Stantec

Post Hurricane Impacts – Coastal Protection through Living Shorelines

Jeff Tabar, PE, D.CE

CMANC Winter

Why Now?

- **Investment**
- **Community**
- **Impact**

Living
Shorelines

Living Shorelines

Survivability

Sustainability

Preparedness

Best Practices

Resiliency

Disaster Recovery

Hazard Mitigation

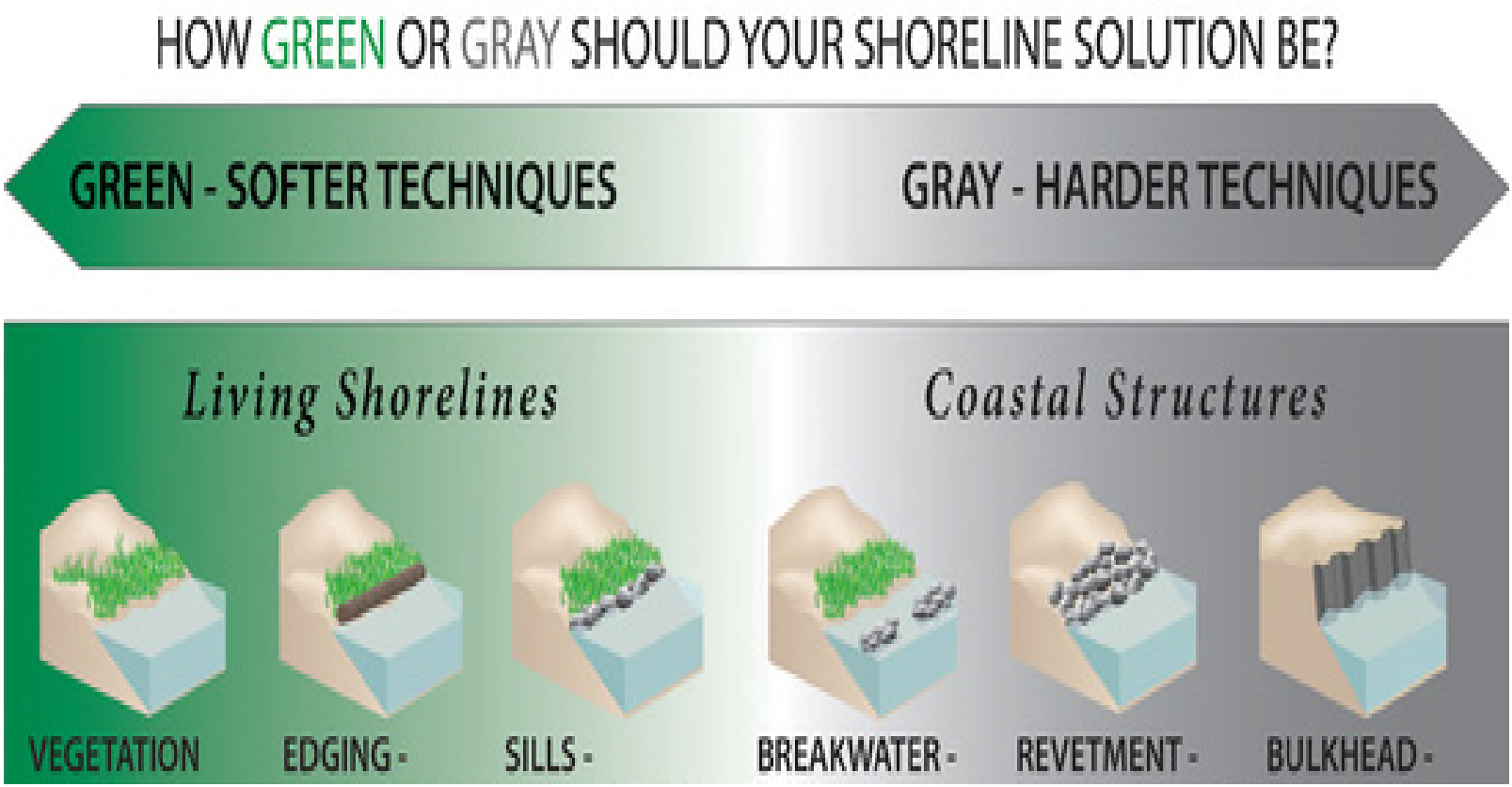
Adaptive Management

Approach

Think Holistically

Think Long-Term

Use a Systems Approach



Goals

Stabilize the Shoreline

Habitat Enhancement

Ecosystem Connectivity

Project Examples

Lagoon House

Hurricane protection

Slope stability

Native plantings

Public education

Camden

Water quality

Wetland restoration

Submerged aquatic vegetation (SAV)

Freshwater mussel habitat

Camden

Water quality

Wetland restoration

Submerged aquatic vegetation (SAV)

Freshwater mussel habitat

Camden

Water quality

Wetland restoration

Submerged aquatic vegetation (SAV)

Freshwater mussel habitat

Prime Hook NWR

- USFWS and USACE Philadelphia District
- Largest Post-Hurricane Sandy Recovery and Restoration Project
- Construction cost - $40 mil
- Restored 5,000 acres of marsh
- Restored 2 miles of shoreline

- **2006 – Hurricane Ernesto**
- **2008 – Mother's Day Storm**
- **2009 – October/November Nor'Easters**
- **2012 – Hurricane Sandy**
  - Two new large breaches
  - Total breached area nearly tripled

Meanwhile, an unhappy public…


STAGING AREA
STAGING AREA
MAIN CHANNEL CONVEYANCE
CHANNEL B
CHANNEL A
UNIT II
FINGER CHANNEL CONVEYANCE
MAIN CHANNEL CONVEYANCE
CHANNEL C
CHANNEL F
CHANNEL E
STAGING AREA
CHANNEL D
FINGER CHANNEL CONVEYANCE
CHANNEL H
CHANNEL G
CHANNEL A
CHANNEL K
CHANNEL I
CHANNEL L
MAIN CHANNEL CONVEYANCE
CHANNEL J
CHANNEL M
CHANNEL N
USPWS HEADQUARTERS
CHANNEL O
CHANNEL I
UNIT III
CHANNEL R
CHANNEL Q
CHANNEL P
DELAWARE BAY


March – Final Project

Prime Hook

Largest Post-Hurricane Sandy Recovery and Restoration Project

Construction cost - $40m

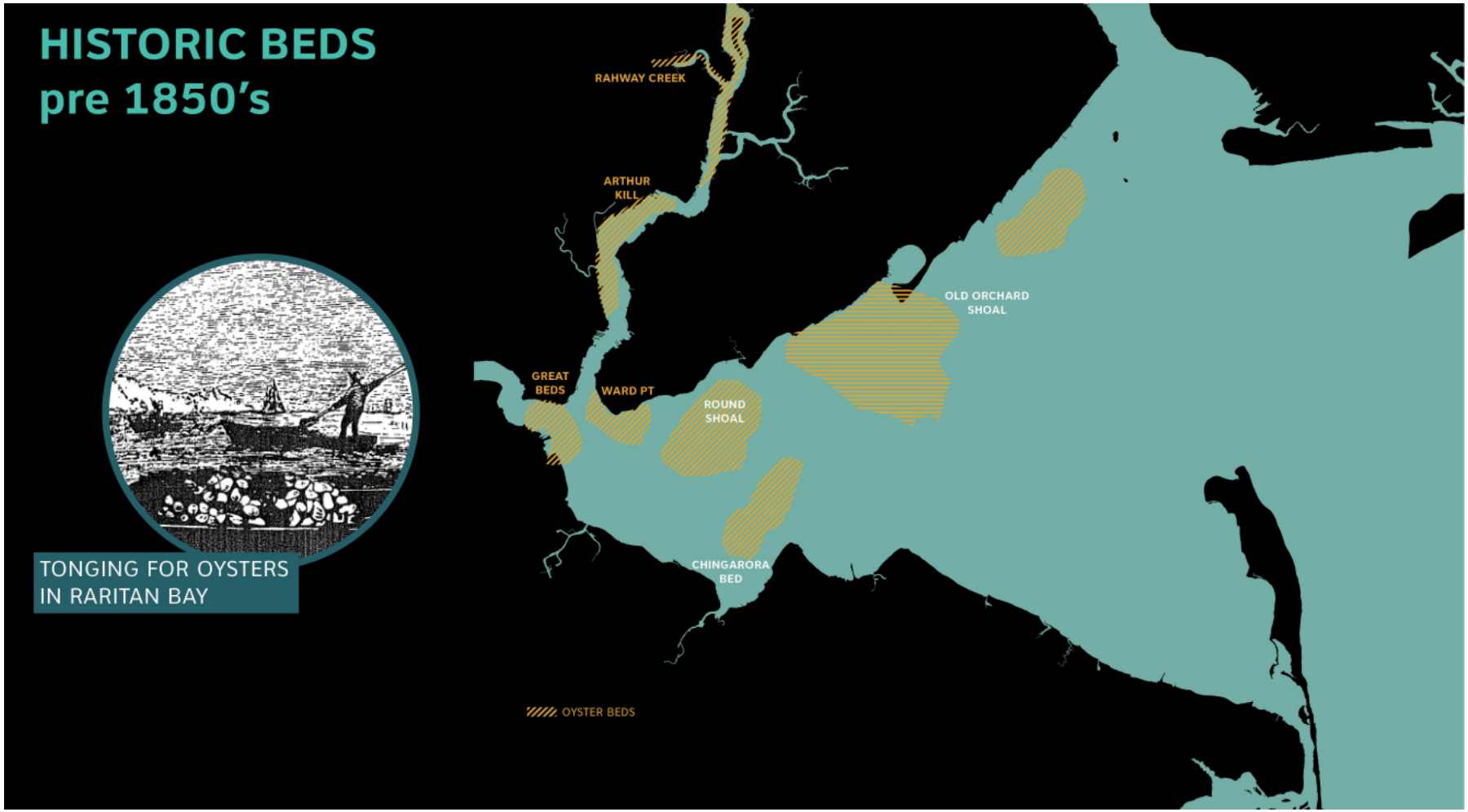
Restored 5,000 acres of marsh

Restored 2 miles of shoreline

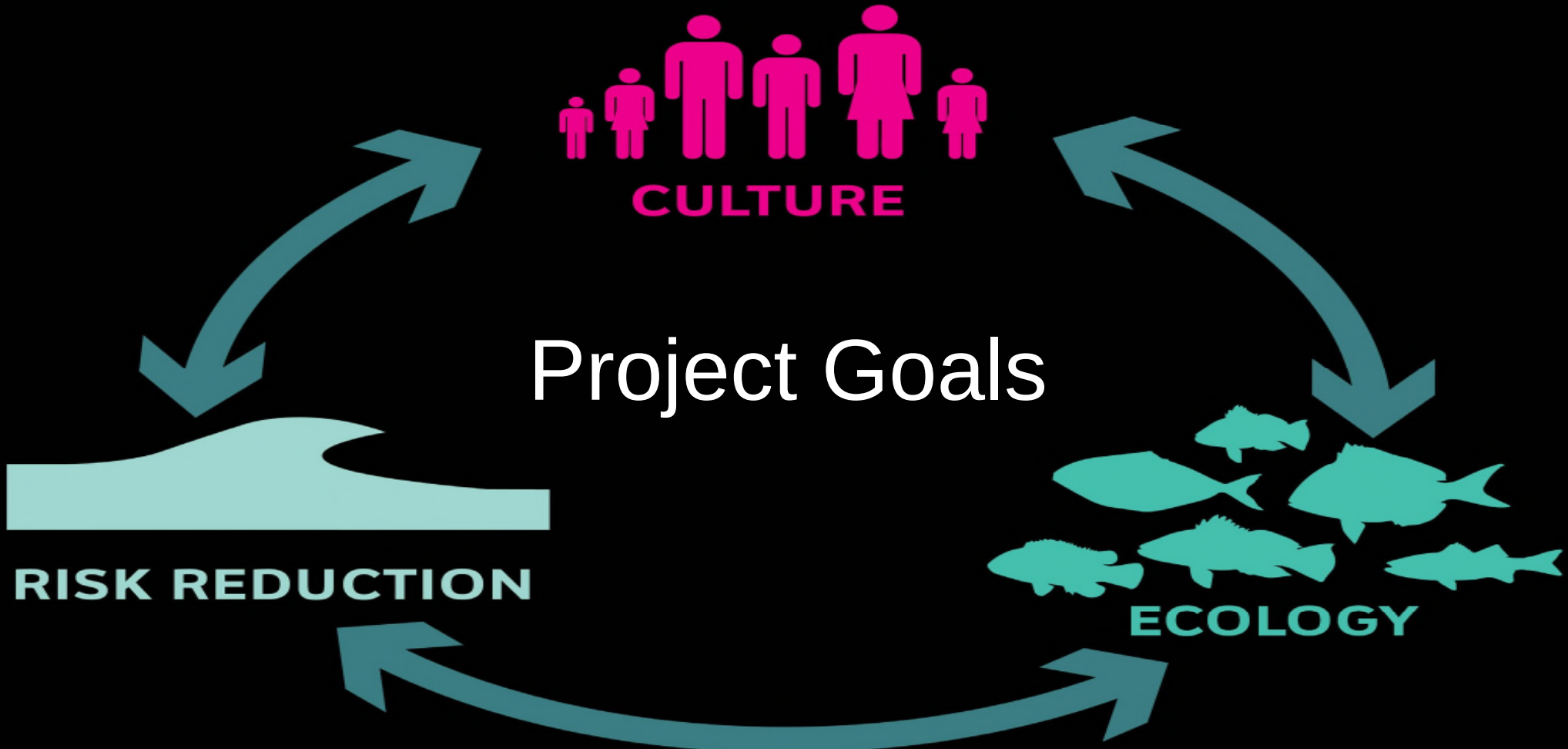
Rebuild By Design Competition Project Example


TOTTENVILLE
SHORELINE &
PROTECTION
LIVING
BREAKWATERS

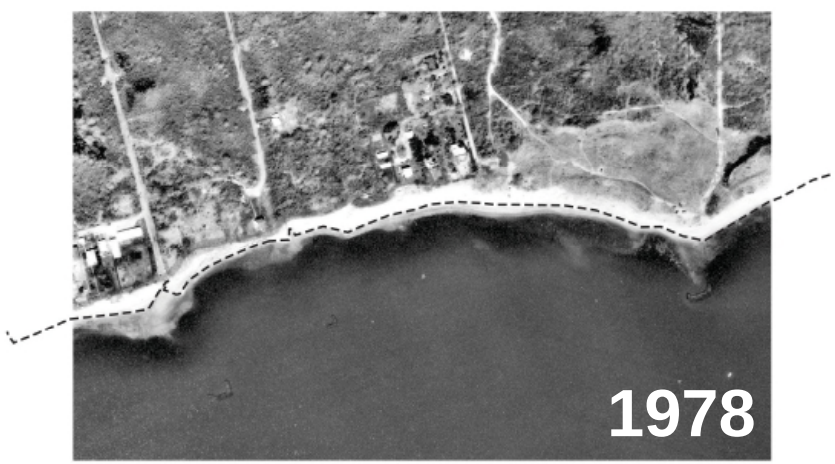
WHAT WAS ONCE THERE?



Project Goals

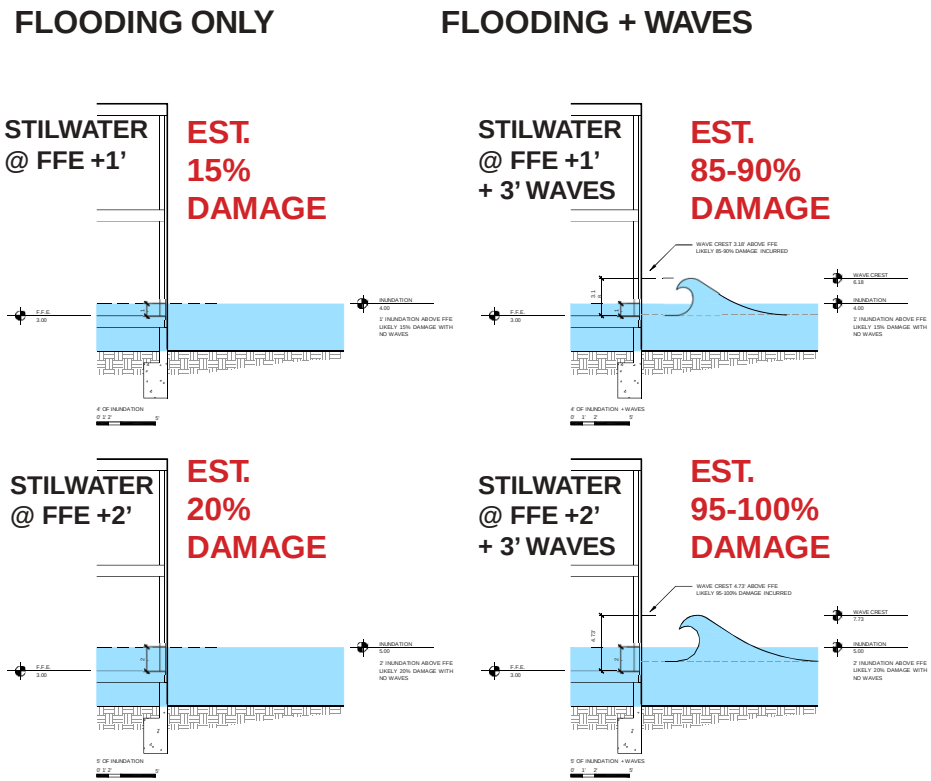


A HISTORY OF EROSION



WHY ATTENUATE WAVES?

House Destroyed on Yetman Street, Tottenville Photo
Credit: C. Warga, NY Daily News



elevations given are height above existing grade.

% Damage values based on the "most likely" depth-damage curves for two-story residences with no basement from the "Physical Depth Damage Function Summary Report" prepared by the US Army Corps of Engineers as part of the "North Atlantic Coastal Comprehensive Study: Resilient Adaptation to Increasing Risk," January 2015.


COMMUNITY CONSULTATION

EDUCATION

STEWARDSHIP

ACCESS

EARLY ENGAGEMENT:

EARLY ENGAGEMENT:

ON-SITE EVENTS

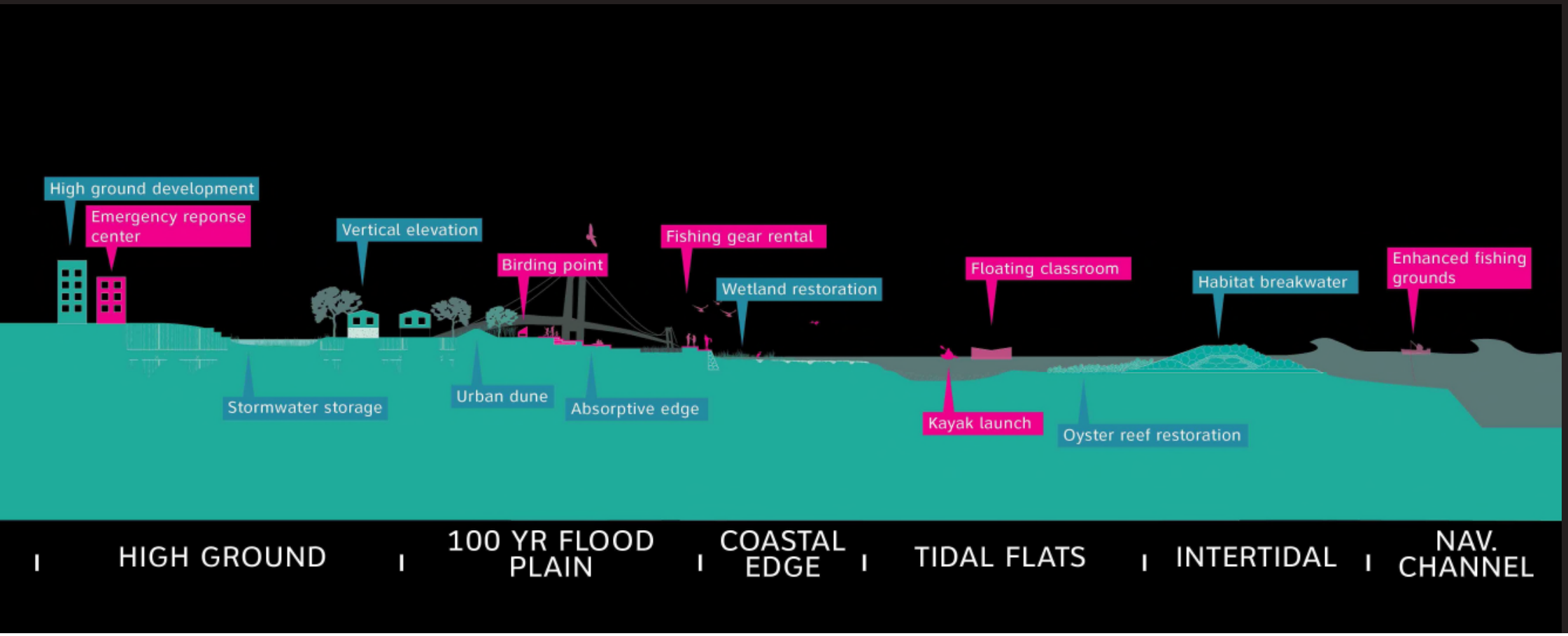
INCLUDING ...

CAC SHORE TOURS
JOIN BEACH CLEAN UPS
SHOREWALKS AS PART OF CITY EVENTS (520 DAY, EARTH DAY, ETC.)

IT'S NOT JUST 2 PROJECTS,

IT IS PART OF A LAYERED APPROACH,

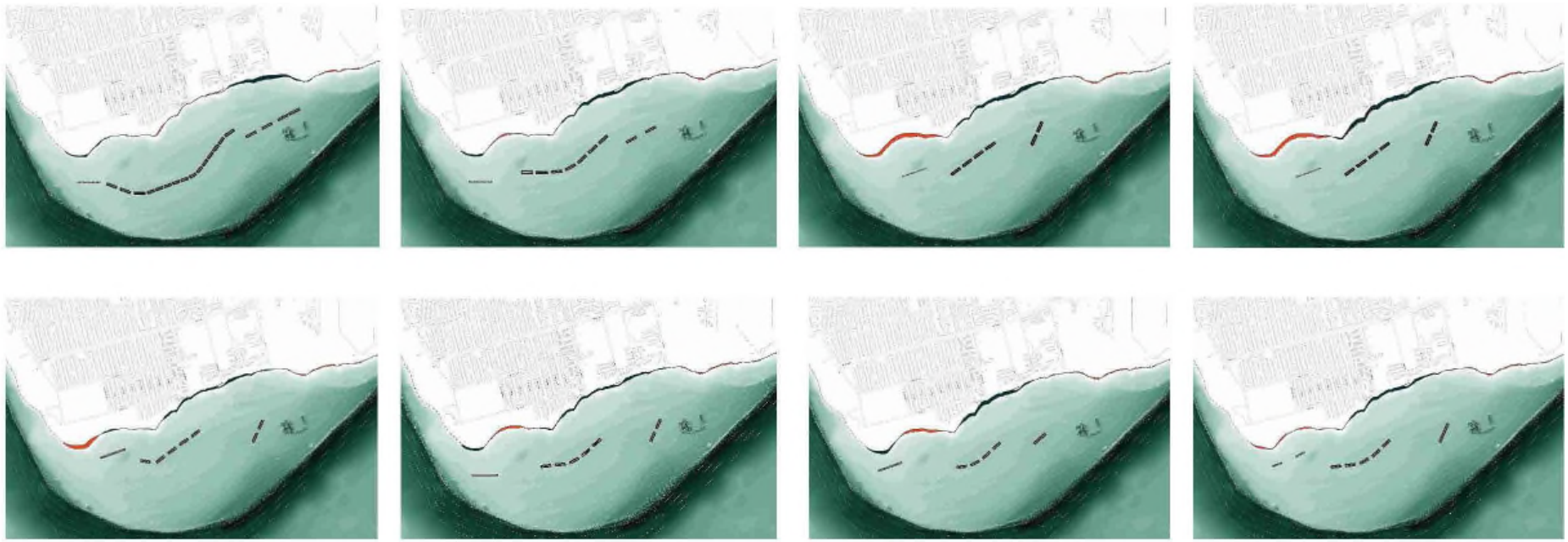
THAT BUILDS RESILIENCE



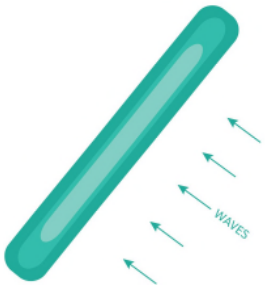
LIVING BREAKWATERS PROJECT OVERVIEW


JUNE 2014
(COMPETITION PROPOSAL)
FEBRUARY 2018
(60% DESIGN)
Governor's Office of
Storm Recovery

MULTIPLE CONFIGURATIONS STUDIED

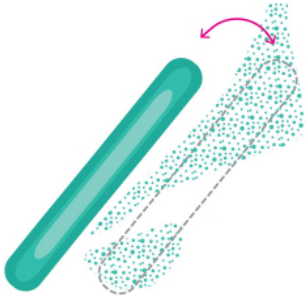


AN ECOLOGICAL DESIGN APPROACH

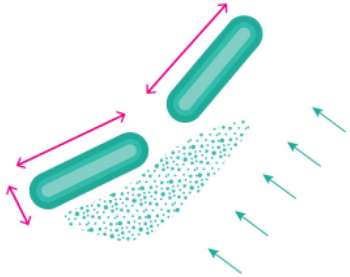


TRADITIONAL BREAKWATER DESIGN

Wave Attenuation
Erosion Control
Creation of Posous Rocky Habitat



AVOID CRITICAL HABITAT

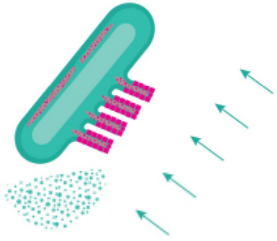


MINIMIZE FOOTPRINT

Narrower Breakwater Cross Section
Reduce Crest Elevation
Multiple Shorter Breakwaters With Gaps

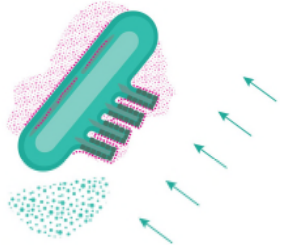
ADD REEF STREETS

Increase Macro Complexity
Increase Intertidal Habitat Mimic
Forms Found in Nature



ADD MICRO-COMPLEXITY

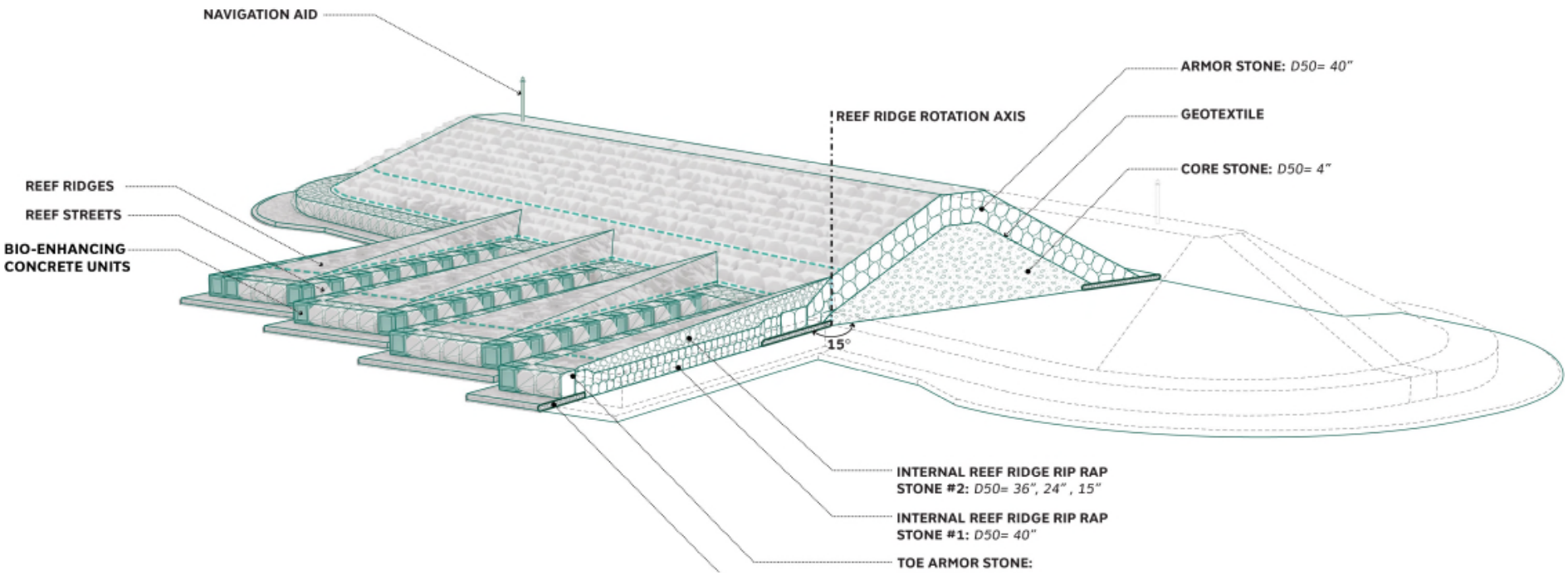
Use Bio-Enhanced Concrete Units
Increase Size Diversity of Crevices
Increase Surface Rugosity Increase
Micro Complexity

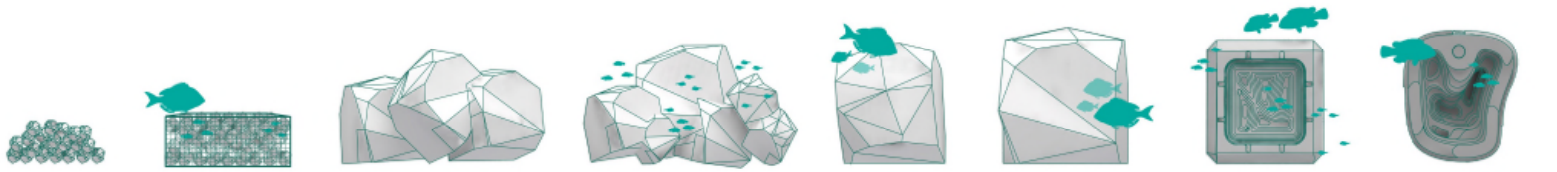


INSTALL OYSTERS

Incorporate Active Restoration Efforts to Further Enhance Habitat and Help Achieve Regional Restoration Goals

WHAT IS A LIVING BREAKWATER?





INTERNAL CORE STONE
D_{50}= 16"

MARINE MATTRESS
HT= 12"

REEF RIDGE CORE STONE
Dmin= 24" D_{50}= 30" Dmax=36"

REEF RIDGE EXTERIOR STONE
D_{15}= 15" D_{50}= 24" D_{100}=36"

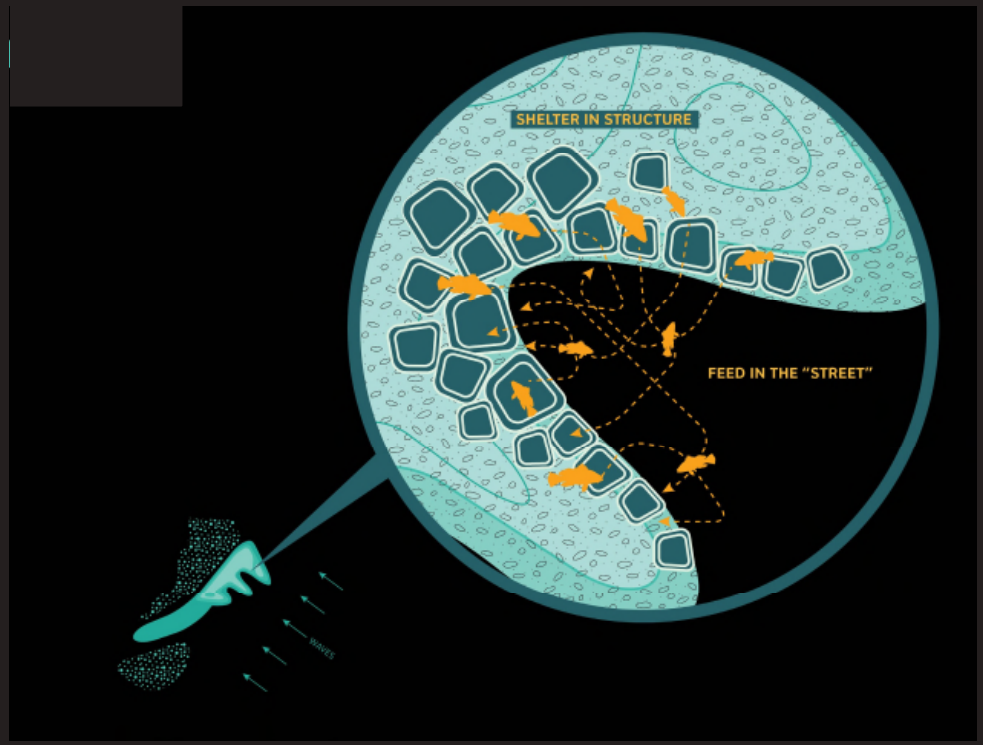
STONE ARMOR UNIT
D_{50}= 40"

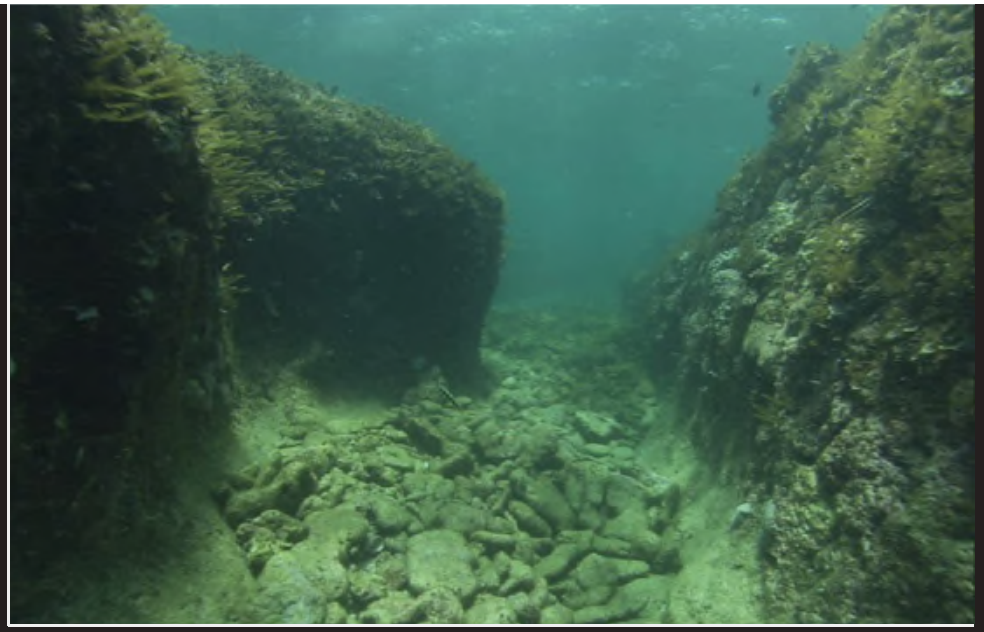
STONE TOE ARMOR UNIT
D_{50}: 48"

ECOncrete® TOE ARMOR UNIT
Dimension: 48"x 48"x 48"

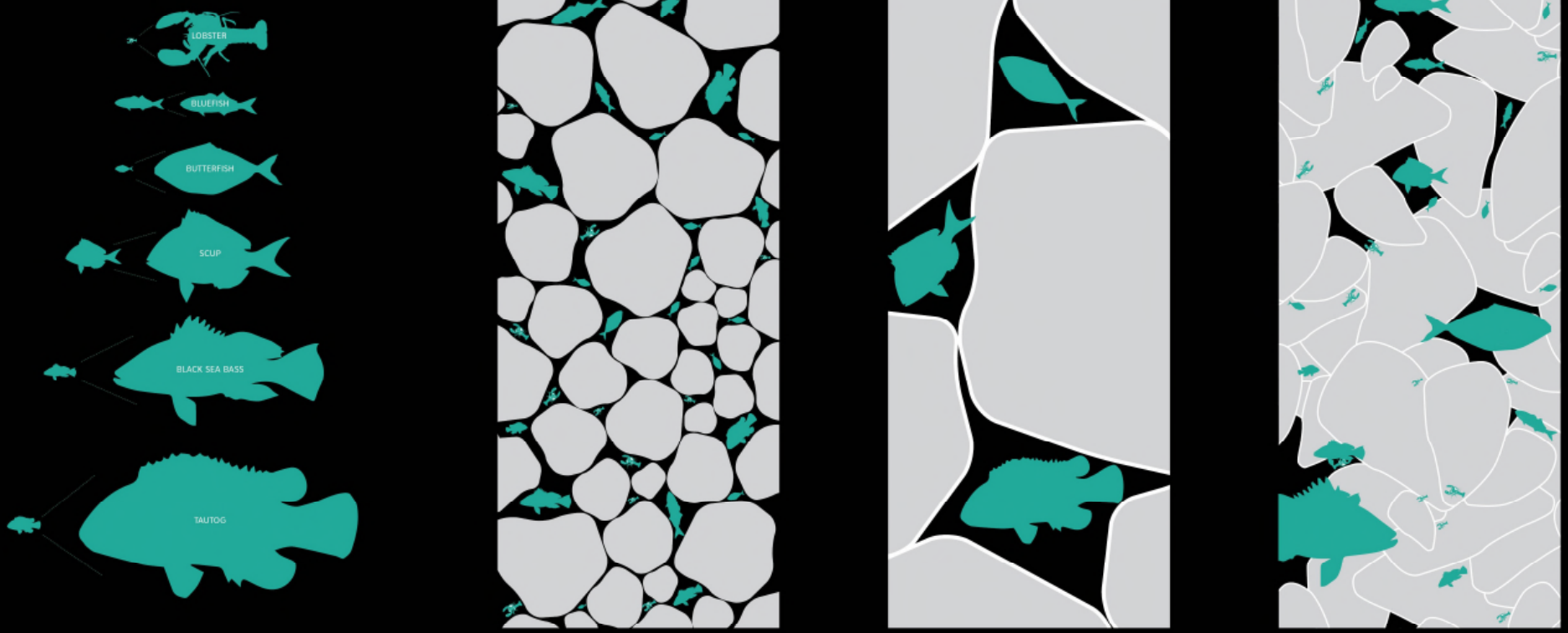
ECOncrete® TIDE POOLS
Dimension: 44"X 48"X27

HOW LIVING BREAKWATERS REEF STREETS

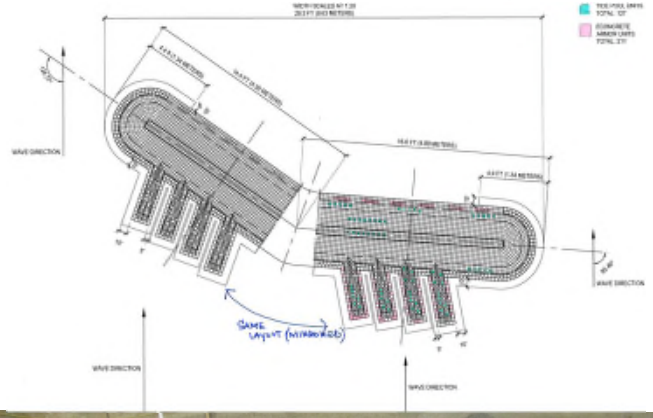


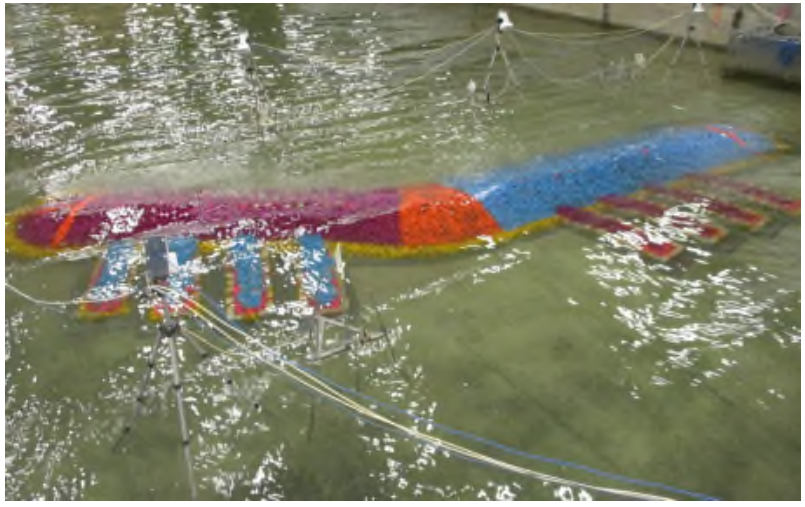


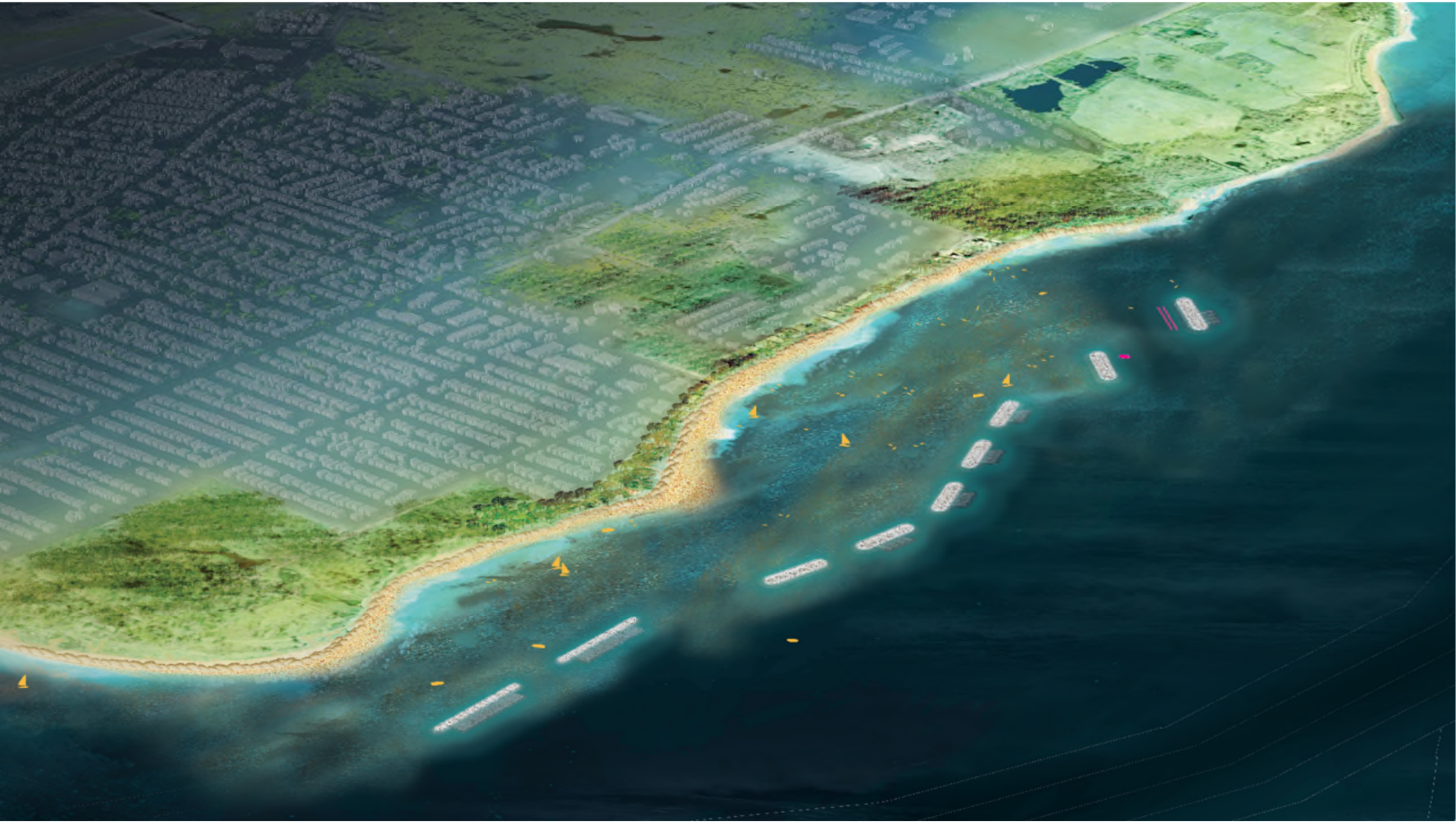
HOW LIVING BREAKWATERS CREATE HABITAT: COMPLEXITY

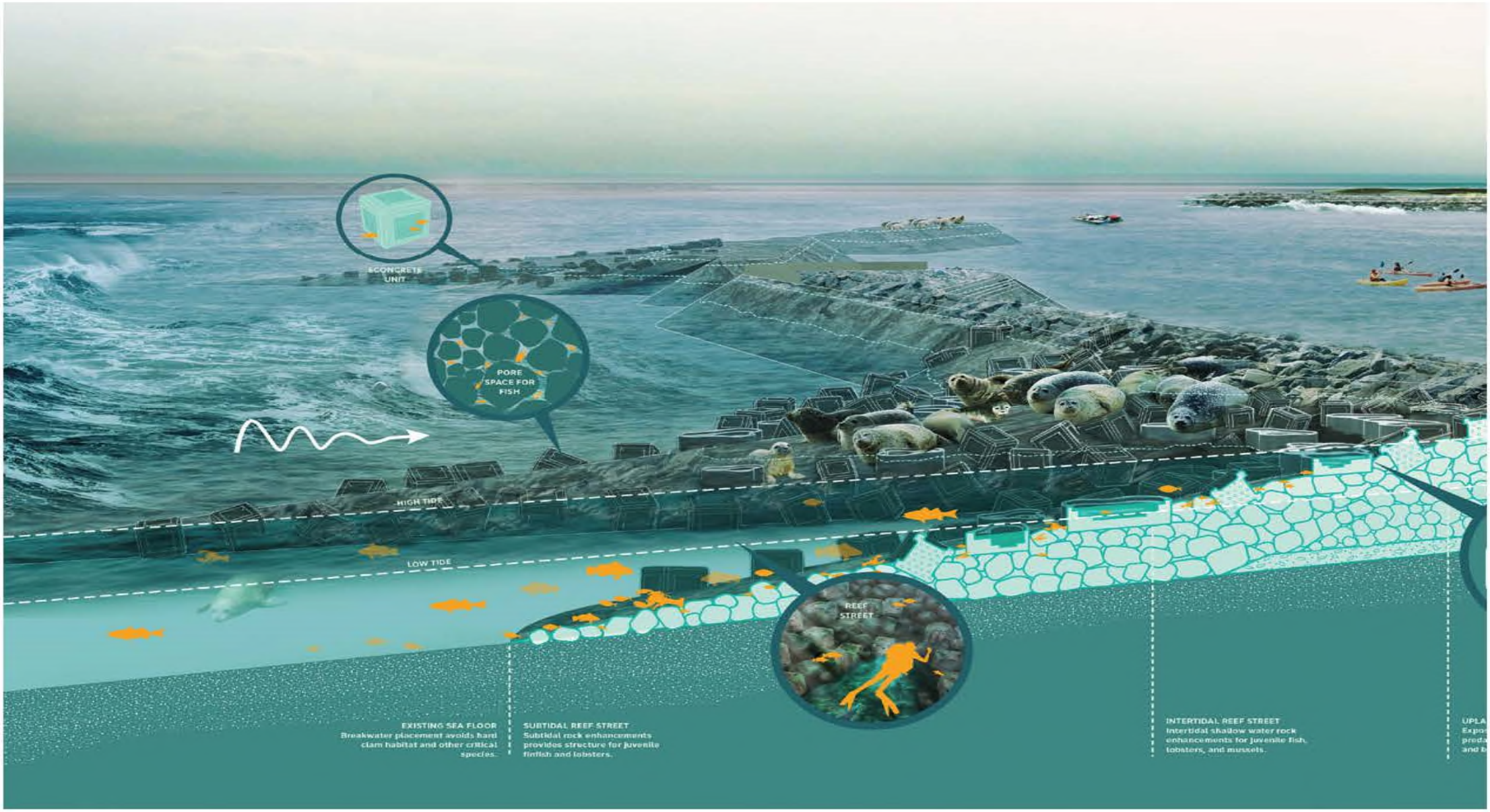


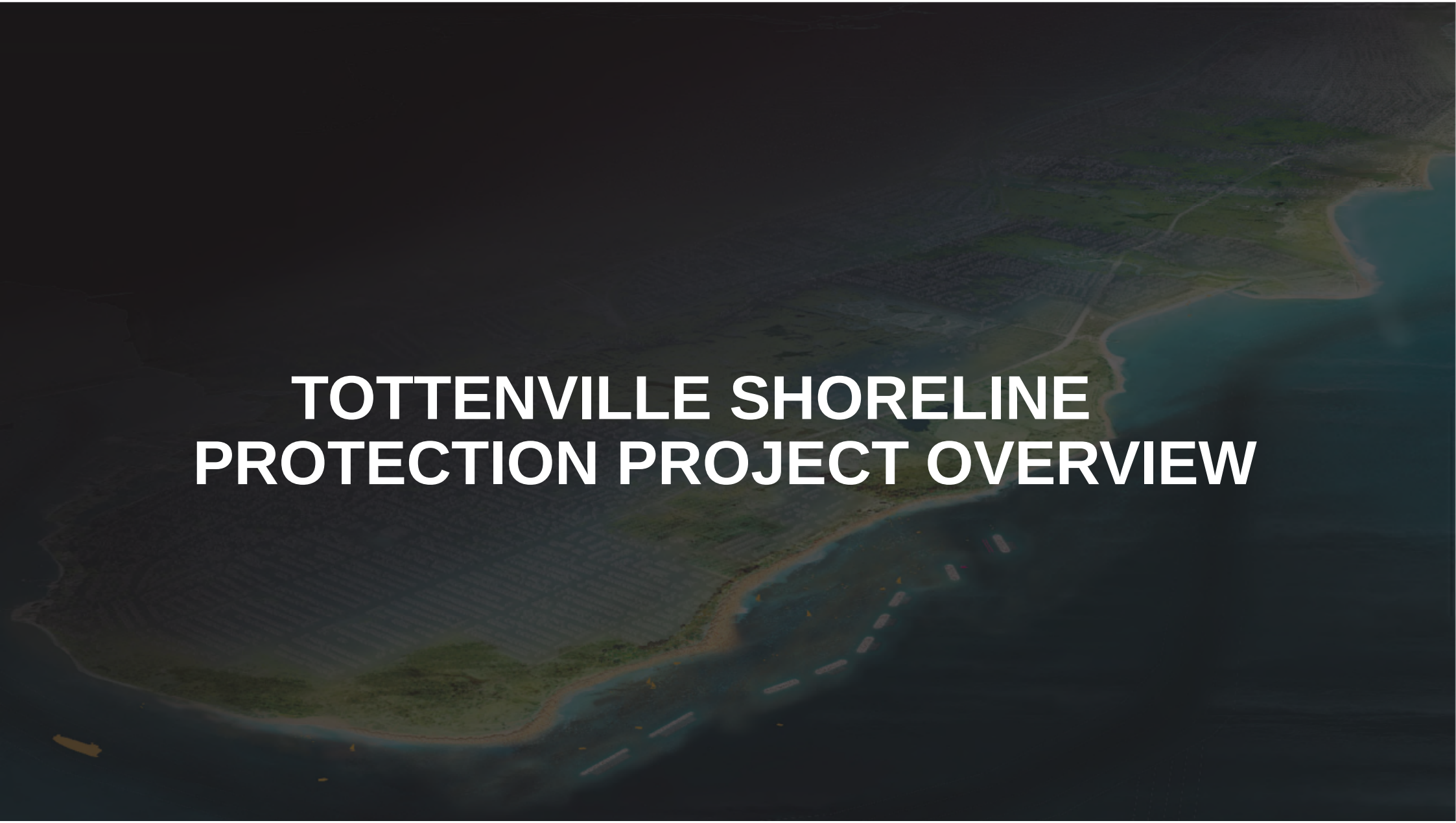
LIVING BREAKWATERS ARE STRUCTURALLY SOUND








CONCRETE UNIT
PORE SPACE FOR FISH
HIGH TIDE
LOW TIDE
REEF STREET
EXISTING SEA FLOOR
Breakwater placement avoids hard clam habitat and other critical species.
SUBTIDAL REEF STREET
Subtidal rock enhancements provides structure for juvenile finfish and lobsters.
INTERTIDAL REEF STREET
Intertidal shallow water rock enhancements for juvenile fish, lobsters, and mussels.

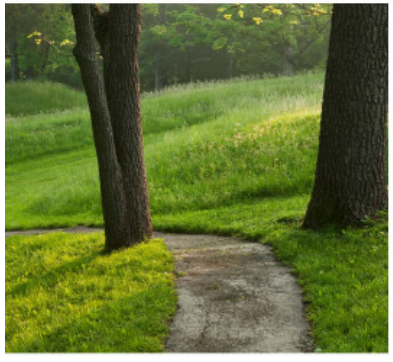


TOTTENVILLE SHORELINE PROTECTION PROJECT OVERVIEW

Layered Approach

Risk Reduction. Ecology. Social Resilience

Earthen Berm



Dune System

Eco-Revetment

Raised Pathway

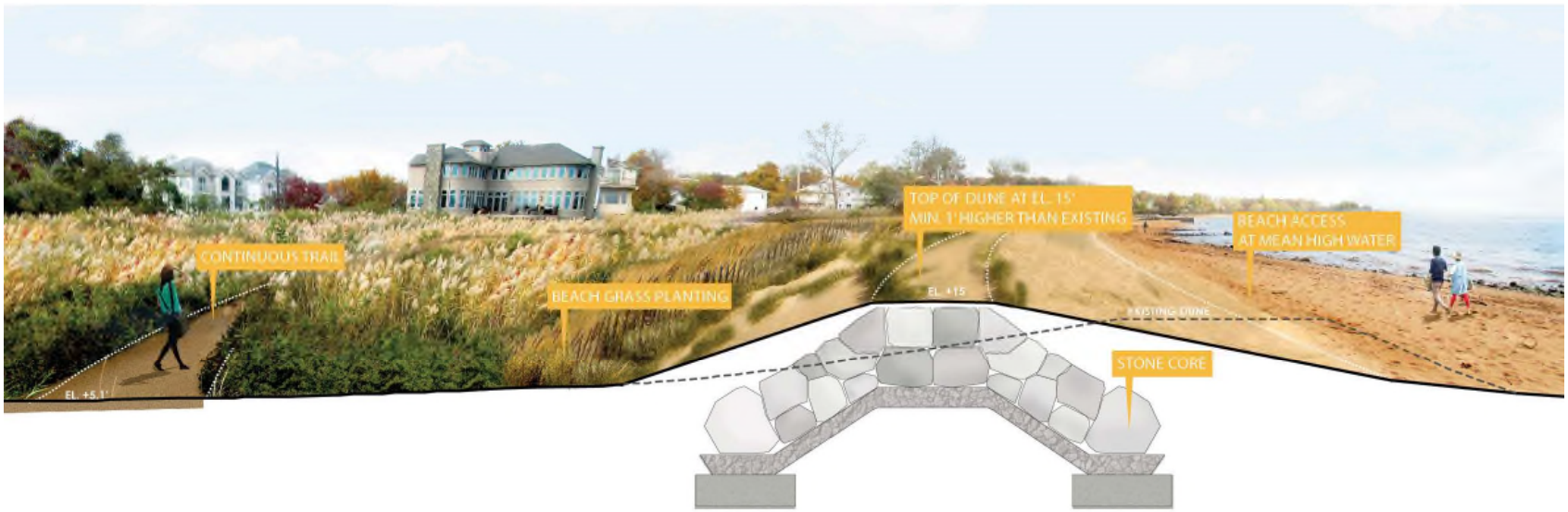
Earthen Berm


KEY MAP

- Earthen Berm at +12.5’
- Wetland Restoration
- Continuous Trails and Park Access
- Ecological Planting and Restoration

Dune System

KEY MAP

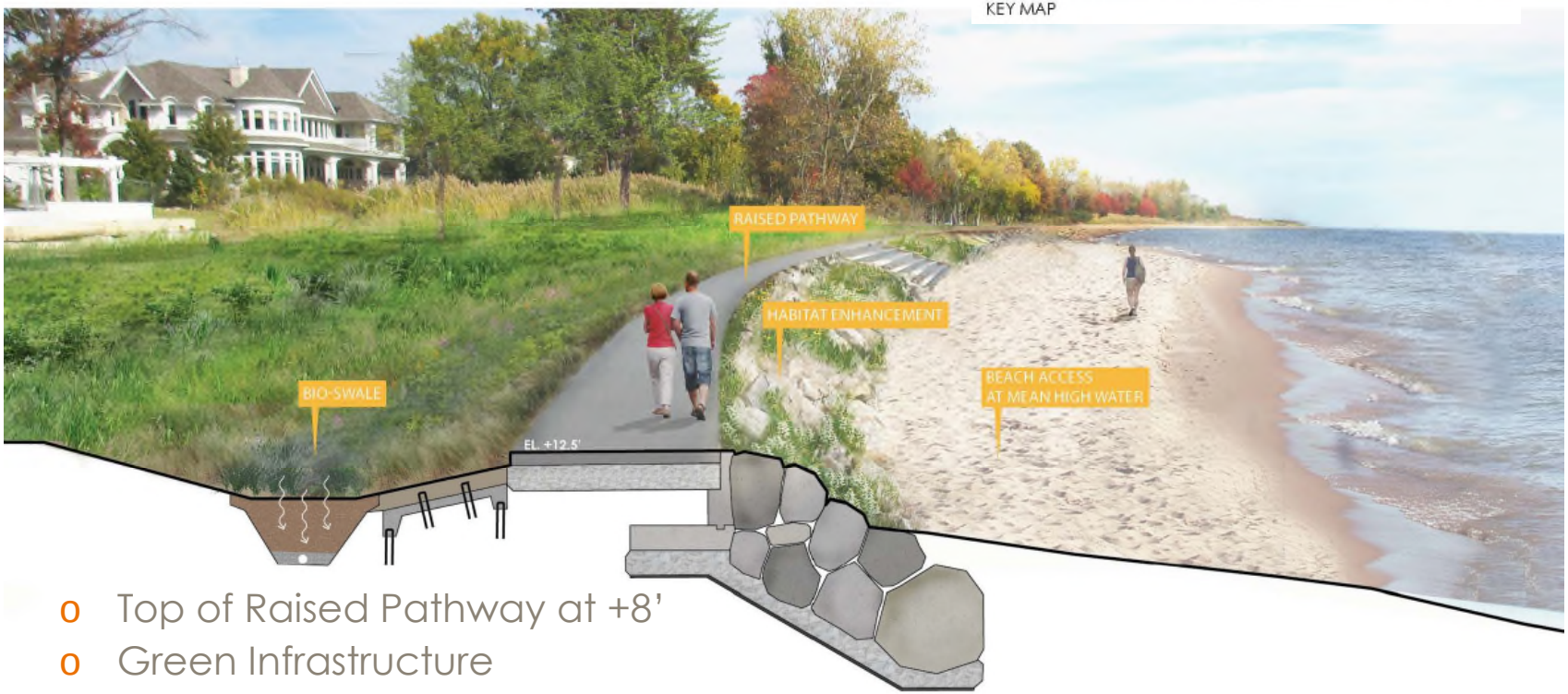


- Reinforced Dune Stone Core +12.5’
- Reinforced Dune Sand +14.5’
- Beach Grass Planting
- Continuous Trails and Park Access

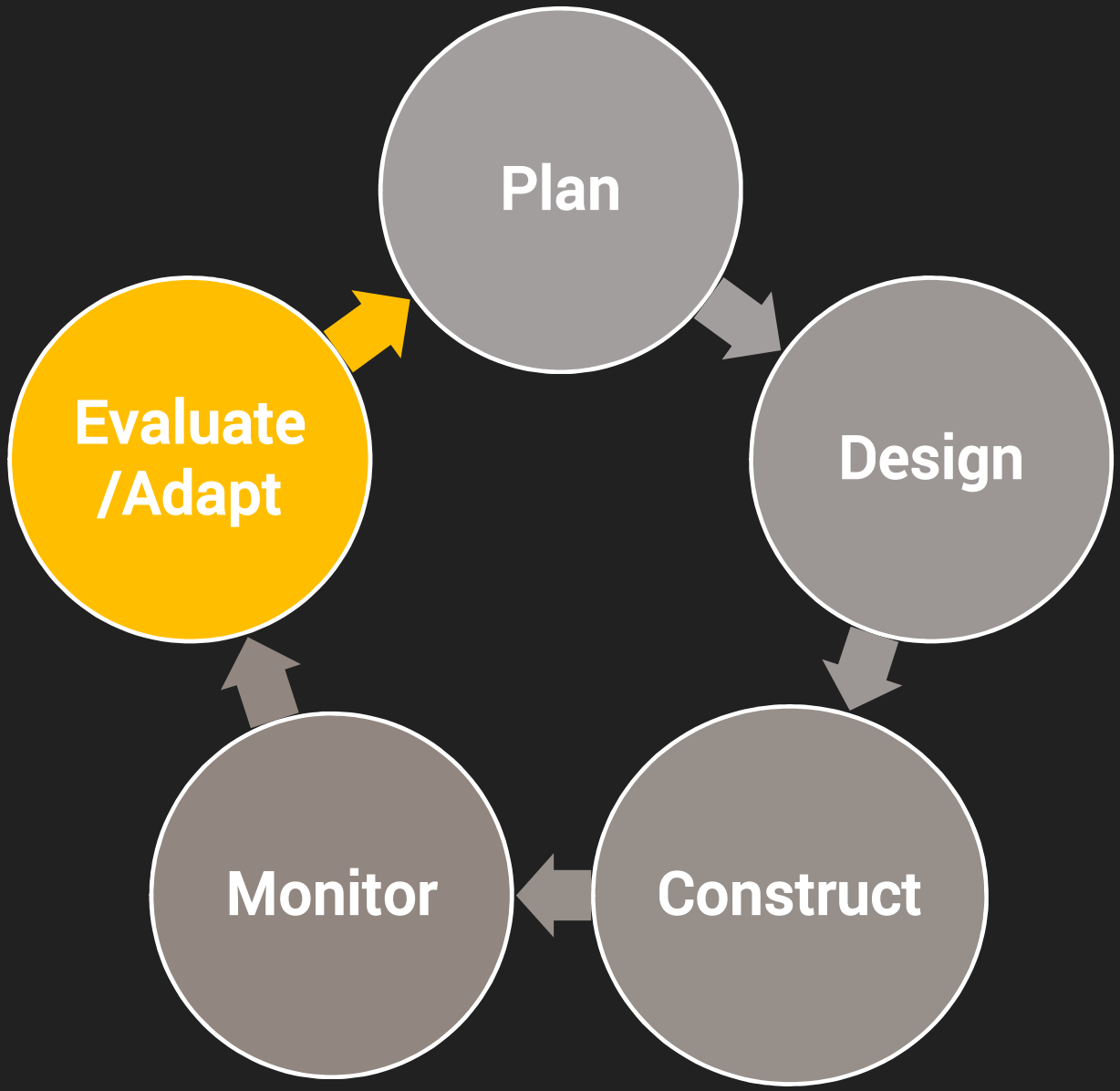
Eco-Revetment

- Top of Eco-Revetment at +12.5'
- Green Infrastructure
- ADA Access Points and Gathering Spaces
- Incorporate ENVISION rating system
- Community buy-in state supported house raising program

Raised Pathway



- Top of Raised Pathway at +8’
- Green Infrastructure
- ADA Pathway and Maintenance Access
- Shoreline Stabilization


Plan
Design
Construct
Monitor
Evaluate
/Adapt

Questions?