tool to use with the city and will be engaging specific stakeholders to conduct the vulnerability assessment. NIST is assisting the city and Brendle Group to adapt the Guide process to be used for considering adaptation and will discuss with Brendle Group, the city, and building commissioners ways to identify bounds based on building codes for high, medium, and low adaptive capacity assignments. NIST is also working on modifications to the resilient performance goals tables that would allow for the inclusion of natural features when assessing resilience, since such features can contribute positively or negatively to overall resilience.

Hazus-MH is being used to estimate the impact of flooding on buildings and infrastructure in Bozeman. At the time of this writing, the results of the initial model runs are being reviewed.

These data will used to inform the anticipated performance for the design and extreme flood hazards.

5.5.5. **Assessment**

The CPT should engage with stakeholders representing social dimensions and infrastructure owners to inform the resilience planning process. Bozeman engaged a large network of stakeholders in their planning process. An initial meeting with this group was held in July 2018 to begin the planning process. A facilitated meeting format with a working session to establish performance goals for building clusters worked well and almost all participants remained engaged for the duration of the two meetings held with the larger group.

Engagement of residents to inform them of the planning process and goals and to gather input to inform the resilience planning process is valuable. The CPT held meetings with city residents to socialize the resilience planning process and to collect input that could be used to support the planning process. The city held two such meetings following the first meeting of the stakeholder group.

Support of the elected leadership is important to bring credibility to the planning process and encourage participation by stakeholders. The CPT has the support of the City Commission to undertake the resilience planning process. The Mayor attended the first meeting of the stakeholder group and voiced her strong support for the planning effort. The support of the elected officials is important to obtaining and retaining the engagement of stakeholders during the assessment and planning process.

Step 2: Understand the Situation

Developing a spreadsheet to organize the building inventory by building cluster helped the stakeholder group establish performance goals. The Bozeman resilience planning process has resulted in further development of tools to assist the stakeholders and CPT to understand the situation. As was done for Nashua, the CPT assembled a spreadsheet that mapped the building inventory for the city within the appropriate building clusters, using the performance goals tables template provided by NIST. Following the first meeting with the CPT and stakeholders, NIST has further expanded the spreadsheet to identify the functions performed by the buildings in the inventory spreadsheet and the location data for the facility (based on data provided by the city).

Step 3: Determine Goals and Objectives

The creation of a spreadsheet linking buildings to building clusters and the facilitated working session to establish resilience performance goals for building clusters are practices that should be repeated in future implementations. The facilitated working session at the first meeting was an efficient way to establish the building clusters and resilience performance goals. Having the building inventory grouped by the appropriate building cluster simplified this working session. Both the spreadsheet linking buildings to clusters and the facilitated working session are practices that should be repeated in future implementations.

The Guide process can be applied to adaptation to stressors as well as hazards (shocks). Working with the Brendle Group on the adaptation to climate change question has provided an opportunity to consider how the Guide process can be adapted to support such analyses. The adaptation work will lead to recommendations for using building code data and building age to estimate the adaptive capacity of buildings. NIST is also considering an update to guidance on the use of the tables to include natural features, since these features can affect the resilience of the community.

6. Results from the Implementation Evaluation

6.1. Background on Communities and Representatives

Most respondents represented communities engaged in planning at the county or city scale. The representatives were in a variety of roles in their communities including program managers, contractors, engineers, architects, emergency management officials, and community resilience coordinators. Time in the current position varied from about half a year to 25 years with an average of 6.3 years. Most of these representatives were residents of the communities in which they worked. The length of residence covered a considerable range – from just over one year to more than 50 years.

There are many motivations for using the Guide. Several reported motivations relate to the value of NIST resilience guidance while other motivations are internal to the community. Users identify the Guide as a beneficial framework for introducing the concept of resilience to the public and for including the socioeconomic impacts of hazards as well as the connections between social functions and the built environment. Communities are motivated to engage in resilience planning by internal factors such as:

- Recent disasters and/or anniversaries of major disaster events;
- Complexity of challenges facing community; and/or
- Criticality of delivering government services during and after a disruption

Finally, financial resources were (limiting) factors for some communities. Motivations included the receipt of funding or other resources for planning as well as requirements associated with federal funding received for disaster recovery. Regardless of motivation, most respondents were “not sure” whether their planning efforts would inform the use of resources received post-disaster (e.g., federal disaster assistance for individuals and businesses, public assistance, and hazard mitigation assistance).

Community representatives reported a range of involvement from NIST, including no direct involvement to technical assistance. When NIST had direct involvement, the types of assistance included the following:

- Presentations to the CPT on implementation of the Guide process
- Technical advice and assistance to the CPT during the planning process
- Facilitation of stakeholder workshop
- Participation by NIST in planning meetings

- Presentations on the use of the EDG and EDGe$

Most respondents indicated that communities had financial resources available for the planning effort through sources such as the Department of Housing and Urban Development's Community Development Block Grants Disaster Recovery Program (CDBG-DR) and the Department of Homeland Security's Regional Resilience Assessment Program (RRAP).

The communities included in the evaluation had experienced the following disruptions/disasters at some point in the past: earthquakes, flooding, hurricanes, severe storms, tornados, wildfire/wildland-urban interface fires, and winter storms. Community representatives were also asked about the other stressors the community is currently experiencing. Several options were available for selection as well as an open ended 'other' response. The most commonly selected stressors are presented in Figure 6-1 along with those selected by less than half of respondents and those selected by less than ten percent 10% of respondents.

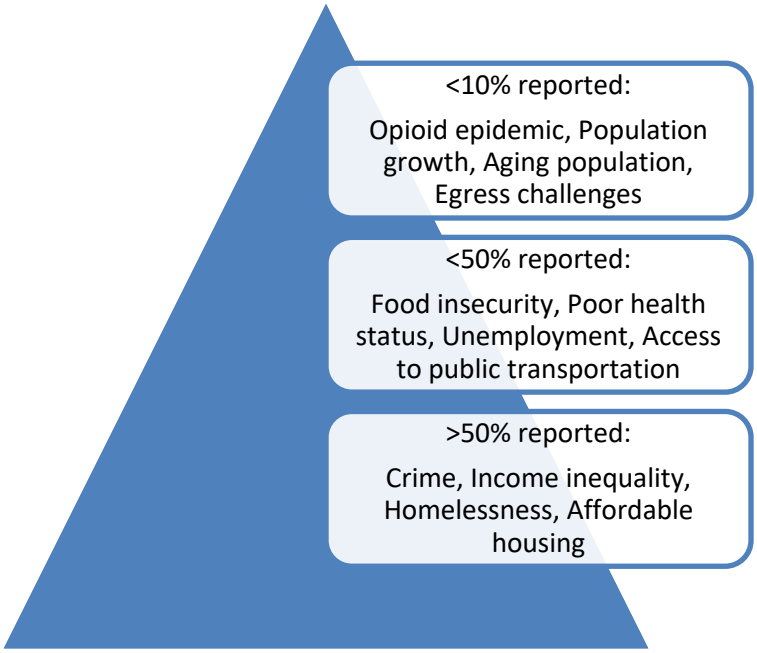

Figure 6-1. Responses on stressors impacting communities.

Well over half of the communities have comprehensive plans, economic development plans, hazard mitigation plans, public safety plans, and transportation plans in place. When asked to respond to the following: "In my community, there is an agreed upon outcome for the resilience planning process," about a third of respondents reported a clear outcome is agreed upon, a little over a third a third are unsure, and the remaining respondents lack an agreed upon outcome.

Of those who answered "yes" or "maybe" to the presence of an agreed upon outcome for the resilience planning process, descriptions of the outcomes were provided. The following best capture the types of outcomes described by community representatives:

- Specific and actionable recommendations for hazard resistance and improved rebuilding
- Better anticipation and mitigation of the impact of infrastructure failures on social infrastructure and social functions
- Improve infrastructure performance for disasters and stressors, including hazards of varying impact and frequency
- To have a means of resuming normal operations as quickly as possible
- To work collaboratively across all community sectors to determine the most efficient means of achieving resilience goals

For the remaining results, communities are delineated as either conventional or unconventional Guide users to better tailor the questions to the individual community's experience of implementation.

6.2. Unconventional Guide Use Process and Outcomes

Communities best characterized by unconventional Guide use were asked an additional series of questions related to the incorporation of the Guide into ongoing processes. There is a nearly even split between communities already in the resilience planning process when the NIST Guide was discovered and those who were not yet in the planning process. The same split applies to those who added something to their process as a result of the Guide. Most communities had developed products out of their resilience planning process, potentially because the innovations of their use of the Guide were geared toward products. Examples include the development of Resilient Design Performance Standards (42) for building clusters and supporting infrastructure systems. None of the Unconventional Guide Use communities included in the evaluation were using EDG at the time of the survey. However, there was clear indication for at least one community that resources would ideally be sought for this additional work.

6.3. Conventional Guide Use Assessment of Step 1

The implementation evaluation included questions specifically directed to communities characterized by conventional Guide use and in accordance with the steps of the 6-step Guide process. Two communities were included in the assessment of Step 1. In this section, the results of the survey module for Step 1: Forming a Collaborative Planning Team are described.

The establishment of the CPT was driven by a recent disaster experience in one case and a routine planning cycle combined with recent funding for resilience planning in the other. Team members for the community planning team were selected similarly and in concert with

the NIST guidance. The conveners of the planning process sought representation from across many sectors of their communities and worked to identify the right individuals and agencies. In one community, the initial collaborative planning team comprised representatives of local departments with a responsibility for risk reduction, such as engineering, community development, public health, and emergency management. This group was further broadened to include other community stakeholders.

When considering the degree to which the CPT was representative of the different stakeholders in their community (e.g., local government, public and private developers, owners and operators of buildings and infrastructure systems, business and industry representatives, community organizations, religious and cultural organizations, volunteer groups), respondents assessed the representativeness of the collaborative planning team as "slightly representative" or better. In both cases, there was room for improvement in representation. On a scale from one to five, with five equaling very difficult, the difficulty of obtaining the level of representativeness of the CPT was reported as a three or higher across the sample. Reasons for this difficulty included scheduling and availability of the right people for the CPT. One means of overcoming some of the challenge of representation was to provide all information digitally as well as in person during meetings to ensure that feedback could be provided online via email when team members were unable to attend meetings. The difficulty encountered regarding availability of team members is perceived to be unavoidable, thereby emphasizing the importance of creative solutions.

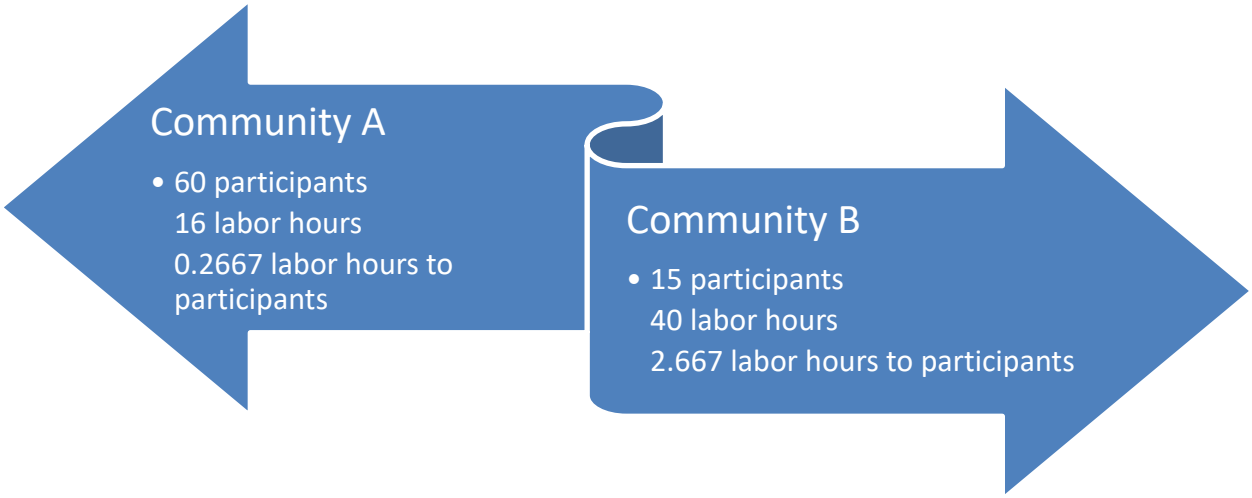

Figure 6-2. Responses on resources required for Step 1.

When asked to describe the resource requirements for Step 1: Forming a Collaborative Planning Team, each community had a different ratio of people to labor hours (Figure 6-2). If

more people were involved, less labor hours were required and if fewer people were involved, more labor hours were required. This relationship of participants to labor hours will continue to be examined throughout the evaluation.

Factors that influenced this step included limited human resources for the resilience planning effort and a lack of prior knowledge of resilience among the team members. Additionally, there was a need to establish how resilience could apply to the work of the individual team members and then a need to show its benefit beyond the members' tenure in the community. The theme of limited personnel availability and challenges with scheduling arose again when asked about the broader challenges associated with Step 1. One community found that there was uneven interest in resilience planning across sectors of government due in part to the time commitment as well as the long-term scale of the problem and solutions. Maintaining a consistent level of engagement among team members over time was also a challenge.

At least one community identified additional Guide Briefs focused on the development of a collaborative planning team as a tool that the planning team needed from NIST to work more effectively. When asked for recommended improvements to benefit similar communities, one community responded that an expansion of the example organization list for the collaborative planning team would be of value. The Guide was cited as useful for providing good examples of the types of team members to include in collaborative planning team and more broadly, for serving as a framework for local governments to follow.

7. Summary

These examples of Guide use and the survey-based implementation evaluation highlight some features of the resilience planning process that NIST believes will help communities increase their resilience to hazards. The Guide use case studies and findings from the survey-based implementation evaluation additionally point to some gaps that NIST is working to address. The range of applications, use of the Guide, and lessons for future guidance and tools are summarized below.

7.1. Range of Applications

The case studies described in this report demonstrate the applicability of the Guide process in different settings. The Fort Collins and Howard County examples demonstrate application for a municipality and a district (within a County). The DelDOT highway corridor case study shows how the process may be applied over a region and in this case with a central infrastructure asset being the focus of the assessment and considering its role in the context of the communities along the corridor. The Nashua and Bozeman projects are good examples of communities taking a more uniform approach to Guide use to develop a resilience plan.

7.2. Use of the Guide

One of the strengths identified in these implementations was that the Guide process provides a means for bringing together a diverse set of stakeholders to establish a shared set of resilience goals for the community. Engagement of stakeholders to communicate the value of

resilience planning, elicit information on dependencies on services, buildings, and infrastructure is essential to accurately characterizing the community and appropriately assigning performance goals.

The concept of integrating resilience into other community-level plans came up in all three implementation case studies. A community resilience plan should identify actions that can be implemented through the community's master plan or hazard mitigation plan. The implementations provided valuable insights as to how the Guide should work in concert with other plans. The Fort Collins implementation illustrates this well; the city has an active planning process, so the team saw little value to developing another plan. Rather, the CPT developed a set of recommendations, based on resilience goals and performance gaps, that could be implemented through the appropriate existing plan.

Howard County is taking measures to integrate their planning processes to make sure that all plans are aligned to the same set of resilience goals and objectives.

Use of the performance goal tables (Step 3) demonstrated the value of obtaining a high-level perspective on the community, inherent dependencies, and where performance gaps exist. Identifying these gaps enables the user to prioritize the gaps and evaluate alternative solutions. Use of the tables also helps the collaborative planning team identify where dependency relationships can lead to unintended performance gaps. The tables are also reported to be useful for tracking progress toward improving resilience over time.

The Nashua and Bozeman implementations demonstrated the value of identifying the specific buildings that make up a buildings cluster. This helped the stakeholders set realistic performance goals for the building clusters and during Step 3 helps identify which buildings contribute to a loss of capacity to deliver service. This is particularly useful when considering anticipated performance, since delivery of services may not be uniformly distributed through a community and disruption may have disproportionate impacts.

7.3. Lessons for Future Guidance and Tools

Resilience planning is driven by many factors, both internal and external to a community. Identifying guidance and tools that match the needs of a community may bring some into a resilience planning process. In other cases, the availability of financial resources is the key to getting started on resilience planning or lack thereof being a halting point. However, one motivation holds true across communities, many resilience planning efforts arise out of prior experience with disasters. The implementations and survey data demonstrate the value of the Guide process, but also identify areas where additional guidance, tools, or information could make the development of a resilience plan easier to navigate. This section details some of the lessons from the survey and implementations.

Determination of anticipated performance for the built environment is an area that requires additional development. There are currently no tools that work to support the Guide process to determine anticipated performance. This determination is currently accomplished through expert judgement. A dependency mapping tool was applied effectively in the Fort Collins work. Geospatial data, showing where buildings or infrastructure are likely to be damaged

and the resulting impacts on social and economic activity can be particularly useful for determining anticipated performance, identifying possible solutions to address performance gaps, and establishing priorities. In Nashua and Bozeman, Hazus-MH was used to inform the determination of anticipated performance. Automating dependency mapping and determination of anticipated performance will make the process more accessible to users and would support broader application of the Guide for resilience planning.

Each of the first three community users developed its own interpretation of how best to use the Guide – the steps were applied but were tailored to the community's specific needs and/or accessible tools (e.g., AHA). In only one case were the performance goal tables used and in that case the tables were modified to suit the assessment, although the basic principles articulated by the Guide were followed. For the latter users, where NIST was directly engaged, the process was followed more closely. The Guide process is most useful to obtain a system level view of the community so that dependencies and cascading consequences can be identified.

These implementations and survey respondents also identified additional guidance and tools that are needed to support broader implementation of the Guide process. These are listed in a general fashion, below:

- Understanding resilience terminology – The concept of resilience is reported to be interpreted in multiple, often conflicting ways, especially at the outset of resilience planning and during initial meetings of the CPT. In turn, this lack of unified understanding prompts some critiques; however, it can also be viewed as bringing together disparate groups, institutions, disciplines and planning scales. While this challenge occurs with the concept of resilience, it also occurs with the concepts used within the 6-step planning process. For example, the building cluster concept used in the Guide can be difficult to understand. NIST found that it was useful to develop a spreadsheet that contained all the buildings in the community's inventory grouped by building cluster. A further refinement of that spreadsheet included a description of the social services provided by each building cluster. This was helpful to the stakeholder groups as they were making decisions on desired performance goals during the workshops.

- Building cluster mapping – The building clusters represent buildings that contribute to the provision of a social service (e.g., housing, critical retail, education). Automating the identification of which buildings in a community belong to a cluster would greatly simplify the process of populating performance goals tables and assist communities in establishing their desired performance for each cluster.

- Dependency mapping – Tools to automate the analysis of dependencies and the cascading consequences of failures would simplify the determination of anticipated performance.

- Tools to determine anticipated performance – Tools that can assist the user in determining anticipated performance would simplify this part of the resilience

planning process. Such tools would need to include not only damage assessment, but recovery of function. Along with dependency mapping, this will help the user determine anticipated performance.

- Training on the use of the Guide – A workbook that takes a user step by step through the Guide process and points to existing tools that can support the resilience planning process will make the planning process more uniform and lead to more consistent outcomes.

- Integration of resilience into existing planning processes – The Guide discusses reviewing existing plans and establishing long-term community goals but does not offer a process for how to accomplish these steps. Often plans are developed in isolation and can be in conflict, creating vulnerabilities. In Nashua, the Plan Integration for Resilience Scorecard developed by Texas A&M (37) was employed to evaluate the existing city plans and support the city's resilience planning process. The combination of tools shows promise and NIST is continuing to work with Texas A&M to refine this process.

- Taking into account values – There is acknowledged absence of explicit values within resilience concepts, which can leave practitioners challenged by how best to inject values and to navigate tradeoffs in resilience improvements between/among groups, locations, and timescales. This can be particularly tricky when a community is faced by short-term timelines in government; when officials are changing office frequently, longer-term resilience planning and the required support can be challenging. There is recognition that communities have competing priorities and though a number of shocks and stressors may either: 1) relate to resilience planning or 2) be alleviated at least partially as a co-benefit of resilience planning (e.g., 43), but not all do. Furthermore, there is an expressed desire to understand the implications of how resilience is first planned and strategically managed, and then measured and assessed over time.

- Financial resources necessary for the NIST resilience planning process – Based on the findings of the evaluation, most communities that were engaged in resilience planning had financial resources to support this effort. Others raised the need for greater financial resources as an issue for ongoing work related to resilience. Guidance on available financial resources to support resilience planning and how to fund resilience-building projects would be useful.

- Human resources necessary for the NIST resilience planning process – Many communities have limited staff resources to conduct resilience assessments and planning. Building a cadre of consultants trained in the use of the Guide and supporting tools would help to meet the need for technical assistance to get broader community participation in resilience planning.

- Inclusion of natural features in the performance goals tables – Communities using the NIST guidance have considered, and in some cases implemented, modifications to the

resilience performance goals tables that would allow for the inclusion of natural features when assessing resilience, since such features can contribute positively or negatively to overall resilience.

- Guidance on development of the collaborative planning team – Additional Guide Briefs, specifically targeted to the development of the collaborative planning team, were recommended as improvements that would enable more communities to better address resilience planning. Thus far, the evaluation offers minimal data on the specific resource requirements per step. Where data has been collected on the number of participants and labor hours, there is a clear indication that having both personnel and time dedicated to the process are critical to the process being completed in an effective and efficient manner. When considered together, these two resources represent the most common challenge that community representatives identify in the resilience planning process.

8. Ongoing implementation evaluation; continued outreach

The case studies along with the evaluation survey data collected are aimed at assessing the implementation of the Guide. As more communities use the Guide, EDG, and associated tools and complete some or all of the six-step process, the intent is to generate information that further supports program improvement. The lessons learned, barriers encountered, and solutions sought will take the form of future guidance for communities yet to embark on the resilience planning process.

Phase 1 of the Guide use evaluation, presented in this report, includes survey modules through Step 2. Phase 2 evaluation will consist of modules for Steps 3-6 and the EDG. This interim systematic assessment of the Guide implementation across community types will increase the power and relevance of any future outcome evaluation. This interim evaluation is essential for program learning and has yielded a series of suggestions across potential tools and assistance identified by communities as well as improvements that may be applicable to future NIST resilience guidance and tools. In cases where it makes sense, communities assessed in this interim evaluation report will be additionally assessed into the future. Thus, it will be possible to evaluate implementation successes in Phase 2 against the successes and challenges identified during the Phase 1 assessment.

NIST will also continue working directly with communities, including Nashua, NH, Bozeman, MT, and Salt Lake County, UT. As this engagement evolves, additional case studies and analysis of what worked and what did not may be required. Ultimately, the guidance that NIST has produced is expected to continue to grow, whether through new versions or the creation of new tools to support the existing process.

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Appendix A: Survey Instruments and Consent Form for the Assessment of Community Use of the NIST *Community Resilience Planning Guide for Buildings and Infrastructure Systems*

Survey Modules for Conventional Use of the NIST Guide

OMB Control #0693-0078
Expiration date: 07/31/2019

This information collection is focused on communities that have used or are currently using the *NIST Community Resilience Planning Guide for Buildings and Infrastructure Systems*. We are collecting information from representatives of these communities in order to 1) inform the next generation of guidance on community resilience planning including Version 2.0 of the *NIST Community Resilience Planning Guide* and accompanying tool development, 2) better understand the process of resilience planning, and 3) identify additional resources that communities need for resilience planning.

This collection of information contains Paperwork Reduction Act (PRA) requirements approved by the Office of Management and Budget (OMB). Notwithstanding any other provisions of the law, no person is required to respond to, nor shall any person be subject to a penalty for failure to comply with, a collection of information subject to the requirements of the PRA unless that collection of information displays a currently valid OMB control number. Public reporting burden for this collection is estimated to be 15 minutes per survey, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed and completing and reviewing the collection of information. Send comments regarding this burden estimate or any aspect of this collection of information, including suggestions for reducing this burden, to the National Institute of Standards and Technology, Attn: Jennifer Helgeson, Economist, NIST, 100 Bureau Drive, MS 8603, Gaithersburg, MD 20899-1710, telephone 301-975-6133, or via email to jennifer.helgeson@nist.gov.

Background on Representative and Community (General Survey Module C)

Pre-screen question:

1. Please enter your uniquely assigned ID Code.

[REQUIRE ANSWER - This question requires an answer. If you do not know your ID Code, please contact maria.dillard@nist.gov for assistance.]
[VALIDATE ANSWER - The ID Code you entered is in an invalid format.]

We are aware that your community has used or is using the *NIST Community Resilience Planning Guide for Buildings and Infrastructure Systems* for resilience planning. In order to better understand your community's use, we would like to first ask a general set of questions about you and the community you represent.

1. At what scale of community is the NIST Community Resilience Planning Guide being implemented?
    a. state
    b. region
    c. county
    d. city
    e. town
    f. municipality
    g. Other _____
2. Do you live in the community where you are participating in resilience planning?
    a. Yes
    b. No
3. If yes, how long have you lived in this community?
    a. _____ years _____months
    b. other _____
4. What is your current position in the community where you are participating in resilience planning (e.g., elected leader, educator, business owner)?
5. How long have you been in this role?
    a. _____ years _____ months
6. What is your role in the NIST Community Resilience Planning Guide implementation process?
7. What is motivating your community to use the NIST Community Resilience Planning Guide?
8. If your motivation is the experience of a recent disaster, will this process be used to inform use of resources received post-disaster (e.g. federal disaster assistance for individuals and businesses, public assistance, and hazard mitigation assistance)?
    a. Yes
    b. No
    c. Not sure

9. What, if any, technical assistance has NIST provided to your community (e.g., presentations to your collaborative planning team, meeting facilitation, teleconference check ins, participation in process, technical advice)?
10. Were there financial resources available for the implementation of the NIST Guide?

    a. Yes
    b. No
11. If yes, please identify each source and indicate the amount received from each source.

Source	**Amount**

12. What types of hazards/disasters has your community experienced at any point in the past, to the best of your knowledge? Select all that apply:
    a. earthquake
    b. flooding
    c. hurricane
    d. severe storms
    e. terrorism
    f. tornado
    g. Other _____
    h. Other _____
    i. Other _____

13. What other types of stressors is your community currently experiencing? Select all that apply:
    a. crime
    b. food insecurity
    c. income inequality
    d. homelessness
    e. lack of affordable housing
    f. low high school graduation rates
    g. poor health status
    h. unemployment
    i. unreliable public transportation
    j. Other _____
    k. Other _____
    l. Other _____

14. What other types of plans does your community have in place? Select all that apply:
    a. comprehensive plan
    b. economic development plan
    c. hazard mitigation plan
    d. public health plan
    e. public safety plan
    f. recovery plan
    g. urban development plan
    h. transportation plan
    i. sustainability plan
    j. energy efficiency plan
    k. Other _____
    l. Other _____
    m. Other _____

15. In your community, is there is an agreed upon outcome for the resilience planning process?
    a. Yes
    b. No
    c. Maybe

16. If yes or maybe, please describe that outcome.

Step 1 "Form a Collaborative Planning Team" Survey Module

Pre-screen question:

1. Please enter your uniquely assigned ID Code.

[REQUIRE ANSWER - This question requires an answer. If you do not know your ID Code, please contact maria.dillard@nist.gov for assistance.]
[VALIDATE ANSWER - The ID Code you entered is in an invalid format.]

Thank you for continuing to provide feedback on your community's experience with the NIST Community Resilience Planning Guide. We would now like to ask you a set of questions about Step 1 "Form a Collaborative Planning Team".
INSTRUCTIONS: The following questions apply at the completion of the NIST Community Resilience Planning Guide Step 1 in which the community forms a collaborative team.

1. The community resilience planning team got started because of a:
    a. new state requirement
    b. recent disaster experience
    c. request by a specific sector such as business, health
    d. routine planning cycle

e. other _____

2. How were the members of the community planning team selected?
3. How representative would you say that your team is of the different stakeholders in your community (e.g., local government, public and private developers, owners and operators of buildings and infrastructure systems, business and industry representatives, community organizations, religious and cultural organizations, volunteer groups)?
    a. Absolutely unrepresentative
    b. Unrepresentative
    c. Slightly unrepresentative
    d. Slightly representative
    e. Representative
    f. Absolutely representative
4. Would you say that trying to obtain representativeness across stakeholder groups was:
    a. Very difficult
    b. Difficult
    c. Neutral
    d. Easy
    e. Very easy

SKIP PATTERN: For Q4, If respondent answers either a or b, then proceed to Q5. If respondent answers c, d, or e, then skip to Q8.

5. Please briefly describe the difficulty encountered.
6. Was this difficulty overcome, or did it prevent getting adequate representation? Please explain.
7. How could this difficulty be avoided in the future?

General Process Evaluation Questions (General Survey Module D)

8. Please describe the resource requirements for this step (Forming a Collaborative Planning Team) by estimating the total number of participants and labor hours to the best of your ability.
9. Are there tools and/or support that your planning team needs from NIST or other organizations that would enable you to work more effectively?
    a. Yes
    b. No
10. Please provide examples or an explanation of these needs.
11. What significant challenges were encountered in this step?
12. What external factors influenced this step? (e.g., limited staff, staff with limited knowledge/skill, not enough money, unfavorable vote by local government)
13. In what ways has the NIST Community Resilience Planning Guide been useful?
14. In what ways would you recommend changing or improving the NIST Community Resilience Planning Guide for communities similar to your own?

15. Is there anything else you would like to tell us about your community's experience with the resilience planning process at this time?

Step 2 "Understand the Situation" Survey Module

Pre-screen question:

1. Please enter your uniquely assigned ID Code.

[REQUIRE ANSWER - This question requires an answer. If you do not know your ID Code, please contact maria.dillard@nist.gov for assistance.]
[VALIDATE ANSWER - The ID Code you entered is in an invalid format.]

Thank you for continuing to provide feedback on your community's experience with the NIST Community Resilience Planning Guide. We would now like to ask you a set of questions about Step 2 "Understand the Situation".

1. What processes were used to characterize the population and identify the social institutions?
2. Did the planning team identify dependencies among the social institutions?
    a. Yes
    b. No
3. [IF YES] The level of complexity of the social institution dependencies identified was:
    a. Not at all complex
    b. Slightly complex
    c. Moderately complex
    d. Very complex
    e. Extremely complex
4. What processes were used to characterize the built environment?
5. Did the planning team identify dependencies within the built environment?
6. [IF YES] The level of complexity of the built environment dependencies identified was:
    a. Not at all complex
    b. Slightly complex
    c. Moderately complex
    d. Very complex
    e. Extremely complex
7. Were metrics identified?
    a. Yes
    b. No
8. What processes were used to identify links between social institutions and the built environment?
9. The level of difficulty encountered by the planning team in obtaining information to complete Step 2 was:

a. Very difficult
b. Difficult
c. Neutral
d. Easy
e. Very easy

General Process Evaluation Questions (General Survey Module D)

10. Please describe the resource requirements for this step (Understand the Situation) by estimating the total number of participants and labor hours to the best of your ability.
11. Are there tools and/or support that your planning team needs from NIST or other organizations that would enable you to work more effectively?
    a. Yes
    b. No
12. Please provide examples or an explanation of these needs.
13. What significant challenges were encountered in this step?
14. What external factors influenced this step? (e.g., limited staff, staff with limited knowledge/skill, not enough money, unfavorable vote by local government)
15. In what ways has the NIST Community Resilience Planning Guide been useful?
16. In what ways would you recommend changing or improving the NIST Community Resilience Planning Guide for communities similar to your own?
17. Is there anything else you would like to tell us about your community's experience with the resilience planning process at this time?

Survey Modules for Unconventional Use of the NIST Guide

OMB Control #0693-0078
Expiration date: 07/31/2019

This information collection is focused on communities that have used or are currently using the *NIST Community Resilience Planning Guide for Buildings and Infrastructure Systems*. We are collecting information from representatives of these communities in order to 1) inform the next generation of guidance on community resilience planning including Version 2.0 of the *NIST Community Resilience Planning Guide* and accompanying tool development, 2) better understand the process of resilience planning, and 3) identify additional resources that communities need for resilience planning.

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Background on Representative and Community for Unconventional Applications of the Guide (General Survey Module A)

Pre-screen question:

1. Please enter your uniquely assigned ID Code.

[REQUIRE ANSWER - This question requires an answer. If you do not know your ID Code, please contact maria.dillard@nist.gov for assistance.]
[VALIDATE ANSWER - The ID Code you entered is in an invalid format.]

We are aware that your community has used or is using the *NIST Community Resilience Planning Guide for Buildings and Infrastructure Systems* for resilience planning. In order to better understand your community's use, we would like to first ask a general set of questions about you and the community you represent.

1. At what scale of community is resilience planning being implemented?
    a. state
    b. region
    c. county
    d. city

e. town
f. municipality
g. Other _____

2. Do you live in the community where you are participating in resilience planning?
    a. Yes
    b. No
3. If yes, how long have you lived in this community?
    a. _____ years _____months
    b. other _____
4. What is your current position in the community where you are participating in resilience planning (e.g., elected leader, educator, business owner)?
5. How long have you been in this role?
    a. _____ years _____ months
6. What is your role in the resilience planning process?
7. What is motivating your community to use the NIST Community Resilience Planning Guide?
8. If your motivation is the experience of a recent disaster, will this process be used to inform use of resources received post-disaster (e.g. federal disaster assistance for individuals and businesses, public assistance, and hazard mitigation assistance)?
    a. Yes
    b. No
    c. Not sure
9. What, if any, technical assistance has NIST provided to your community (e.g., presentations to your collaborative planning team, meeting facilitation, teleconference check-ins, participation in process, technical advice)?
10. Were there financial resources available for resilience planning?
    a. Yes
    b. No
11. If yes, please identify each source and indicate the amount received from each source.

Source	**Amount**

12. What types of hazards/disasters has your community experienced at any point in the past, to the best of your knowledge? Select all that apply:
    a. earthquake
    b. flooding
    c. hurricane
    d. severe storms

e. terrorism
f. tornado
g. Other _____
h. Other _____
i. Other _____

13. What other types of stressors is your community currently experiencing? Select all that apply:
    a. crime
    b. food insecurity
    c. income inequality
    d. homelessness
    e. lack of affordable housing
    f. low high school graduation rates
    g. poor health status
    h. unemployment
    i. unreliable public transportation
    j. Other _____
    k. Other _____
    l. Other _____

14. What other types of plans does your community have in place? Select all that apply:
    a. comprehensive plan
    b. economic development plan
    c. hazard mitigation plan
    d. public health plan
    e. public safety plan
    f. recovery plan
    g. urban development plan
    h. transportation plan
    i. sustainability plan
    j. energy efficiency plan
    k. Other _____
    l. Other _____
    m. Other _____

15. In your community, is there is an agreed upon outcome for the resilience planning process?
    a. Yes
    b. No
    c. Maybe

16. If yes or maybe, please describe that outcome.

Assessing Non-traditional Applications of the Guide (General Survey Module B)

Pre-screen question:

1. Please enter your uniquely assigned ID Code.

[REQUIRE ANSWER - This question requires an answer. If you do not know your ID Code, please contact maria.dillard@nist.gov for assistance.]
[VALIDATE ANSWER - The ID Code you entered is in an invalid format.]

Several communities are using the NIST Community Resilience Planning Guide as a reference to support or assess another resilience effort. For example, the NIST Guide may be used to evaluate existing plans, incorporate resilience into other capital and social plans, or to prioritize investments. If this describes the way in which your community is using the NIST Guide, we would like to ask you a brief set of questions to better understand how you have used or are using the NIST Guide to assist in other planning activities.

1. Were you already in the process of resilience planning when you discovered the NIST Community Resilience Planning Guide?
    a. Yes
    b. No
2. Did you add something to your existing process that you learned about from the NIST Community Resilience Planning Guide?
    a. Yes
    b. No
3. If yes, please briefly describe what you added to your existing process.
4. Have you produced any documents, plans, or initiatives as a result of your planning process?
    a. Yes
    b. No
5. If yes, please briefly describe what you have produced up to this point.
6. Several communities are using the *NIST Economic Decision Guide* to support or assess resilience efforts. Did the planning team use the *NIST Economic Decision Guide*?
    a. Yes
    b. No

SKIP PATTERN: If yes to Q6, continue with additional EDG question subset (Q7). If no to Q6, terminate survey.

Economic Decision Guide Survey Module

7. Who performed the economic evaluation?
    a. budget office
    b. citizen group
    c. city manager
    d. consultant/consultancy firm
    e. economic bureau
    f. finance office
    g. planning office
    h. resilience office
    i. university faculty/students
    j. other _____
8. Did the planning team use the *NIST Economic Decision Guide* to decide between candidate strategies to improve the community's resilience?
    k. Yes
    l. No
9. How did the planning team define investment objective and scope?
10. How did the planning team identify benefits and costs?
11. How did the planning team identify non-market considerations?
12. How did the planning team set analysis parameters?
13. What challenges did the planning team encounter with completing the economic evaluation?
14. How did the *NIST Economic Decision Guide* influence the selection of strategies included in the resilience plan?

Appendix B: Sample Stakeholder Questionnaires

The Fort Collins collaborative planning team developed two questionnaires to collect information from stakeholder groups. The first was intended for use by stakeholder groups representing one of the eight social dimensions in the community as identified in the Guide, in the example, Family & Kinship (p. 27 of Volume 2 of the Guide). This social dimension can be mapped onto building clusters, in this example housing, that support the activity within the social dimension. These questionnaires were used in a workshop setting with breakout groups discussing responses to the questions. The references to "table" are instructions to the breakout groups.

A separate questionnaire was developed for use in guiding discussions with infrastructure operators. Responses to the questions provided useful insights to the individual infrastructure systems and helped the collaborative planning team refine the analyses that they were conducting using open source information.

Both questionnaires are provided here.

Example Social Dimensions Task Worksheet & Questions

Family & Kinship

1) Please review the "one pager" of functions/services to the community provided by your social function category.
   - Is it complete? If not, what's missing?
   - Should anything be deleted?

   Please make additions or deletions to the Master Sheet (corresponding to Question 1) provided to your table.

2) List the 1 – 2 – 3 most important functions/services that your social function category provides to the community:

   1. _____
   2. _____
   3. _____

   Please list consensus selections on the Master Sheet (corresponding to Question 2) provided to your table.

3) Indicate which elements of the built environment are necessary to support the provision of the important functions/services listed in question 2? (Include only physical assets, e.g., specific buildings, gathering places, emergency vehicles, etc., or other like assets. Do not include lifeline infrastructure - power, water, wastewater, communications, and transportation systems - that support the provision of these services.)

   1. _____
   2. _____
   3. _____

   Please list consensus selections on the Master Sheet (corresponding to Question 3) provided to your table.

4) Following a disruptive event that impacts lifeline sector services to the built environment (e.g., water or energy to a hospital; delivery of food and supplies to a food bank; communications services to a fire department or 911 call center), what are your recovery goals for the three critical functions/services listed in response to question 2?

1. _____
   _____
2. _____
   _____
3. _____
   _____

Please list consensus selections on the Master Sheet (corresponding to Question 4) provided to your table.

5) What steps have been taken to mitigate the impacts of disruptive events on the critical assets listed in response to question 3?
Please list consensus selections on the Master Sheet (corresponding to Question 5) provided to your table.

6) Please review the list of assets linked to your social function category:
   - Are these facilities properly allocated to the social function category? If so, briefly discuss what role they play under steady state conditions, during a disaster or post disaster. If not, please indicate which assets are misallocated.
   - Are important assets missing? If so, please list them on the spreadsheet provided.
   - If possible, please rank the importance of the listed assets to your social function category using the following key:
     - ✓ 1 (Critical to delivery of essential function provided by this social function category – loss of this asset would result in inability to provide a critical social need. There are no available substitutes for the services/functions provided by this asset)
     - ✓ 2 (Important to delivery of essential function provided by this social function category – loss of this asset would result in diminished capacity to provide a critical social need. There are few readily available substitutes for the services/functions provided by this asset)
     - ✓ 3 (Non-essential to delivery of essential functions/services provided by this social function category – loss of this asset would not result in diminished capacity to provide a critical social need. There are readily available substitutes for the services/functions provided by this asset)

Please list consensus selections on the Master Sheet (corresponding to Question 6) provided to your table.

7) Please provide the group's thoughts and recommendations on how we can best insure that this specific social function group is successfully integrated into the Community Resilience Planning process.
Please list your recommendations on the Master Sheet (corresponding to Question 7) provided to your table.

Example Questions for Infrastructure Owner/Operator

1) What are the factors you don't control that affect your sector or facility's ability to remain operational and perform mission essential functions during or following a disruptive event, e.g., dependencies on other lifeline sectors (power, water, communications, etc.), dependencies on government (road/debris clearing, permitting, regulatory waivers)?
2) Do recovery time objectives (rto's) in your business continuity plan factor in the recovery capabilities of the external entities you depend on?
3) In Northern Colorado, what are the barriers to meeting specific rtos?
4) Do State, County and local emergency managers know what you do and prioritize and facilitate restoration of the services your facility provides? Do they understand your requirements and the consequences of loss of functionality?
5) You provide essential lifeline functions. Have you had discussions with emergency managers and County and local decision-makers about their restoration priorities? Do you factor their priorities into your plans?
6) Have you taken steps to mitigate consequences of a service interruption? (back-up power, priority fuel contracts, WPS/GETS, dual electrical feeds to critical assets, etc.)
7) Do emergency managers and the service providers you depend on know your capacity to remain operational following the loss of a critical service?

Appendix C: Resilience Performance Goals Tables Template

This Appendix contains a template of the resilience performance goals tables used to implement the Guide process. The community assigns desired performance levels for each building cluster, independent of hazard, for routine, design, and extreme hazard levels. Performance levels are:

30% Functional – Minimum needed to initiate the activities assigned to the cluster
60% Functional – Minimum needed to initiate normal operations
90% Functional – Minimum needed to declare cluster at normal operating capacity

Once the performance levels are assigned, the community then defines the hazards of concern and assesses the anticipated performance for each hazard at each of the three hazard levels. This allows the community to identify where gaps exist between desired performance and anticipated performance. It also allows the community to identify where dependency relationships may influence overall recovery. The resilience performance goals table are useful for establishing a baseline for planning and evaluating progress as resilience enhancements are made.

Summary Performance Goal Table

Disturbance [1]	
Hazard Type	Any
Hazard Level	Routine, Design, Extreme
Affected Area	Localized, Community, Regional
Disruption Level	Usual, Moderate, Severe

Restoration Levels [2,3]	
30%	Function Restored
60%	Function Restored
90%	Function Restored
X	Anticipated Performance

Building Clusters	Design Hazard Performance								
	Phase 1: Short-Term			Phase 2: Intermediate			Phase 3: Long-Term		
	Days			Weeks			Months		
	0	1	1-3	1-4	4-8	8-12	4	4-24	24+
Critical Facilities									
Buildings									
Transportation									
Energy									
Water									
Wastewater									
Communications									
Emergency Housing									
Buildings									
Transportation									
Energy									
Water									
Wastewater									
Communications									
Housing/Neighborhoods/Businesses									
Buildings									
Transportation									
Energy									
Water									
Wastewater									
Communications									
Community Recovery									
Buildings									
Transportation									
Energy									
Water									
Wastewater									
Communications									

Footnotes:

1 Specify hazard type being considered
Specify hazard level – Routine, Design, Extreme
Specify the anticipated size of the area affected – Local, Community, Regional
Specify anticipated severity of disruption – Minor, Moderate, Severe

2
- 30%
- 60%
- 90%

Desired restoration times for percentage of elements within the cluster

3 x

Anticipated performance for 90 % restoration of cluster for existing buildings and infrastructure systems
Cluster recovery times will be shown on the Summary Matrix

Transportation Infrastructure Performance Goals Table

Disturbance [1]	
Hazard Type	Any
Hazard Level	Routine, Design, Extreme
Affected Area	Localized, Community, Regional
Disruption Level	Usual, Moderate, Severe

Restoration Levels [2,3]	
30%	Function Restored
60%	Function Restored
90%	Function Restored
X	Anticipated Performance

Building Clusters	Support Needed[4]	Design Hazard Performance								
		Phase 1: Short-Term			Phase 2: Intermediate			Phase 3: Long-Term		
		Days			Weeks			Months		
		0	1	1-3	1-4	4-8	8-12	4	4-24	24+
Ingress (goods, services, disaster relief)										
Local Roads, Bridges and Tunnels										
State Highways, Bridges and Tunnels										
National Highways, Bridges and Tunnels										
Regional Airport										
National/International Airport										
Military Airports										
Marine Port										
Ferry Terminal										
Subway Station										
Rail Stations										
Egress (emergency egress, evacuation, etc)										
Local Roads, Bridges and Tunnels										
State Highways, Bridges and Tunnels										
National Highways, Bridges and Tunnels										
Regional Airport										
National/Int'l Airport										
Military Airports										
Subway Station										
Ferry Terminal										
Rail Stations										
Community Recovery										
Critical Facilities										
Critical Medical										
Emergency Operations Center										
Critical Government										
Critical City Services										
Critical Commercial										
Emergency Housing										
Skilled Nursing Facilities										
Emergency Medical										
Public Information Centers										
Emergency Shelters										
Emergency Retail										
Housing/Neighborhoods										
Essential City Services										
Essential Retail										
Essential Medical										
Essential Non-Governmental Organizations										
Residential Housing										
Schools										
Essential City Services										
Community Recovery										
Commercial										
Industrial										
Manufacturing										
Colleges and Universities										

Footnotes:

1 Specify hazard type being considered
Specify hazard level – Routine, Design, Extreme
Specify the anticipated size of the area affected – Local, Community, Regional
Specify anticipated severity of disruption – Minor, Moderate, Severe

2 30% / 60% / 90% — Desired restoration times for percentage of elements within the cluster

3 X — Anticipated performance for 90 % restoration of cluster for existing buildings and infrastructure systems
Cluster recovery times will be shown on the Summary Matrix

4 Indicate levels of support anticipated by plan
R = Regional; S= State; MS=Multi-State; C = Civil (Corporate/Local)

Pipelines Performance Goals Table

Disturbance [1]	
Hazard Type	Any
Hazard Level	Routine, Design, Extreme
Affected Area	Localized, Community, Regional
Disruption Level	Usual, Moderate, Severe

Restoration Levels [2,3]	
30%	Function Restored
60%	Function Restored
90%	Function Restored
X	Anticipated Performance

Building Clusters	Support Needed[4]	Design Hazard Performance								
		Phase 1: Short-Term			Phase 2: Intermediate			Phase 3: Long-Term		
		Days			Weeks			Months		
		0	1	1-3	1-4	4-8	8-12	4	4-24	24+
Distribution										
Critical Facilities										
Critical Medical										
Emergency Operations Center										
Critical Government										
Critical City Services										
Critical Commercial										
Emergency Housing										
Skilled Nursing Facilities										
Emergency Medical										
Public Information Centers										
Emergency Shelters										
Emergency Retail										
Housing/Neighborhood										
Essential City Services										
Essential Retail										
Essential Medical										
Essential Non-Governmental Organizations										
Residential Housing										
Schools										
Essential City Services										
Community Recovery										
Commercial										
Industrial										
Manufacturing										
Colleges and Universities										

Footnotes:

1 Specify hazard type being considered
Specify hazard level – Routine, Design, Extreme
Specify the anticipated size of the area affected – Local, Community, Regional
Specify anticipated severity of disruption – Minor, Moderate, Severe

2 30% / 60% / 90% — Desired restoration times for percentage of elements within the cluster

3 x — Anticipated performance for 90 % restoration of cluster for existing buildings and infrastructure systems
Cluster recovery times will be shown on the Summary Matrix

4 Indicate levels of support anticipated by plan
R = Regional; S= State; MS=Multi-State; C = Civil (Corporate/Local)

Electrical Energy Infrastructure Performance Goals Table

Disturbance [1]	
Hazard Type	Any
Hazard Level	Routine, Design, Extreme
Affected Area	Localized, Community, Regional
Disruption Level	Usual, Moderate, Severe

Restoration Levels [2,3]	
30%	Function Restored
60%	Function Restored
90%	Function Restored
X	Anticipated Performance

Building Clusters	Support Needed[4]	Design Hazard Performance								
		Phase 1: Short-Term			Phase 2: Intermediate			Phase 3: Long-Term		
		Days			Weeks			Months		
		0	1	1-3	1-4	4-8	8-12	4	4-24	24+
Power - Electric Utilities										
Community Owned or Operated Bulk Generation										
Generation Requiring Fuel Transport (Coal, Gas, Oil fired)										
In Place Fueled Generation (Hydro, solar, wind, wave, compressed air)										
Storage (Thermal, Chemical, Mechanical)										
Community Owned or Operated Distributed Generation										
Generation Requiring Fuel Transport (Coal, Gas, Oil fired)										
In Place Fueled Generation (Hydro, solar, wind, wave, compressed air)										
Storage (Thermal, Chemical, Mechanical)										
Transmission and Distribution (including Substations)										
Critical Facilities										
Critical Medical										
Emergency Operations Center										
Critical Government										
Critical City Services										
Critical Commercial										
Emergency Housing										
Skilled Nursing Facilities										
Emergency Medical										
Public Information Centers										
Emergency Shelters										
Emergency Retail										
Housing/Neighborhood										
Essential City Services										
Essential Retail										
Essential Medical										
Essential Non-Governmental Organizations										
Residential Housing										
Schools										
Essential City Services										
Community Recovery										
Commercial										
Industrial										
Manufacturing										
Colleges and Universities										

Footnotes:

1 Specify hazard type being considered
Specify hazard level – Routine, Design, Extreme
Specify the anticipated size of the area affected – Local, Community, Regional
Specify anticipated severity of disruption – Minor, Moderate, Severe

2 30% 60% 90% Desired restoration times for percentage of elements within the cluster

3 x Anticipated performance for 90 % restoration of cluster for existing buildings and infrastructure systems
Cluster recovery times will be shown on the Summary Matrix

4 Indicate levels of support anticipated by plan
R = Regional; S= State; MS=Multi-State; C = Civil (Corporate/Local)

Communication Infrastructure Performance Goals Table

Disturbance [1]	
Hazard Type	Any
Hazard Level	Routine, Design, Extreme
Affected Area	Localized, Community, Regional
Disruption Level	Usual, Moderate, Severe

Restoration Levels [2,3]	
30%	Function Restored
60%	Function Restored
90%	Function Restored
X	Anticipated Performance

Building Clusters	Support Needed[4]	Design Hazard Performance								
		Phase 1: Short-Term			Phase 2: Intermediate			Phase 3: Long-Term		
		Days			Weeks			Months		
		0	1	1-3	1-4	4-8	8-12	4	4-24	24+
Core and Communications Buildings										
Communications Hub (e.g., Central Office, IXP, Data Centers, etc.)										
First/Last Mile										
Critical Facilities										
Critical Medical										
Emergency Operations Center										
Critical Government										
Critical City Services										
Critical Commercial										
Emergency Housing										
Skilled Nursing Facilities										
Emergency Medical										
Public Information Centers										
Emergency Shelters										
Emergency Retail										
Housing/Neighborhoods										
Essential City Services										
Essential Retail										
Essential Medical										
Essential Non-Governmental Organizations										
Residential Housing										
Schools										
Essential City Services										
Community Recovery Infrastructure										
Commercial										
Industrial										
Manufacturing										
Colleges and Universities										

Footnotes:

1 Specify hazard type being considered
Specify hazard level – Routine, Design, Extreme
Specify the anticipated size of the area affected – Local, Community, Regional
Specify anticipated severity of disruption – Minor, Moderate, Severe

2 30% / 60% / 90% — Desired restoration times for percentage of elements within the cluster

3 X — Anticipated performance for 90 % restoration of cluster for existing buildings and infrastructure systems
Cluster recovery times will be shown on the Summary Matrix

4 Indicate levels of support anticipated by plan
R = Regional; S= State; MS=Multi-State; C = Civil (Corporate/Local)

Water Infrastructure Performance Goals Table

Disturbance [1]	
Hazard Type	Any
Hazard Level	Routine, Design, Extreme
Affected Area	Localized, Community, Regional
Disruption Level	Usual, Moderate, Severe

Restoration Levels [2,3]	
30%	Function Restored
60%	Function Restored
90%	Function Restored
X	Anticipated Performance

Building Clusters	Support Needed[4]	Design Hazard Performance								
		Phase 1: Short-Term			Phase 2: Intermediate			Phase 3: Long-Term		
		Days			Weeks			Months		
		0	1	1-3	1-4	4-8	8-12	4	4-24	24+
Source										
Raw or source water and terminal reservoirs										
Raw water conveyance (pump stations and piping to WTP)										
Water Production										
Well and/or Treatment operations functional										
Transmission (including Booster Stations)										
Backbone transmission facilities (pipelines, pump stations, and tanks)										
Water for fire suppression at key supply points (to promote redundancy)										
Control Systems										
SCADA or other control systems										
Distribution										
Critical Facilities										
Critical Medical										
Emergency Operations Center										
Critical Government										
Critical City Services										
Critical Commercial										
Emergency Housing										
Skilled Nursing Facilities										
Emergency Medical										
Public Information Centers										
Emergency Shelters										
Emergency Retail										
Housing/Neighborhoods										
Essential City Services										
Essential Retail										
Essential Medical										
Essential Non-Governmental Organizations										
Residential Housing										
Schools										
Essential City Services										
Community Recovery Infrastructure										
Commercial										
Industrial										
Manufacturing										
Colleges and Universities										

Footnotes:

1 Specify hazard type being considered
Specify hazard level – Routine, Design, Extreme
Specify the anticipated size of the area affected – Local, Community, Regional
Specify anticipated severity of disruption – Minor, Moderate, Severe

2 30% / 60% / 90% — Desired restoration times for percentage of elements within the cluster

3 X — Anticipated performance for 90 % restoration of cluster for existing buildings and infrastructure systems
Cluster recovery times will be shown on the Summary Matrix

4 Indicate levels of support anticipated by plan
R = Regional; S= State; MS=Multi-State; C = Civil (Corporate/Local)

Wastewater Infrastructure Performance Goals Table

Disturbance [1]	
Hazard Type	Any
Hazard Level	Routine, Design, Extreme
Affected Area	Localized, Community, Regional
Disruption Level	Usual, Moderate, Severe

Restoration Levels [2,3]	
30%	Function Restored
60%	Function Restored
90%	Function Restored
X	Anticipated Performance

Building Clusters	Support Needed[4]	Design Hazard Performance								
		Phase 1: Short-Term			Phase 2: Intermediate			Phase 3: Long-Term		
		Days			Weeks			Months		
		0	1	1-3	1-4	4-8	8-12	4	4-24	24+
Treatment Plants										
Treatment plants operating with primary treatment and disinfection										
Treatment plants operating to meet regulatory requirements										
Trunk Lines										
Backbone collection facilities (major trunk line, pump stations, siphons, relief mains, aerial crossings)										
Flow equalization basins										
Control Systems										
SCADA and other control systems										
Collection Lines										
Critical Facilities										
Critical Medical										
Emergency Operations Center										
Critical Government										
Critical City Services										
Critical Commercial										
Emergency Housing										
Skilled Nursing Facilities										
Emergency Medical										
Public Information Centers										
Emergency Shelters										
Emergency Retail										
Housing/Neighborhoods										
Essential City Services										
Essential Retail										
Essential Medical										
Essential Non-Governmental Organizations										
Residential Housing										
Schools										
Essential City Services										
Community Recovery Infrastructure										
Commercial										
Industrial										
Manufacturing										
Colleges and Universities										

Footnotes:

1 Specify hazard type being considered
Specify hazard level – Routine, Design, Extreme
Specify the anticipated size of the area affected – Local, Community, Regional
Specify anticipated severity of disruption – Minor, Moderate, Severe

2 30% / 60% / 90% — Desired restoration times for percentage of elements within the cluster

3 X — Anticipated performance for 90 % restoration of cluster for existing buildings and infrastructure systems
Cluster recovery times will be shown on the Summary Matrix

4 Indicate levels of support anticipated by plan
R = Regional; S= State; MS=Multi-State; C = Civil (Corporate/Local)

Summary Performance Goal Table

Disturbance [1]	
Hazard Type	Any
Hazard Level	Routine, Design, Extreme
Affected Area	Localized, Community, Regional
Disruption Level	Usual, Moderate, Severe

Restoration Levels [2,3]	
30%	Function Restored
60%	Function Restored
90%	Function Restored
X	Anticipated Performance

Building Clusters	Design Hazard Performance								
	Phase 1: Short-Term			Phase 2: Intermediate			Phase 3: Long-Term		
	Days			Weeks			Months		
	0	1	1-3	1-4	4-8	8-12	4	4-24	24+
Critical Facilities									
Buildings									
Transportation									
Energy									
Water									
Wastewater									
Communications									
Emergency Housing									
Buildings									
Transportation									
Energy									
Water									
Wastewater									
Communications									
Housing/Neighborhoods/Businesses									
Buildings									
Transportation									
Energy									
Water									
Wastewater									
Communications									
Community Recovery									
Buildings									
Transportation									
Energy									
Water									
Wastewater									
Communications									

Footnotes:

1 Specify hazard type being considered
Specify hazard level – Routine, Design, Extreme
Specify the anticipated size of the area affected – Local, Community, Regional
Specify anticipated severity of disruption – Minor, Moderate, Severe

2 30% / 60% / 90% — Desired restoration times for percentage of elements within the cluster

3 X — Anticipated performance for 90 % restoration of cluster for existing buildings and infrastructure systems
Cluster recovery times will be shown on the Summary Matrix