Integrating Resiliency into Architecture, Landscape Infrastructure, and Energy Systems
Agenda

• Resiliency:
  • Definition
  • Drivers and Challenges
  • Scales

• Solutions
  • Energy Systems
  • New York City Climate Stewardship
  • Landscape as Infrastructure
RESILIENCY
Resiliency is “the capacity to recover quickly from difficulties; toughness” and/or “the ability of a substance or object to spring back into shape; elasticity”

English Dictionary
“Resilience is something that may be very hard to see, unless you exceed its limits, overwhelm and damage the balancing loops, and the system structure breaks down. Because resilience may not be obvious without a whole-system view, people often sacrifice resilience for stability, or for productivity, or for some other more immediately recognizable system property”

Donella H. Meadows: Thinking in Systems
This map denotes the approximate location for each of the 15 billion-dollar weather and climate disasters that have impacted the United States January through September of 2017, a record pace.
CHALLENGE: CLIMATE
Lower Scenario
Change in average surface temperature (1986–2005 to 2081–2100)

Higher Scenario
Change in average precipitation (1986–2005 to 2081–2100)
SOLUTION

RESILIENCY

RAISED GROUND
FORTIFY ARCHITECTURE
DEPLOYABLE
BERM
FLOOD GATE
FLOOD PROTECTION

SUSTAINABILITY

SMART-GRID
MASSING ORIENTATION
LOCAL RENEWABLE ENERGY
GHG EMISSIONS REDUCTION
Biodiversity
Pervious Surface
Microgrids

District Energy

High Performance Design
NYC’s Climate Leadership

Divestment

- NYC is the first major US city to commit to divesting its pension funds from fossil fuels
- Commitment of $4B in clean water, energy and other climate-friendly investments
Climate Risks
The City’s climate risks come from both chronic hazards and extreme events.

The NYC Panel on Climate Change (NPCC) projects increased chronic climate hazards…

- By the 2050s:
  - 4.1°F to 5.7°F increase in average temperature
  - 4% to 11% increase in average annual precipitation
  - Sea levels likely to rise 1-2 ft.; maybe 2½ ft.

- By 2100:
  - High-end projections may reach 6 ft.

…and increased impact from extreme weather events.

- By the 2050s:
  - Number of days in NYC above 90° could triple

Even today:
- 100-year floodplain encompasses 218,000 New Yorkers and is projected to expand as the City’s flood maps are revised
Climate Vulnerability Assessment and Adaptation Planning

NYC publishes PlaNYC

2007

NPCC publishes first set of NYC climate projections

2009

Inventory of at-risk built and natural infrastructure

2009-2010

A Stronger, More Resilient New York/Climate Risk Information 2013

2013

Mayor de Blasio establishes Office of Recovery and Resiliency; OneNYC released

2014

Opportunity to conduct a multi-hazard climate vulnerability assessment to shape the future of resiliency efforts

2019
Climate Adaptation

To adapt to these threats, NYC is investing over $20 billion in its multilayered resiliency program to protect New Yorkers.

- **Neighborhoods**: Every city neighborhood will be safer by strengthening community, social, and economic resiliency.
- **Buildings**: The city’s buildings will be upgraded against changing climate impacts.
- **Infrastructure**: Infrastructure systems across the region will adapt to enable continue services.
- **Coastal Defense**: New York City’s coastal defenses will be strengthened against flooding and sea level rise.
Climate Adaptation
In practice, this means integrated resilience measures along our coastline...
Coastal Protection
IMPLEMENTATION FUNDING IN PLACE

- TWO BRIDGES
  - $176M (CDBG-NDR)
  - $27M (City Capital)
  - Total: $203M

- FIDI + BPC
  - $100M (City Capital)
  - $8M for The Battery
  - Total: TBD
CORE MISSION

FLOOD RISK REDUCTION + PUBLIC BENEFIT
EVALUATION CRITERIA

CONSTRUCTABILITY
- Cost
- Structural requirements
- Impacts on utilities
- Disruptions to existing structures and transportation
- Failure risk

SCHEDULE
- Regulatory actions
- Environmental impacts
- Jurisdictional coordination

RESILIENCE
- Buildings, residents, and infrastructure protected
- Adaptability

OPERATIONS & MAINTENANCE
- Accessibility
- O&M requirements

PUBLIC REALM BENEFITS
- Opportunity for community amenities, placemaking, and urban design
TWO BRIDGES NEIGHBORHOOD

75 out of 163 acres of Two Bridges is within the 2050s 100 year floodplain

46%

71% of buildings in the flood zone are residential

20% of the population is elderly (65+)

52% of the elderly have a classified disability

REFINED ALIGNMENT STUDY AREA
ALIGNMENT STUDY AREA BOUNDARY
2050s 100 YR FLOODLINE

PREFERRED PROJECT FOOTPRINT

- Preserves inland / neighborhood operations during storm event
- Streamlines coordination with property owners + stakeholders
- Allows project team to maximize opportunity for public benefit
- Minimizes permanent disruptions to traffic + operations
- Maximum protection for residents, utilities, + infrastructure
- Pier 36 will require building level resiliency measures

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DESIGN OBJECTIVES

1. PRESERVE VIEWS + ACCESS

2. DISTRIBUTE PROGRAM EQUITABLY

3. INTEGRATE INFRASTRUCTURE INTO THE PUBLIC REALM
INFRASTRUCTURE TO PRESERVE VIEWS + WATERFRONT ACCESS

ENGINEERING APPROACH

HOW CAN INFRASTRUCTURE TYPOLOGIES PROMOTE ACCESSIBILITY AND FRAME WATERFRONT VIEWS?

FLOOD WALL

SWING GATE

ROLLER GATE

FLIP UP GATE

FLIP UP GATE - DEPLOYED
EVENT SPACE | CONCEPT IDEA
STRATEGIC PLAN FOR LOWER MANHATTAN

STUDY OBJECTIVES

• Identify extent of climate hazards and exposure in Lower Manhattan
• Assess options for adapting to climate threats over the long-term (2050 to 2100)
• Develop a long-term strategy to adapt Lower Manhattan
• Identify and evaluate key implementation considerations

KEY FINDINGS

• Lower Manhattan's evolving economy and population growth are stressing existing systems—transportation, stormwater infrastructure and the public realm.

• Lower Manhattan faces increasingly frequent climate events of ever greater intensity, impacting critical infrastructure systems and the economy of not only the district but also New York City and the wider region.

• Interventions to date to address climate change in Lower Manhattan are focused on individual climate hazards and are limited in benefits due to a lack in real estate—a comprehensive approach to adaptation that addresses the totality of risk is recommended.
LONG TERM CLIMATE PLAN APPROACH

POLICY OBJECTIVES

- Provide comprehensive protection towards all hazards in 2100
- Provide interim protection between now and 2050, where feasible
- Support urban co-benefit generation
- Promote approaches that have the ability to self-fund or be balance-sheet neutral to City
- Leverage existing investment
By 2050, storm surge combined with 30" sea level rise will cause even more extreme coastal flood risk.

**Impacts**

- Surge height 10+ feet at the Seaport and the Financial District
- Surge height in 11+ feet at the Battery
- Street and basement flooding
- Saltwater inundation of subway system and tunnels

By 2100...

51% of buildings exposed to 100yr surge

776 buildings in historic districts or landmarks exposed 100yr surge

Source: AECOM COASTAL MODEL
BY 2100, SEA LEVEL RISE WILL SUBMERGE THE EDGE, CAUSE MONTHLY TIDAL INUNDATION

299
Buildings at risk from monthly tidal inundation

17%
All roadways exposed to monthly tidal inundation
IN ADDITION TO STORM SURGE AND SEA LEVEL RISE, GROUNDWATER TABLE RISE WILL BECOME A SIGNIFICANT THREAT BY 2100

GWT rise will expose underground infrastructure to corrosion, settlement, and uplift.

Buildings vulnerable to destabilization due to GWT rise.
A RANGE OF ADAPTATION MEASURES WERE STUDIED
ADAPTATION SCENARIOS

BUILDING-LEVEL

1. BUILDING AND PUBLIC REALM PROTECTION
Adapt the public realm through street raising and utility waterproofing; adapt individual buildings using wet and dry floodproofing measures.

2. BUILDING AND LOW EDGE PROTECTION
At the district’s edge, protect against sea-level rise and groundwater table rise using a low physical barrier and a below-ground seepage barrier; adapt buildings using wet and dry floodproofing measures.

3. DISTRICT DEPLOYABLE PROTECTION
At the district’s edge, protect against sea-level rise using a low physical barrier and protect against storm surge using deployable flood protection; protect against groundwater table rise using a below-ground seepage barrier.

4. HIGH EDGE PROTECTION
At the district’s edge, protect against sea-level rise and storm surge using a higher physical barrier and groundwater table rise using a below-ground seepage barrier.

5. OUTBOARD PROTECTION
Protect against sea-level rise, storm surge, and groundwater table rise through land reclamation outboard of the existing Lower Manhattan edge.

DISTRICT-WIDE
## EVALUATION CRITERIA

<table>
<thead>
<tr>
<th><strong>Benefits</strong></th>
<th><strong>Feasibility</strong></th>
<th><strong>Financial Constraints</strong></th>
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<tbody>
<tr>
<td>Climate Benefit</td>
<td>Technical</td>
<td>Net Cost</td>
</tr>
<tr>
<td>achieved through avoided losses and disruption caused by hazard impacts</td>
<td>constructability and ability to phase without large-scale disruption</td>
<td>to the city, net of revenues created or existing budgeted capital</td>
</tr>
<tr>
<td>District Reputation</td>
<td>Permitting</td>
<td>Sectoral Burden</td>
</tr>
<tr>
<td>of long-term exposure and frequent flooding</td>
<td>ease and ability, as well as environmental considerations</td>
<td>to the public and private sectors</td>
</tr>
<tr>
<td>Co-Benefits</td>
<td></td>
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<tr>
<td>produced through improved mobility, enhanced and expanded public realm, and building modernization</td>
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LANDSCAPE AS INFRASTRUCTURE

As part of a larger LMCR project, the project investigates design, engineering, and mitigation in the Two Bridges community.
FLOOD RISK REDUCTION + PUBLIC REALM
THE CHALLENGE IN LOWER MANHATTAN

EXISTING CONDITIONS

VULNERABILITY

DISRUPTION OF ACCESS

SANDY FLOOD LEVELS

LASTING EFFECTS

DISRUPTION OF MOBILITY
DESIGNING WITHIN DENSE URBAN WATERFRONTS

APPRAOCH TO THE CHALLENGE

CONCEPTUAL ALIGNMENTS

EDGE
UPLAND
HYBRID

SUBSURFACE STRUCTURES
UTILITY NETWORKS
BULKHEAD

TRANSPORTATION + CIRCULATION
ROADWAYS + SIDEWALKS

ADJACENT USES
EXISTING OPEN SPACE
NEW WATERFRONT IMPROVEMENTS
ADJACENT PROPERTIES
FDR VIADUCT
STRUCTURAL FOUNDATIONS
SUBWAY INFRASTRUCTURE
DESIGNING LANDSCAPE INFRASTRUCTURE WITH THE COMMUNITY

DESIGN OBJECTIVES

- PRESERVE VIEWS + WATERFRONT ACCESS
- DISTRIBUTE PROGRAM EQUITABLY
- INTEGRATE INFRASTRUCTURE INTO THE PUBLIC REALM
INFRASTRUCTURE TO PRESERVE VIEWS + WATERFRONT ACCESS
PUBLIC REALM AS FLOOD RISK REDUCTION

DEPLOYED CONDITION
DESIGN TO DISTRIBUTE PROGRAMS EQUITABLY

PROGRAM ORGANIZATION

HOW CAN FLOOD RISK MITIGATION ACCOMODATE A DIVERSE ARRAY OF PROGRAMS ACROSS THE SITE?

EXISTING ESPLANADE ORGANIZATION
CREATE POCKETS FOR PROGRAMMING
DISTRIBUTE PROGRAMS

PROMOTE INTERACTION
INTEGRATE FLOOD INFRASTRUCTURE
FLEXIBLE
SCALEABLE
DIVERSE PROGRAMS WITHIN FLOOD RISK REDUCTION

HOW CAN FIXED INFRASTRUCTURE CATALYZE A DYNAMIC PUBLIC REALM?

- WALL PROGRAMMING
- POST PROGRAMMING

- AS A SPORT COURT
- AS AN INTERACTIVE WALL
- AS A CLASSROOM
- AS WAYFINDING
- AS FITNESS EQUIPMENT
- AS A SWINGSET
- AS A CANOPY
INFRASTRUCTURE INTEGRATED INTO THE PUBLIC REALM

SETTING A PRECEDENT FOR FLOOD RISK REDUCTION

DEPLOYED CONDITION
REBUILD BY DESIGN: MEADOWLANDS

DESIGNING INFRASTRUCTURE FOR A COMMUNITY AT RISK
REBUILD BY DESIGN: MEADOWLANDS

TWO MAIN INFRASTRUCTURE CHALLENGES

1. MAJOR STORM SURGE
   Flooding

2. FREQUENT RAIN
   Flooding

- FILLED HISTORICAL WETLANDS
- LOW ELEVATION
- INSUFFICIENT PROTECTION
- FAILING BERMS
- UNDERPERFORMING
- INADEQUATE DITCHES + DRAINAGE
- WATER QUALITY
- INSUFFICIENT DRAINAGE
FLOOD RISK REDUCTION INFRASTRUCTURE + PUBLIC REALM

THREE PUBLIC REALM DESIGN TYPLOGIES

INFRASCTURE AT THE WATER'S EDGE

PERFORMATIVE INTERIOR PARKS

HYBRID FLUVIAL PARKS
DESIGNING TO MEET COMMUNITY CONCERNS

WORKSHOPS / ENGAGEMENT / TOOLS
DESIGN TYPOLOGY 1
MULTI-FUNCTIONAL WALL STUDIES

BASIC WALL STUDIES

BENCH STUDIES

BENCH + PLANTER STUDIES
LANDSCAPE AS INFRASTRUCTURE
INFRASTRUCTURE AT THE WATER’S EDGE

1. MULTI-FUNCTIONAL BENCH UNIT
2. MULTI-FUNCTIONAL PLANTER UNIT
3. ACCESS & MAINTENANCE PATH

FLOOD PROTECTION
DESIGN TYPOLOGY 2
PERFORMATIVE INTERIOR PARKS

REVIVING THE DITCH

REVIVING THE DITCH

NEW FORCE MAINS

STREET IMPROVEMENTS

STREET IMPROVEMENTS

NEW AND IMPROVED OPEN SPACE
PERFORMATIVE INTERIOR PARKS
WETLANDS + PLACEMAKING PARK

1. ELEVATED WETLAND BOARDWALK
2. CHANNEL IMPROVEMENTS TO DITCHES
3. SHALLOW EMERGENT MARSH
4. ATLANTIC WHITE CEDAR FOREST
DESIGN TYPOLOGY 3
HYBRID FLUVIAL PARKS

MODULAR PROTECTION STRATEGY
RESIDENTIAL PASSAGE
ECOLOGICAL PATH
BERMS + OPEN SPACE
PLANTED STREET MEDIAN
DEPLOYABLE STRATEGY
HYBRID FLUVIAL PARKS
PLACEMAKING + FLOOD REDUCTION

1. US ROUTE 48 BRIDGE
2. NEWLY CREATED TIDAL WETLAND
3. ELEVATED WETLAND BOARDWALK
4. WOOD SLAT AND CONCRETE BENCH
5. UPLAND HABITAT
THANK YOU