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

https://sundaebean.com/wp-content/uploads/2014/02/BendorBreak.jpg

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”

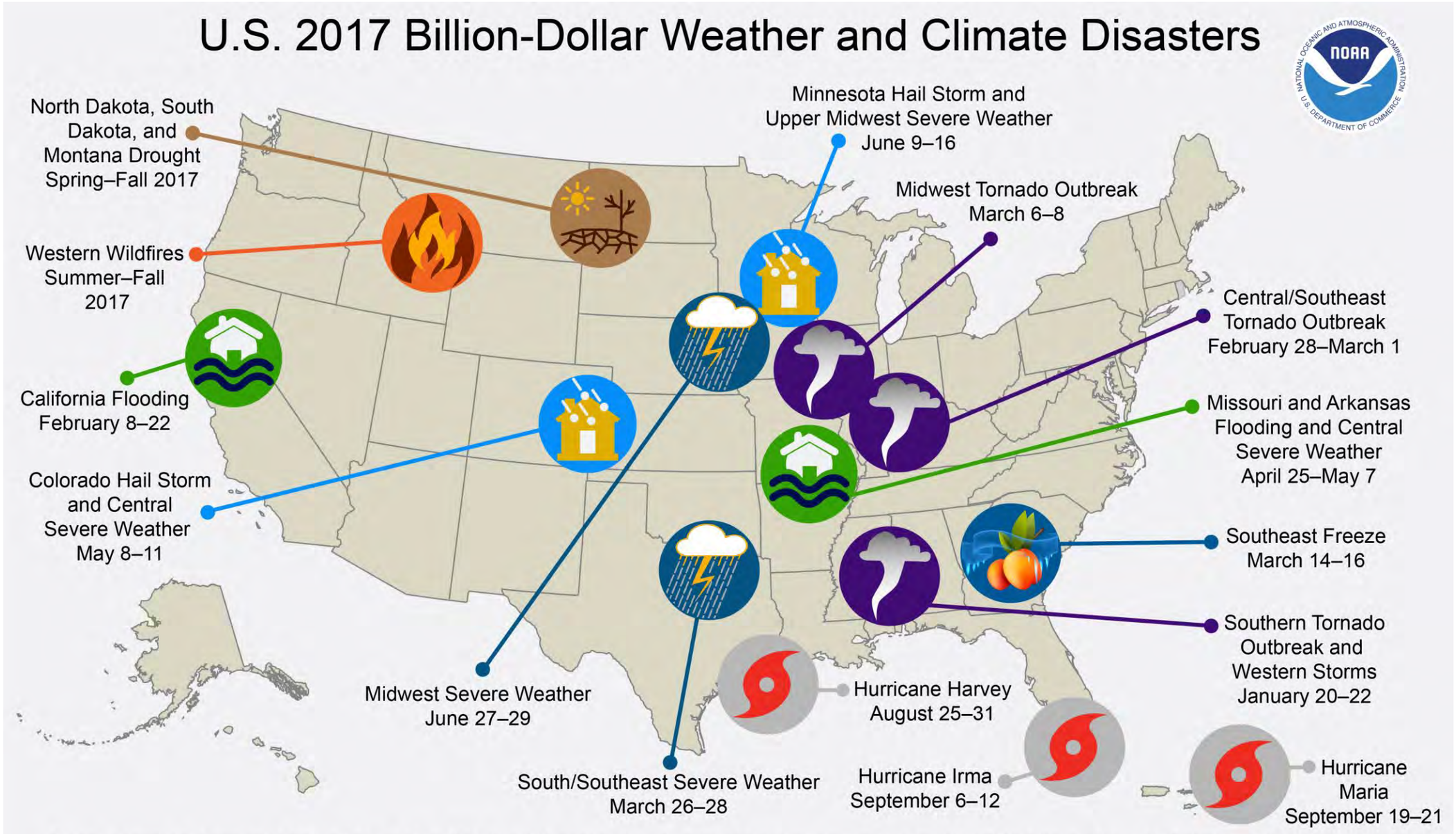
English Dictionary

“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

http://arrestedmotion.com/wp-content/uploads/2012/11/a_4.5x.jpg

U.S. 2017 Billion-Dollar Weather and Climate Disasters

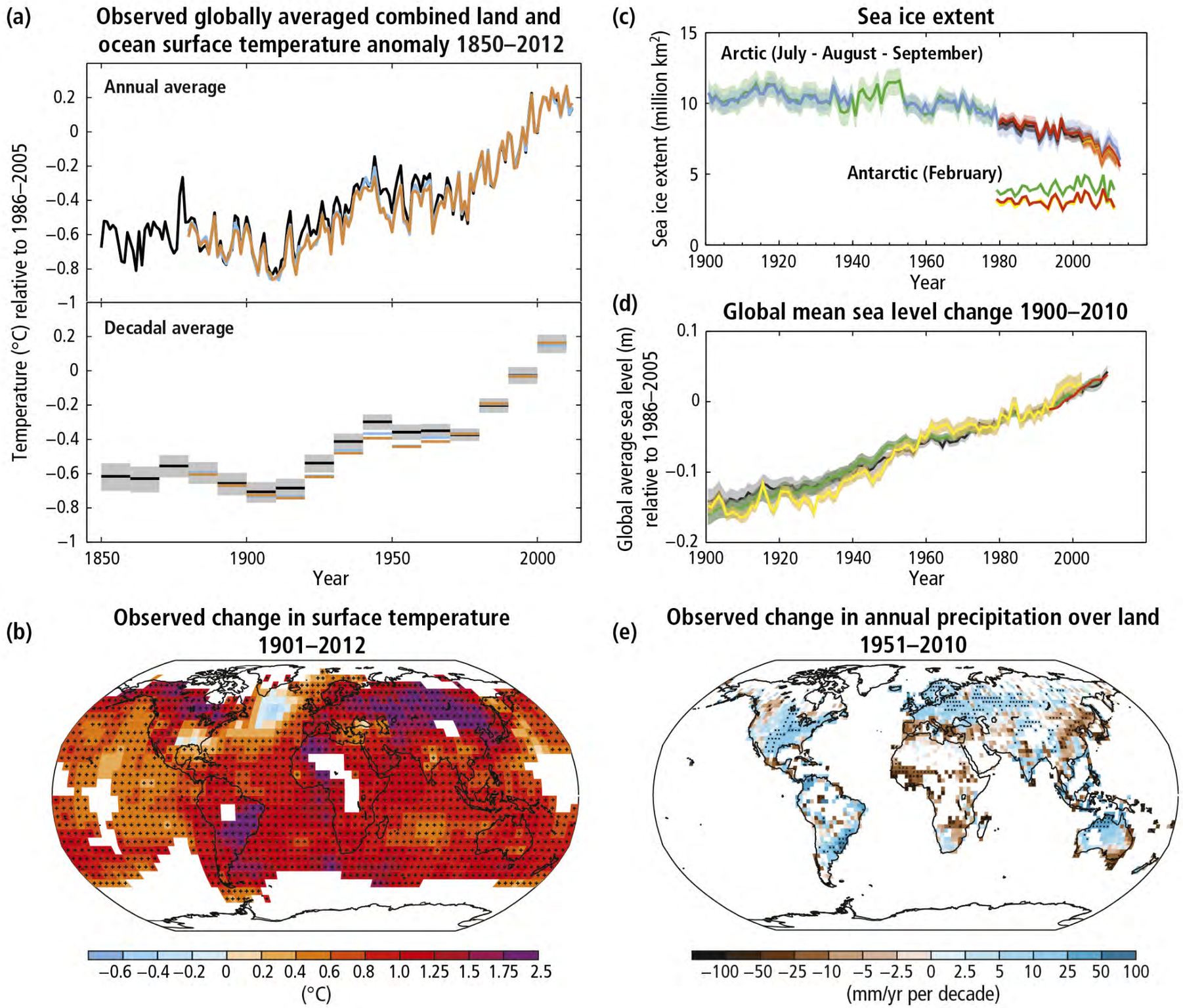


*This map denotes the approximate location for each of the **15 billion-dollar weather and climate disasters** that have impacted the United States **January through September of 2017, a record pace**.*

https://www.ncdc.noaa.gov/billions/

CHALLENGE: CLIMATE

http://www.unoosa.org/images/psa/emnrm/CC/PolarIceRim_UNPhotoMarkGarten.jpg

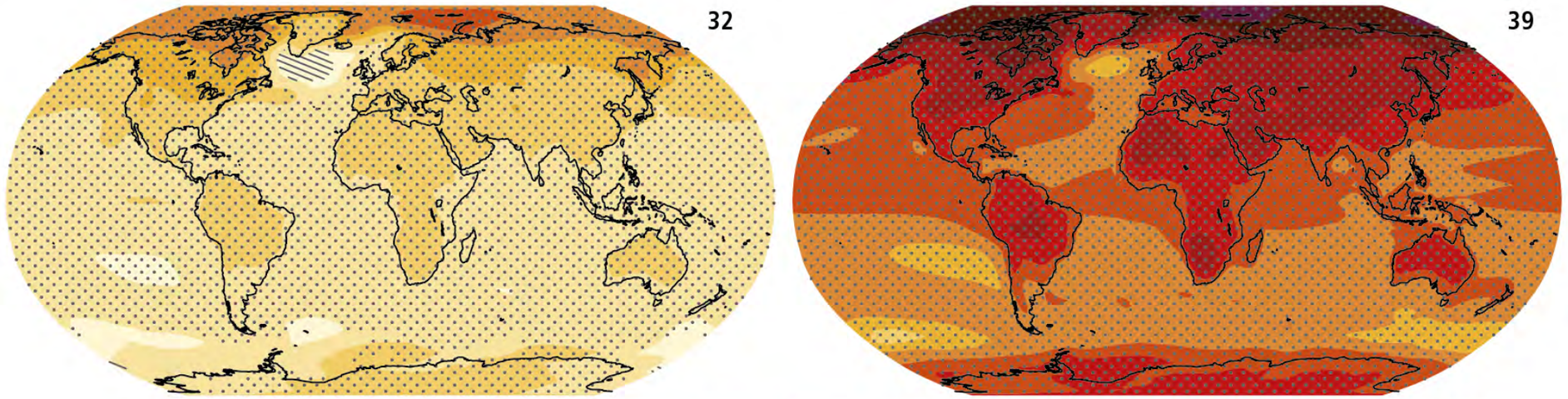


IPCC, 2014: Climate Change 2014: Synthesis Report

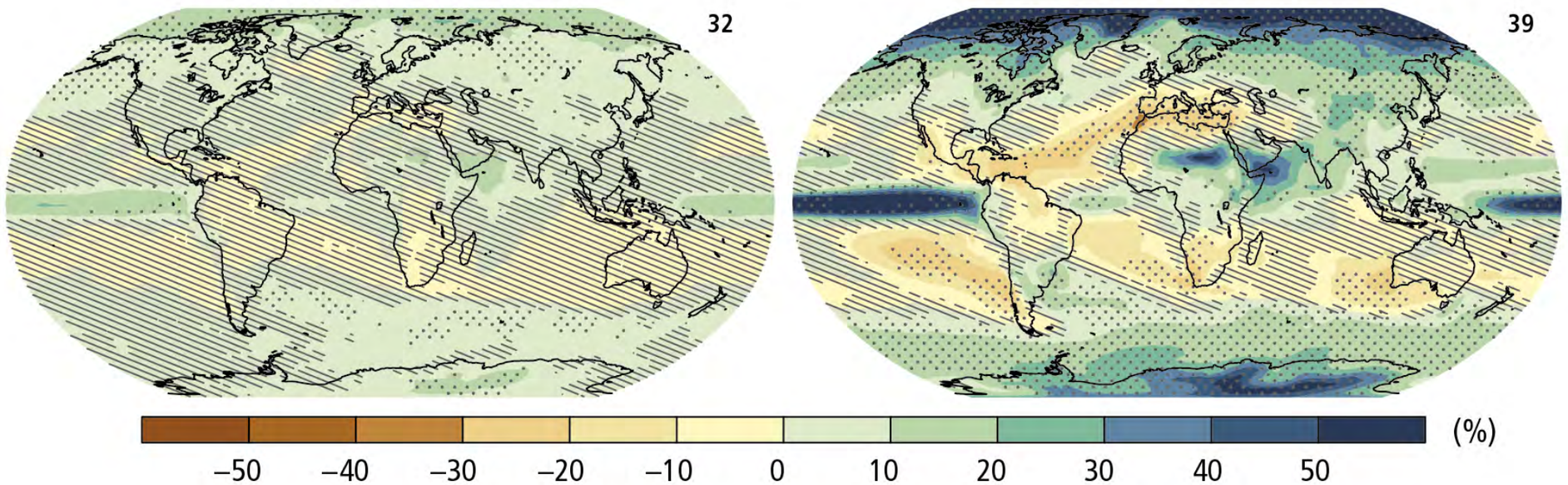
Lower Scenario

Higher Scenario

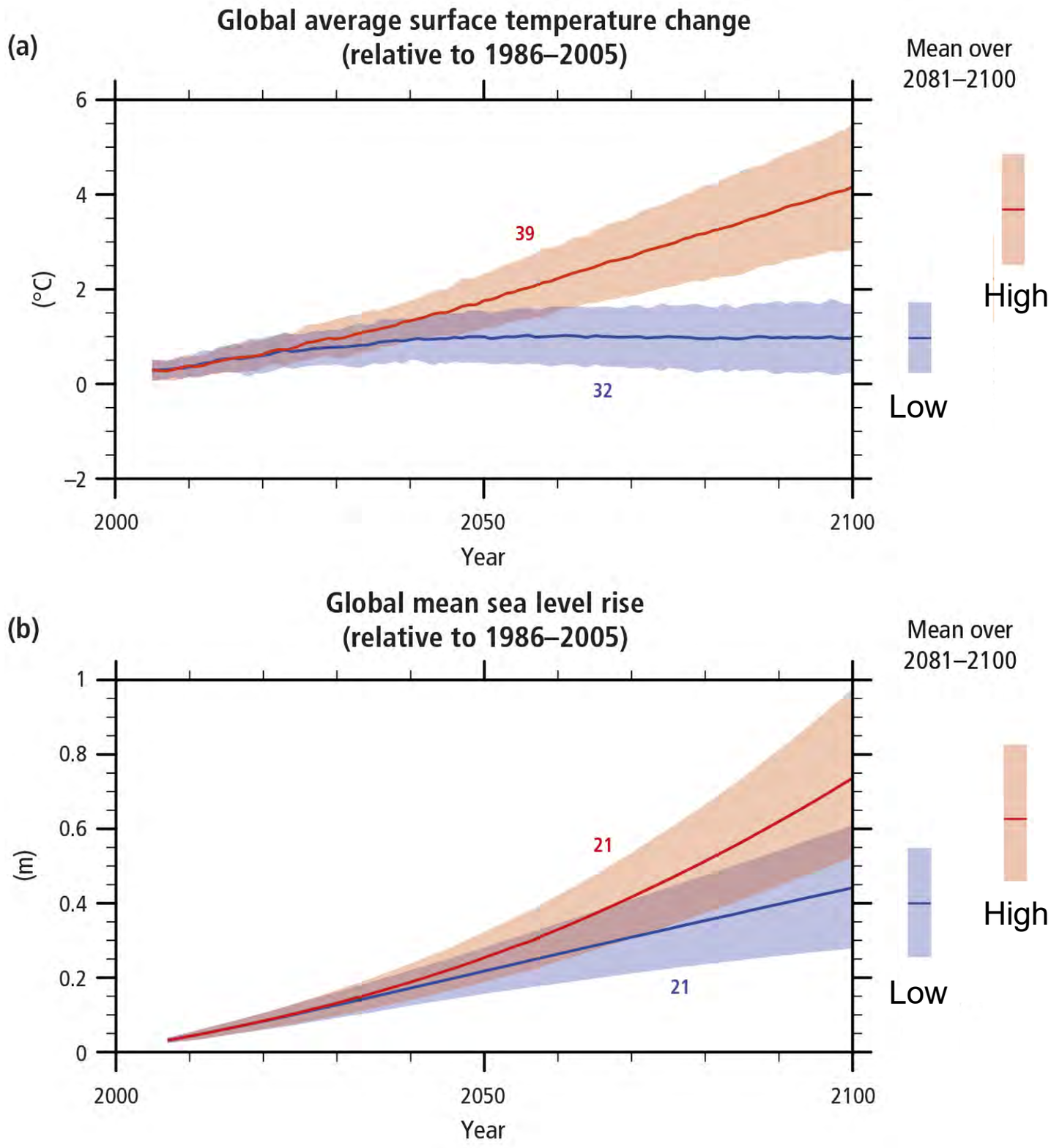
(a) **Change in average surface temperature (1986–2005 to 2081–2100)**



(b) **Change in average precipitation (1986–2005 to 2081–2100)**



IPCC, 2014: Climate Change 2014: Synthesis Report

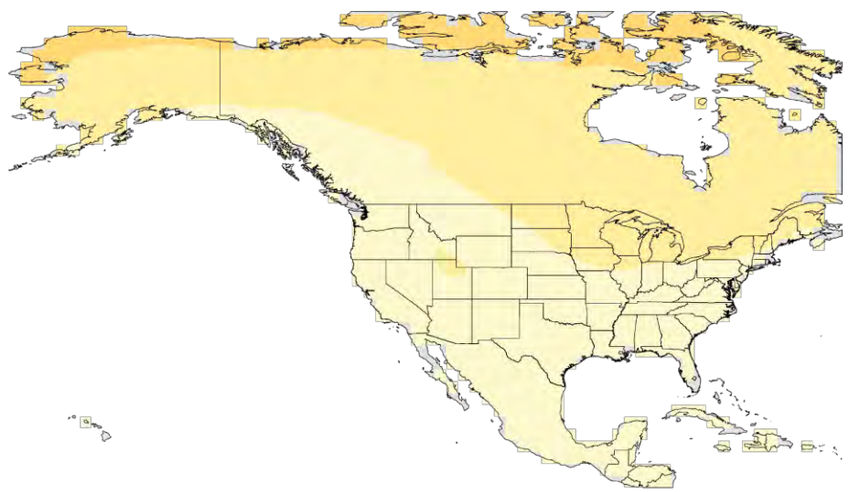


IPCC, 2014: Climate Change 2014: Synthesis Report

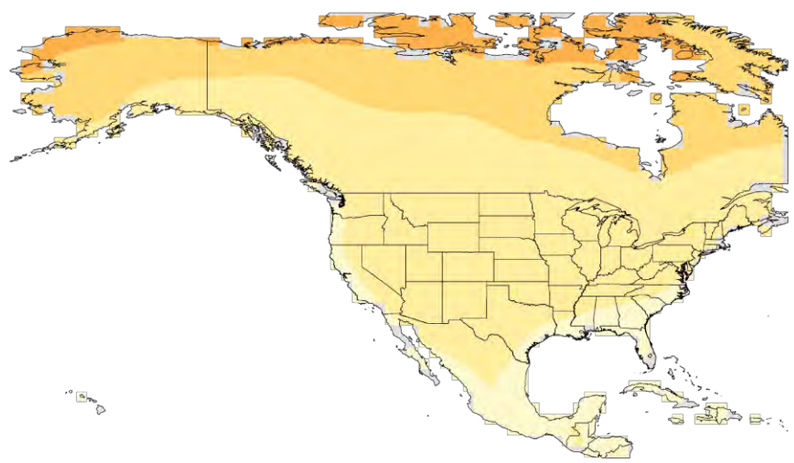
Projected Changes in Annual Average Temperature

Mid 21st Century

Lower Scenario

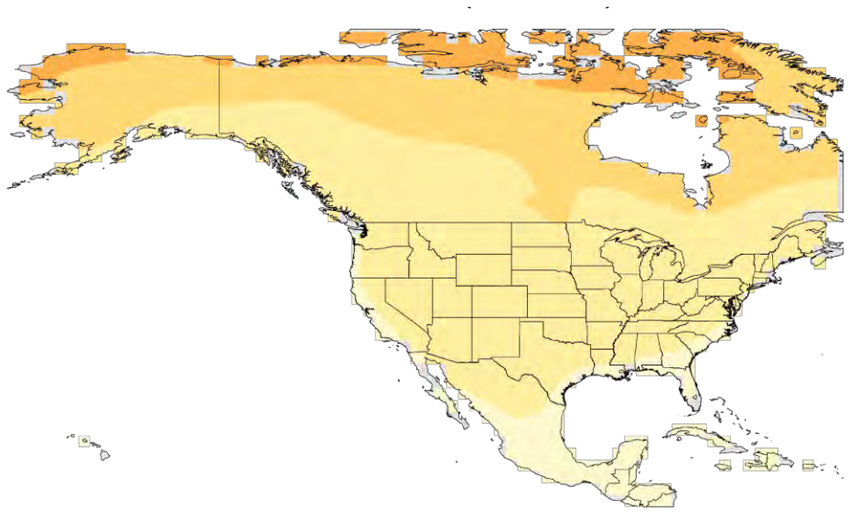


Higher Scenario

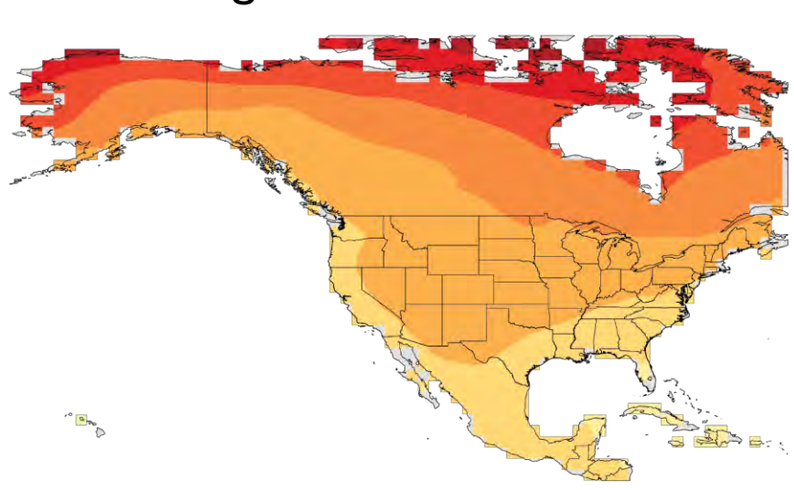


Late 21st Century

Lower Scenario



Higher Scenario



Change in Temperature (°F)

2 4 6 8 10 12 14 16 18

USGCRP, 2017: Climate Science Special Report: Fourth National Climate Assessment, Volume I

SOLUTION

RESILIENCY

RAISED GROUND

FORTIFY ARCHITECTURE

DEPLOYABLE

BERM

FLOOD GATE

FLOOD PROTECTION

SUSTAINABILITY

SMART-GRID

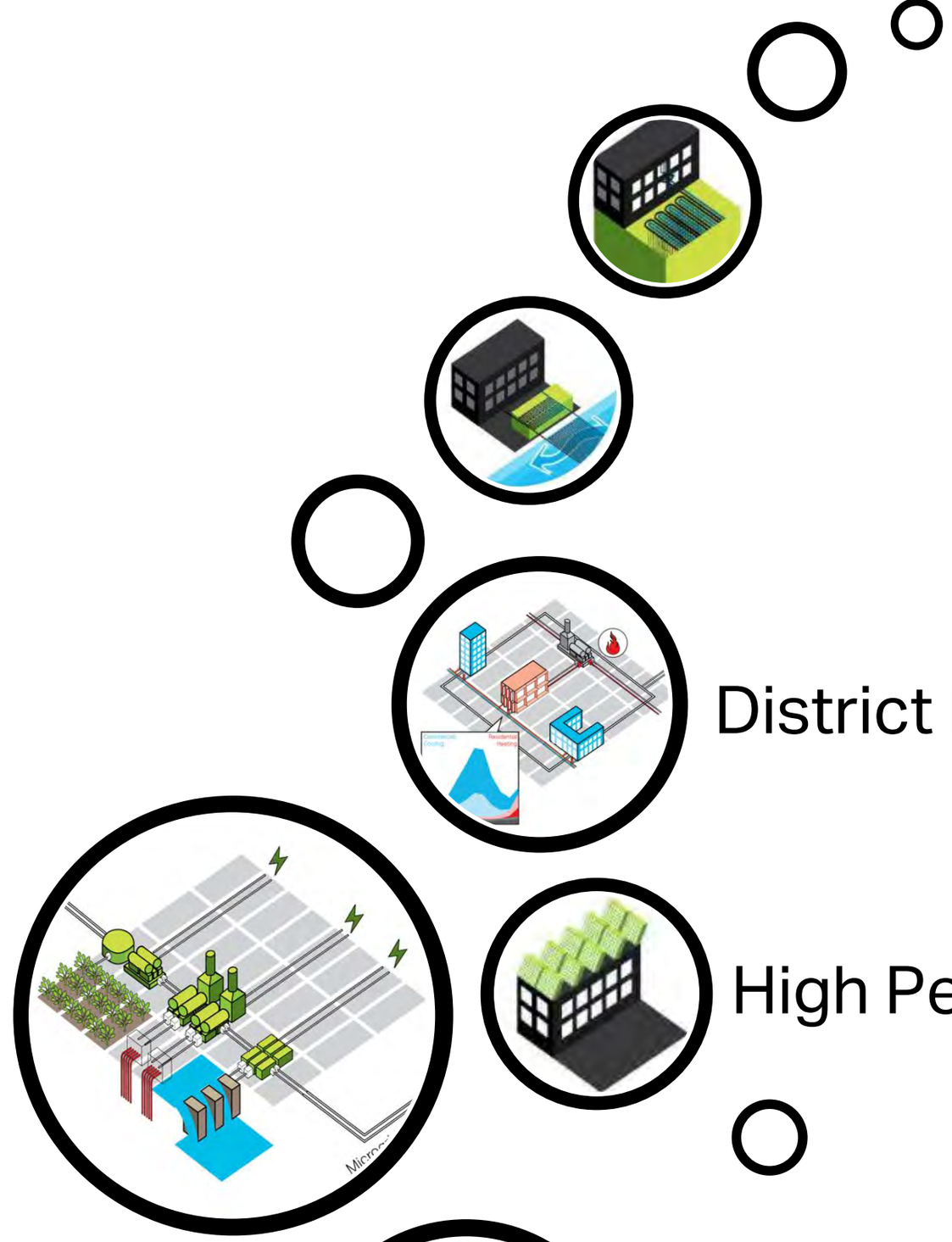
MASSING ORIENTATION

LOCAL RENEWABLE ENERGY

GHG EMISSIONS REDUCTION

BIODIVERSITY

PERVIOUS SURFACE



District Energy

Microgrids

High Performance Design

NYC's Climate Leadership

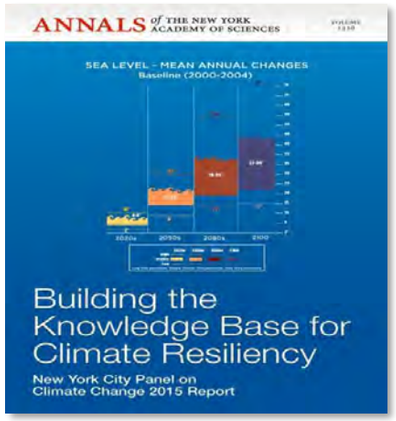
Divestment

- 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 90º 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

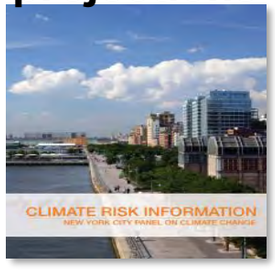
Climate Vulnerability Assessment and Adaptation Planning

2007

NYC publishes PlaNYC

2009

NPCC publishes first set of NYC climate projections

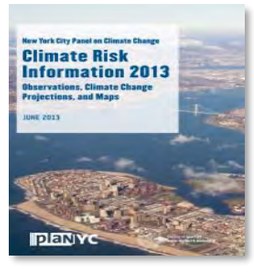


2009-2010

Inventory of at-risk built and natural infrastructure

2013

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



2014

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

2019

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

Climate Adaptation

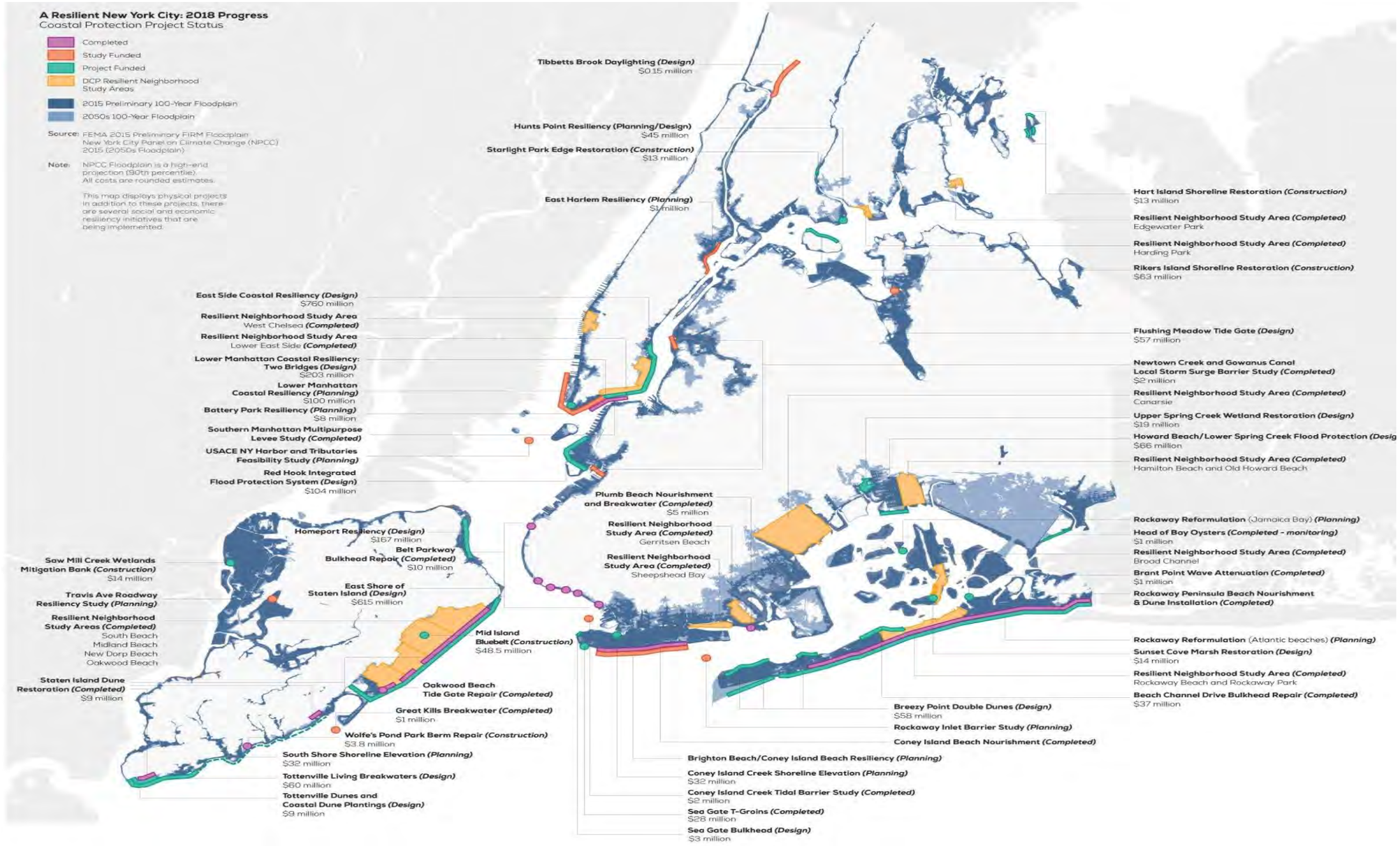
To adapt to these threats, NYC is investing over $20 billion in its multilayered resiliency program to protect New Yorkers.

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

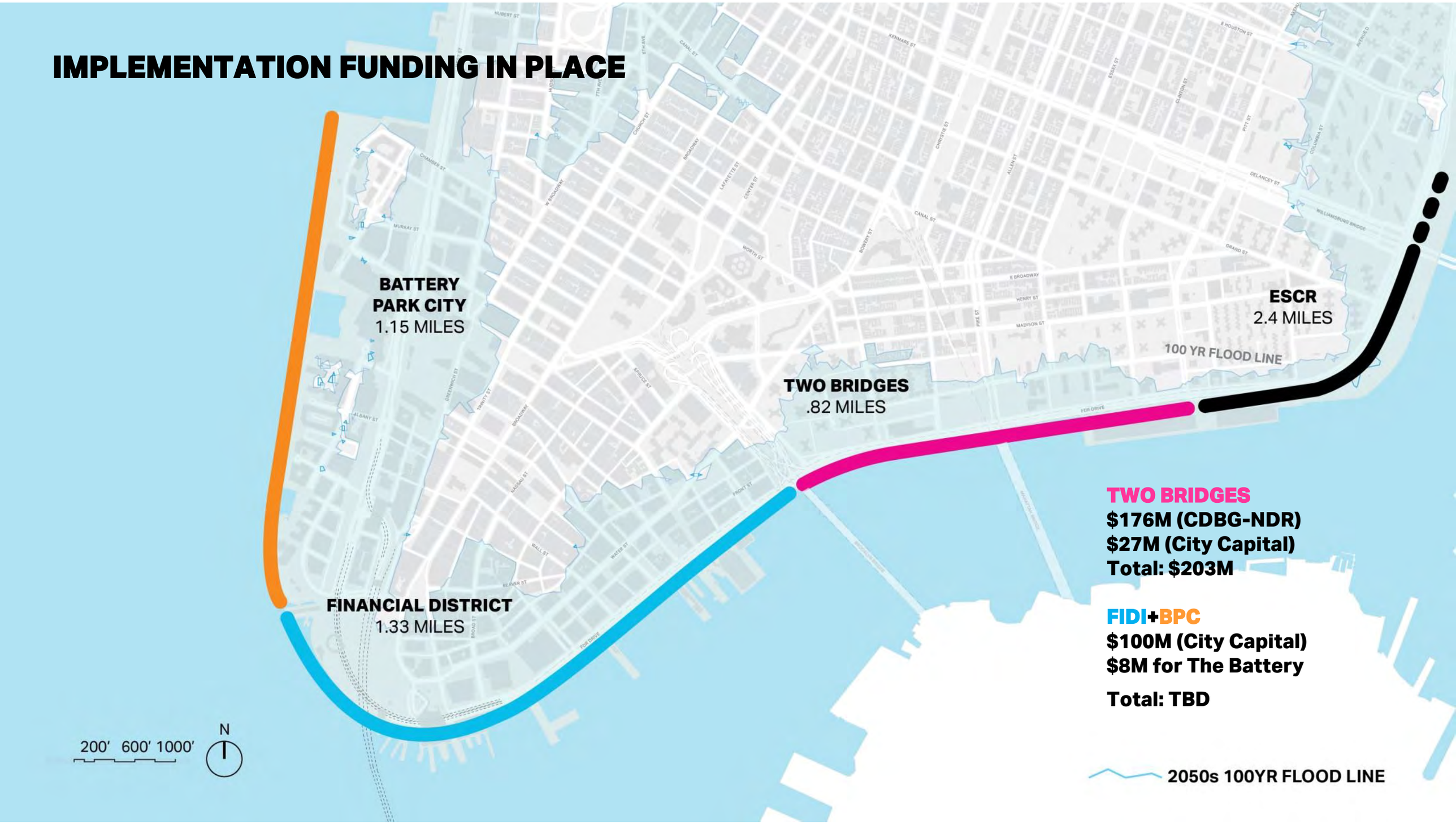
Climate Adaptation

In practice, this means integrated resilience measures along our coastline…

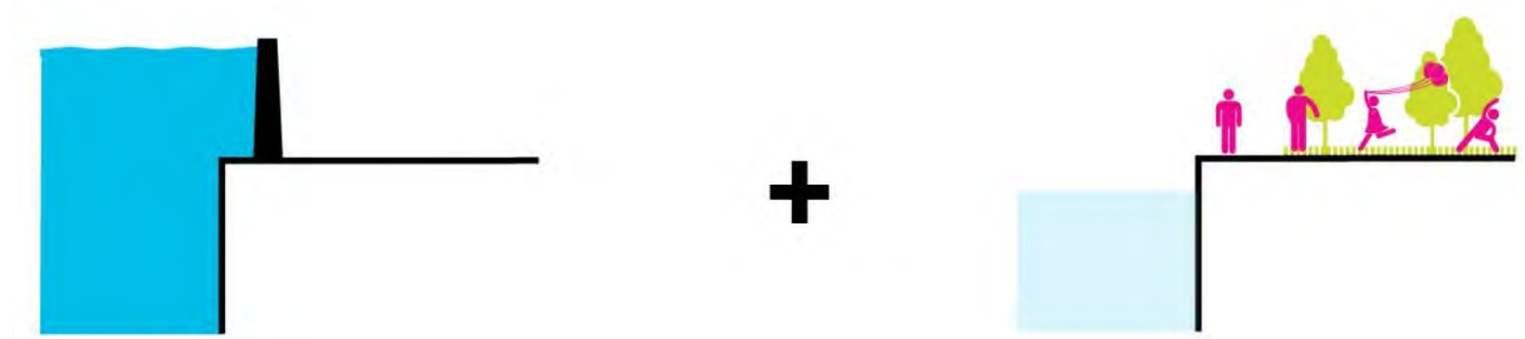
Coastal Protection



IMPLEMENTATION FUNDING IN PLACE



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

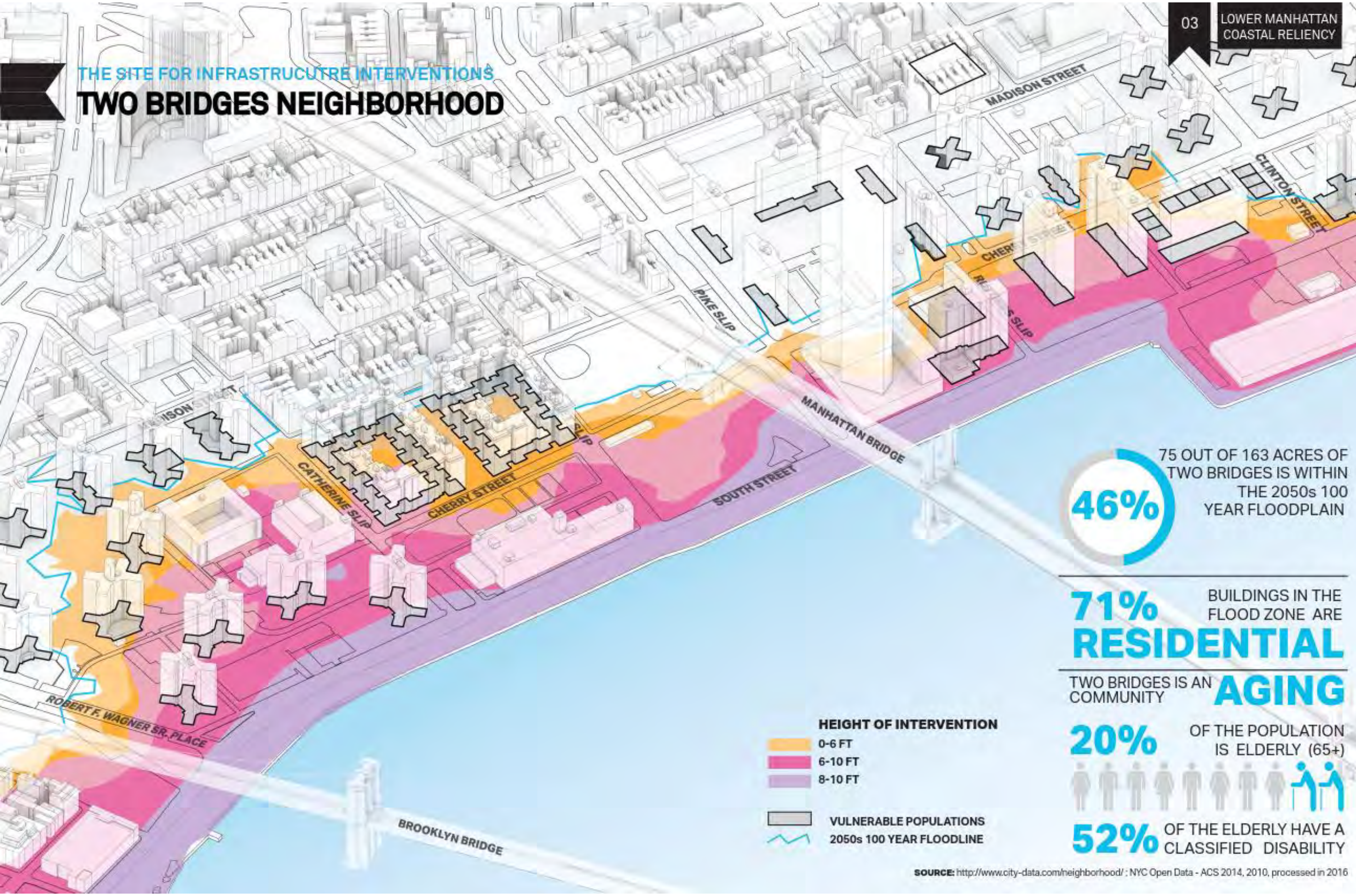
- Accessibility
- O&M requirements

PUBLIC REALM BENEFITS

- Opportunity for community amenities, placemaking, and urban design

THE SITE FOR INFRASTRUCUTRE INTERVENTIONS

TWO BRIDGES NEIGHBORHOOD



46% 75 OUT OF 163 ACRES OF TWO BRIDGES IS WITHIN THE 2050s 100 YEAR FLOODPLAIN

71% BUILDINGS IN THE FLOOD ZONE ARE **RESIDENTIAL**

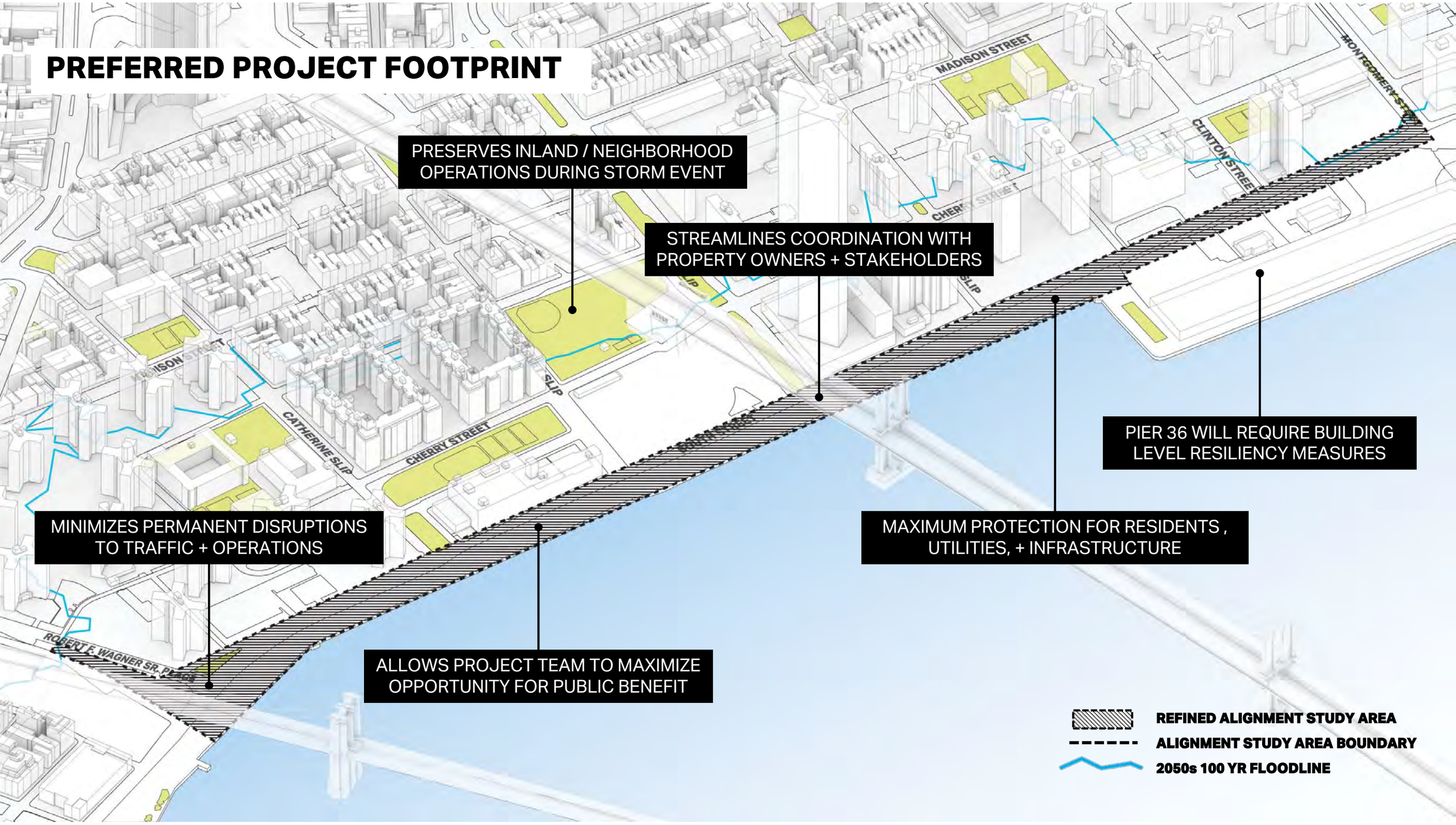
TWO BRIDGES IS AN **AGING** COMMUNITY

20% OF THE POPULATION IS ELDERLY (65+)

52% OF THE ELDERLY HAVE A CLASSIFIED DISABILITY

SOURCE: http://www.city-data.com/neighborhood/ ; NYC Open Data - ACS 2014, 2010, processed in 2016

PREFERRED PROJECT FOOTPRINT



DESIGN OBJECTIVES

1 **PRESERVE VIEWS + ACCESS**

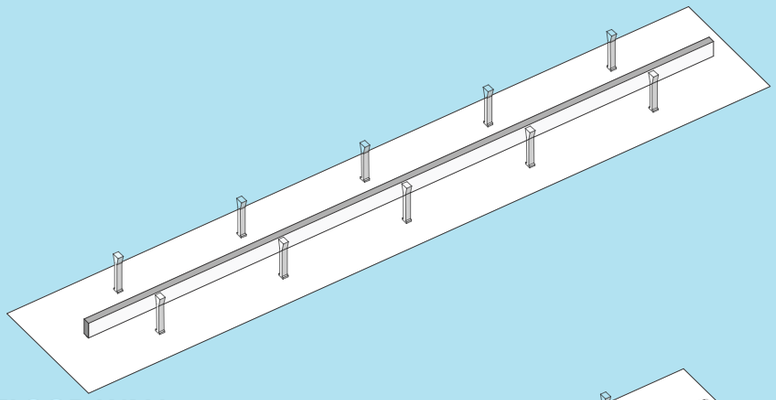
2 **DISTRIBUTE PROGRAM EQUITABLY**

3 **INTEGRATE INFRASTRUCTURE INTO THE PUBLIC REALM**

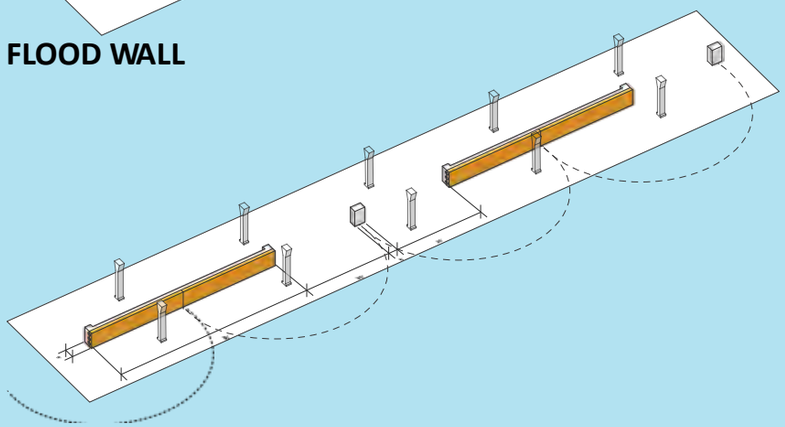
INFRASTRUCTURE TO PRESERVE VIEWS + WATERFRONT ACCESS

ENGINEERING APPROACH

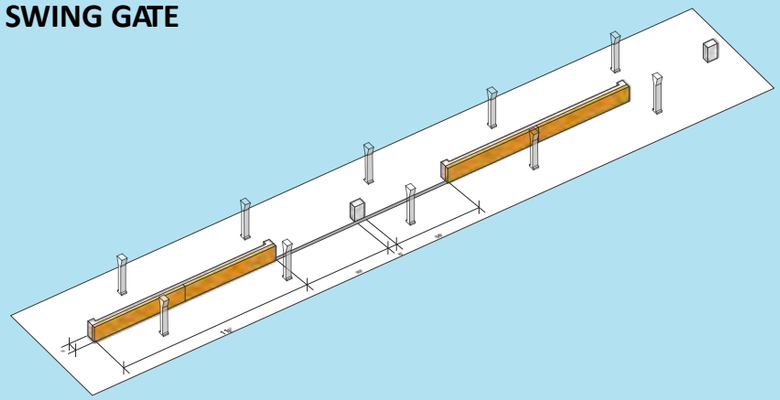
HOW CAN INFRASTRUCTURE TYPOLOGIES PROMOTE ACCESSIBILITY AND FRAME WATERFRONT VIEWS?



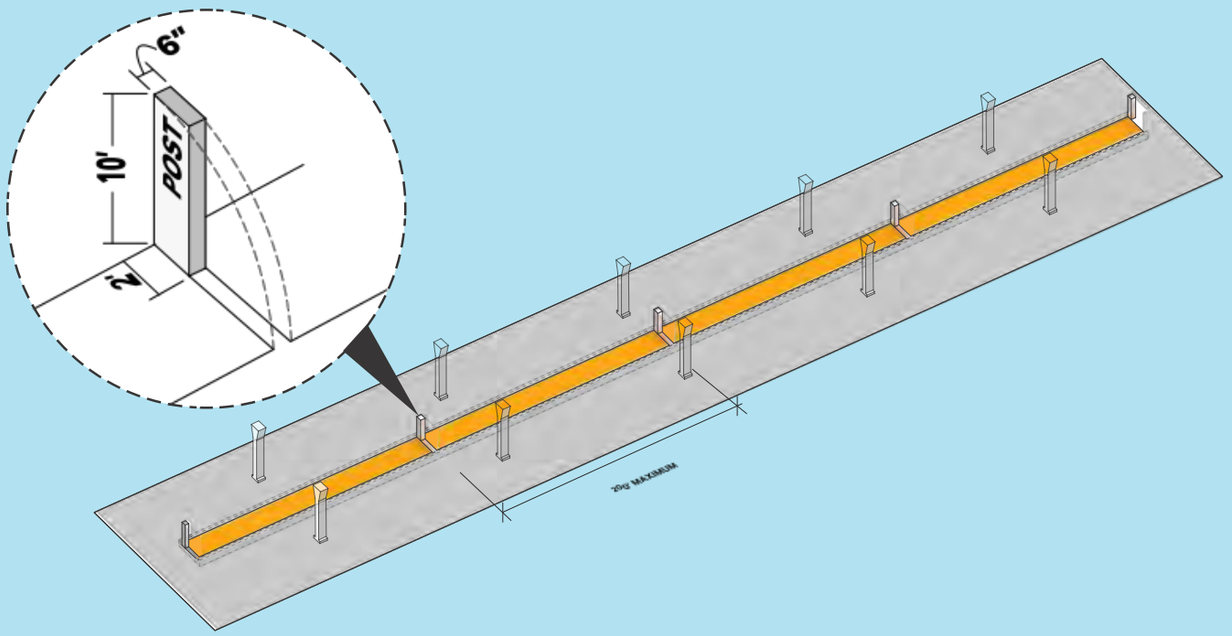
FLOOD WALL



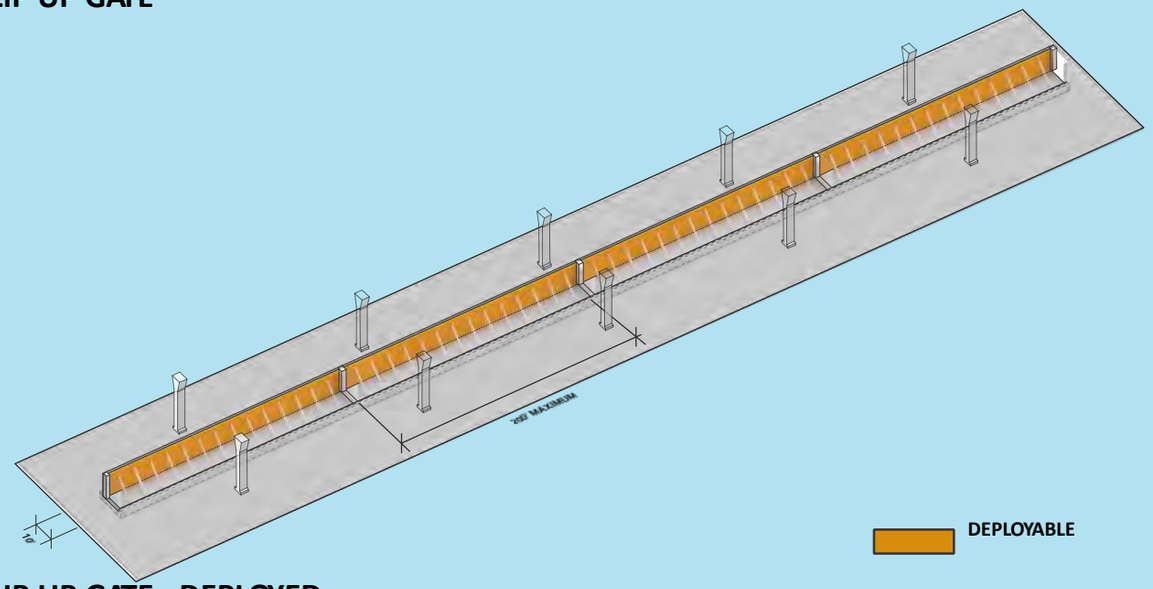
SWING GATE



ROLLER GATE



FLIP UP GATE



FLIP UP GATE - DEPLOYED

EVENT SPACE | CONCEPT IDEA

STRATEGIC PLAN FOR LOWER MANHATTAN

NYCEDC
New York City Economic Development Corporation

NYC
Mayor's Office of
Recovery & Resiliency

STRATEGIC PLAN FOR LOWER MANHATTAN

STUDY OBJECTIVES

- Identify extent of climate hazards and exposure in Lower Manhattan
- Assessoptions 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.

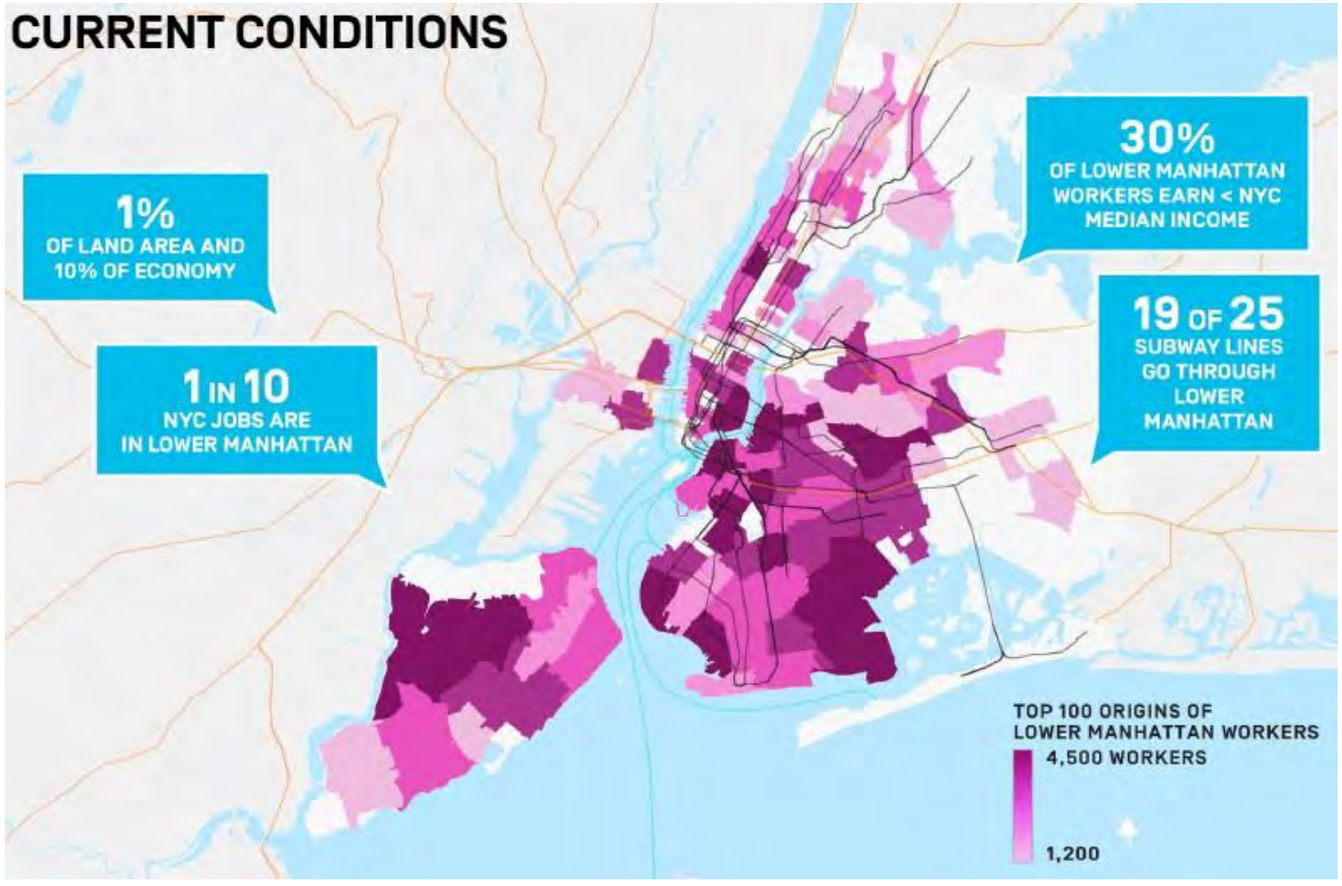
- Lower Manhattan faces **increasingly frequent climate events of ever greater intensity**, impacting critical infrastructure systems and the economy of not only the district but also New York City and the wider region.

- 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

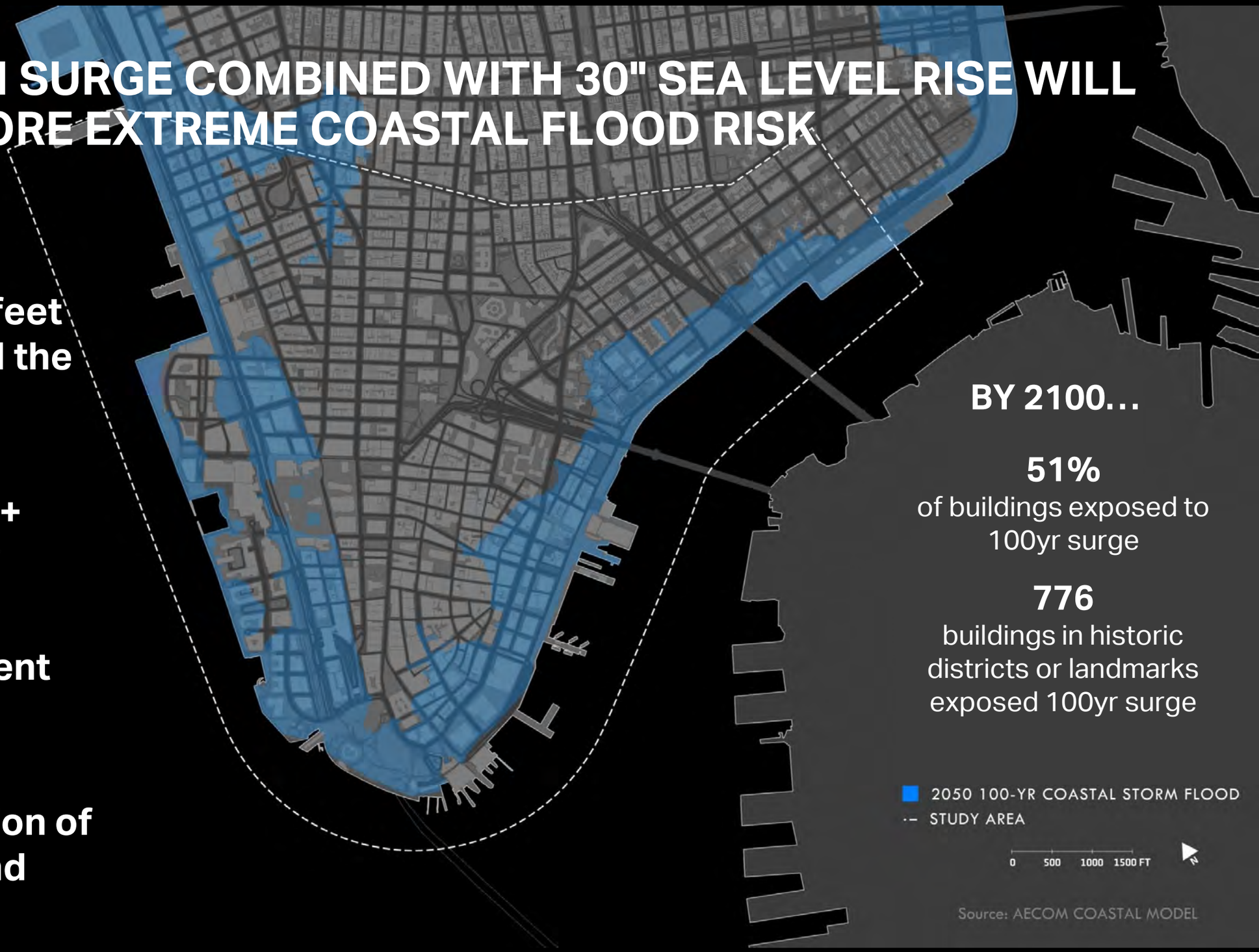
- Provide comprehensive protection towards all hazards in 2100
- Provide interim protection between now and 2050, where feasible
- Support urban co-benefit generation
- Promote approaches that have the ability to self-fund or be balance-sheet neutral to City
- Leverage existing investment



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, 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

141

Buildings vulnerable to destabilization due to GWT rise

2100 SLR UTILITY IMPACTS

STUDY AREA

0 500 1000 1500 FT

Source: AECOM

(Assuming utility depths at -4’ below grade.)

A RANGE OF ADAPTATION MEASURES WERE STUDIED

EDGE

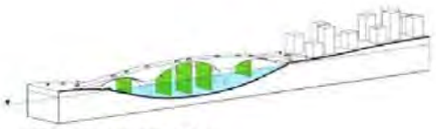

SEEPAGE BARRIER


RAISED TO SLR


RAISED TO SURGE - INBOARD


RAISED TO SURGE - OUTBOARD


WAVE BREAK ISLANDS


STORM SURGE GATE

PUBLIC REALM


GREEN STREETS


ELEVATED STREETS


ELEVATED PEDESTRIAN REALM


INCREASE TREE CANOPY

SUBSURFACE


UTILITY BOX


EMERGENCY PUMPING


RAISED UTILITIES


STORMWATER TANK


PARALLEL SYSTEM

BUILDINGS


STORMWATER RETENTION


LOCAL ENERGY ASSURANCE


DEPLOYABLES

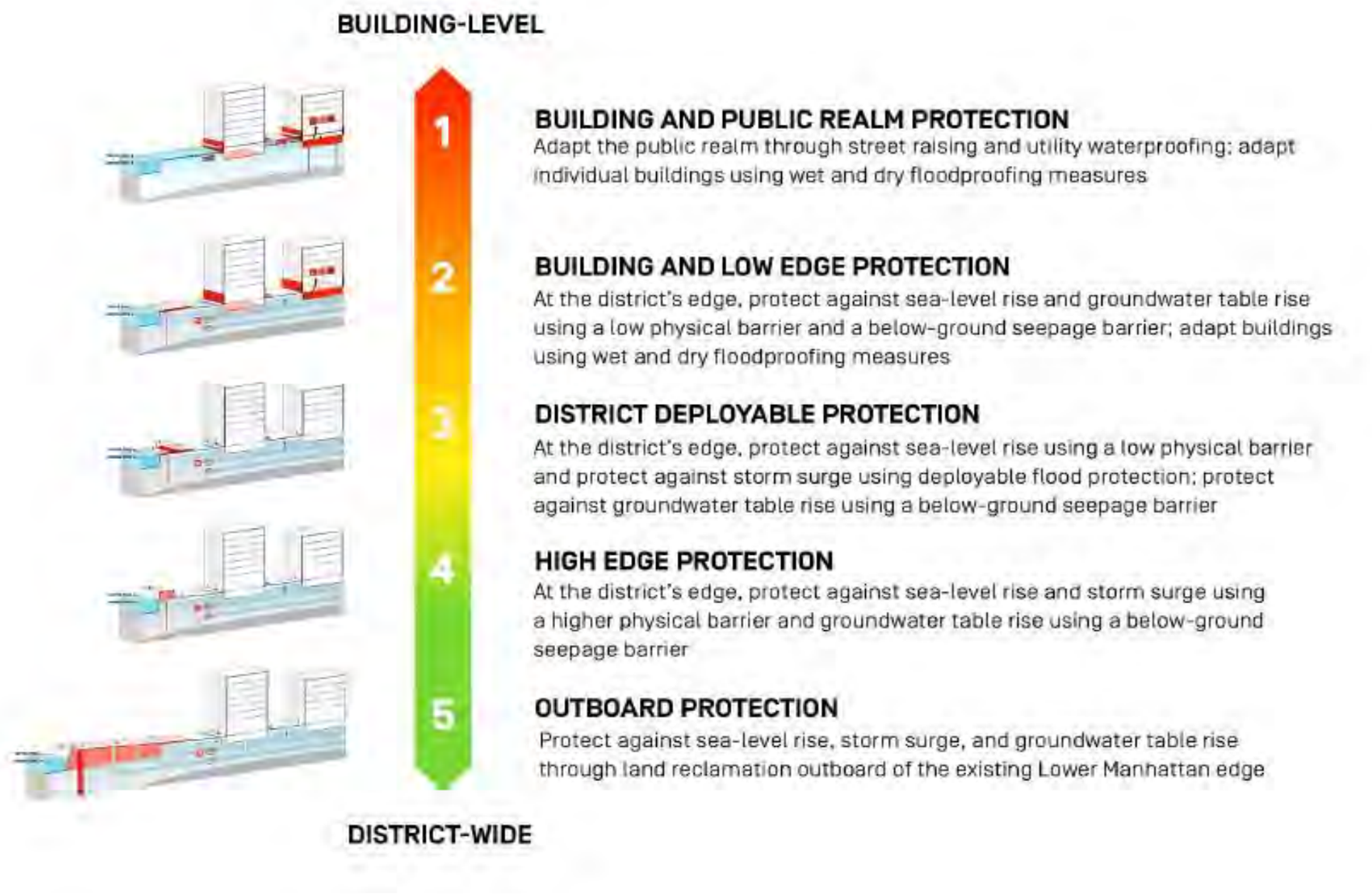

ELEVATE/RAISE


WET FLOODPROOFING


DRY FLOODPROOFING


STABILIZATION/TIE-DOWN

ADAPTATION SCENARIOS



EVALUATION CRITERIA

BENEFITS

Climate Benefit achieved through avoided losses and disruption caused by hazard impacts

District Reputation of long-term exposure and frequent flooding

Co-Benefits produced through improved mobility, enhanced and expanded public realm, and building modernization

FEASIBILITY

Technical constructability and ability to phase without large-scale disruption

Permitting ease and ability, as well as environmental considerations

FINANCIAL CONSTRAINTS

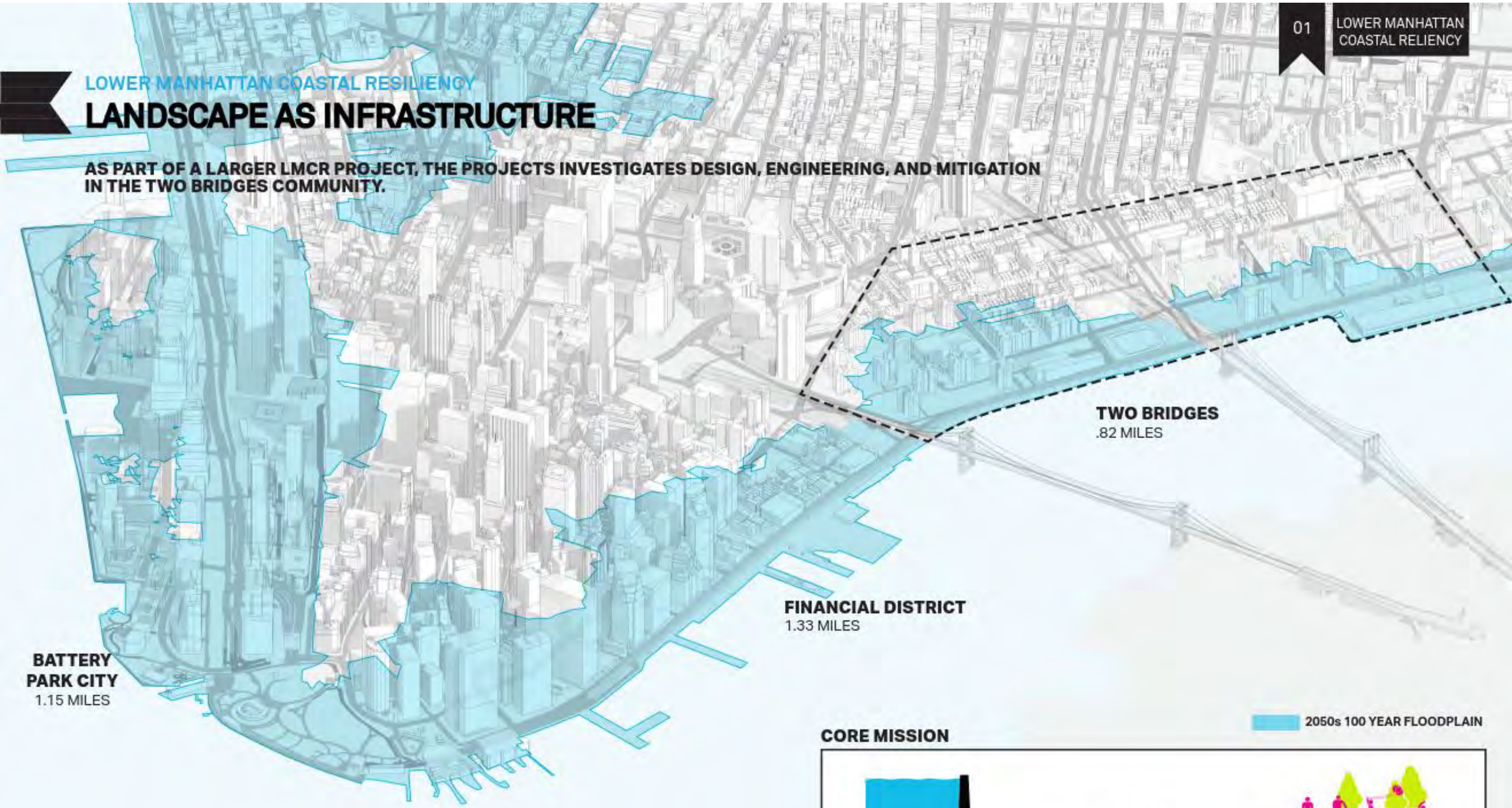
Net Cost to the city, net of revenues created or existing budgeted capital

Sectoral Burden to the public and private sectors

LOWER MANHATTAN COASTAL RESILIENCY

LANDSCAPE AS INFRASTRUCTURE

AS PART OF A LARGER LMCR PROJECT, THE PROJECTS INVESTIGATES DESIGN, ENGINEERING, AND MITIGATION IN THE TWO BRIDGES COMMUNITY.



CORE MISSION

FLOOD RISK REDUCTION + PUBLIC REALM

THE CHALLENGE IN LOWER MANHATTAN

EXISTING CONDITIONS

SANDY FLOOD LEVELS

VULNERABILITY

LASTING EFFECTS

DISRUPTION OF ACCESS

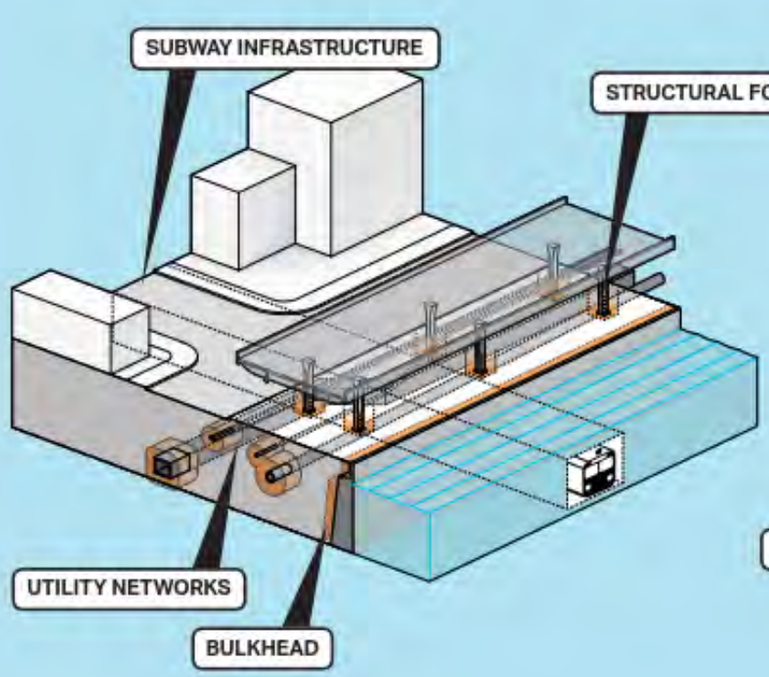
DISRUPTION OF MOBILITY

DESIGNING WITHIN DENSE URBAN WATERFRONTS

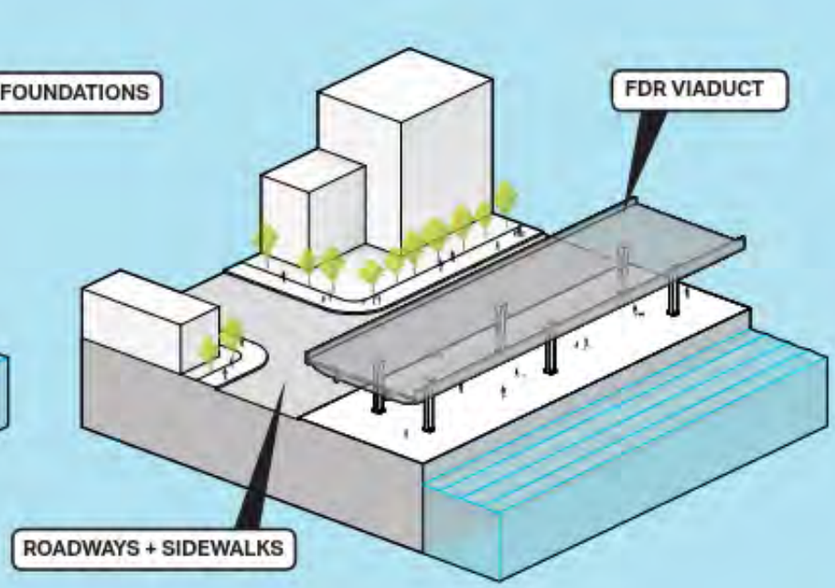
APPROACH TO THE CHALLENGE

EDGE UPLAND HYBRID

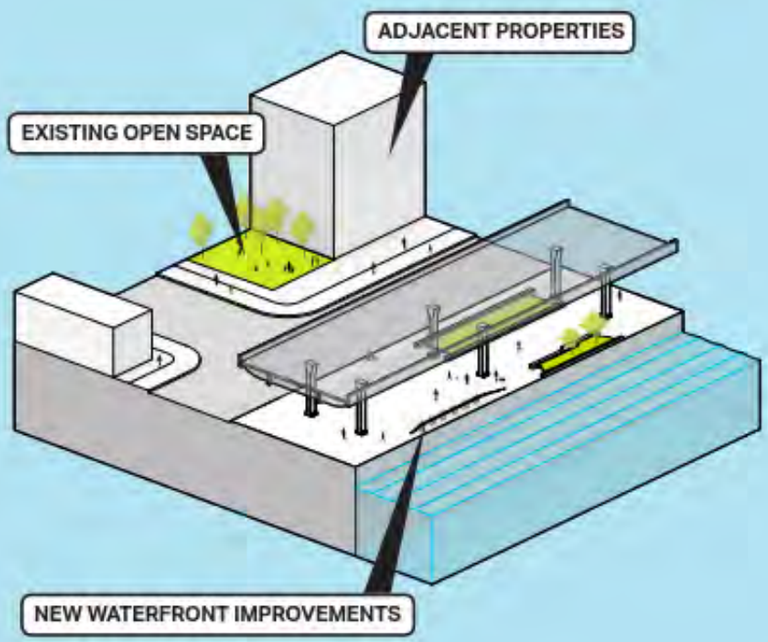
CONCEPTUAL ALIGNMENTS



SUBSURFACE STRUCTURES



TRANSPORTATION + CIRCULATION



ADJACENT USES

KEY CONSIDERATIONS

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

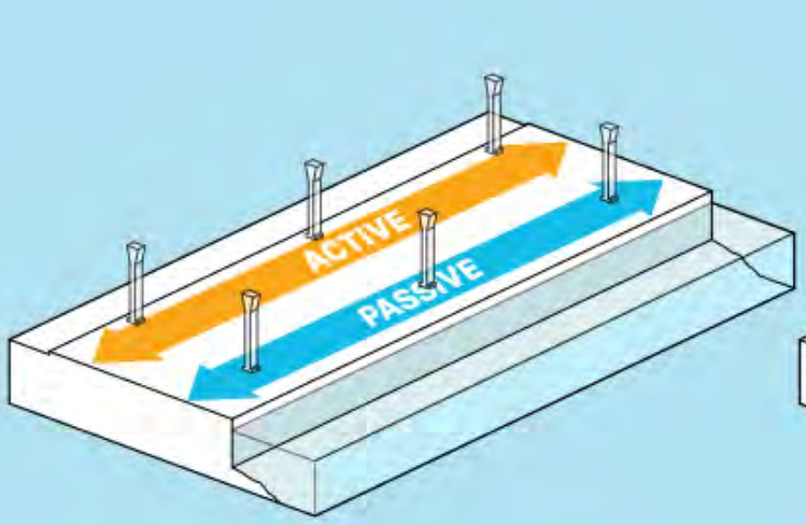
PUBLIC REALM AS FLOOD RISK REDUCTION

DEPLOYED CONDITION

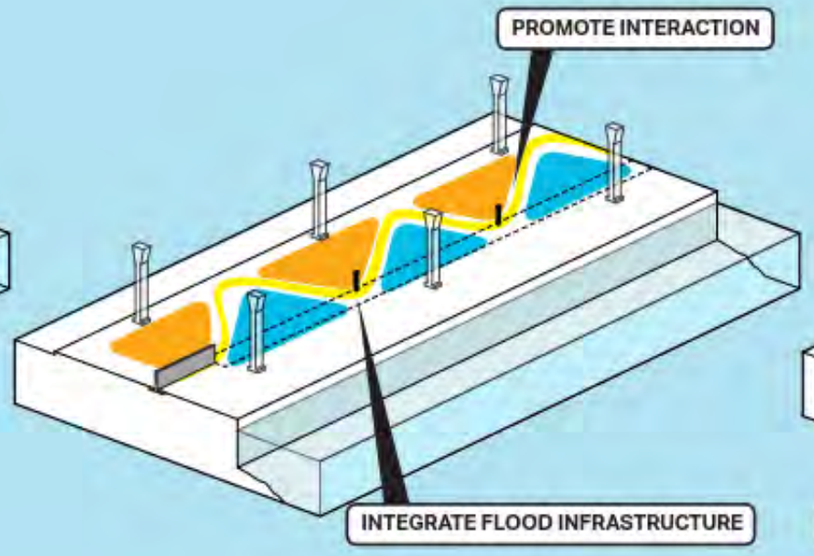
DESIGN TO DSITRIBUTE PROGRAMS EQUITABLY

PROGRAM ORGANIZATION

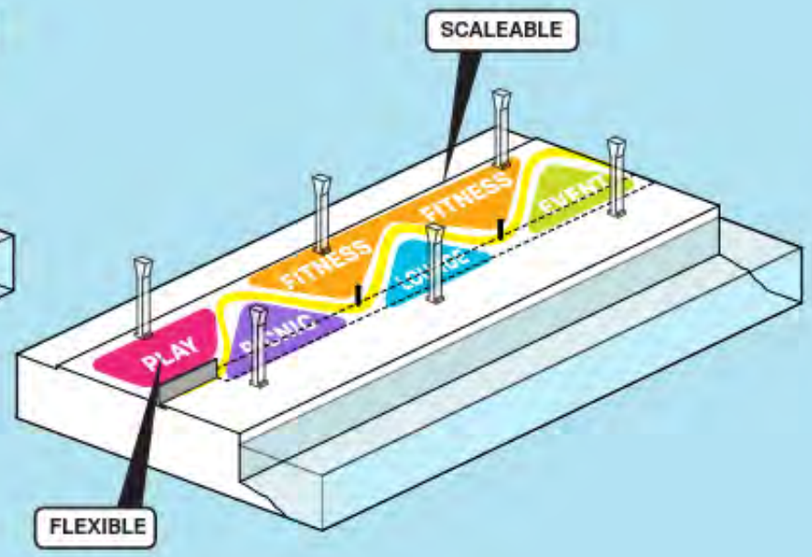
HOW CAN FLOOD RISK MITIGATION ACCOMODATE A DIVERSE ARRAY OF PROGRAMS ACROSS THE SITE?



EXISTING ESPLANADE ORGANIZATION



CREATE POCKETS FOR PROGRAMMING

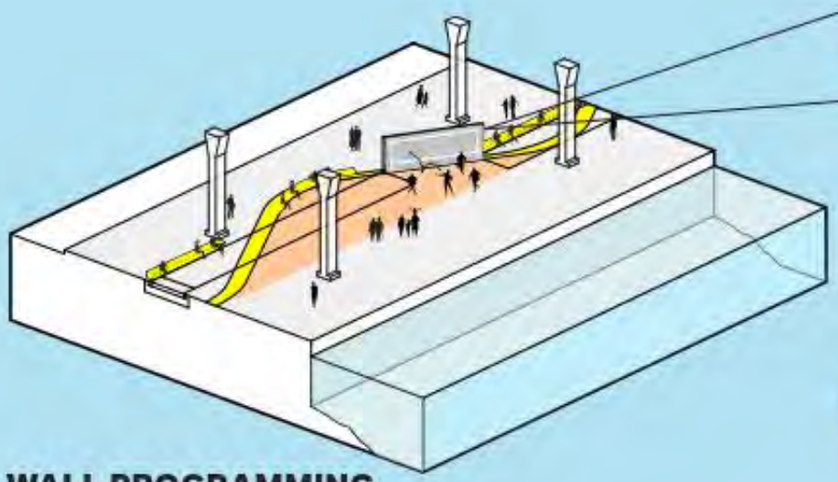


DISTRIBUTE PROGRAMS

INFRASTRUCTURE INTEGRATED INTO THE PUBLIC REALM

DIVERSE PROGRAMS WITHIN FLOOD RISK REDUCTION

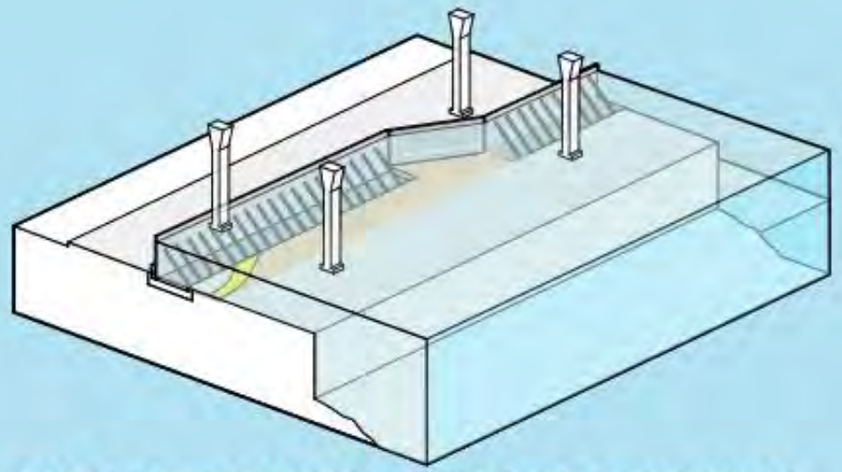
HOW CAN FIXED INFRASTRUCTURE CATALYZE A DYNAMIC PUBLIC REALM?



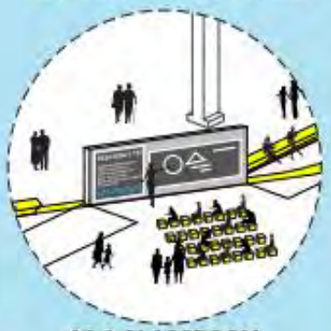
WALL PROGRAMMING

AS A SPORT COURT

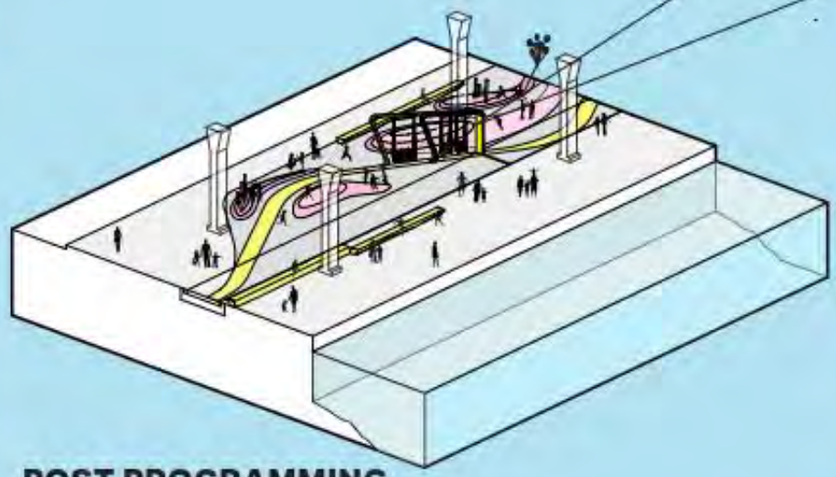
AS AN INTERACTIVE WALL



WALL PROGRAMMING - DEPLOYED CONDITION



AS A CLASSROOM

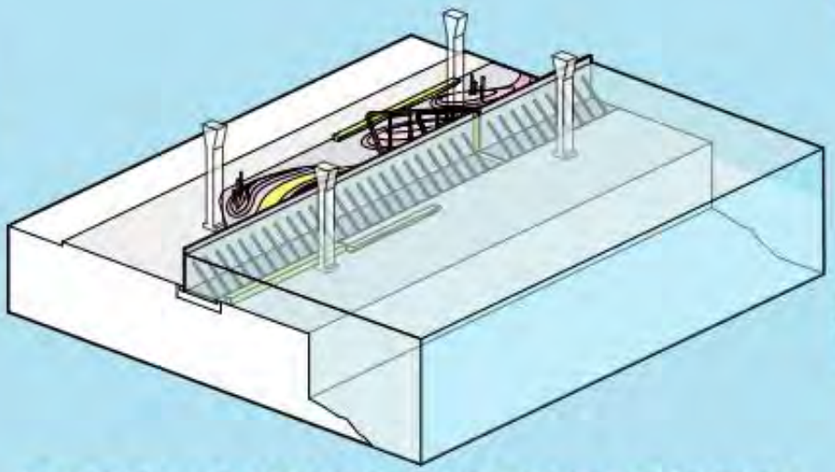


POST PROGRAMMING

AS A SWINGSET

AS A CANOPY

AS WAYFINDING

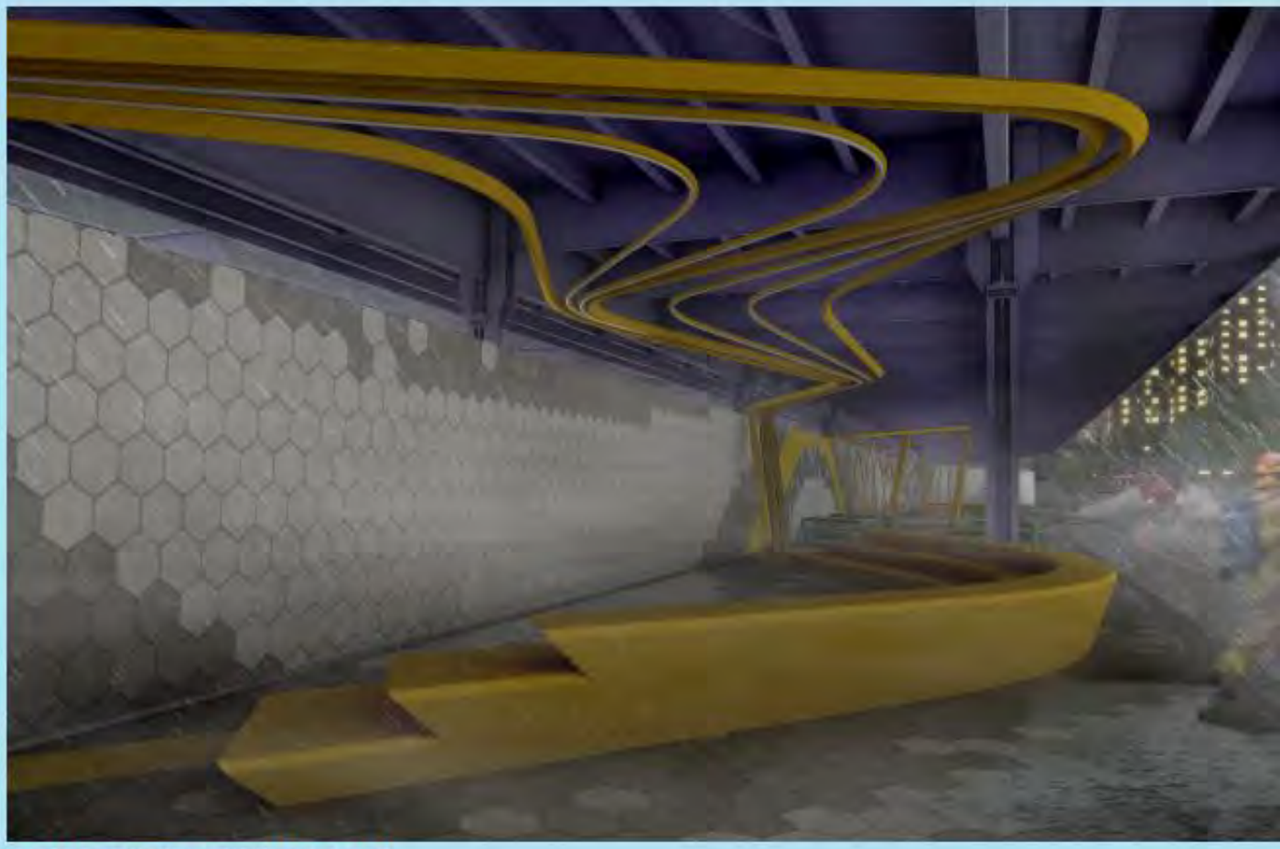


POST PROGRAMMING - DEPLOYED CONDITION

AS FITNESS EQUIPMENT

INFRASTRUCTURE INTEGRATED INTO THE PUBLIC REALM

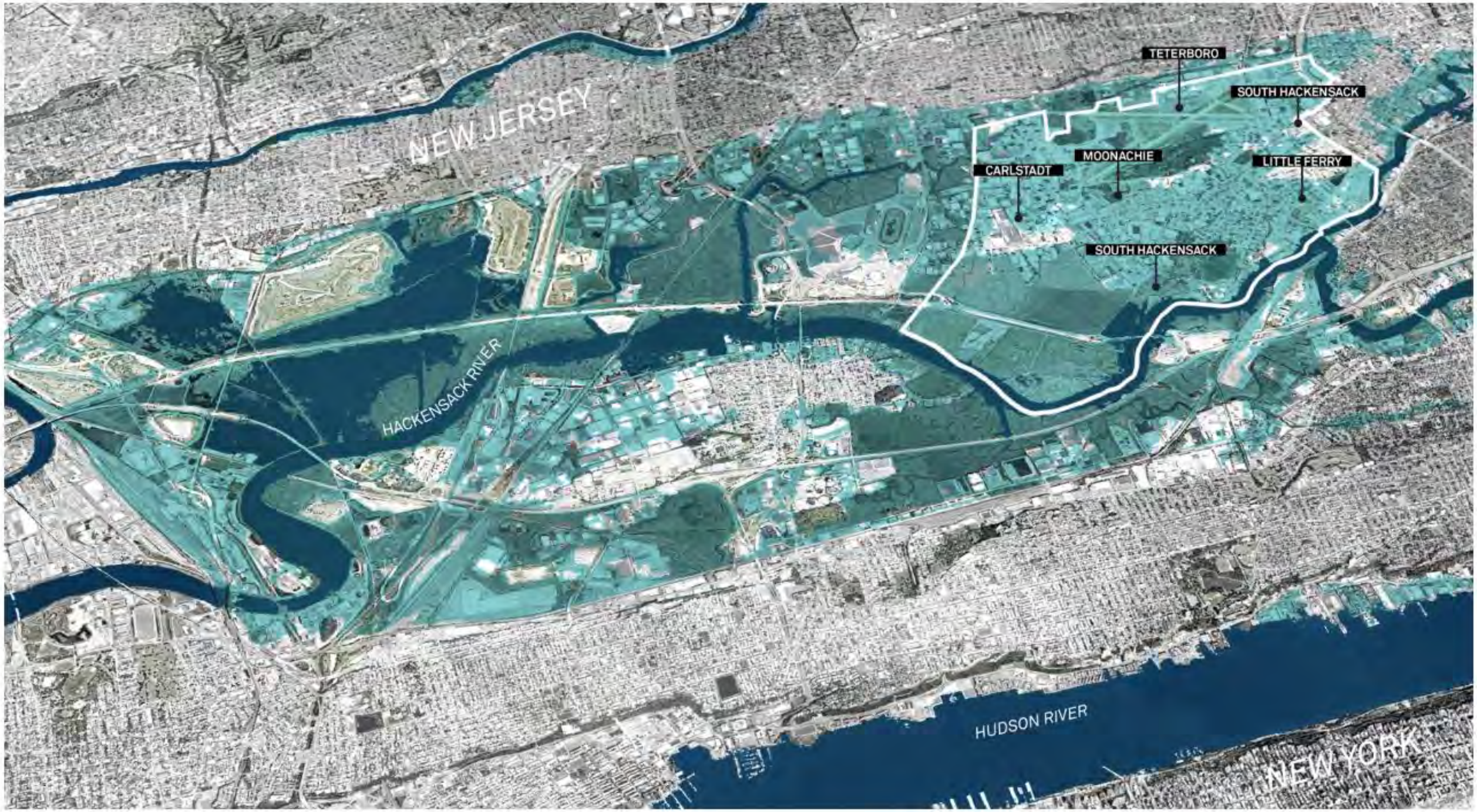
SETTING A PRECEDENT FOR FLOOD RISK REDUCTION



DEPLOYED CONDITION

REBUILD BY DESIGN: MEADOWLANDS

DESIGNING INFRASTRUCTURE FOR A COMMUNITY AT RISK

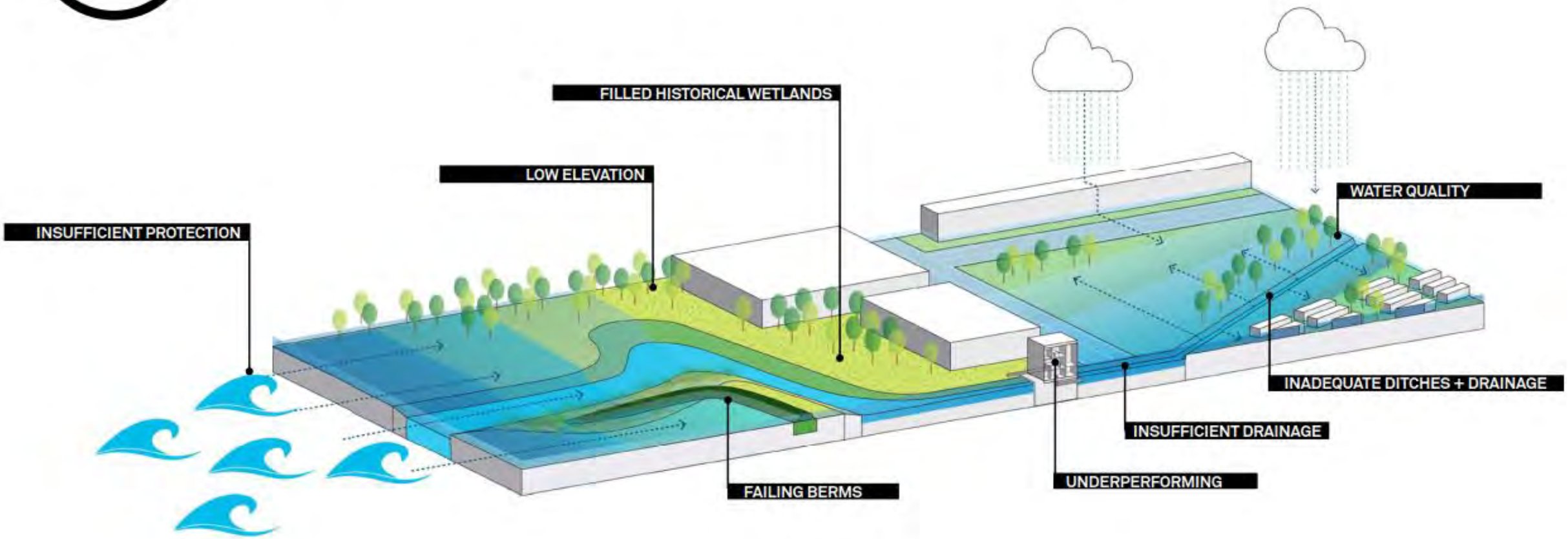


REBUILD BY DESIGN: MEADOWLANDS

TWO MAIN INFRASTRUCTURE CHALLENGES

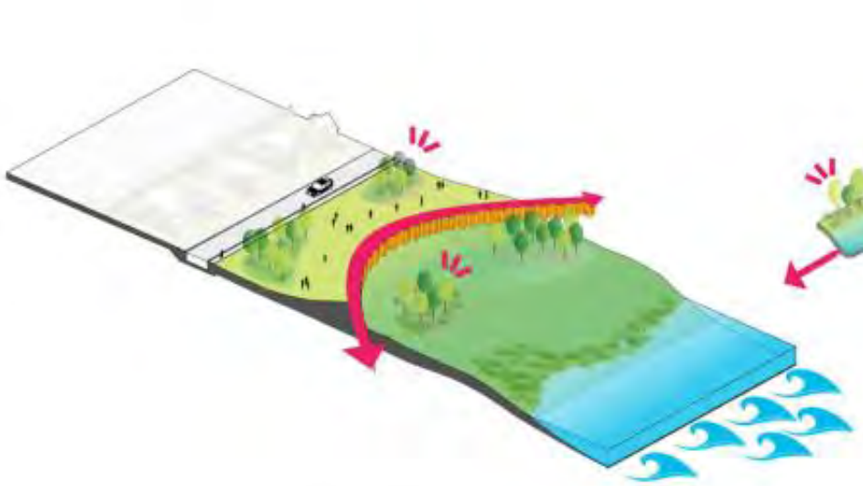
1 MAJOR STORM SURGE Flooding

2 FREQUENT RAIN Flooding



FLOOD RISK REDUCTION INFRASTRUCTURE + PUBLIC REALM

THREE PUBLIC REALM DESIGN TYPOLOGIES



INFRASTRUCTURE AT THE WATER'S EDGE

PERFORMATIVE INTERIOR PARKS

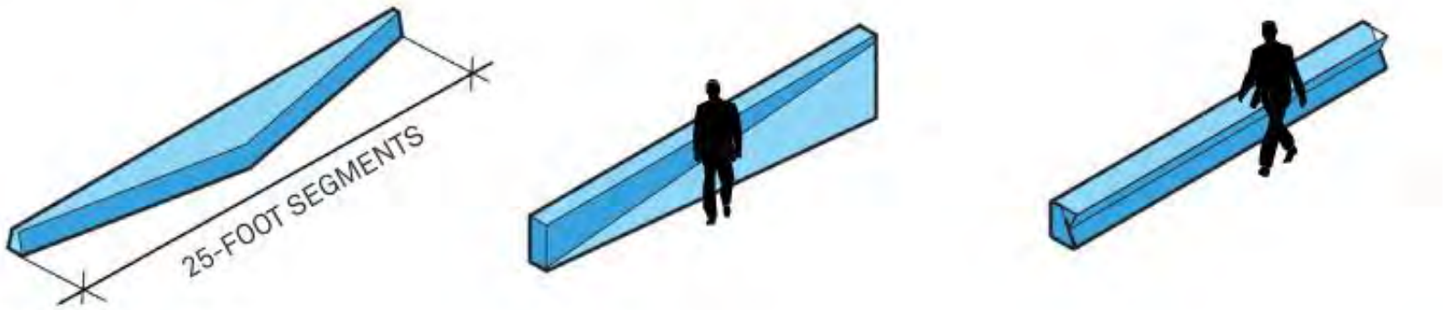
HYBRID FLUVIAL PARKS

DESIGNING TO MEET COMMUNITY CONCERNS

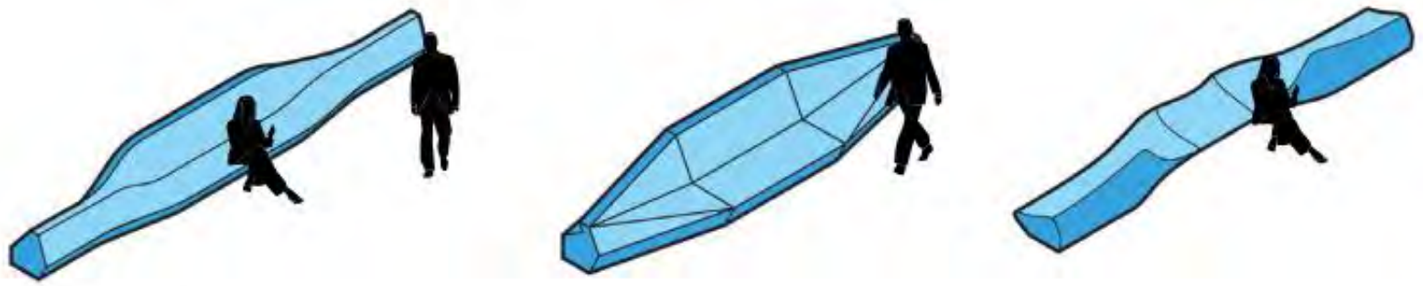
WORKSHOPS / ENGAGEMENT / TOOLS

DESIGN TYPOLOGY 1

MULTI-FUNTIONAL 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

DESIGN TYPOLOGY 2

PERFORMATIVE INTERIOR PARKS

REVIVING THE DITCH

REVIVING THE DITCH

NEW FORCE MAINS

STREET IMPROVEMENTS

STREET IMPROVEMENTS

NEW AND IMPROVED OPEN SPACE

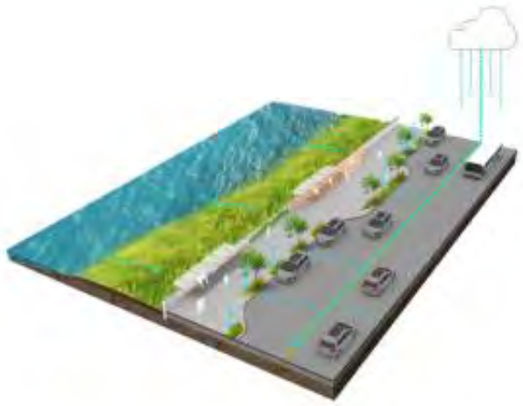
PERFORMATIVE INTERIOR PARKS

WETLANDS + PLACEMAKING PARK

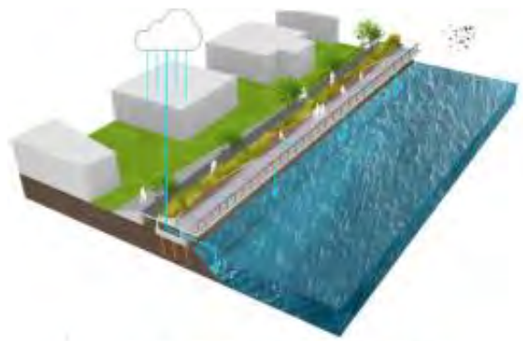
1. ELEVATED WETLAND BOARDWALK
2. CHANNEL IMPROVEMENTS TO DITCHES
3. SHALLOW EMERGENT MARSH
4. ATLANTIC WHITE CEDAR FOREST

DESIGN TYPOLOGY 3

HYBRID FLUVIAL PARKS

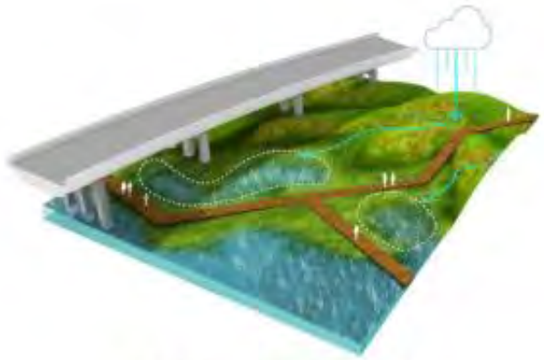


MODULAR PROTECTION STRATEGY



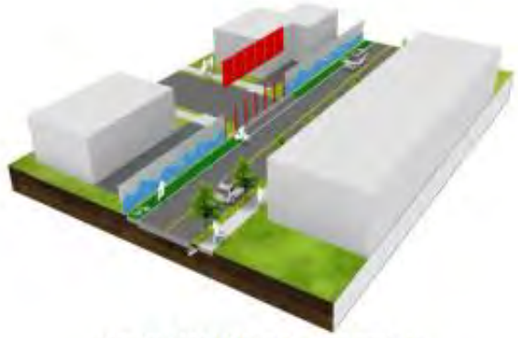
RESIDENTIAL PASSAGE

ECOLOGICAL PATH



BERMS + OPEN SPACE

PLANTED STREET MEDIAN



DEPLOYABLE STRATEGY

HYBRID FLUVIAL PARKS

PLACEMAKING + FLOOD REDUCTION

1. US ROUTE 46 BRIDGE
2. NEWLY CREATED TIDAL WETLAND
3. ELEVATED WETLAND BOARDWALK
4. WOOD SLAT AND CONCRETE BENCH
5. UPLAND HABITAT

THANK YOU