# A Look at Your Campus with Resilience in Mind

**FGM** ARCHITECTS

**Presented by:**
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# What is Resilient Design?

- **RDI** defines **Resilience** as "the capacity to adapt to changing conditions and to maintain or regain functionality and vitality in the face of stress or disturbance.  It is the capacity to bounce back after a disturbance or interruption."

- College campuses are community resources that are subjected to **Destructive Forces**.

- **Responsibility** to design facilities in response to these vulnerabilities.  Essential mindsets and design strategies.

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# Educational Facilities

- Future of learning, communities
- Shelter from disasters
- Physical, mental health and well being

# Resiliency

- The ability to prepare and plan for, absorb, recover from, and more successfully adapt to adverse events.

Essential Mindsets

Design Strategies

# Essential Mindset

## Building Resilience

**Shocks**
Threats & Hazards



- Riot/Civil Unrest
- Heat Wave
- Tornado
- Flooding

- Endemic Violence
- Educational Disparities
- Declining Populations
- Aging Infrastructure
- Health and Well Being

# Shared Attributes

Systems Thinking*

Diversity and Shared Goals

Integrative Design Approach

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# Systems Thinking



Building

Environment

Occupant

Community

Individual Parts

Interconnected

# Environment

Protect the Native Habitat

Water Efficiency*

Plan the Site

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# Water Efficiency

Reduce potable water consumption

No irrigation

Reduce runoff

Improve water quality

On-site food production

Rainwater Harvesting


Missouri Botanical Gardens

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# Community

Community Engagement

Community Connectivity*

Local Investments

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# Connectivity

Walkability

Non-Motorized
Transit

Public Transit

Crisis and
Health Services

Green
Focused
Services

Social Equity

Economic
Vitality

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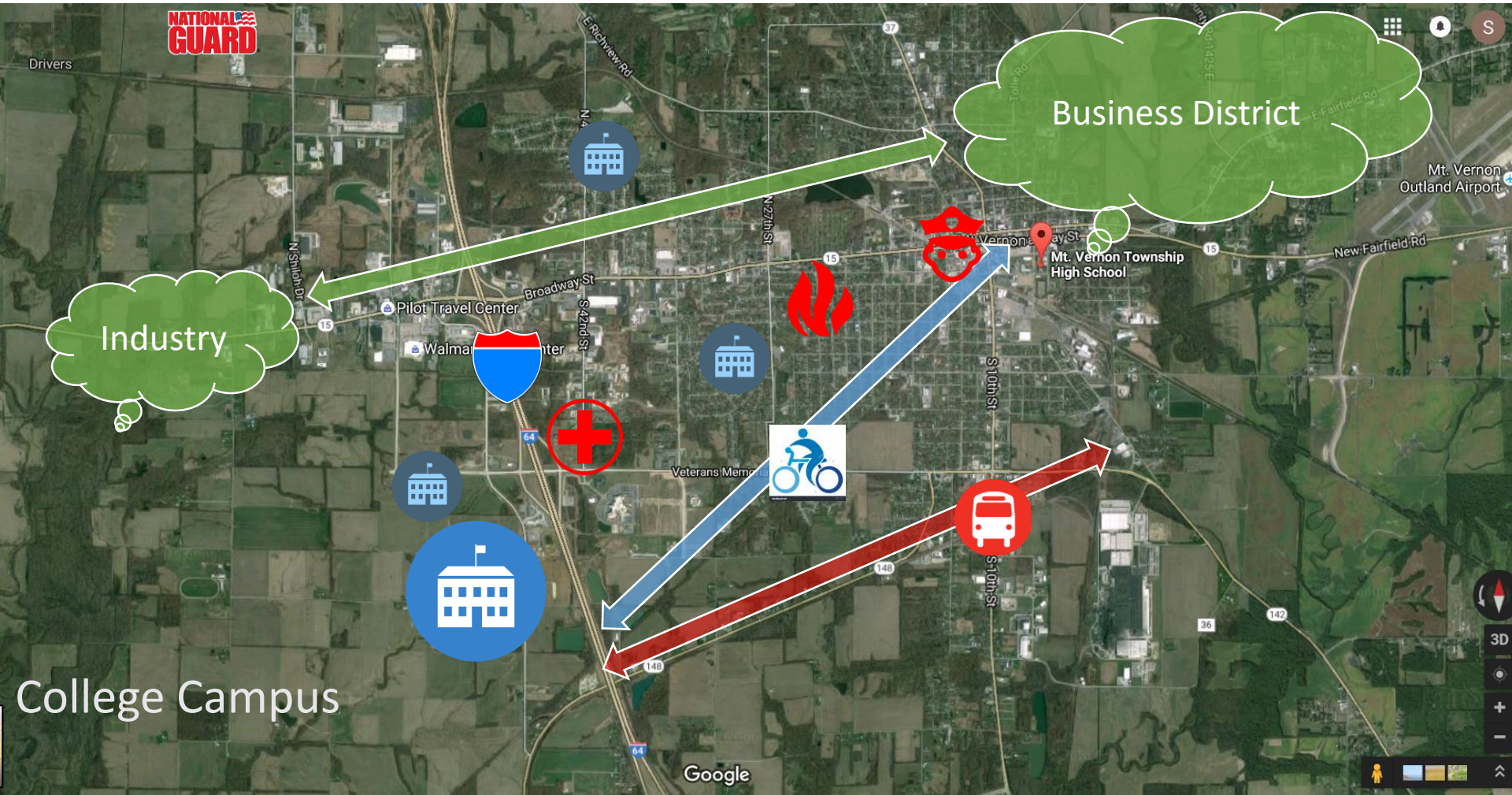
# Community Connectivity

# Building

Performance and Productivity

Hazard Preparedness and Mitigation

Threats Assessment*

# Threats/Security – Trends Impacting Design

Earthquake

Wind

Snow

Rain

Flood
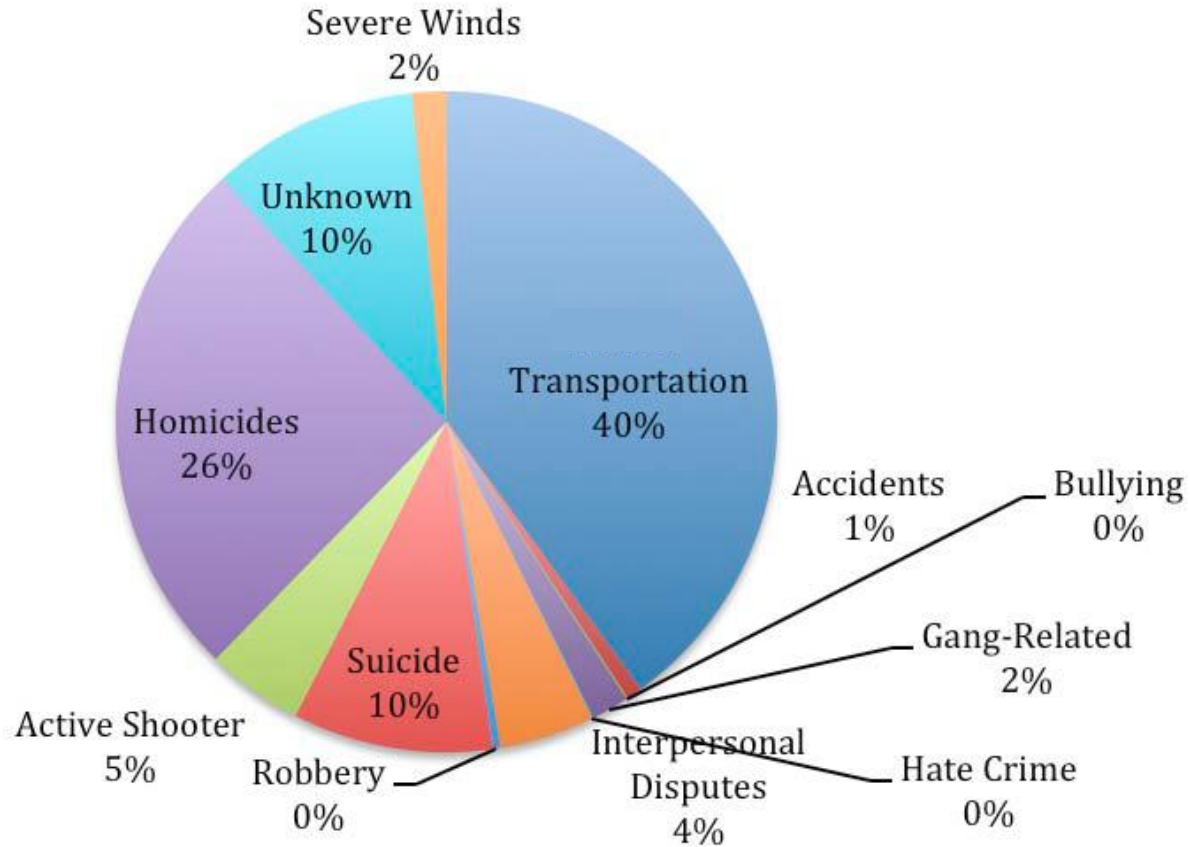
Hurricane

Water

Tornado

Hazard

Assault

Arson

Crime

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?

What is leading cause of school related fatalities?

# **Fatalities**



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# Active Shooter Threats



194 School Shootings Since 2013

# Weather Safety Disastersafety.org



**Discover the risks you face.**

Click your state on the map or enter your Zip Code below.
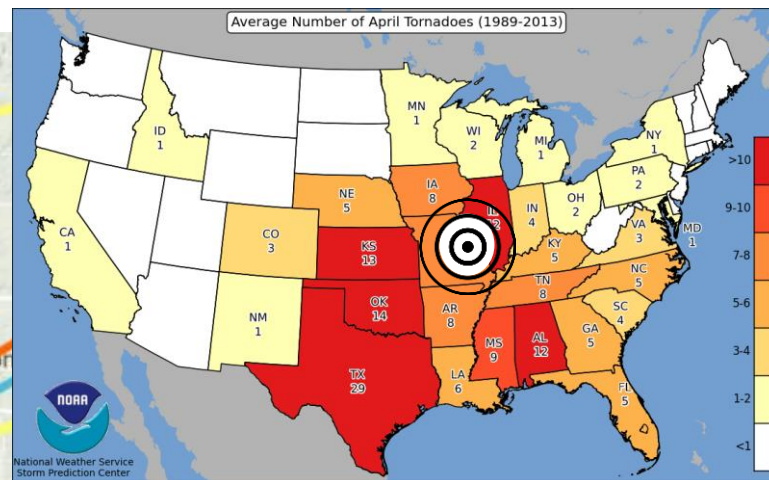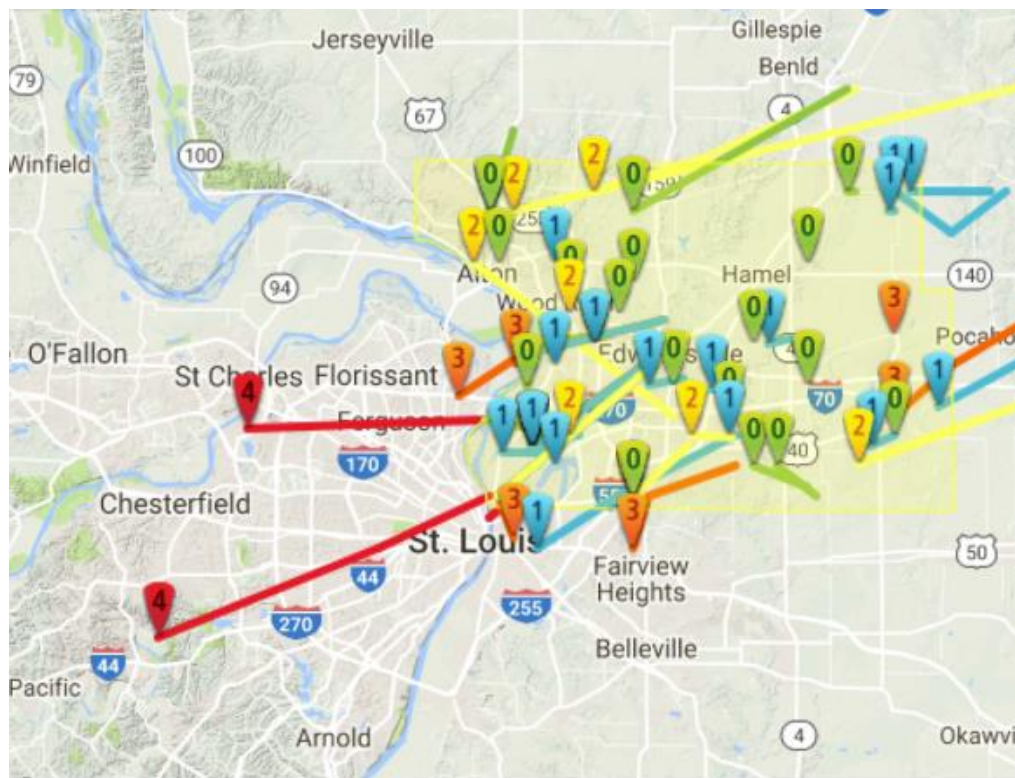
62002    GO

Results highlighted below ⬇

| THIS IS A RISK YOU FACE IN YOUR AREA | THIS IS A RISK YOU FACE IN YOUR AREA | THIS IS A RISK YOU FACE IN YOUR AREA |
|---|---|---|
| Earthquake ✔ | Flood ✔ | Hail ✔ |
| Hurricane | Water ✔ | Storm ✔ |
| Tornado ✔ | Fire ✔ | Snow ✔ |

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# Weather Safety:
## [TornadoHistoryProject.com](TornadoHistoryProject.com)



| Date(s) (yyyy-mm-dd) | Tornadoes | Fatalities | Highest Fatalities | Injuries | Highest Injuries | Longest Path | Widest Path |
|---|---|---|---|---|---|---|---|
| 1950-01-03 - 2014-02-20 | 56 | 27 people | 21 people | 468 people | 345 people | 156.7 miles | 1000 yards |

# Emergency / Hazard Planning

## Emergency Generator

- Lighting
- Exit signs
- Communications
- Command center
- Fire alarm
- Coolers and freezers

## Manual Transfer Switch

- Portable generator
- Lights and heating at gyms, locker rooms kitchen, cafeteria maintenance
- Kitchen equipment

**Food Prep**

**Locker rooms**

**Assembly**
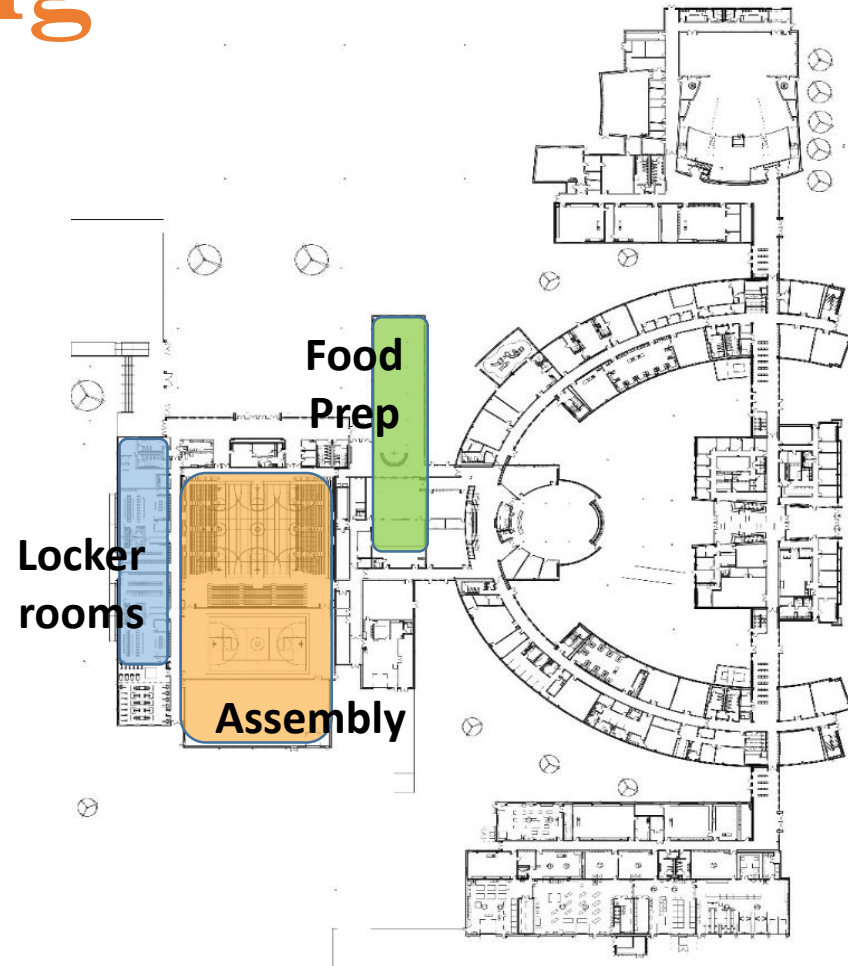
# Reinforced Design for Hazards

- 38 individual rooms
- 8 locations
- 2,800 occupants

Educational Facility

# Site Avoidance

- Site Access
- Safety during emergencies

Educational Facility

# Site Avoidance

- December 30, 2015
- <u>No</u> Site Access
- <u>No</u> Building Access
- <u>No</u> Community Services

Eureka, MO

# Occupant Health And Well Being

**WELL**

IS FOR PEOPLE

# Design Strategies

### Occupant health outcomes:

The physical factors influence the health of occupiers which can be measured or evaluated.

Health:
- Headaches
- Eye strain/damage
- Skin irritation
- Infections
- Fatigue
- Season Affective Disorder
- Asthma & breathing disorders
- Stress & depression
- Other physical complaints, e.g. back ache
- Other serious disorders, including cardio vascular etc.

### Occupant well-being and Perception outcomes:

Health is an important element of well-being, but an occupant's sense of well-being is also comprised of their perception of numerous factors, including how productive they think they are:

- Perceived physical health
- Perceived psychological health
- Perceived productivity
- Perceived environment
- Perceived organizational culture

### Organizational or financial Outcomes:

The environment can have a direct impact on occupant productivity, in which health and well-being is often a compounding factor. This outcome for the organization can be measured or evaluated in the following ways (not exhaustive), all of which have financial implications for the employer.

Productivity:
- Absenteeism
- Presenteeism
- Staff turnover/retention
- Revenue
- Medical Costs
- Medical Complaints
- Physical complaints
- Task efficiency & deadlines met

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# Design Strategies
## Occupant Health and Well-Being
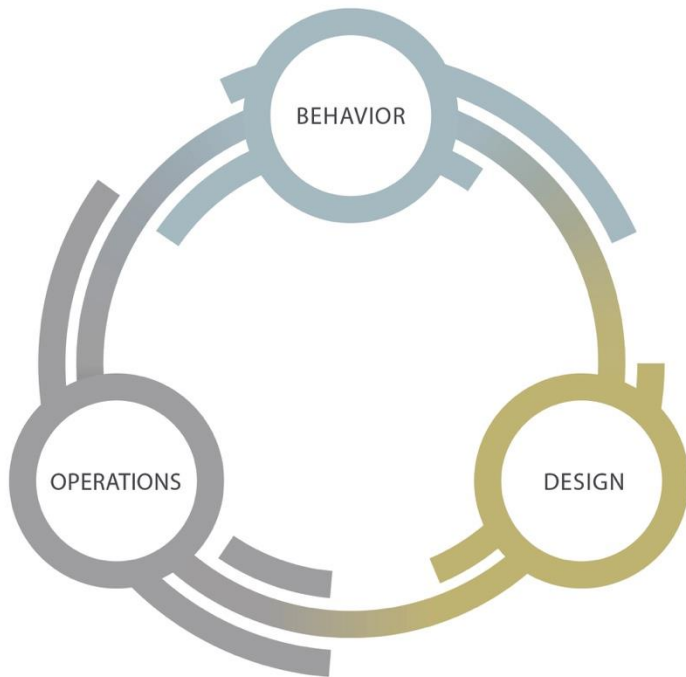


WELL Features evaluate ongoing aspects of building performance and occupant behavior to support the operations and maintenance of healthy buildings throughout the building lifecycle.

# WELL

**Building Standard**

## Seven Concepts



air

water

nourishment

light

fitness

comfort

mind

# Air Quality

## SOURCES OF INDOOR AIR QUALITY CONCERN



- **INADEQUATE VENTILATION** — 52%
- **CONTAMINATION FROM INSIDE BUILDING** — 16%
- **CONTAMINATION FROM OUTSIDE BUILDING** — 10%
- **MICROBIAL CONTAMINATION** — 5%
- **CONTAMINATION FROM BUILDING FABRIC** — 4%
- **UNKNOWN SOURCE** — 13%
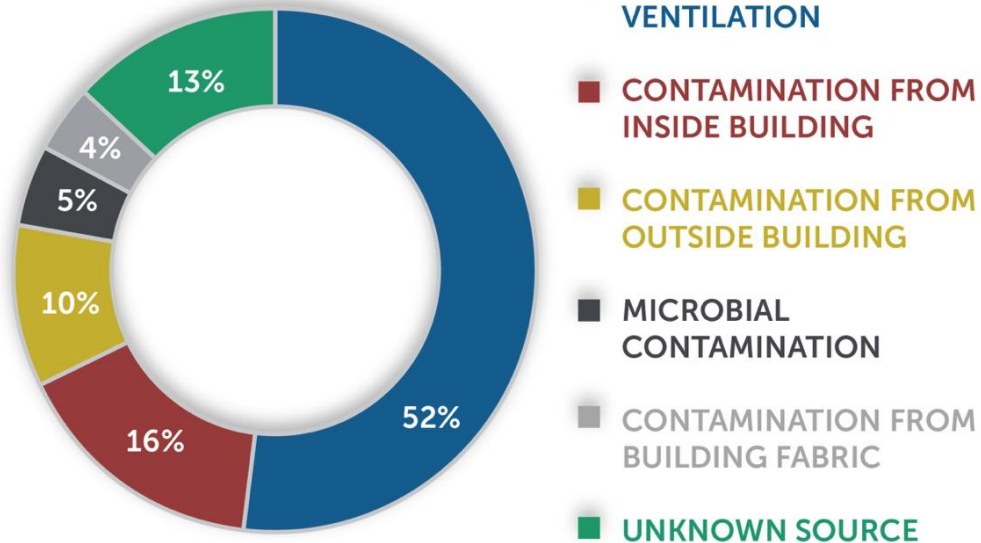
# Water Quality

## water

Promote safe and clean water through proper filtration and other methods, and require the appropriate quality of water for various uses.

*performance testing · treatment · maintenance & operations · hydration promotion*

# Light

## Circadian Lighting Emulates the Natural Environment

The eyes detect light and send this information to the brain, triggering the calibration of our 24-hour cycle. Light has impacts on human health and well-being outside of image formation and color perception – including:

*calibration of the body's biological clock and circadian rhythms*

*direct effects on alertness, mood and cognition*



morning          afternoon          evening

# Comfort

## Thermal Considerations

**4%** reduction in performance at warmer temperatures.[1]

**6%** reduction in performance at cooler temperatures.[1]

## Acoustic Considerations

**66%** drop in performance when exposed to distracting noise.[2]

[1]Lan L. Wargocki P. Wyon DP. Lian Z. (2011) Effects of Thermal Discomfort in an Office on Perceived Air Quality, SBS symptoms, physiological responses, and human performance. Indoor Air 21:5, pp. 376-90.
[2]Banbury SP. and Berry DC. (1998) Disruption of Office-related Tasks by Speech and Office Noise. British Journal of Psychology 89:3, pp. 499–517.

# Fitness

## What happens to your body when you sit for a prolonged period of time?

Calorie burning drops to less than
1 per minute.[1]

Cardiovascular, endocrine, digestive, reproductive, respiratory, muscular, skeletal and nervous systems are
negatively affected.[2]

Prolonged sitting disturbs
mood, energy levels and productivity.[3]

[1]Standing based of ce ork sho s encouraging signs of attenuating ost randial glycaemic e cursion. Buckley, J, et al. 2, s.l.: Occupational and Environmental Medicine, February 2014, Vol. 71, pp. 109-11. http://www.ncbi. nlm.nih.gov/pubmed/24297826. 10.1136/ oemed-2013-101823.
[2] IWBI Fitness Wellography, Elements of Fitness: Physical Inactivity
[3] Reducing Occupational Sitting Time and Improving Worker Health: The Take-a-Stand Project, 2011. Pronk, N, et al. s.l. : Preventing Chronic Disease, 2012, Vol. 9. http://www.cdc.gov/pcd/issues/2012/11_0323.htm. 110323.

# References

C3 Living Design Project - RELi
U.S. Green Building Council (USGBC)
ASCE – PRISM Infrastructure Resilience
Envision - Institute for Sustainable Infrastructure
Zofnass Program for Sustainable Infrastructure (Harvard)
Financial System Resilience Index (NEF)
2030 Challenge / SB2030
International Living Future Institute
Living Future
Living Building Challenge
Autodesk
2030 Palette: Design and Planning Strategies
Disaster Safety
TornadoHistoryProject
Illinois State Geological | ISGS
Red Cross

FEMA P-320, Taking Shelter from the Storm: Building a Safe Room
FEMA P-361, Safe Rooms for Tornadoes and Hurricanes
FEMA-428, Design Safe School Projects in Case of Terrorist Attacks and School Shootings
IBC 2015 – International Building Code
ICC 500-2014: ICC/NSSA Standard for the Design and Construction of Storm Shelters
NFPA 909: Code for the Protection of Cultural Resource
NFPA 13: Standard for the Installation of Sprinkler Systems
National Institute of Building Sciences
NIST Special Publication 1190
Community Resilience Planning Guide
Newsweek
Every Town

ASCE 7-10 American Society of Civil Engineers (ASCE) 2010. Minimum Design Loads For Buildings and Other Structures.
ASCE 24-14. Flood Resistant Design and Construction.
FEMA P-750 NEHRP Recommended Seismic Provisions for New Buildings and Other Structures
FEMA P-55. Coastal Construction Manual.
FEMA P-908. Mitigation Assessment Team Report
ICC 500 ICC/NSSA Standard for the Design and Construction of Storm Shelters.
IRC International Residential Code.
NOAA National Weather Service, National Hurricane Center.
WELL Building Institute

Add well building

# Resilient Communities



- **Resilient Design**
  - Shocks and Stresses Assessment
  - Resilient Design Analysis

- **Sustainable Design**
  - Low or No Cost Design Strategies
  - Energy Efficiency
  - Systems, Materials and Finishes

- **WELL Building**
  - Students, teachers and administrators
  - Air, Water, Nourishment, Light, Fitness Comfort and Mind

- **Safety and Security**
  - Crime Prevention through Environmental Design, CPTED
    Natural Surveillance, Territorial Reinforcement, Access Control and Maintenance
  - Vulnerability Assessment

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# Shocks and Stresses

| ID | Description | Likelihood (0-10) | Severity (0-10) |
|---|---|---|---|
| U | **Unintentional Act** | 7 | 3 |
| U1 | Fire/Explosion | 9 | 1 |
| U2 | Health Emergency | 8 | 5 |
| U3 | Hazardous Material Spill or Release | 7 | 2 |
| U4 | Transportation Accident | 5 | 3 |
| | | | |
| I | **Intentional Act** | 5 | 5 |
| I1 | Terrorism | 1 | 7 |
| I2 | Cyber Attack | 5 | 8 |
| I3 | Arson | 8 | 5 |
| I4 | Theft | 4 | 1 |
| I5 | Vandalism | 9 | 8 |
| I6 | Sabotage | 1 | 9 |
| I7 | Civil Distrubance, Public Unrest, Mass Hysteria, Riot | 1 | 1 |
| I8 | Strike | 8 | 1 |
| | | | |
| F | **System Failure - Aging Infrastructure** | 5 | 5 |
| F1 | Loss of Electricity | 2 | 9 |
| F2 | Water Leak | 5 | 5 |
| F3 | Building Collapse/Structural Failure | 9 | 8 |
| F4 | Fuel Shortage | 5 | 6 |
| F5 | Communications System Interruption | 2 | 2 |
| F6 | Air/Water Pollution Containment | 8 | 5 |
| F7 | Water Control Structure, Dam, or Levee Failure | 1 | 8 |
| F8 | HVAC System Failure | 5 | 1 |
| F9 | Loss of Protection Systems | 7 | 4 |
| | | | |
| G | **Geological** | 7 | 3 |
| G1 | Earthquake | 7 | 2 |
| G2 | Tsunami | 4 | 5 |
| G3 | Volcano | 8 | 1 |
| G4 | Landslide/Mudslide | 9 | 6 |
| G5 | Pollution | 8 | 3 |

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| ID | Description | Likelihood (0-10) | Severity (0-10) |
|----|-------------|:-:|:-:|
| **B** | **Biological** | **3** | **6** |
| B1 | Pandemic Disease | 1 | 9 |
| B2 | Animal or Insect Infestation | 2 | 8 |
| B3 | Chronic Disease | 5 | 5 |
| B4 | Physical Inactivity | 1 | 9 |
| B5 | Acoustic Problems | 6 | 6 |
| B6 | Ergonomic Problems | 8 | 9 |
| B7 | Thermal Issues | 1 | 9 |
| B8 | Mental Health & Mood Disorders | 2 | 7 |
| B9 | Adverse biodiversity & biophilia | 2 | 2 |
| B10 | Contamination | 2 | 2 |
| B11 | Recycling | 3 | 3 |
| B12 | Sensory | 3 | 3 |
| | | | |
| **M** | **Meteorological - Climate Change** | **2** | **7** |
| M1 | Flood, Flash Flood, Seiche, Tidal Surge | 1 | 9 |
| M2 | Drought | 2 | 8 |
| M3 | Wild Fire (Forest, Range, Urban) | 1 | 5 |
| M4 | Snow, Ice, Hail, Sleet, Avalanche | 2 | 9 |
| M5 | Windstorm, Tropical Cyclone, Hurricane, Tornado, Water Spout, Dust/Sand Storm | 1 | 7 |
| M6 | Extreme Heat/Cold | 2 | 8 |
| M7 | Lightning | 3 | 8 |
| M8 | Sea Level Rise | 2 | 5 |
| | | | |
| **S** | **Social** | **6** | **3** |
| S1 | Increasing Population | 9 | 1 |
| S2 | Lack of Affordable Housing | 9 | 1 |
| S3 | Decreasing Population | 8 | 2 |
| S4 | Unemployment | 7 | 1 |
| S5 | Financial Ruin | 2 | 5 |
| S6 | Safety & Security | 3 | 6 |
| S7 | Social Equity | 2 | 2 |

Resilience from Shocks and Stresses

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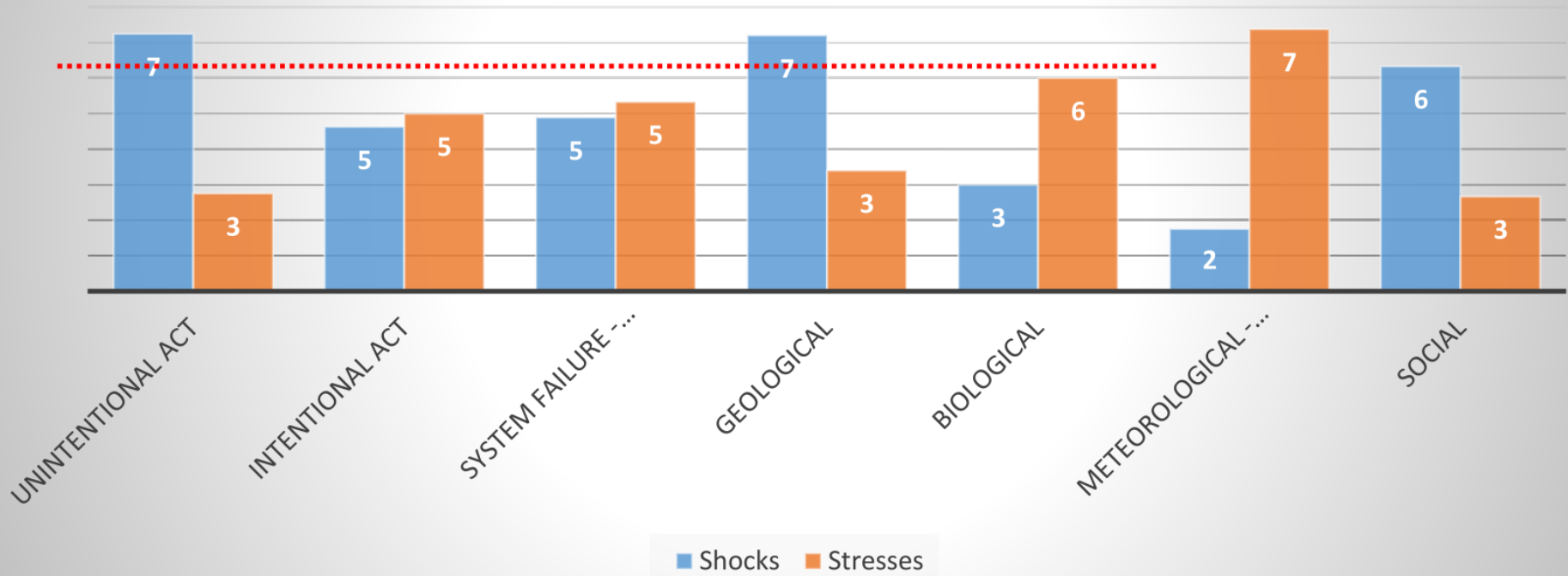
# Resilient Design Action List

| Strategy | Credit | Description | Reference | Design, Construction, Operations | Shocks and Stresses | Importance Factor (0-3) | Cost ($-$$$) | Value | |
|---|---|---|---|---|---|---|---|---|---|
| **Environment and Site** | | | | | | | | **112** | **Total** |
| **E1** | | **Protection For Prime Habitat & Floodplain Functions** | | | | Max. Value: 50 | | **50** | **Subtotal** |
| Required | E1.1 | Construction Activity Pollution Prevention | LEED BD+C V4 | Design/Const | G5 | - | - | - | |
| Action | E1.2 | Preserve Prime Habitat (protect local biodiversity) | Envision NW1.1 | Design | B9 | 3 | $ | 3 | |
| Action | E1.3 | Preserve Prime Farmland (protect cultural & ecological | Envision NW1.1 | Design | B9 | 2 | $$ | 4 | |
| Action | E1.4 | Protect Wetlands and Surface Water | Envision NW1.2 | Design | B9 | 2 | $$ | 4 | |
| Action | E1.5 | Preserve (predevelopment) Floodplain Functions | Envision NW1.3 | Design | M1 | 2 | $$ | 4 | |
| Action | E1.6 | Avoid Adverse Geology | Envision NW1.4 | Design | M1 | 3 | $$$ | 9 | |
| Action | E1.7 | Avoid Unsuitable Development on Steep Slopes | Envision NW1.6 | Design | M1 | 3 | $$$ | 9 | |
| Action | E1.8 | Preserve Species Biodiversity: Restore & Create Habitat | Envision NW3.1 | Design/Ops | B9 | 2 | $ | 2 | |
| Action | E1.9 | Site Development - Protect or Restore Habitat: Restoration | LEED NC V4 | Design | B9 | 2 | $ | 2 | |
| Action | E1.10 | Environmental Protection - Develop action plans & stow needed supplies on-site for flood protection | RELi | Design/Ops | M1 | 2 | $ | 2 | |
| Action | E1.11 | Environmental Protection - Develop flood protection with natural systems | | Design | M1 | 2 | $$ | 4 | |
| Action | E1.12 | Provide Buffer Zones protecting from development & supporting bio-diversity and biophilia | | Design | B1, M9 | 3 | $$ | 6 | |
| Action | E1.13 | Provide wildlife corridors between parks & preserves to support bio-diversity and biophilia | | Design | B9, B10 | 2 | $$ | 4 | |
| **E2** | | **Prevent** | | | | Max. Value: 10 | | **6** | **Subtotal** |
| Action | E2.1 | Reduce Pesticide/Herbidice & Fertilizer Impacts | Envision NW2.2 | Design | B10 | 3 | $ | 3 | |
| Action | E2.2 | Prevent Surface & Groundwater Contamination | Envision NW2.3 | Design/Constr | B10 | 3 | $ | 3 | |
| **E3** | | **Water Efficiency & Resilient Water & Landscapes** | | | | Max. Value: 25 | | **12** | **Subtotal** |
| Action | E3.1 | Indoor Water Use Reduction (20% < LEED Baseline) | LEED BD+C V4 | Design | F6 | 3 | $ | 3 | |
| Action | E3.2 | Outdoor Water use Reduction (30% < Calculated Baseline) | LEED BD+C V4 | Design | B9 | 3 | $ | 3 | |
| Action | E3.3 | Rainwater Management - Option 1. 95th Percentile of Rainfall Events | LEED BD+C V4 | Design | B9 | 2 | $ | 2 | |
| Action | E3.4 | Rainwater management - Water Recycling / Reuse: Space and Planning | | Design | B9 | 1 | $$ | 2 | |
| Action | E3.5 | Rainwater Harvesting, Recycled Water, On-Site and/or Neighborhood Water Storage | | Design/Ops | B9 | 1 | $$ | 2 | |
| Action | E3.6 | Alternative Sewage Management | | Design | F6, B9 | 0 | $$$ | 0 | |
| Action | E3.7 | Deep, Net Zero & Net Positive Water | LBC | Design/Constr/Ops | B9 | 0 | $$$ | 0 | |