2017 AASHTO Resiliency
Peer Exchange
Washington, DC
November 6-7, 2017

A Guide to Community Resilience Planning for Buildings and Infrastructure Systems

Therese McAllister, PE, PhD
Community Resilience Group Leader
and Program Manager
National Institute of Standards and Technology

NIST
National Institute of
Standards and Technology
U.S. Department of Commerce

Why Community Resilience Planning?

- All communities face potential disruption from hazards and must face the consequences.
- Disasters can take a high toll in lives, livelihoods, and quality of life – the impact can be reduced by better managing risks.
- Planning and implementing prioritized measures can improve a community's ability to restore vital services in a timely way – and build back better.
- The built environment exists to serve social functions (e.g., a hospital provides healthcare). Therefore, social functions should drive the performance goals of buildings and physical infrastructure.

Cedar Rapids, Iowa 2008 floods

Hurricane Sandy 2012

How is Resilience Defined?

- Resilience is defined as:
  - "the ability to prepare for and adapt to changing conditions and to withstand and recover rapidly from disruptions.
  - Resilience includes the ability to withstand and recover from deliberate attacks, accidents, or naturally occurring threats or incidents." (PPD-21)

New Orleans Flooding in 2005 (FEMA)

- In the context of community resilience, the emphasis is not solely on mitigating risk, but on ensuring that a community recovers its functions within a defined timeframe.

Key Concepts for Infrastructure Resilience

- Context
  - What is the role of the infrastructure in the community, including its recovery?
- Functionality
  - Time to recovery of function should be tied to community social needs.
- Dependencies
  - No system is an island.

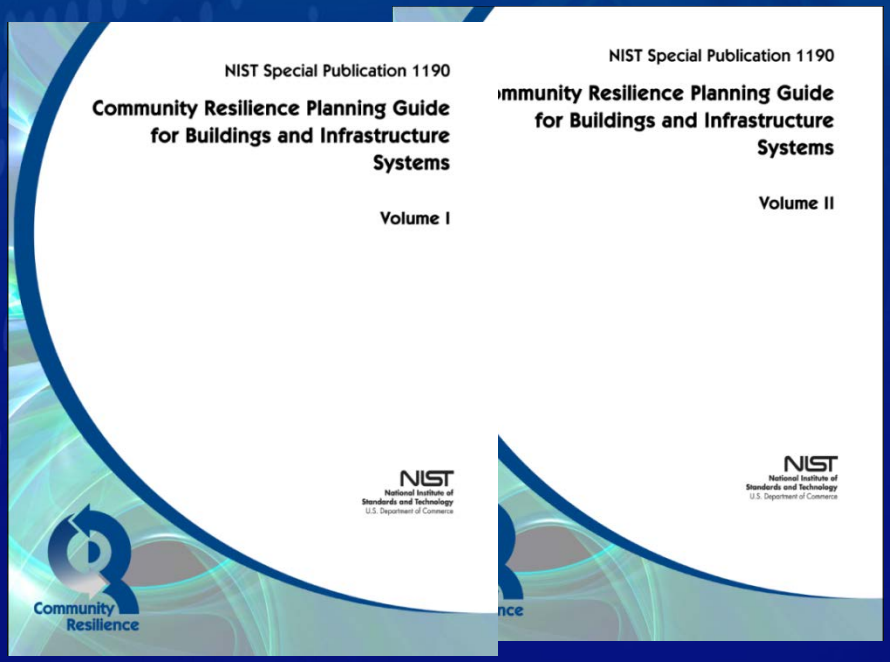
NIST Planning Guide Basics

- A *practical, flexible methodology* to help set priorities, allocate resources, and manage risks…improving resilience.
- Offers a way to turn resilience concepts into action – both short and long-term considerations.
- Developed with private and public sector experts, the Guide can help communities to:
  - Set goals and develop resilience plans for both public and private systems.
  - Identify collaborative plans and actions to improve resilience.

Planning Guide Outline

Volume 1 - Methodology

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



Volume 2 - Reference

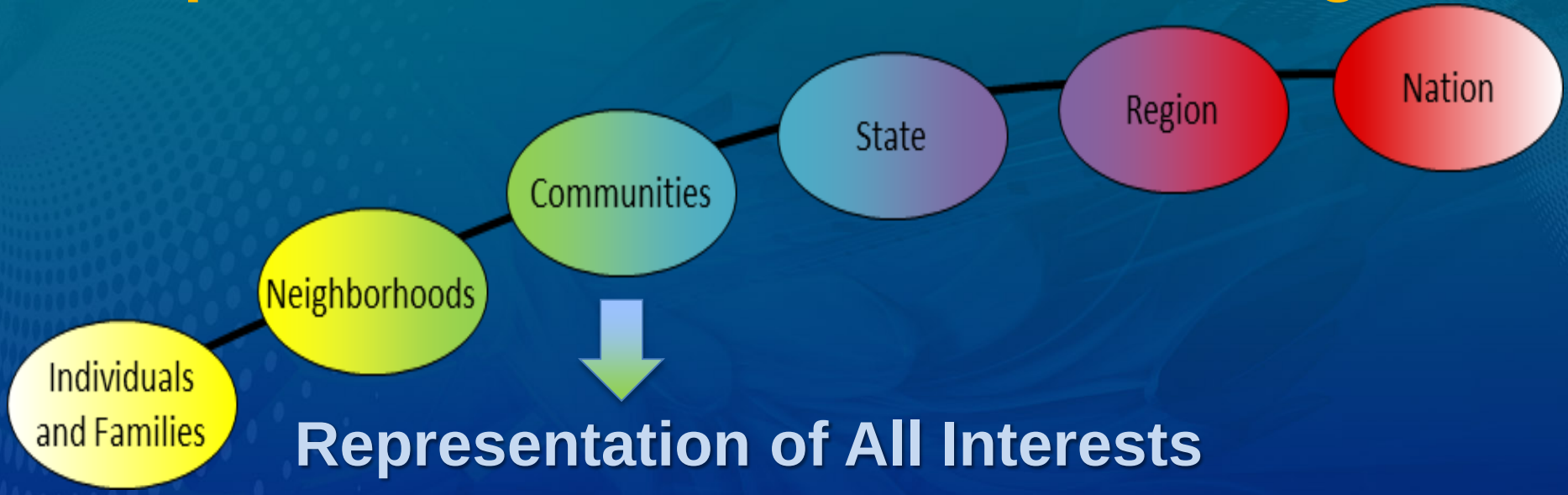
- Social Institutions
- Dependencies and Cascading Effects
- Buildings
- ***Transportation Systems***
- Energy Systems
- Communications Systems
- Water & Wastewater Systems
- Community Resilience Metrics

Transportation Chapter

- Roadways, airports, marine ports, rail, subway, etc.
- Performance goals
  - Ingress (goods, services, emergency response)
  - Egress (evacuation)
  - Community Recovery
    - Critical Facilities (hospitals, police, fire, EOC)
    - Emergency Housing (shelters, emergency responder housing)
    - Housing and Neighborhoods (schools, business)
    - Community Recovery
- Regulations, codes, standards
- Strategies for implementing community resilience
  - Maintain and manage, strengthen and protect, enhance redundancy, retreat

Six Steps for Community Resilience

Step 1. Form a Collaborative Planning Team



Representation of All Interests

Public

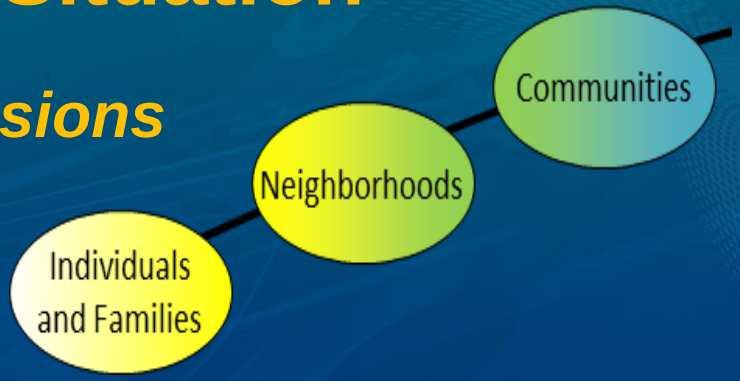
- Elected Officials
- Local Government
- Transportation
- Water and Wastewater

Private

- Business and Services
  - Banking, Health
  - Power and Communications
  - Media
- Organizations
  - NGOs (VOAD, Relief)

Step 2. Understand the Situation

a. Characterize the Social Dimensions

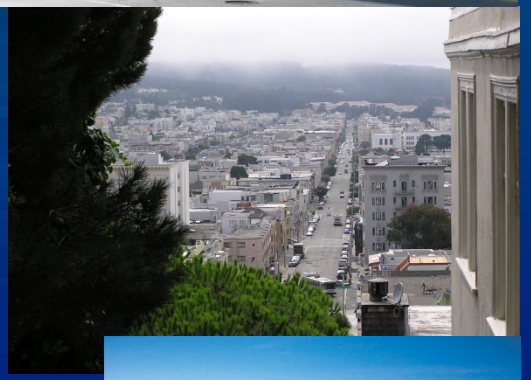


- Community members
  - Present and future needs
  - Demographics and economic indicators
  - Social capital and vulnerabilities
- Social institutions
  - Community services and functions
  - Gaps in capacity
  - Dependencies on other institutions

Maslows Hierarchy

Step 2. Understand the Situation

b. Characterize the Built Environment



Buildings

Structures, including equipment and contents, that house people and support social institutions

Building Clusters

A set of buildings that serve a common function such as housing, healthcare, etc.

Infrastructure Systems

Physical networks that support and link structures – transportation, energy, communications, and water systems

Dependencies

Internal, External, Time, Space

Step 2. Understand the Situation

c. Link Social Functions and Built Environment (Context)

Some rely more on the built environment

Emergency Rooms

Industrial Plants

Some functions change

Schools → Shelters

Step 3. Establish Desired Performance Goals for the Built Environment

- Performance goals are independent of hazard events.
  - Community functions are needed during recovery, such as acute health care, 911 call centers, emergency response
  - Consider role of a facility or system in the community.
- Define goals in terms of *time needed to restore functionality*.
  - Use goals to help prioritize repair and reconstruction efforts.
  - Goals may suggests criteria for new construction and retrofit of existing construction.

Example Summary Table

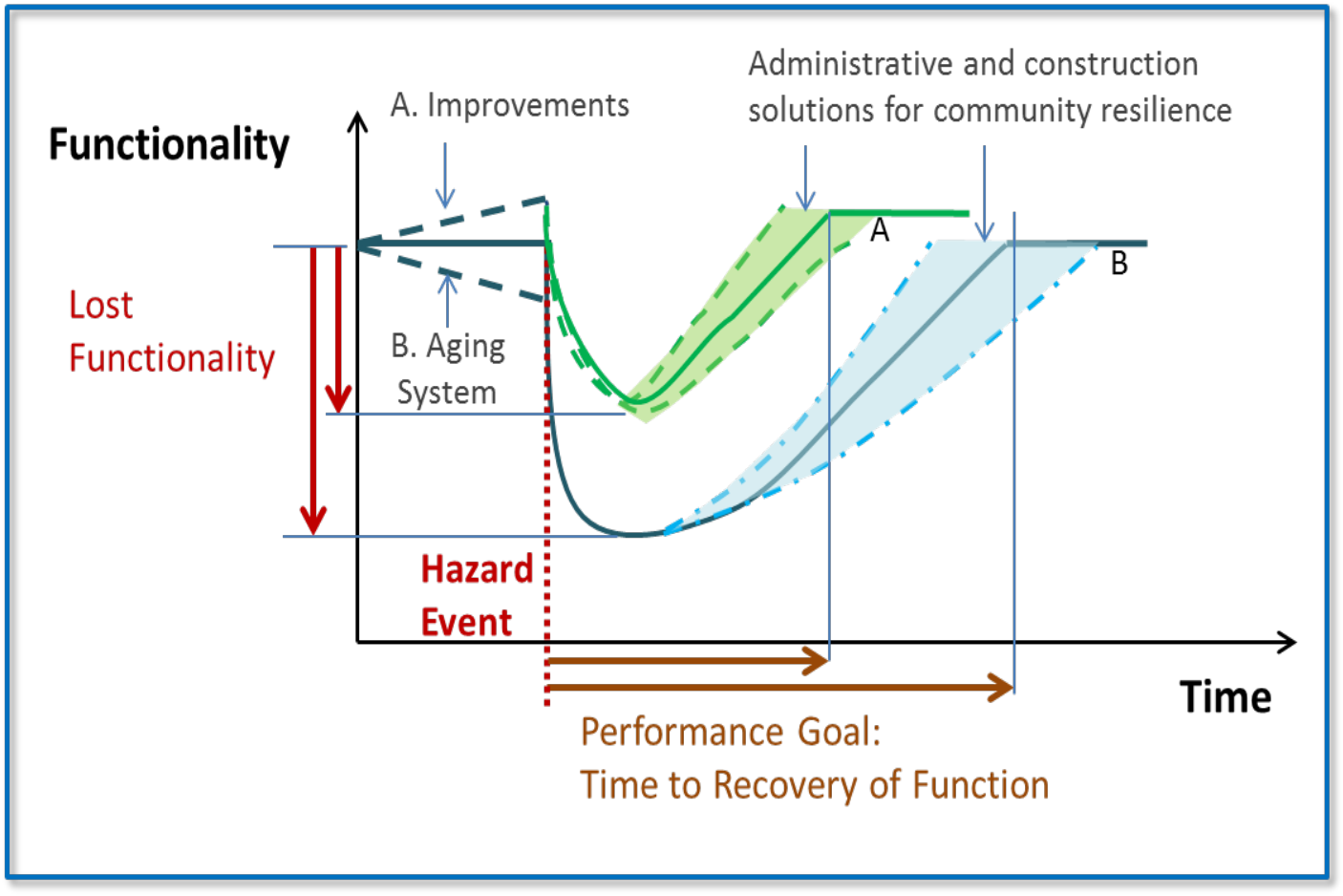
Infrastructure	Recovery Time								
	Days 0	Days 1	Days 1-3	Wks 1-4	Wks 4-8	Wks 8-12	Mos 4	Mos 4-24	Mos 24+
Critical Facilities									
Buildings	90%							X	
Transportation		90%	X						
Energy		90%	X						
Water			90%		X				
Wastewater				90%				X	
Communication		90%		X					
Emergency Housing									
Buildings				[illegible]					
Transportation				X					
Energy				X					
Water					X				
Waste Water				[illegible]					
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 for a hazard

Superstorm Sandy

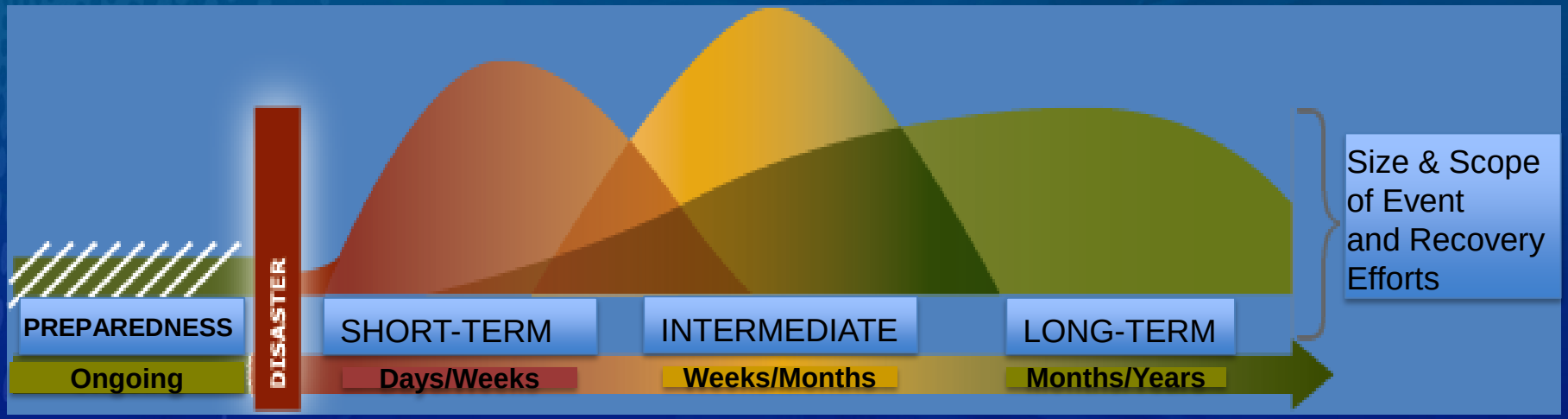
Recovery of Function



Resilience can be expressed in terms of system functionality and the time to recover functionality following a hazard event.

Recovery of the Built Environment

Prioritize restoring community functionality over time



When is each system needed for recovery?

Resilience Challenges for Transportation Systems

- Multiple system owners within a community – federal, state, local, private
- Co-location of utilities
- Critical for emergency response and starting recovery efforts – debris, supplies, personnel
- Need long-term focus to reduce chronic and acute risks and improve performance

Hurricane Irene

Hurricane Katrina

How Can You Improve Infrastructure Resilience?

- Context
  - How does the infrastructure system support community functions? Develop appropriate performance goals and criteria
  - Consider mitigation and recovery concepts together when comparing alternatives
- Functionality
  - Can recovery of function be staged with temporary measures?
  - Does its function change over time during recovery?
- Dependencies
  - What other systems depend on this system?
  - What can be done to reduce dependencies during recovery?

THANK YOU

NIST Contacts

Website: **http://www.nist.gov/el/resilience/**

Guide: **http://www.nist.gov/el/resilience/guide.cfm**

Or google “NIST Resilience Planning Guide”

Panel: **http://www.crpanel.org**

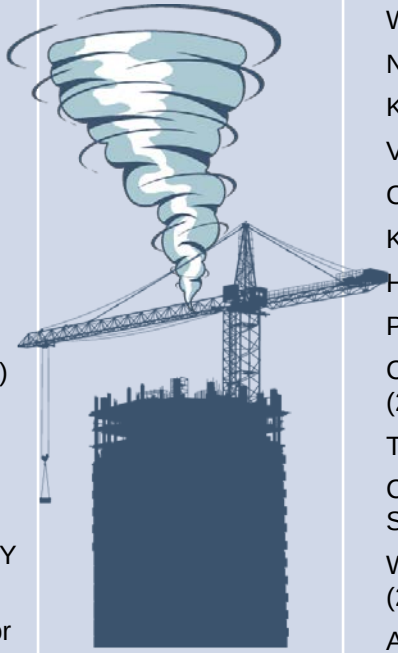
E-mail: **resilience@nist.gov**

therese.mcallister@nist.gov

cauffman@nist.gov

Why NIST? Disaster & Failure Studies

Earthquakes	Hurricanes	Construction/ Building	Tornadoes	Fires
San Fernando, CA (1971)	Camille, MS/LA (1969)	Skyline Plaza Apartments, Bailey's Crossroads, VA (1973)	Jarrell, TX (1997)	DuPont Plaza Hotel, San Juan, PR (1986)
Mexico City, Mexico (1985)	Alicia, Galveston, TX (1983)	Willow Island Cooling Tower, WV (1978)	Spencer, SD (1998)	First Interstate Bank Building, Los Angeles, CA (1988)
Loma Prieta, CA (1989)	Hugo, SC (1989)	Kansas City Hyatt Regency, Kansas City, MO (1981)	Oklahoma City, OK (1999)	Loma Prieta Earthquake, CA (1989)
Northridge, CA (1994)	Andrew, FL (1992)	Riley Road Interchange, East Chicago, IN (1982)	Joplin, MO (2011)	Hillhaven Nursing Home (1989)
Kobe, Japan (1995)	Hurricanes Mitch and Georges, LAC (1998)	Harbor Cay Condominium, Cocoa Beach, FL (1981)	Moore OK (2013)	Pulaski Building, Washington, DC (1990)
Kocaeli, Turkey (1999)	Hurricanes Katrina and Rita (2005)	L'Ambiance Plaza, Hartford, CT (1987)		Happyland Social Club, Bronx, NY (1990)
Maule, Chile (2010)		Ashland Oil Tank Collapse, Floreffe, PA (1988)		Oakland Hills, CA (1991)
Christchurch, NZ (2011)		U.S. Embassy, Moscow, USSR (1987)		Watts St, New York City (1994)
		Murrah Federal Building, Oklahoma City, OK (1995)		Northridge Earthquake, CA (1994)
		World Trade Center Disaster, New York, NY (2001)		Kobe, Japan (1995)
		Dallas Cowboys Indoor Practice Facility, May 2009		Vandalia St, New York City (1998)
				Cherry Road, Washington, DC (1999)
				Keokuk, IA (1999)
				Houston, TX (2000)
				Phoenix, AZ (2001)
				Cook County Administration Building Fire (2003)
				The Station Nightclub, RI (2003)
				Charleston, SC, Sofa Super Store Fire (2007)
				Witch Creek & Guejito, CA, WUI Fire (2007)
				Amarillo, TX, WUI Fire (2011)
				San Francisco, CA (2012)



Resilient & Sustainable Development and Climate Adaptation

- These concepts can be viewed through *time*
  - Resilience - improved performance and recovery over a long planning horizon
  - Sustainability – meeting current needs without impact on future generations
  - Climate adaptation – future conditions and events that diverge from historical patterns
- And their *goals*
  - Resilience – rapid recovery of functions
  - Sustainability – solutions that minimize social, environmental, economic impacts
  - Climate adaptation – minimize future impacts on current investments

Triple Bottom Line (US DOT)

Charleston, SC Sea Level Rise (NOAA)

Guide Development Process

- Extensive public and private sector input from organizations and individuals

What is Needed to Achieve Resilient Communities?

Status Quo

- Prescriptive codes and standards for life safety
- Poor performance during hazard events
- Emergency response planning but little resilience planning
- Reliance upon federal disaster funding for recovery

Moving Forward

- Community based performance goals – social and economic functions
- Integrated design approach for built environment
- Proactive development plans by communities that address recovery
- Reduced emergency response and recovery costs