



Measuring Community Resilience

*National Academy of Sciences
Measuring Community Resilience
Consensus Study
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Stephen A. Cauffman
National Institute of Standards and Technology

Guiding Premise

- Communities are socio-technical systems
- Buildings and infrastructure enable social and economic function
- Social and economic needs and functions should drive the goals for performance of buildings and physical infrastructure



Challenges

- What should the community be resilient to?
- How to account for interconnected nature of buildings and infrastructure?
- How to identify performance gaps (“measure”) resilience?

Hazards

- Natural hazards
- Technological hazards
- Human-caused hazards
- Degradation



Hazard Level

- Routine
- Expected
- Extreme



Planning Guide Outline

Volume 1 - Methodology

Executive Summary

- Introduction
- 6 Step Methodology
- Planning Example – Riverbend
- Glossary and Acronyms

Volume 2 - Reference

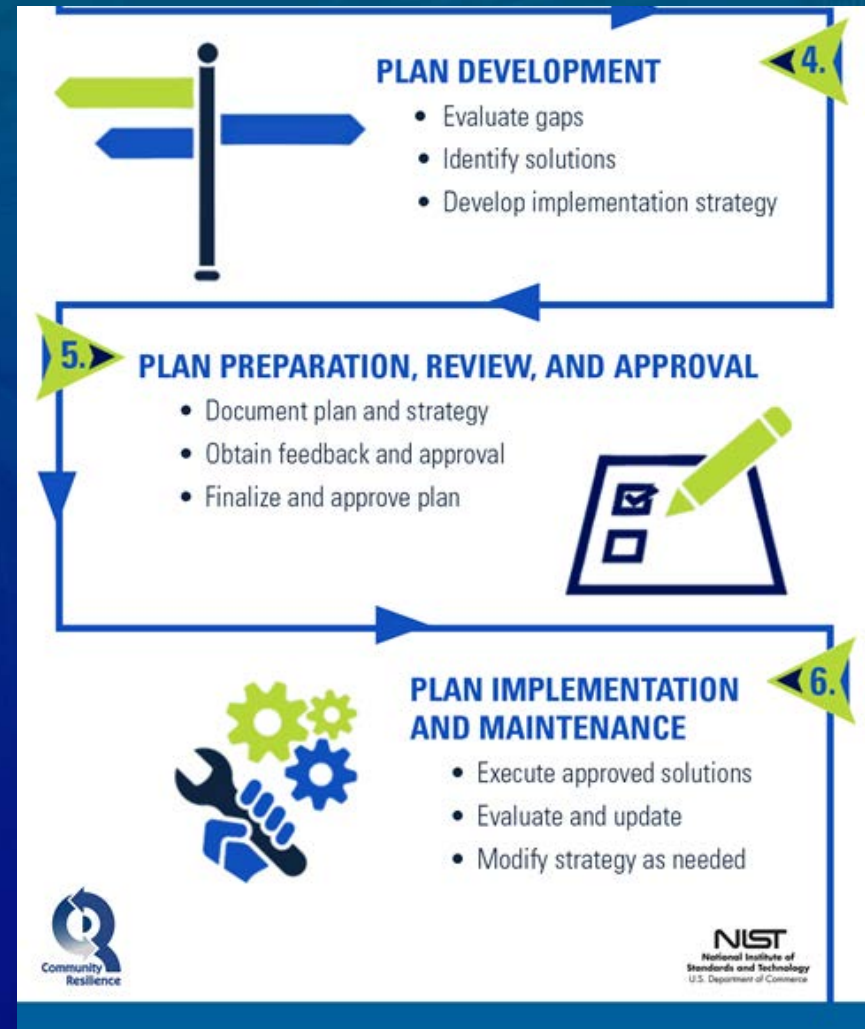
Executive Summary

- **Social** Community
- Dependencies and Cascading Effects
- **Buildings**
- **Transportation** Systems
- **Energy** Systems
- **Communications** Systems
- **Water & Wastewater** Systems
- Community Resilience Metrics



Planning Steps for Community Resilience

SIX-STEP GUIDE TO PLANNING FOR COMMUNITY RESILIENCE



Approach

- Characterize social and economic functions of the community
 - Importance
 - When needed following disruption (recovery time objective)
- Characterize buildings and infrastructure
 - Consider building “clusters” (like function and construction, e.g., single family housing)
 - Functional goals (to meet social and economic needs)
 - Consider dependencies
 - Establish recovery time objective



Example Matrix: Building Performance Goals

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+
		Building Performance Category								
A			B			C		D		
Critical Facilities										
Emergency Operation Centers	R, S, MS	90%						X		
First Responder Facilities	R, S, MS	90%						X		
Memorial Hospital	R, S, MS	90%						X		
Non-ambulatory Occupants (prisons, nursing homes, etc.)	R, S, MS	90%						X		
National Aircraft Parts Factory (NAP)	R, S, C	90%						X		
Emergency Housing										
Temporary Emergency Shelters	R, S	30%	90%						X	
Single and Multi-family Housing (Shelter in place)	R, S	60%			90%				X	
Housing/Neighborhood										
Critical Retail	R, S, C		30%	60%	90%				X	
Religious and Spiritual Centers	R, S			30%	60%	90%			X	
Single and Multi-family Housing (Full Function)	R, S			30%		60%	90%		X	
Schools	R, S			30%	60%	90%			X	
Hotels & Motels	R, S, C			30%		60%	90%		X	
Community Recovery										
Businesses – Manufacturing (except NAP)	R, S, C				30%	60%	90%		X	
Businesses - Commodity Services	R, S, C				30%	60%		90%	X	
Businesses - Service Professions	R, S, C				30%		60%	90%	X	
Conference & Event Venues	R, S, C				30%		60%	90%	X	



Example Matrix: Transportation Infrastructure

Transportation Infrastructure	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
Ingress (goods, services, disaster relief)									
Local Roads	R, S	60%	90%	X					
State Highways and Bridge	R, S	60%	90%		X				
Regional Airport	R, S		30%	60%	90%		X		
Egress (emergency egress, evacuation, etc.)									
Local Roads	R, S	60%	90%	X					
State Highways and Bridge	R, S	60%	90%		X				
Regional Airport	R, S		30%	60%	90%		X		
Community resilience									
Critical Facilities									
Hospitals	R, S	60%	90%	X					
Police and Fire Stations	R, S	60%	90%	X					
Emergency Operational Centers	R, S	60%	90%	X					
Emergency Housing									
Residences	R, S	30%	60%	90%	X				
Emergency Responder Housing	R, S	30%	60%	90%	X				
Public Shelters	R, S	90%		X					
Housing/Neighborhoods									
Essential City Service Facilities	R, S	30%	60%	90%	X				
Schools	R, S	30%	60%	90%	X				
Medical Provider Offices	R, S	30%	60%	90%	X				
Retail	R, S	30%	60%	90%	X				
Community Recovery									
Residences	R, S	30%	60%	90%	X				
Neighborhood retail	R, S	30%	60%	90%	X				
Offices and work places	R, S	30%	60%	90%	X				
Non-emergency City Services	R, S	30%	60%	90%	X				
All businesses	R, S		30%	60%	90%	X			



Example Matrix: Energy Infrastructure

Energy Infrastructure	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 Owner or Operated Bulk Generation										
In Place Fueled Generation (Hydro, solar, wind, wave, compressed air)	R/C	90%	X							
Transmission and Distribution (including Substations)										
Critical Response Facilities and Support Systems										
Hospitals, Police and Fire Stations / Emergency Operations Centers	R, C	60%	90%	X						
Disaster debris / recycling centers/ related lifeline systems	R, C	60%	90%	X						
Emergency Housing and Support Systems										
Public Shelters / Nursing Homes / Food Distribution Centers	R, C		60%	90%	X					
Emergency shelter for response / recovery workforce/ Key Commercial and Finance	R, C		60%	90%	X					
Housing and Neighborhood infrastructure										
Essential city services / schools / Medical offices	R, C		60%	90%	X					
Houses of worship/meditation/ exercise	C		60%	90%	X					
Buildings/space for social services (e.g., child services) and prosecution activities	C		60%	90%	X					
Community Recovery Infrastructure										
Commercial and industrial businesses / Non-emergency city services	C			90%	X					
Residential housing restoration	R, S, MS, C			90%	X					



Example Matrix: Water Infrastructure

Water Infrastructure	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	R, S			90%						
Raw water conveyance (pump stations, piping to WTP)	R, S				90%				X	
Potable water at supply (WTP, wells, impoundment)	R, S	30%		60%	90%			X		
Water for fire suppression at key supply points (to promote redundancy)	R, S	90%			X					
Transmission (including Booster Stations)										
Backbone transmission facilities (pipelines, pump stations, and tanks)	R, S	90%					X			
Control Systems										
SCADA or other control systems	R, S	30%		60%	90%		X			
Distribution										
Critical Facilities										
Wholesale Users (other communities, rural water districts)	R, S		60%	90%			X			
Hospitals, EOC, Police Station, Fire Stations	R, S		60%	90%			X			
Emergency Housing										
Emergency Shelters	R, S		60%	90%			X			
Housing/Neighborhoods										
Drinking water available at community distribution centers	R, S			60%	90%					
Water for fire suppression at fire hydrants	R, S				90%				X	
Community Recovery Infrastructure										
All other clusters	R, S			30%	90%				X	



Example Summary Resilience Matrix

Infrastructure	Recovery Time								
	Days 0	Days 1	Days 1-3	Wks 1-4	Wks 4-8	Wks 8-12	Mos 4	Mos 4-24	Mos 24+
Critical Facilities									
Buildings	90%							X	
Transportation		90%	X						
Energy		90%	X						
Water			90%		X				
Wastewater				90%				X	
Communication		90%		X					
Emergency Housing									
Buildings									
Transportation									
Energy									
Water					X				
Waste Water									
Communication				90%	X				
Housing/Neighborhoods									
Buildings						90%			X
Transportation			90%	X					
Energy			90%	X					
Water				90%				X	
Waste Water					90%			X	
Communication				90%			X		
Community Recovery									
Buildings								90%	X
Transportation				90%	X				
Energy			90%	X					
Water				90%				X	
Waste Water							90%	X	
Communication				90%			X		

Desired Performance

Anticipated Performance



Superstorm Sandy



Summary and Next Steps

- NIST is working with its partners in the Center for Risk-Based Community Resilience, led by Colorado State University, to develop tools to model resilience at the community scale
- Rather than focus on a single measure, NIST's efforts seek to develop tools to identify performance gaps and evaluate possible solutions
- Recovery time objective is a lagging indicator
- Also considering leading indicators (predictors) of resilience outcomes
- The goal is to provide tools and guidance that encourage incorporating resilience into community planning



NIST Contact

Website:

<http://www.nist.gov/el/resilience/>

Guide:

<http://www.nist.gov/el/resilience/guide.cfm>

Or google “NIST Resilience Planning Guide”

General E-mail: resilience@nist.gov



Questions?

