The Resilience Gap: How Can Designers, Owners, and Stakeholders Better Address Future Vulnerability?

CUWR
Center for Urban Watershed Renewal

Wendi Goldsmith, PhD, PG
Director, Center for Urban Watershed Resilience

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Underlying Legal Issues

Professional Practitioners

- Duty to Warn
- Standard of Care
- Cautious Innovation

Owners and Investors

- Disclosure
- Due Diligence
- Standards, customs, precedents

What about public duties for health, safety, and taxpayer responsibility?

Priorities

- Reduce SLR/storm damage risk to life and property *AND IMPROVE RESILIENCE AND SUSTAINABILITY GENERALLY*
- Anticipate future conditions
- Achieve life cycle value
- Engage the public in understanding risk
- Put new technology & strategy into action
- Produce results quickly….built to last

What is Resilience?

Resilience—from the Latin resilio, meaning "to spring back"—is the ability to recover after an impact or misfortune. It is the ability to adapt to the consequences associated with an instance of failure or systemic breakdown.

Applying "resilience thinking" to cities and communities requires us to think not only about bouncing back from environmental, economic, and social crises, but adapting to changing circumstances by "bouncing forward" through new frames, processes, and ways of working that address future changing conditions.

Don't just BOUNCE BACK, take the opportunity to BOUNCE FORWARD!

Climate Change as Forcing Factor

- Sustainability objectives transformed into resilience mandates
- Changing conditions pose risk and uncertainty
- Impacts to/from projects become intrinsically evaluated
- Project service life performance displaces initial design focus

- Pentagon defines resilience to Climate Change as:

"Ability to anticipate, prepare for, and adapt to changing conditions; and to withstand, respond to, and recover rapidly from disruptions"

- Translation into design criteria?
- Incorporation into design process?

Generalized Riprap vs Bioengineering Lifecycle Inputs and Outputs

Energy to quarry and ship

Displaced riparian buffer

Lost soil carbon storage

Lost shade and cover

Photo Courtesy NRCS

Local materials collection

Solar gain for photosynthesis

Water quality and habitat

Ongoing Carbon capture/storage

Photo Courtesy Bioengineering Group

DESIGN METHOD FOCUS

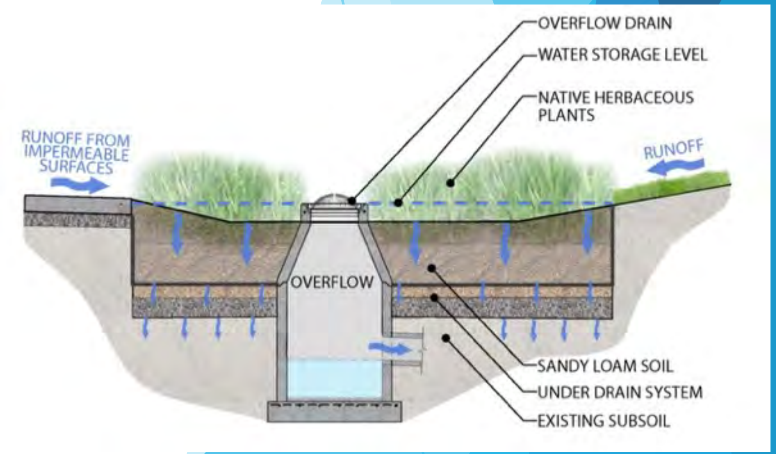
- Builds the features and functions that provide for ongoing self-maintenance and adaptation
- Maximizes use of photosynthesis to drive biomass accretion, root reinforcement, durable shell materials, natural cements, and biological renewal generally
- Links ecosystem productivity with regional planning of infrastructure, commercial, residential, and natural resources

Public Works Facility, Lexington, MA LEED Silver Certified

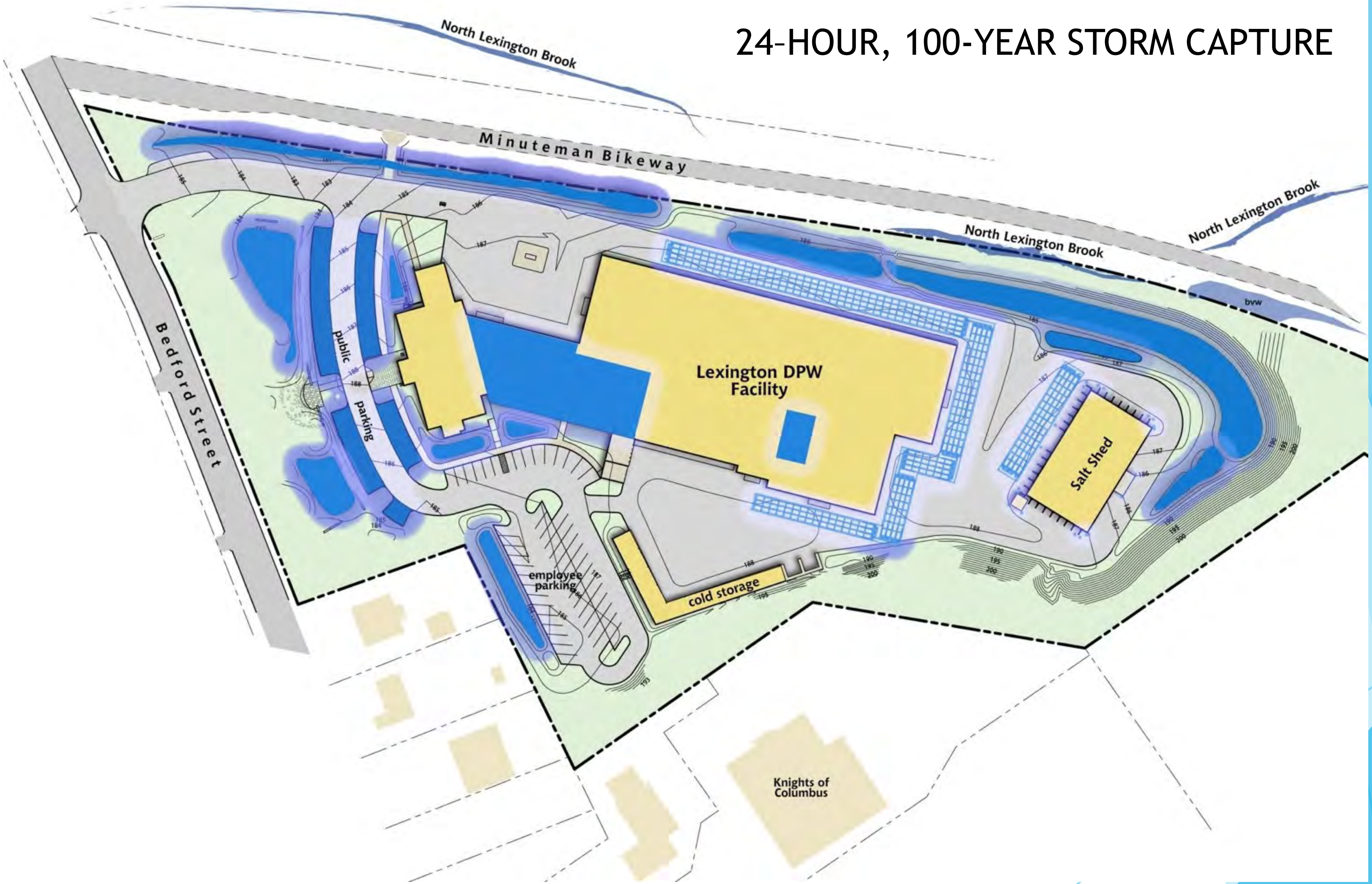

ELGIN







OVERFLOW DRAIN
WATER STORAGE LEVEL
NATIVE HERBACEOUS PLANTS
RUNOFF FROM IMPERMEABLE SURFACES
RUNOFF
OVERFLOW
SANDY LOAM SOIL
UNDER DRAIN SYSTEM
EXISTING SUBSOIL

24-HOUR, 100-YEAR STORM CAPTURE



Lower Cost, Higher Resilience, Fully Compliant

OK, so your property is all set…but….

- What about your power supply?
- How about drinking water? Sewers?
- Can hospitals, police, fire facilities function?
- A safe route for emergency responders?
- How soon are you able to commute?
- All those nice things your town bought (vehicles, schools, bridges, etc.)?
- Will your community tax base survive?
- Does the municipal bonding capacity face problems?

Regional Adaptation Strategies Can:

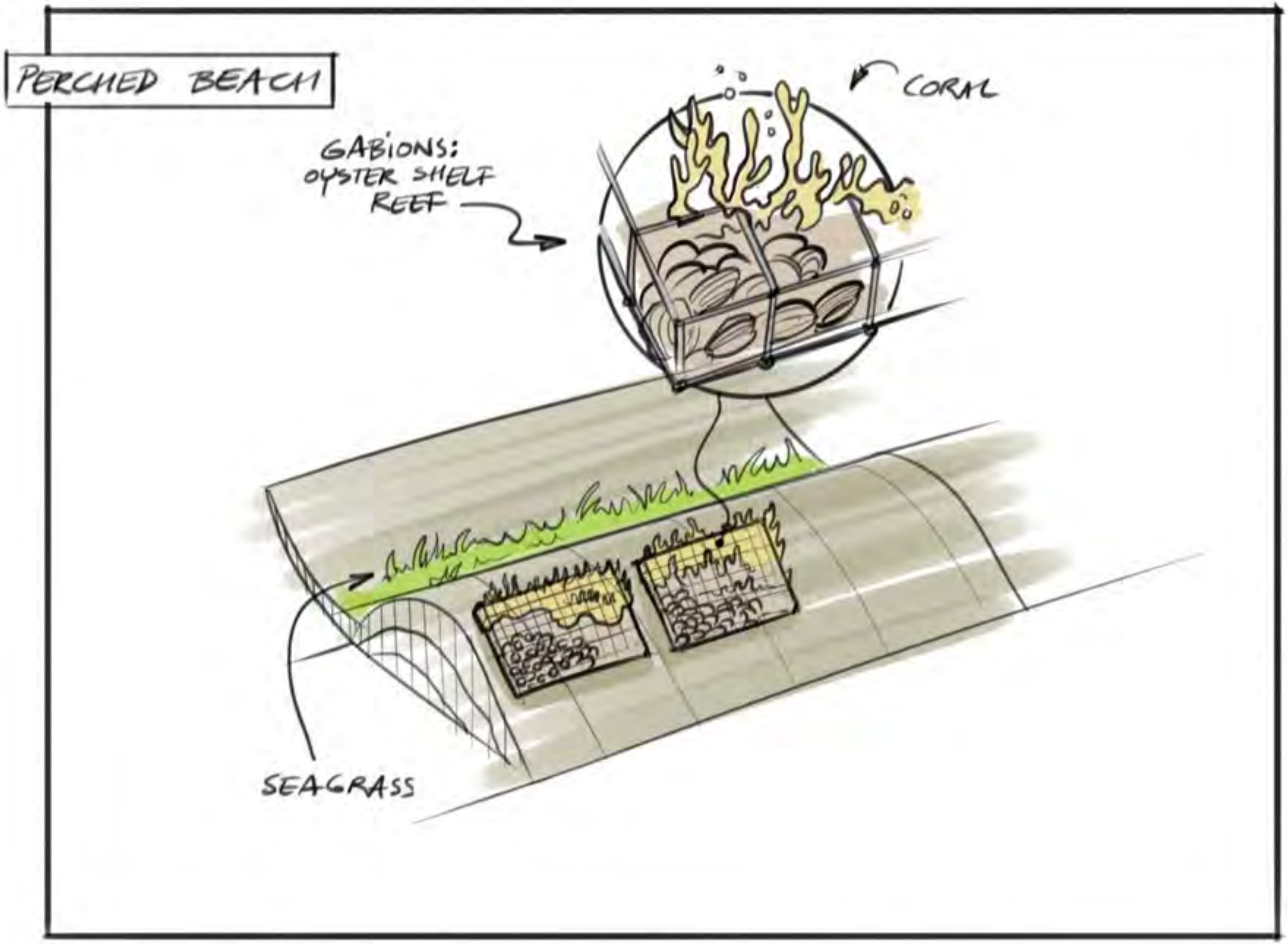
- Account for complex rigorous models of physical change and risk under multiple scenarios
- Address risk for shared assets
- Provide better resilience
- Furnish Multiple Lines of Defense
- Buy us time to plan better for the future…
- Allow for a century of smart reinvestment?

NOTE: Choosing regional approaches using green or hard barrier elements is not IN CONFLICT with charting a course towards highly sustainable future postures based on retreat and generally Living with Water in affordable, flexible, and elegant ways

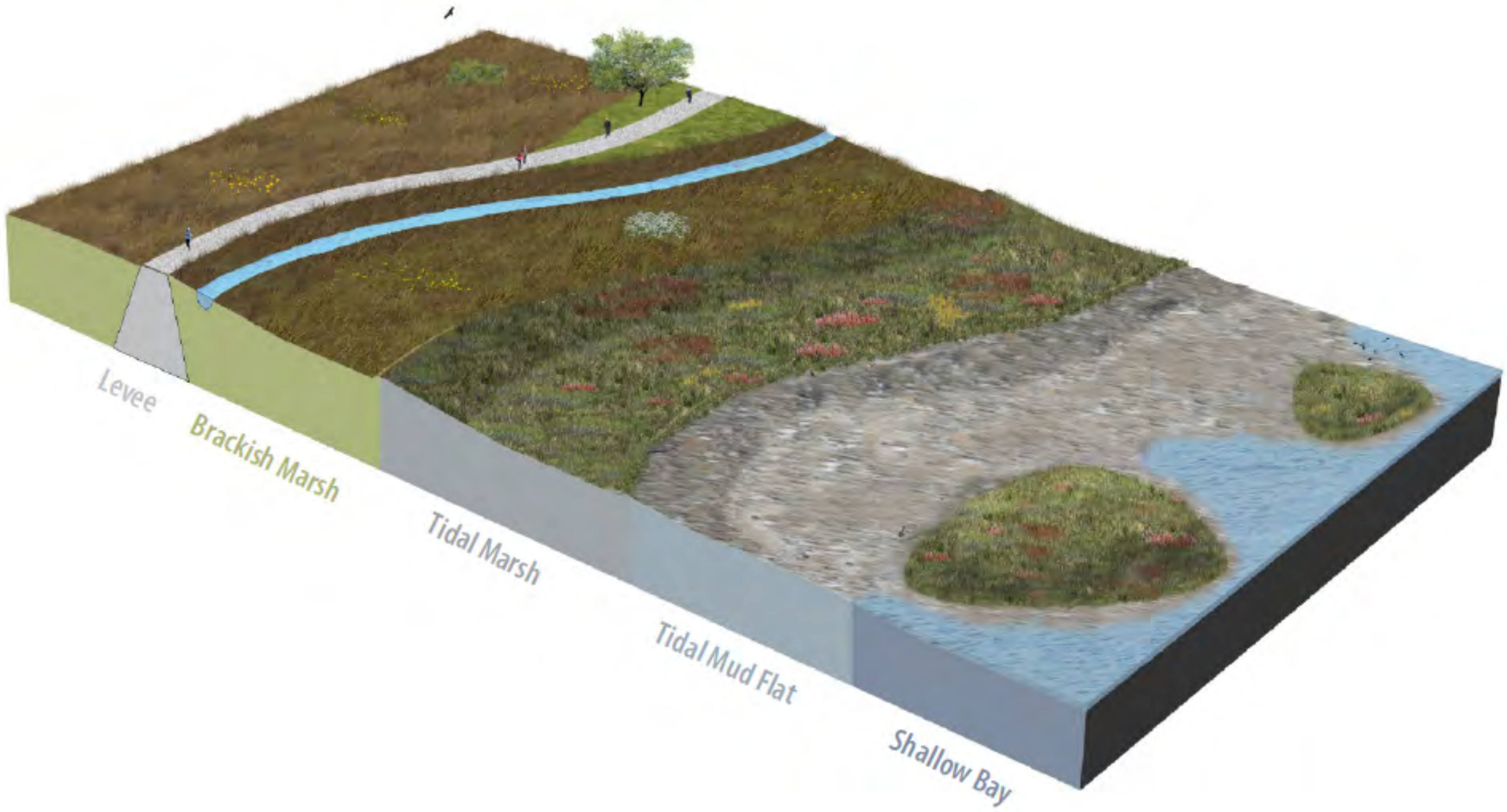
Examples: Conventional vs. w/Nature

Concrete Seawall or Oyster Reef

Riprap or Bioengineered Bank


PERCHED BEACH
CORAL
GABIONS:
OYSTER SHELF
REEF
SEAGRASS

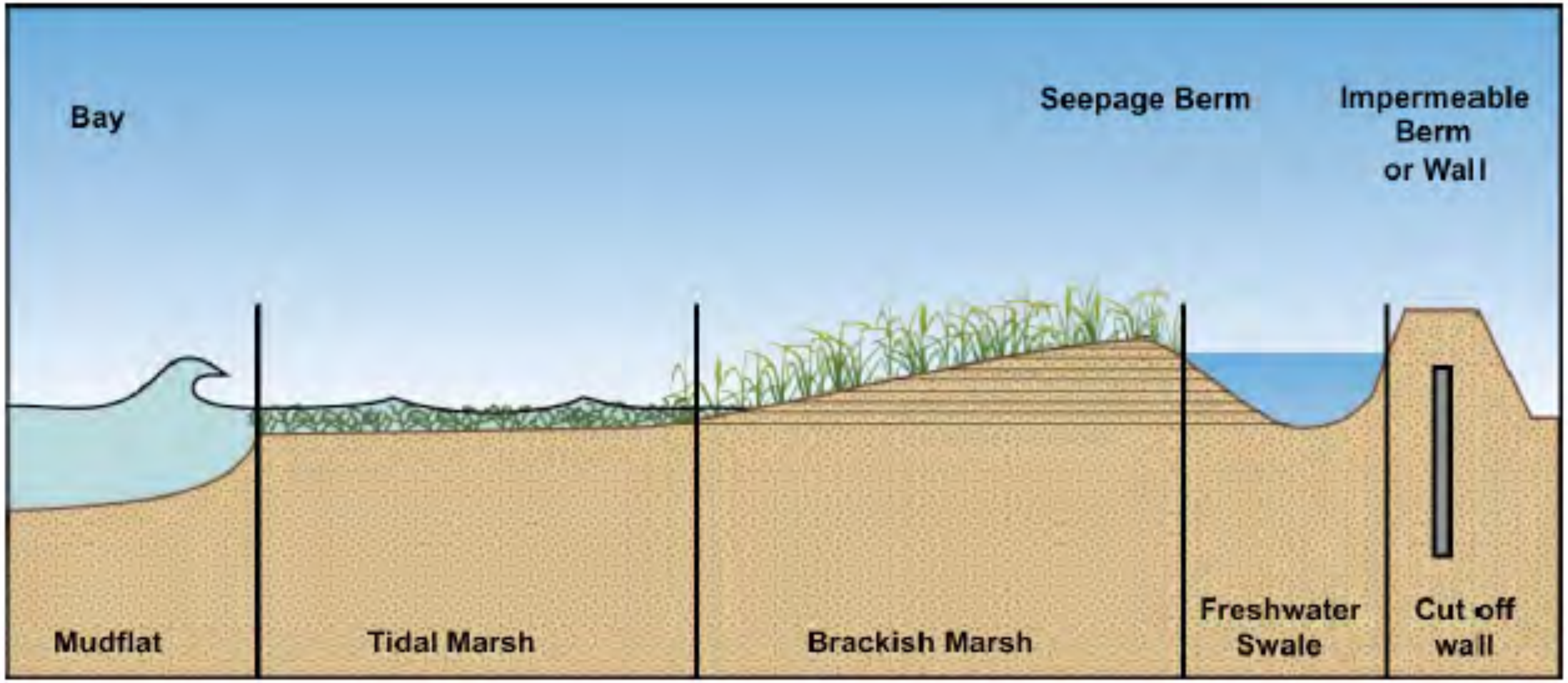
The Horizontal Levee



Courtesy of The Bay Institute

THE HORIZONTAL LEVEE

Nature's Low-Cost Defense Against Sea Level Rise



Courtesy of The Bay Institute

Natural Systems in Planning & Design

Pros -- Why we want it

- Low impact (to wetlands, ecosystems)
- Carbon footprint low or negative
- Self-repair
- Regenerative

"MESSY" BUT FLEXIBLE

Cons - Why we resist it

- Beyond PE authority, requires diverse skills and communication
- Site-specific, variable, uncertain
- Less robust, especially at first
- Change/adaptation may differ from intentions/predictions

"SIMPLE" BUT BRITTLE

Conundrum: Design professionals seeking to improve their practice to achieve environmentally sustainable outcomes face many hindrances

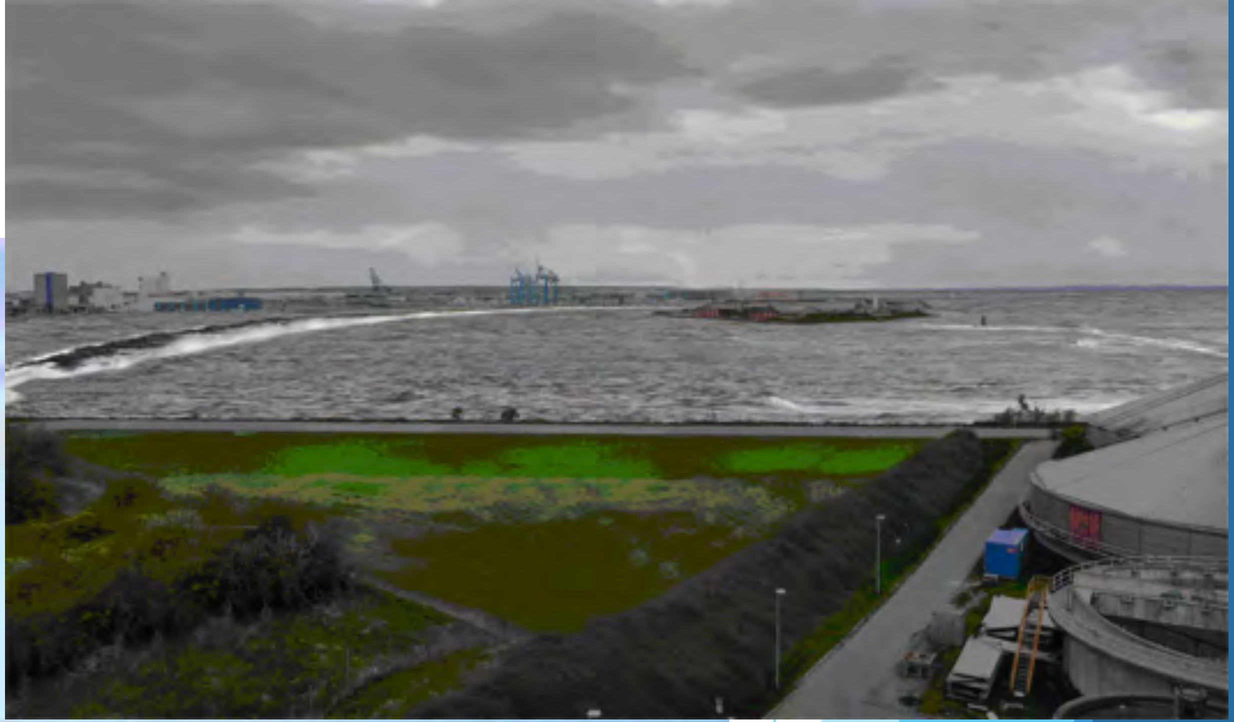
Assumption- Professionals are attentive to minimizing risk and improving methods

Yes, but…

- Self-interest is easiest to address
- Standards are followed – not altered
- Novel approaches are unfamiliar
- Scenarios become guesswork
- “Community” or “environment” are highly abstract

COPENHAGEN EXAMPLE

- 1998 Subway Risk Assessment only looked at tunnel collapse issues…who scoped it?
- 2003 Climate Vulnerability Assessment
- 2.2 meters above current sea level was used for design flood
- 2009 International Climate Conference
- 2010 large rainstorm floods subway system



Unwinding the Problem

- Pursuing sustainability
- Pursuing adaptation and resilience
- Accounting for changing conditions
- Addressing systems level issues
- Community support
- Accepting innovation

The Missing Sequence

1. Convene Stakeholders
2. Facilitate Engagement
3. Conduct Vulnerability Assessments
4. Establish Design Criteria
5. ID Hazard Mitigation Alternatives
6. Develop Scenarios
7. Perform Benefit Cost Analysis
8. Evaluate Hazard Mitigation Synergies
9. Apply Rigorous Decision Science
10. Formulate Plan
11. Proceed to A/E Design Phase

GOAL: Adaptation and Resilience

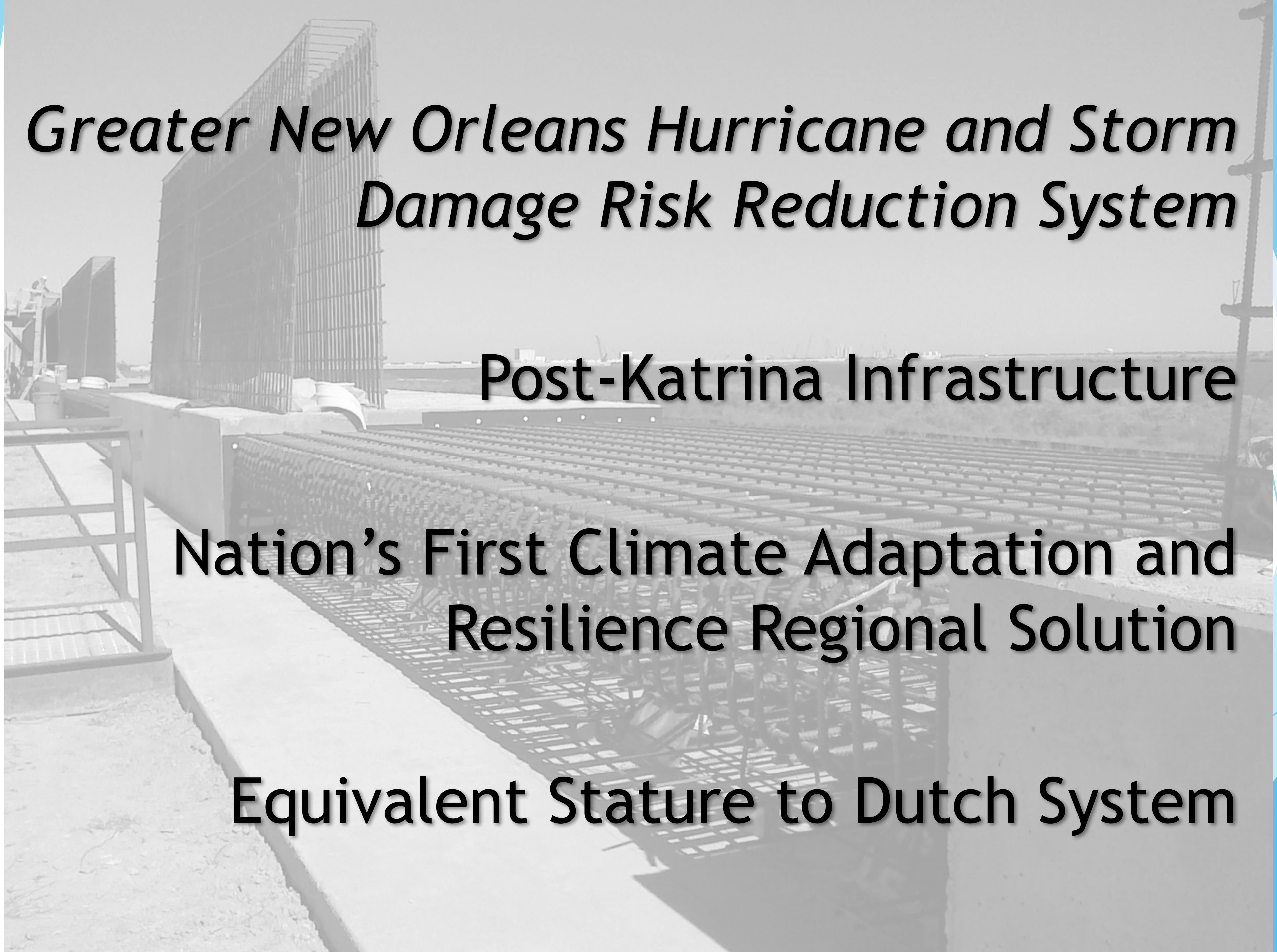
Value: Whose? When? How? Why?

Community

- Preferences
- Priorities
- Preparedness
- Self-sufficiency
- Adequacy vs. ideal
- Continuous improvement

Resilience

- Initial cost
- Operations and maintenance
- Disaster losses
- Critical reliance
- Redundancy and adaptability
- Fail gracefully



Greater New Orleans Hurricane and Storm Damage Risk Reduction System

Post-Katrina Infrastructure

Nation's First Climate Adaptation and Resilience Regional Solution

Equivalent Stature to Dutch System

Led Ecogeomorphic and Climate Science Integration for Post-Katrina $14 Billion Infrastructure Program

The Elements

- **Multiple Lines of Defense**
  - Linear Infrastructure: Levees, Walls, Gates, etc
  - Energy harvesting: sun-gathering ecosystems
  - Energy dissipation: landforms as barriers, regenerating
  - Behavior: Evacuation, pumps, raised buildings, etc
- **Adaptive Management**
  - Works for different storm events today
  - Capable of performing and evolving over time
  - Designed for modified structures and operations
  - Could address scenarios not currently known

Plan Formulation

- **Congress Mandated 1% annual risk**
  - What is service life? Steel/Concrete = 50 yrs
  - What will conditions be at

  END OF SERVICE? ***CHANGED!***
  - How to optimize budget provided?
- **Project Re-Defined Risk-Based Infrastructure Formulation**
  - Factored in SLR, subsidence, etc
  - Forecasts for basis of design
  - Truly systems-based approach of hard and green
  - Not just 1% chance of flooding **TODAY** as is typical
  - End of service 1% chance of flooding
  - **PLUS** resilience for 500-yr storm throughout and beyond

FEMA Certified Feb 2014

- First time greater New Orleans ever had federally certified Flood Management Infrastructure
- Complies with new national standards
- Was first in US to meet new standards
- Areas considered outside FEMA maps for NFIP
- Due to future-based engineering, will remain so
- Example for preemptive loss avoidance

A New Standard of Care? What more?

- **New Ways to Collaborate**
  - Government ↔ Industry
  - Government ↔ Public
  - Government ↔ Researchers
- **New Ways to Communicate**
  - Risk and Uncertainty
  - Resilience and Community Preparedness
  - Future Scenarios and Life Cycle Issues
  - Transparency and Verification

Questions?

“Eventually, the world will no longer be divided by the ideologies of 'left' and 'right,' but by those who accept ecological limits and those who don't”.
– Wolfgang Sachs, Wuppertal Institute