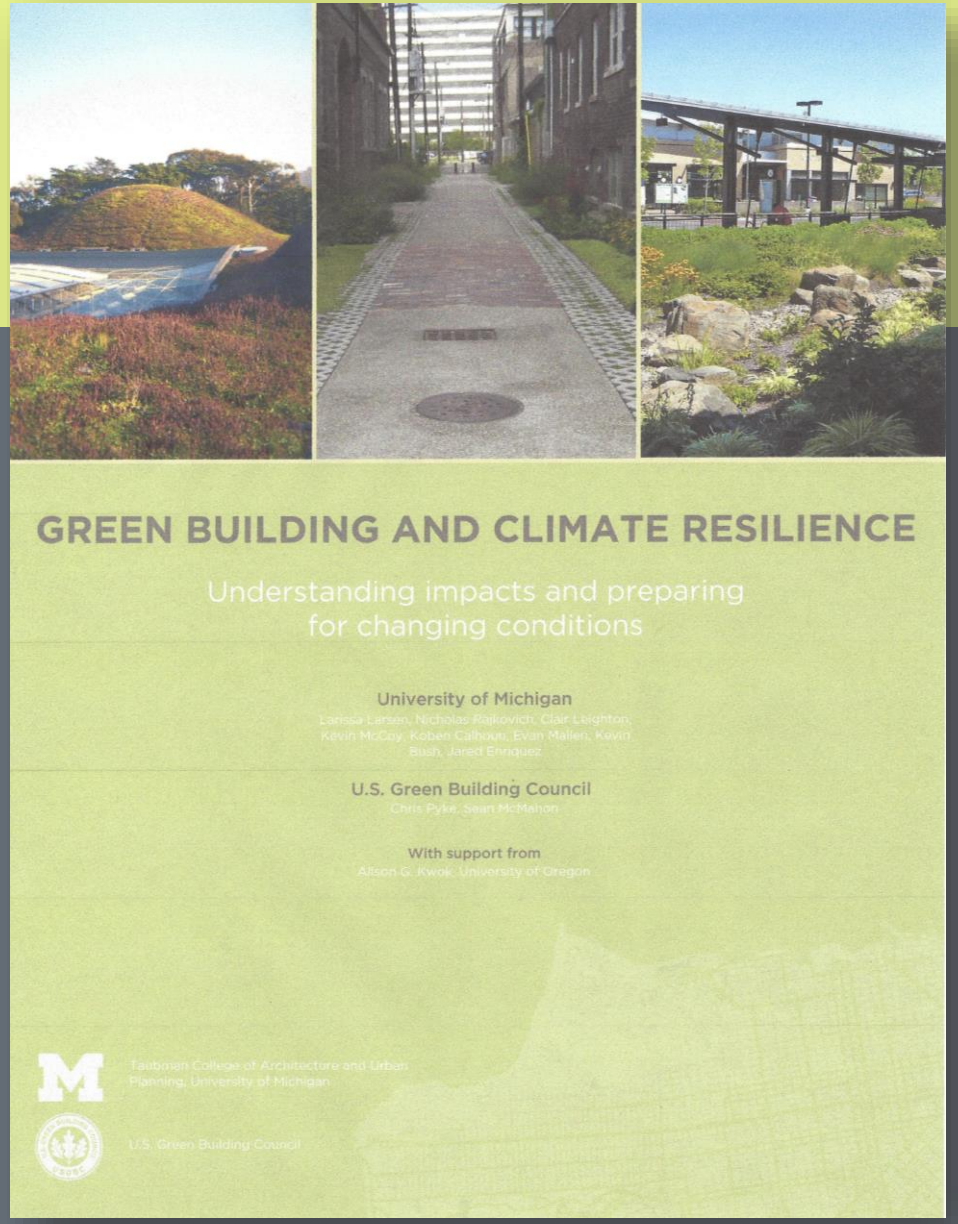
RESILIENCE

The measure of a system to buffer negative climate effects with maintaining its structure and function



Green Building and Climate Resilience: Understanding Impacts and Preparing for Changing Conditions

Published by University of Michigan and USGBC in 2011

http://www.usgbc.org/advocacy/priorities/resiliency

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RESILIENCY: DEFINITIONS

CLIMATE CHANGE

- Long-term weather patterns, temperature, precipitation, and humidity
- Statistically significant changes for decades or longer
- Consider both past climate data and projected climate impacts

GREEN BUILDING

- Interdisciplinary approach to building design from planning to operations
- Concerned with air quality, energy & water use, human health, waste reduction , pollution & environmental degradation
- Poised to incorporate climate adaptation strategies in order to lessen the negative effects of future climate impacts

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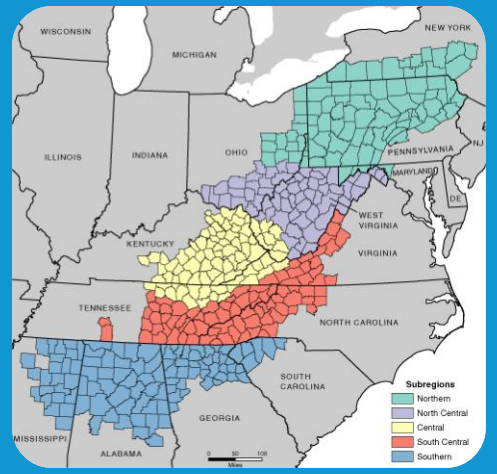
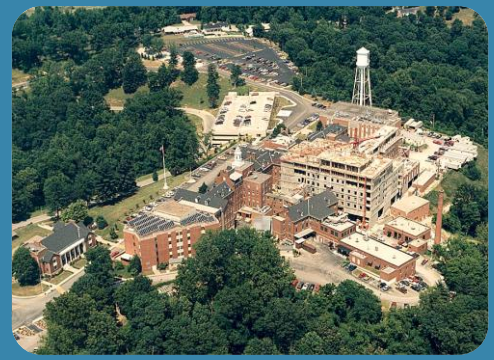
RESILIENCY: IMPACTS

Regional Impacts



Neighborhood Impacts

Site/Project Impacts



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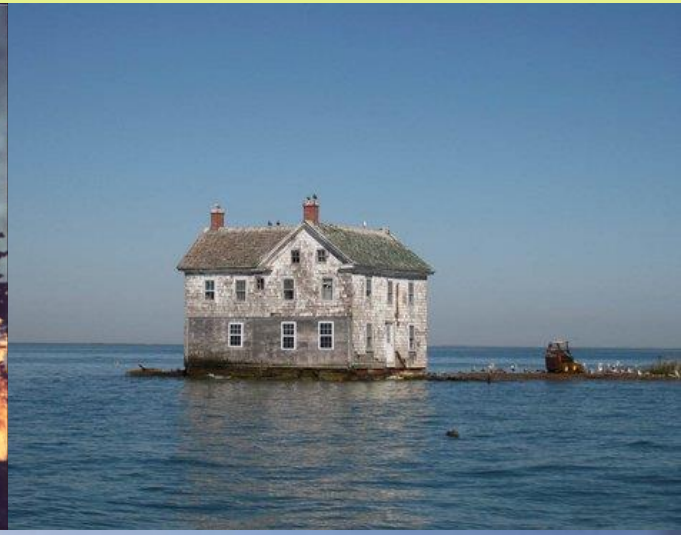
REGIONAL IMPACTS

- Energy systems
- Water systems
- Transportation systems

NEIGHBORHOOD IMPACTS

- Sea level rise
- Wildfires
- Urban heat islands



SITE OR PROJECT IMPACTS

- Landscapes
- Water consumption patterns
- Stormwater runoff
- More extreme heat events
- Decreased use of natural ventilatio
- Building materials
- More intense/frequent storms

RESILIENCY: FACTORS

MITIGATION

- Actions that aim to reduce greenhouse gases
- Buildings contribute 39% of U.S. CO_2 emissions
- Reduce energy demand and increase efficiency

ADAPTATION

- Adjustment of our built environment and infrastructure to climatic events
- Proactive adaptation: actions taken before impacts are observed
- Planned adaptation: decisions motivated by awareness of actual or impending change

VULNERABILITY

- Susceptible to and unable to cope with climate change
- Result of age, condition, proximity to infrastructure

RISK

- Magnitude of an impact and the probability of its occurance
- Ability to reduce risk depends on time for implementing adaptation measures

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CLIMATE ZONE MAP

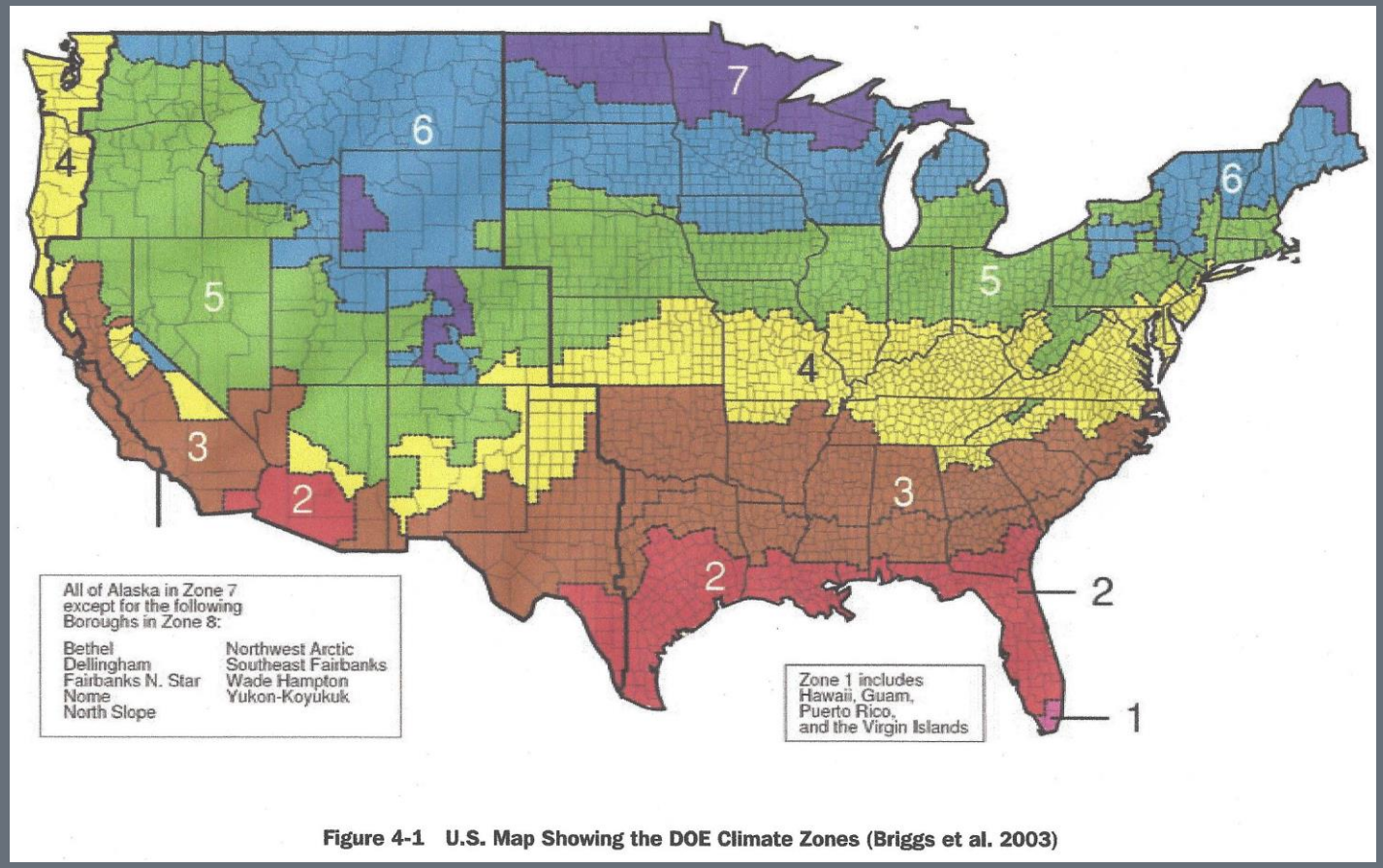

Figure 4-1 U.S. Map Showing the DOE Climate Zones (Briggs et al. 2003)

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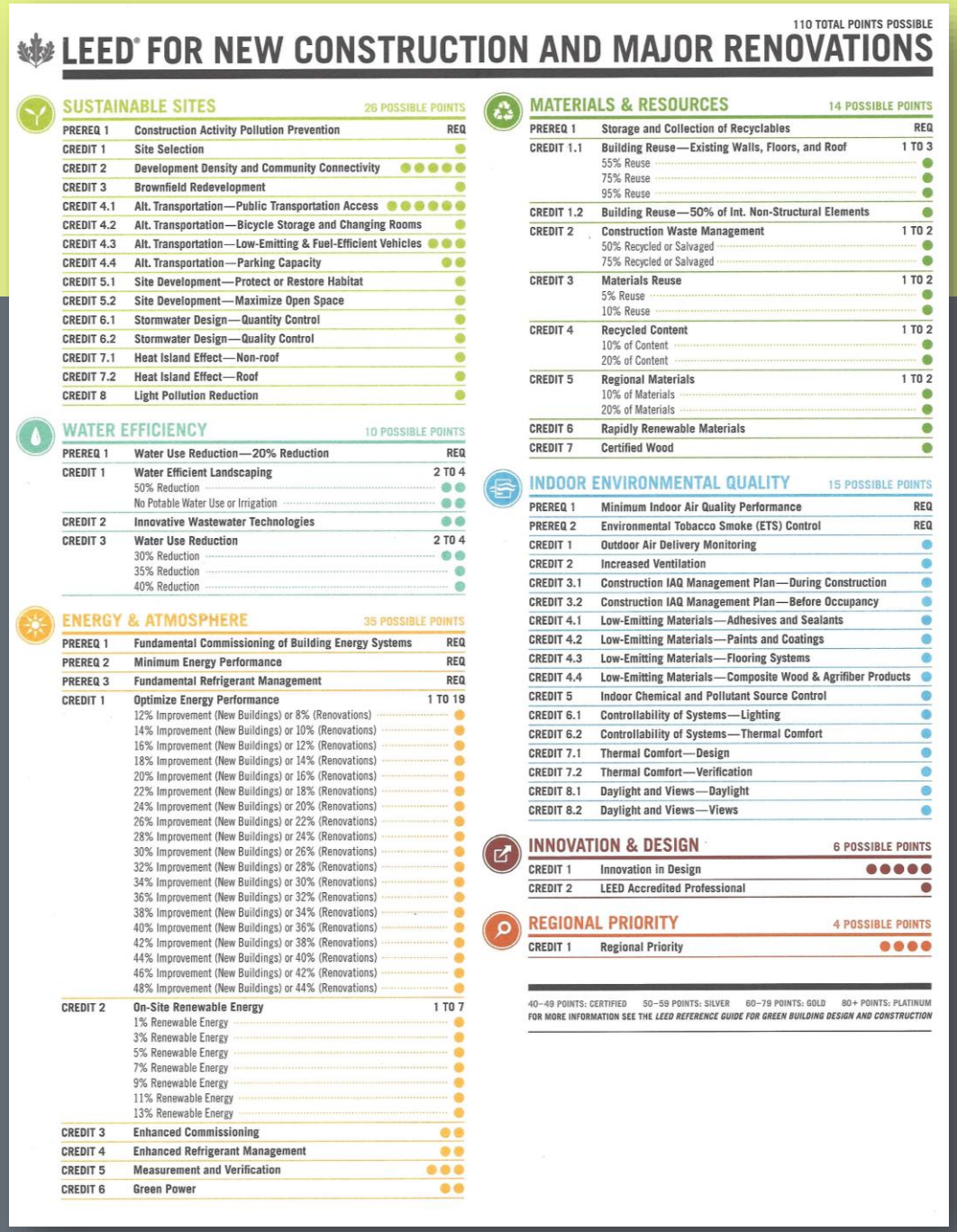

110 TOTAL POINTS POSSIBLE

LEED® FOR NEW CONSTRUCTION AND MAJOR RENOVATIONS

SUSTAINABLE SITES — 26 POSSIBLE POINTS

PREREQ 1	Construction Activity Pollution Prevention	REQ
CREDIT 1	Site Selection	1
CREDIT 2	Development Density and Community Connectivity	5
CREDIT 3	Brownfield Redevelopment	1
CREDIT 4.1	Alt. Transportation—Public Transportation Access	6
CREDIT 4.2	Alt. Transportation—Bicycle Storage and Changing Rooms	1
CREDIT 4.3	Alt. Transportation—Low-Emitting & Fuel-Efficient Vehicles	3
CREDIT 4.4	Alt. Transportation—Parking Capacity	2
CREDIT 5.1	Site Development—Protect or Restore Habitat	1
CREDIT 5.2	Site Development—Maximize Open Space	1
CREDIT 6.1	Stormwater Design—Quantity Control	1
CREDIT 6.2	Stormwater Design—Quality Control	1
CREDIT 7.1	Heat Island Effect—Non-roof	1
CREDIT 7.2	Heat Island Effect—Roof	1
CREDIT 8	Light Pollution Reduction	1

WATER EFFICIENCY — 10 POSSIBLE POINTS

PREREQ 1	Water Use Reduction—20% Reduction	REQ
CREDIT 1	Water Efficient Landscaping	2 TO 4
	50% Reduction	2
	No Potable Water Use or Irrigation	2
CREDIT 2	Innovative Wastewater Technologies	2
CREDIT 3	Water Use Reduction	2 TO 4
	30% Reduction	2
	35% Reduction	3
	40% Reduction	4

ENERGY & ATMOSPHERE — 35 POSSIBLE POINTS

PREREQ 1	Fundamental Commissioning of Building Energy Systems	REQ
PREREQ 2	Minimum Energy Performance	REQ
PREREQ 3	Fundamental Refrigerant Management	REQ
CREDIT 1	Optimize Energy Performance	1 TO 19
	12% Improvement (New Buildings) or 8% (Renovations)	1
	14% Improvement (New Buildings) or 10% (Renovations)	2
	16% Improvement (New Buildings) or 12% (Renovations)	3
	18% Improvement (New Buildings) or 14% (Renovations)	4
	20% Improvement (New Buildings) or 16% (Renovations)	5
	22% Improvement (New Buildings) or 18% (Renovations)	6
	24% Improvement (New Buildings) or 20% (Renovations)	7
	26% Improvement (New Buildings) or 22% (Renovations)	8
	28% Improvement (New Buildings) or 24% (Renovations)	9
	30% Improvement (New Buildings) or 26% (Renovations)	10
	32% Improvement (New Buildings) or 28% (Renovations)	11
	34% Improvement (New Buildings) or 30% (Renovations)	12
	36% Improvement (New Buildings) or 32% (Renovations)	13
	38% Improvement (New Buildings) or 34% (Renovations)	14
	40% Improvement (New Buildings) or 36% (Renovations)	15
	42% Improvement (New Buildings) or 38% (Renovations)	16
	44% Improvement (New Buildings) or 40% (Renovations)	17
	46% Improvement (New Buildings) or 42% (Renovations)	18
	48% Improvement (New Buildings) or 44% (Renovations)	19
CREDIT 2	On-Site Renewable Energy	1 TO 7
	1% Renewable Energy	1
	3% Renewable Energy	2
	5% Renewable Energy	3
	7% Renewable Energy	4
	9% Renewable Energy	5
	11% Renewable Energy	6
	13% Renewable Energy	7
CREDIT 3	Enhanced Commissioning	2
CREDIT 4	Enhanced Refrigerant Management	2
CREDIT 5	Measurement and Verification	3
CREDIT 6	Green Power	2

MATERIALS & RESOURCES — 14 POSSIBLE POINTS

PREREQ 1	Storage and Collection of Recyclables	REQ
CREDIT 1.1	Building Reuse—Existing Walls, Floors, and Roof	1 TO 3
	55% Reuse	1
	75% Reuse	2
	95% Reuse	3
CREDIT 1.2	Building Reuse—50% of Int. Non-Structural Elements	1
CREDIT 2	Construction Waste Management	1 TO 2
	50% Recycled or Salvaged	1
	75% Recycled or Salvaged	2
CREDIT 3	Materials Reuse	1 TO 2
	5% Reuse	1
	10% Reuse	2
CREDIT 4	Recycled Content	1 TO 2
	10% of Content	1
	20% of Content	2
CREDIT 5	Regional Materials	1 TO 2
	10% of Materials	1
	20% of Materials	2
CREDIT 6	Rapidly Renewable Materials	1
CREDIT 7	Certified Wood	1

INDOOR ENVIRONMENTAL QUALITY — 15 POSSIBLE POINTS

PREREQ 1	Minimum Indoor Air Quality Performance	REQ
PREREQ 2	Environmental Tobacco Smoke (ETS) Control	REQ
CREDIT 1	Outdoor Air Delivery Monitoring	1
CREDIT 2	Increased Ventilation	1
CREDIT 3.1	Construction IAQ Management Plan—During Construction	1
CREDIT 3.2	Construction IAQ Management Plan—Before Occupancy	1
CREDIT 4.1	Low-Emitting Materials—Adhesives and Sealants	1
CREDIT 4.2	Low-Emitting Materials—Paints and Coatings	1
CREDIT 4.3	Low-Emitting Materials—Flooring Systems	1
CREDIT 4.4	Low-Emitting Materials—Composite Wood & Agrifiber Products	1
CREDIT 5	Indoor Chemical and Pollutant Source Control	1
CREDIT 6.1	Controllability of Systems—Lighting	1
CREDIT 6.2	Controllability of Systems—Thermal Comfort	1
CREDIT 7.1	Thermal Comfort—Design	1
CREDIT 7.2	Thermal Comfort—Verification	1
CREDIT 8.1	Daylight and Views—Daylight	1
CREDIT 8.2	Daylight and Views—Views	1

INNOVATION & DESIGN — 6 POSSIBLE POINTS

CREDIT 1	Innovation in Design	5
CREDIT 2	LEED Accredited Professional	1

REGIONAL PRIORITY — 4 POSSIBLE POINTS

CREDIT 1	Regional Priority	4

40–49 POINTS: CERTIFIED 50–59 POINTS: SILVER 60–79 POINTS: GOLD 80+ POINTS: PLATINUM

FOR MORE INFORMATION SEE THE *LEED REFERENCE GUIDE FOR GREEN BUILDING DESIGN AND CONSTRUCTION*

U.S. Green Building Council is a non-profit organization located in Washington, D.C.

The Leadership in Energy and Environmental Design (LEED) Green Building Rating System was developed over 10 years ago in order to provide a 3rd party method of standardizing green building design and construction methods.

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RESILIENCY: STRATEGIES

Building Envelope

Site / Landscape

Heating / Cooling

Water / Waste

Equipment

Process

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BUILDING ENVELOPE

- Interior shading devices
- Exterior shading devices
- High performance glazing
- Beyond code roof insulation

- Enhanced roof access
- Design for increased wind
- Oversized roof drainage
- Pressure-neutral rain screens
- Plan for pest expansion

BUILDING ENVELOPE

- High albedo roofs
- Vegetated roofs

SITE AND LANDSCAPING

- Mixed use development
- Woody trees and shrubs
- Minimize impervious surfaces
- Building orientation
- Retention ponds
- Infiltration galleries / French drains
- Bioswales
- Natural or constructed wetlands
- Solar zoning / solar envelope
- High albedo paving

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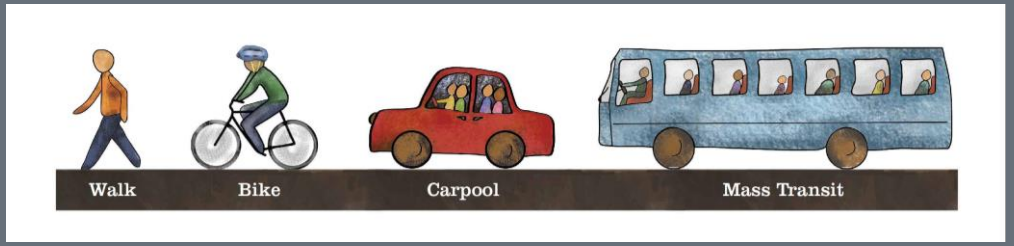
SITE AND LANDSCAPING

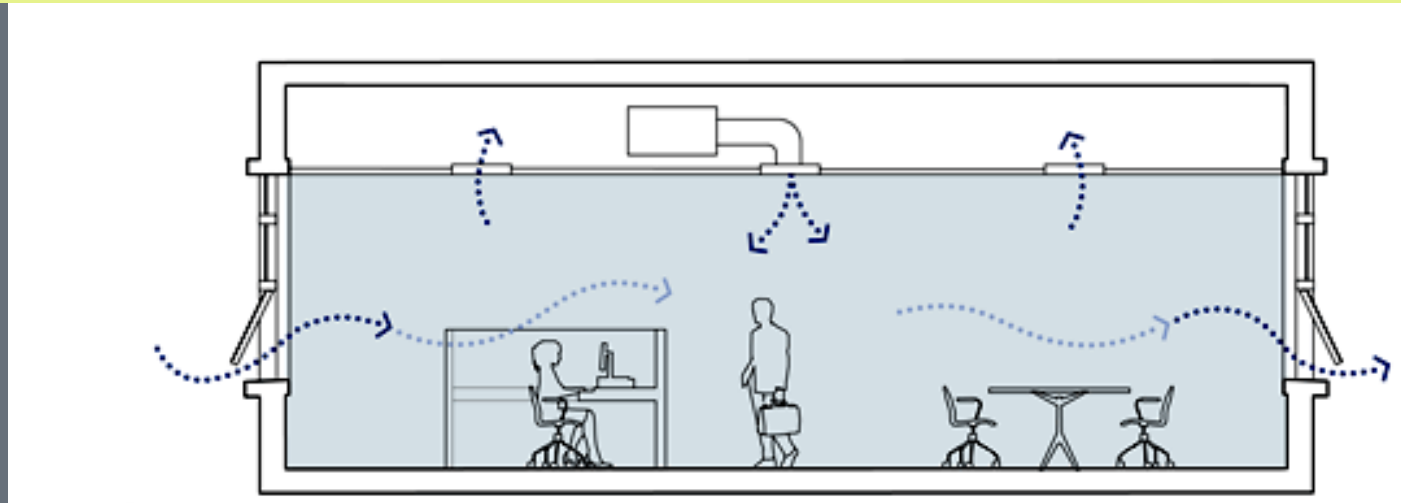
- Redundant transportation options
- Avoidance of flood plains
- Elevated first floor
- Elevated essential infrastructure



HEATING, COOLING, LIGHTING

- Cross ventilation
- Thermal zoning
- Stack ventilation
- Mixed mode ventilation
- Ceiling fans
- Thermal energy storage
- Daylighting

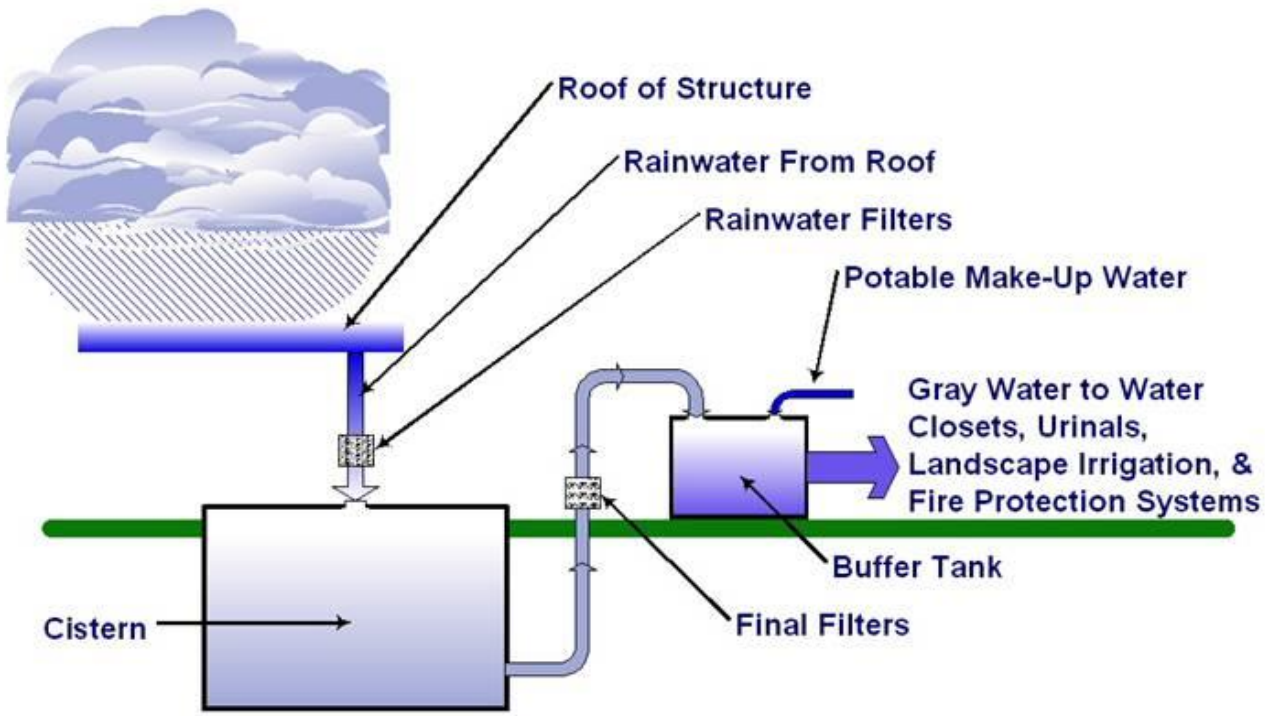
- High efficacy egress lighting



WATER AND WASTE

- High efficiency fixtures
- HVAC condensate capture
- Solar domestic water heating
- Graywater system rough-out
- Insulated water system
- Graywater system installation

- Reclaimed water use
- Sewage backflow preventer
- Water catchment / cistern



Storm Water Catchment System

EQUIPMENT

- Variable frequency drives
- Energy management system
- Reduced friction losses

- Elevator system design
- Equipment room sizing
- Insulated refrigeration equipment

PROCESS AND OPERATIONS

- Energy modeling
- Building operations manual
- Retrocommissioning

- Areas of refuge
- Emergency management plan

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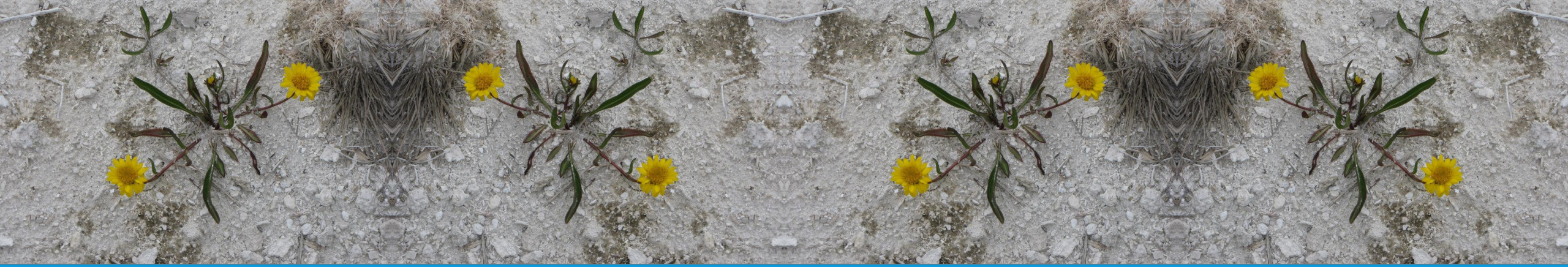

THANK YOU!

A resilient system is not sensitive to climate change and has the capacity to adapt.

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