Living with the Bay: A Comprehensive Regional Resiliency Plan for Nassau County's South Shore

Living with the Bay is a project by the Interboro Team for Rebuild by Design.

This document was submitted on March 25, 2014.

Interboro Team:
Interboro / Apex / Bosch Slabbers / Deltares / H+N+S / Palmbout / IMG Rebel with Center for Urban Pedagogy, David Rusk, NJIT Infrastructure Planning Program, Project Projects, RFA Investments, TU Delft

Copyright

All content within this proposal is protected by U.S. and international intellectual property rights such as copyrights, trademarks, or similar rights recognized under law or comparable international conventions in any country, state, or jurisdiction in the world. No part may be reproduced in any form or by any means for commercial purposes without the express written consent of Interboro Partners on behalf of the Interboro Team.

Table of Contents

About Rebuild by Design
About our Team
About our Coalition

Chapter 1
Introduction

Chapter 2
Process

Chapter 3
Overall Challenge

Chapter 4
Hydrodynamic Modeling

Chapter 5
The Plan

Strategies for the Ocean Shore: Sediment Flow
Strategies for the Barrier Island: The Smart Barrier
Strategies for the Marsh: The Eco-Edge
Strategies for the Lowlands: Slow Streams
Strategies for the Uplands: The Green Corridor

Chapter 6
Implementation

Interboro Team:
Interboro / Apex / Bosch Slabbers
/ Deltares / H+N+S / Palmbout /
IMG Rebel with Center for Urban
Pedagogy, David Rusk,
NJIT Infrastructure Planning
Program, Project Projects, RFA
Investments, TU Delft

Interboro Team:
Interboro / Apex / Bosch Slabbers
/ Deltares / H+N+S / Palmbout /
IMG Rebel with Center for Urban
Pedagogy, David Rusk,
NJIT Infrastructure Planning
Program, Project Projects, RFA
Investments, TU Delft

About Rebuild by Design

Rebuild by Design, an initiative of President Obama's Hurricane Sandy Rebuilding Task Force and the U.S. Department of Housing and Urban Development, is aimed at identifying the unique structural and environmental vulnerabilities Hurricane Sandy exposed in communities throughout the region. Its goal is to develop innovative and implementable solutions as the region rebuilds to mitigate the impacts of future climate events. The process itself is an innovation to reconsider how we build and sustain coastal communities. It seeks to shape and inform both local and national policy, sharing lessons learned across the U.S. and the world.

This competition brings together experts from across the planning and design fields to think critically about resiliency, innovation, and rebuilding. In August 2013, the Hurricane Sandy Rebuilding Task Force announced the selection of the ten interdisciplinary design teams that will envision solutions to increase resiliency across the Sandy-affected region.

Ten teams—selected from more than 140 around the world—were tasked with conducting extensive research and public outreach to examine the interdependencies and vulnerabilities throughout the region and come up with ideas to make communities stronger. After a 3-month period of research and talking to stakeholders around the region, the teams collectively submitted a total of 41 different "design opportunities" that varied in approach, focus, and geography. HUD Secretary Shaun Donovan selected one idea from each team to move forward to the next phase—design.

The Interboro Team was asked to move forward with *Living with the Bay*, our design opportunity for Nassau County. We have spent the past few months turning this design opportunity into a "design solution"—a project proposal developed in collaboration with local, state, and federal stakeholders that may be eligible for HUD Community Development Block Grant Disaster Recovery funds and other public and private funding.

Living with the Bay will be evaluated by a competition jury, chaired by the HUD Secretary, which will identify the winning solutions that may receive HUD disaster recovery funds to help implement.

Interboro Team
Interboro / Area / Dosu / Stantec
/ Deltares / Philip Orton / Stevens Institute of Technology
IMG Rebuild with Science for Urban Resiliency / David Rockefeller Center for Urban Politics
Pennsylvania State University / Department of Landscape Architecture / Planning
NJIT / Program in Urban Systems
Program Director / Projects, RFA
Investments / Urban Design

About Our Team

Our unique team combines the best of Dutch land-use planning, environmental and coastal engineering, and urban water management with the best of American urban design, participatory planning, community development, engineering, and economic analysis and financial engineering. The Dutch contingent, which consists of design professionals who have extensive experience working together to adaptively plan coastal regions around the world, have envisioned, designed, and implemented some of the most important flood mitigation and management strategies worldwide. The American contingent, which consists of professionals in the fields of architecture, urban design, urban planning, coastal engineering, community economic development, governance, education, graphic design, and financial-economic advising, are recognized leaders in their fields and have an extensive track record working with communities to build resiliency.

Interboro Team:
Interboro / Apex / Bosch Slabbers / Deltares / H+N+S / Palmbout / IMG Rebel with Center for Urban Pedagogy, David Rusk, NJIT Infrastructure Planning Program, Project Projects, RFA Investments, TU Delft

Interboro Partners

www.interboropartners.net

Apex

www.apexenv.com

Bosch Slabbers

www.bosch-slabbers.nl

Center for Urban Pedagogy

welcometocup.org

David Rusk, Innovative Housing Institute

www.inhousing.org

Deltares

www.deltares.nl

H+N+S Landscape Architects

www.hnsland.nl

IMG Rebel

www.rebelgroup.com

NJIT Infrastructure Planning Program

www.architecture.njit.edu/academics/graduate/mip.php

Palmbout Urban Landscapes

www.palmbout.nl

Project Projects

www.projectprojects.com

RFA Investments

www.rfainvestments.com

TU Delft

www.tudelft.nl

Interboro Team: Interboro / Apex / Bosch Slabbers / Deltares / H+N+S / Palmbout / IMG Rebel with Center for Urban Pedagogy, David Rusk, NJIT Infrastructure Planning Program, Project Projects, RFA Investments, TU Delft

About Our Coalition

Throughout Rebuild by Design, we have combined an outside-in, systems approach that seeks to determine what is best for the region with an inside-out, community approach that seeks to determine what is desirable and possible in the region. *Living with the Bay*'s proposals are located at the intersection of these two approaches.

For *Living with the Bay*, the Interboro Team engaged over 100 organizations, including academic institutions, NGOs, nonprofits, community groups, governmental agencies, and private companies.

This outreach resulted in a diverse coalition of project partners and supporters.

Interboro Team:
Interboro / Apex / Bosch Slabbers / Deltares / H+N+S / Palmbout / IMG Rebel with Center for Urban Pedagogy, David Rusk, NJIT Infrastructure Planning Program, Project Projects, RFA Investments, TU Delft

Key supporters of *Living with the Bay* include the following entities:

Academic

Adelphi University Environmental Studies Program
Hofstra University Suburban Studies Program
Stonybrook University Department of Geosciences

NGOs, Non-profits, and Community Groups

Association of Marine Industries
Baldwin Civic Association
Citizen's Campaign for the Environment
Community Development Corporation of Long Island
Empire Justice
ERASE Racism
Garden Club of Long Island
Health and Welfare Council of Long Island
LIVOAD Long Term Recovery Group
Long Island Housing Partnership
Long Island Index
Operation SPLASH
South Shore Estuary Reserve
Sustainable Long Island
The Health and Welfare Council of Long Island
Trout Unlimited
Vision Long Island
Western Bays Coalition

Government

City of Long Beach
Governor's Office of Storm Recovery and New York Rising
CRZ
Long Island Regional Economic Development Council
Long Island Regional Planning Council
Nassau County Executive Office
Nassau County Department of Public Works
New York State Department of Environmental Conservation
Office of Congresswoman Carolyn McCarthy
Office of Senator Kirsten Gillibrand
Office of Senator Chuck Schumer
Town of Hempstead Department of Conservation and Waterways
Town of Hempstead Department of Engineering
Village of East Rockaway
Village of Freeport
Village of Lynbrook
Village of Rockville Centre

Private

Georgica Green Ventures
Jaral Properties

Chapter 1: Introduction

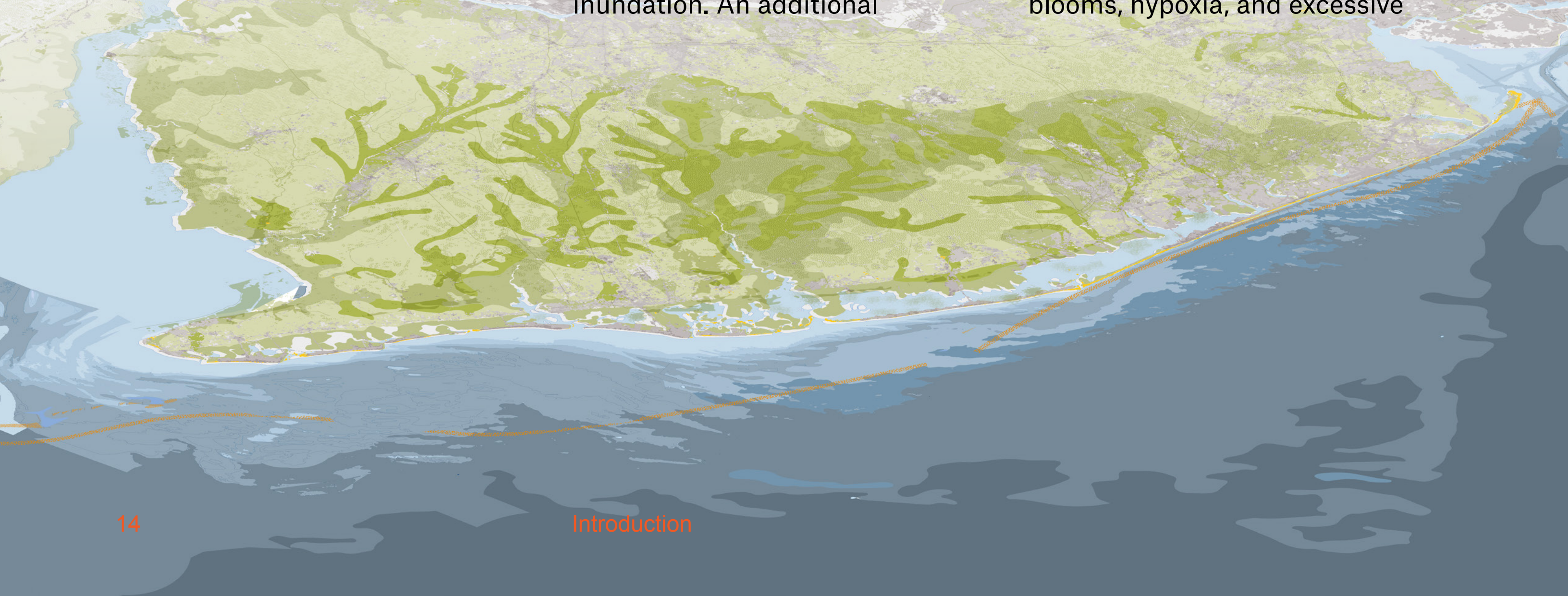
Interboro Team:
Interboro / Apex / Bosch Slabbers
/ Deltares / H+N+S / Palmbout /
IMG Rebel with Center for Urban
Pedagogy, David Rusk,
NJIT Infrastructure Planning
Program, Project Projects, RFA
Investments, TU Delft

Interboro Team:
Interboro / Apex / Bosch Slabbers
/ Deltares / H+N+S / Palmbout /
IMG Rebel with Center for Urban
Pedagogy, David Rusk,
NJIT Infrastructure Planning
Program, Project Projects, RFA
Investments, TU Delft

On Long Island, Superstorm Sandy killed 14 people and destroyed or rendered uninhabitable over 2,000 homes. In total, 113,901 residents applied for disaster relief. For residents with federal flood insurance policies, 43,106 were affected by flooding. FEMA estimates that roughly 10% of Nassau and Suffolk's 948,540 households experienced flooding or storm damage. Overall, 95,534 buildings were damaged or destroyed, producing nearly four million cubic yards of structural debris. Of these, 38,189 structures sustained damage that totaled over 50% of their value. Twenty-eight fire stations, 26 schools, 3 police stations, 1 hospital, and 44 power stations or other electrical facilities were seriously damaged. Immediately following the superstorm, 90% (11 million) of Long Island Power Authority customers lost power.

Nearly 65% of all structures and 70% of homes destroyed on Long Island were located in Nassau County. A total of 35,725 of the county's residents were displaced and requested FEMA housing assistance, with over 1,400 homes destroyed or deemed uninhabitable. A total of 74,736 structures were flooded or destroyed, 17,405 of which only experienced stormwater inundation. An additional 34,602 personal automobiles were damaged or wiped out. Furthermore, the Bay Park Sewage Treatment Plant in East Rockaway, which normally treats 40% of Nassau County's waste, sustained major damages. It failed to operate at full capacity until mid-December of 2012. According to the NY Daily News, the plant released "hundreds of millions of gallons of raw and partially treated sewage into nearby waterways and streets." Residents complained of wastewater spilling out of their toilets and flooding their homes.

The damage from Sandy was caused primarily by storm surge. But unfortunately storm surge is not Long Island's only water-related threat. For example, because groundwater is insufficiently recharged, saltwater intrusion is contaminating the aquifer. And, as we describe in Chapter 3, Long Island faces serious threats from sea level rise, stormwater, and wastewater. The latter two threats are a major source of pollution: unfiltered stormwater runoff entering the bay by way of the region's rivers and creeks threatens the bay's ecology. Effluent from the Bay Park Sewage Treatment Plant—which is currently released in the bay—exacerbates nitrogen levels that cause harmful algae blooms, hypoxia, and excessive



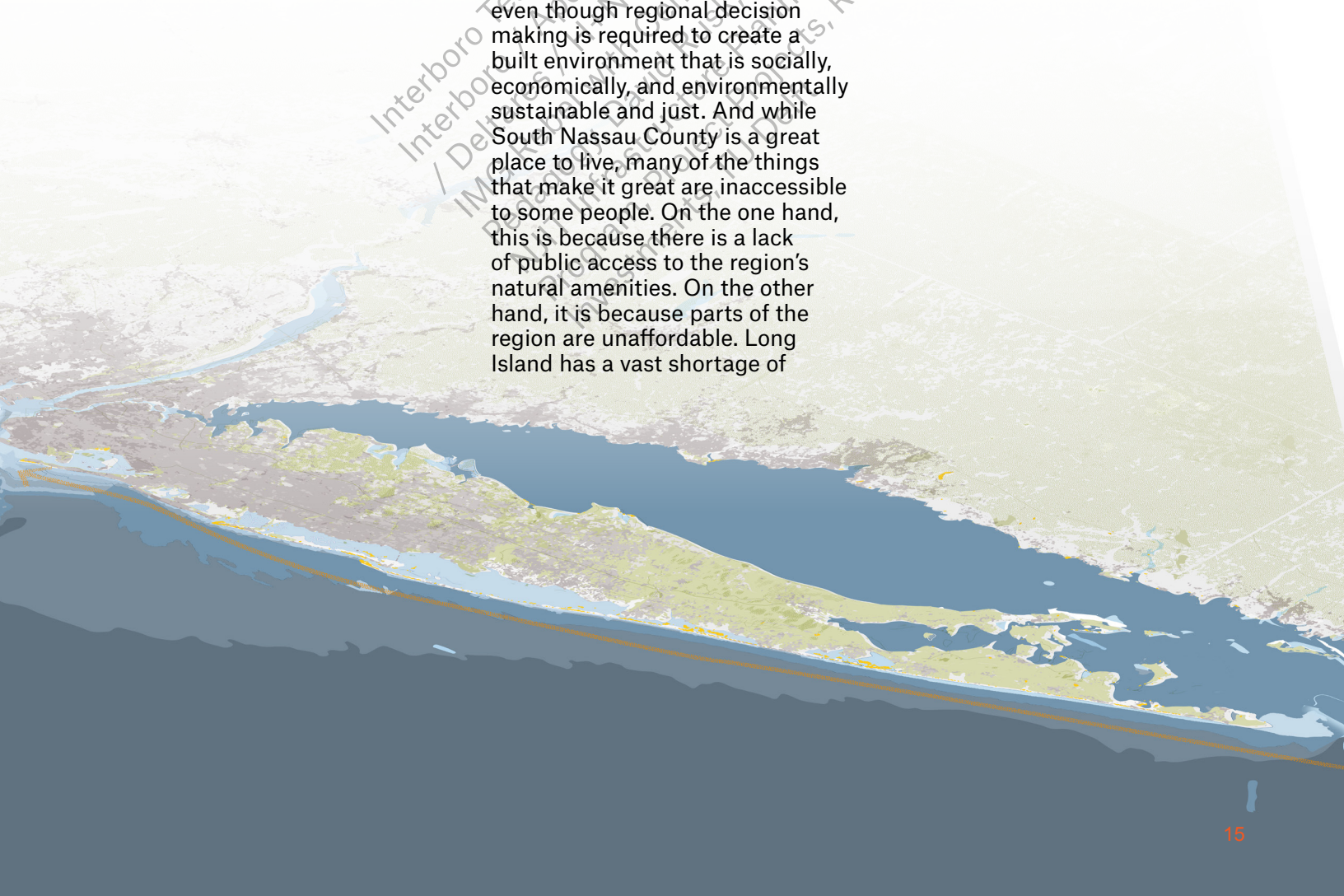
Ulva seaweed growth and that deteriorate salt marshes that could otherwise help protect Long Islanders from storm surge. The salt marshes are also undermined by overdevelopment, which has increased polluted stormwater runoff and restricted the sediment flow that is essential to the marshes.

These threats pose a serious challenge to the bay, which is in many ways the cultural, ecological, and economic engine of the region.

In addition, these water-based threats are exacerbated by other threats. For example, New York's system of "home rule" creates a barrier to the kind of regional decision making that is required to adequately address regional issues that don't respect municipal lines, even though regional decision making is required to create a built environment that is socially, economically, and environmentally sustainable and just. And while South Nassau County is a great place to live, many of the things that make it great are inaccessible to some people. On the one hand, this is because there is a lack of public access to the region's natural amenities. On the other hand, it is because parts of the region are unaffordable. Long Island has a vast shortage of apartments and rentals. When Sandy struck, Long Island's rental vacancy rate was just over 4%: neither displaced residents nor relief workers were able to find suitable temporary housing.

So, how do we ensure that the next big storm won't be as devastating as Sandy? How do we keep Long Islanders safe in the face of future extreme weather events and sea level rise? And what can we do to improve the water quality and quality of life in southern Nassau County? What can we do to make *living with the bay* safe, healthy, fun, and accessible to everyone?

These are the questions we address in *Living with the Bay*, our comprehensive regional resiliency plan for Nassau County's South Shore.



Interboro Team / Deborah Berke Partners / Dewberry / Dr. Ken Lynch / Deltais / Arup / Pennoni / Parsons Brinckerhoff / Pedalo / Cooper Robertson / Urban Infrastructure Partners / Cities for Climate Investments / Urban Planning Collaborative / Projects, RFA

About Our Plan

The goal of *Living with the Bay* is to make the communities around the South Shore's bays more resilient in the face of future extreme weather events and sea level rise and also to strengthen what makes living near the bays great in the first place.

But because there are multiple threats, there needs to be a range of responses. Indeed, there are no "silver bullet" solutions here, and there is no one response that will solve all of Long Island's water-related problems. A surge barrier might protect Long Islanders from storm surge, but it won't do much to keep us safe from nor'easters and other rain events that routinely flood our communities. Withdrawing or retreating from the coast would result in less flood damage, but the South Shore is certainly not going to throw in the towel. And neither should it. There's a reason why people live on the South Shore: it's a great place to live. We think there is a way to live with the bay!

To determine how to live with the bay in a way that increases safety and quality of life, we investigated four long-term options:

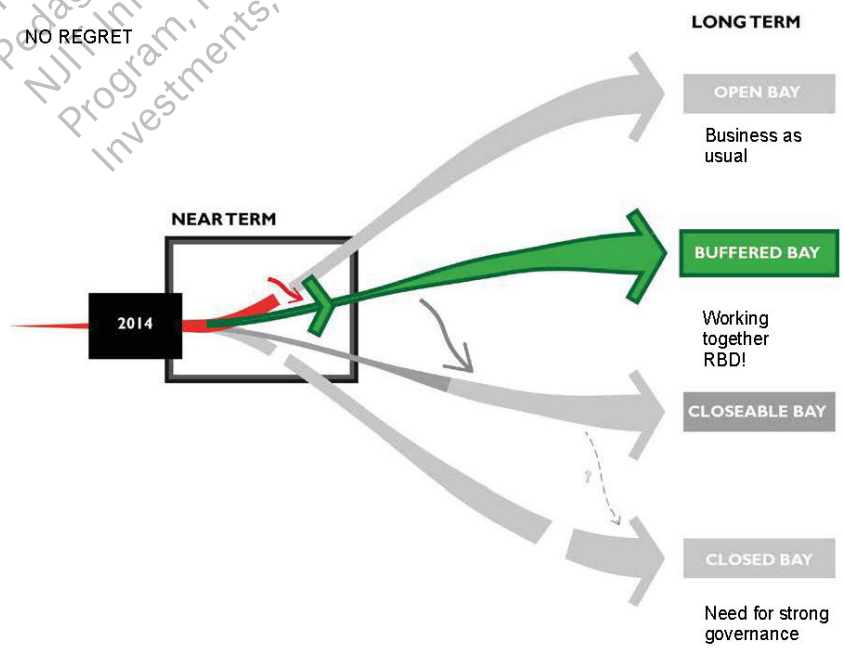
—a bay that is completely open to the ocean
—a bay that is buffered from the ocean
—a closable bay that can be closed off to the ocean by means of operable surge barriers
—a bay that is closed off permanently to the ocean by fixed surge barriers

Because of the threats from storm surge and sea level rise, a completely open bay with no protection is not possible. And because we value the ecosystem of the bay, a closed bay is not viable since it would greatly undermine this ecosystem. (It would also potentially trap water in the bay and have the effect of increasing flooding.) The best option is the buffered bay: a solution that avoids both extremes.

Our buffered bay presents a range of integrated adaptive measures that keep Nassau County residents safe and add to the economic, ecological, and social quality of the region.

These adaptive measures include mitigating the damage from storm surge, stormwater runoff, and

Interboro Team / Apex / Bom Stages / Deltares / Arup / N+S / Rambow / IMG Rebuild Center / Pedagogy, Dave Brock, NJIT Infrastructure Planning Program, Project Prosper, RFA Investments, TU Delft



sea level rise by recovering the sediment system and strategically deploying protective measures like constructed marshes, dikes, and cross structures along the urbanized edge; managing stormwater to mitigate the damages from common rain events as well as improve the water quality in the bay; and expanding housing options in high and dry areas near public transportation.

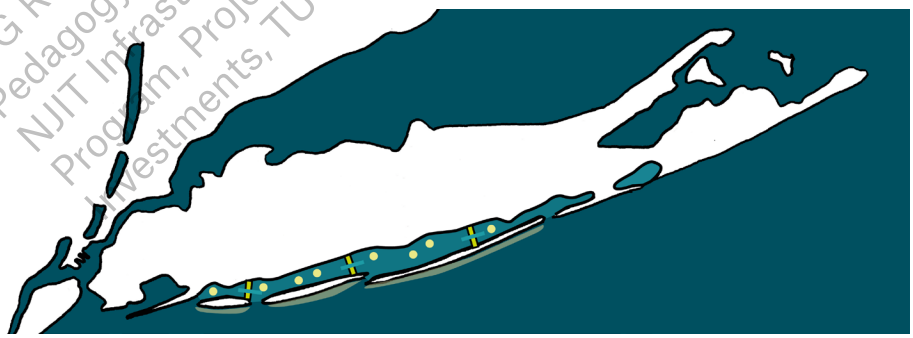
Towards a buffered bay, we have developed an integrated, tri-scalar approach that includes planning and design efforts at the scale of the region, the sub-region, and specific sites.

At the scale of the region, we have developed a draft, long-range, comprehensive, regional resiliency plan for southern Nassau County. This plan includes research, planning and design, and the development of decision-making tools that address the interrelationships between the region's natural and human-made systems.

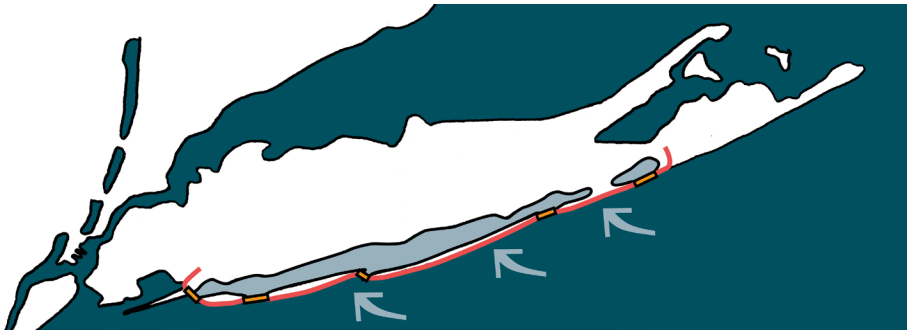
At the scale of the sub-region, we zoomed in and focused on high-impact areas to develop prototypical resiliency strategies for ocean shores, barrier islands, saltwater marshes, creeks and river estuaries, and highlands, respectively. While this plan zeroes in on a particular ocean shore, barrier island (Long Beach Barrier Island), saltwater marsh (West, Middle, and East Bays), river estuary (Mill River), and highland (Sunrise Highway corridor), each strategy is prototypical and broadly applicable to other ocean shores, barrier islands, saltwater marshes, creeks and river estuaries, and uplands in the entire Sandy-affected region.

Further zooming in to these areas, we selected five specific sites—one for each of the five strategies—to develop catalytic projects that are implementable within the short term and can kick-start long-term change. These Phase One projects are located in Jones Inlet, Long Beach, Freeport, Rockville Centre, and East Rockaway.

Interboro Team / Alex Ely, Joseph Stabile / Interboro / Deltares / H+N+S / Dominique / IMG Rebel with Center for Urban Pedagogy, David Rush / NJIT Infrastructure Planning Program, Project Projects, RFA Investments, TU Delft



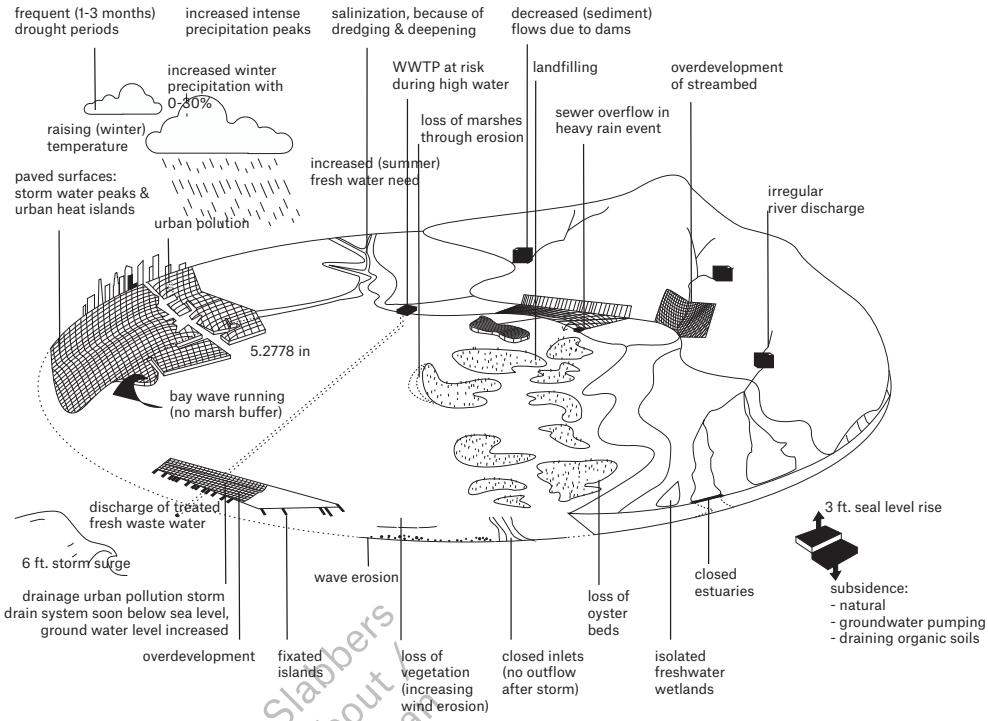
The Buffered Bay



Extreme Closed

Guiding principles

A number of principles have guided our work on *Living with the Bay*.



Interboro Team: Interboro / Apex / Bosch Slabbers / Deltares / HKN+S / Palmbout / IMG Rebel with Center for Urban Research / David Rock, NJIT / Infrastructure Planning Program, Parsons Brinckerhoff, Investments, Tu Delft

Plan and design for a dynamic landscape

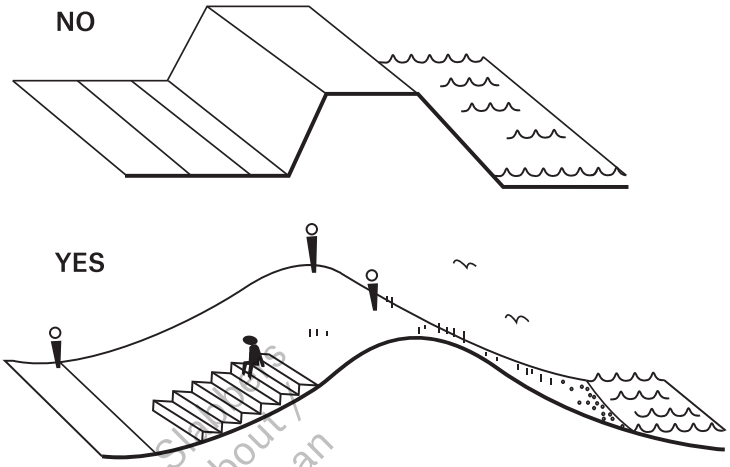
The landscape is continuously transforming. Knowledge of dynamic natural processes such as tidal movement, erosion, and sediment movement allows us to anticipate and work with these transformations. If we take into account the various interconnections within the natural system, we can use these processes to our advantage and create a landscape that is more safe, productive, accessible, and attractive.

Interboro Team / Bosch Slabbers / Palmbout / Interboro / Apex / N+S / Deltaeff / IMG Rebuild Center for Urban Pedagogy Design Desk, Urban Manufacture Planning Commission, Design Consultants / Design Projects, RFA

Plan and design interventions that are prototypical and catalytic

Most Sandy-damaged communities on Long Island are still recovering and struggling to determine where and how to find the resources to rebuild, adapt, or move on. Many of Long Island's communities are as vulnerable today as they were before Sandy hit. How do we as architects, planners, and policymakers ensure that our projects help those who need help the most? How can we ensure that our projects are maximally impactful?

Towards this, we have identified design opportunities that are prototypical and catalytic. They are prototypical in that they address common problems: while each design opportunity can be implemented in Nassau County, each offers solutions that may be applicable elsewhere. The design opportunities are catalytic in that each is a concrete starting point that can catalyze other desired outcomes.

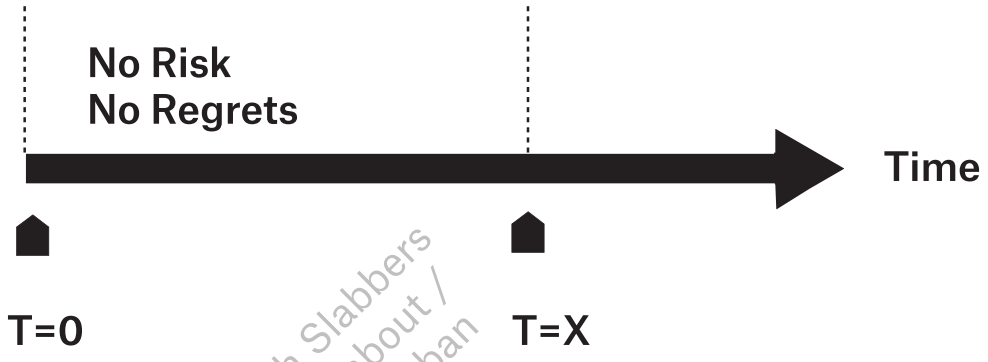


Plan and design for the storm and the norm

Architecture that protects us from the occasional disaster (for example, a terrorist attack or a flood) too often requires us to sacrifice things we enjoy about everyday, non-disaster moments.

In our plan, each and every investment in flood protection in one way or another improves everyday life. If we're going to build protective structures, there is simply no reason not to add value to them so that they do more than merely protect.

Interboro Team: Interboro / Apex / Bosch Slabbers / Deltares / H+N+S / Palmbout / IMG Rotterdam / Atlantic Center for Urban Pedagogy / Paul Husk, NJIT Infrastructure Planning Program, PhD Project, RIA Investments, TU Delft



Interboro Team:
Interboro / Apex / Bosch Slabbers
/ Deltares / H+N+S / Palmbout /
IMC / Center for Urban
Resilience / Dave Dusk,
NYC Department of Planning
Program Director Projects, RIA
Investment Portfolio

Plan and design low-risk, "no regrets" scenarios

There are a lot of uncertainties in the long term. For example, we don't know exactly how the climate will change, where the economy will go, or who will get elected to what office. Therefore, we have to develop a long-term perspective that can be achieved along different paths, on which one can adjust the route as circumstances change. Our strategies are relatively low-risk, "no regret" propositions for the present that sow seeds and offer a mixture of adapt, retreat, and protect strategies.

Implementation

For *Living with the Bay* the Interboro Team engaged over 100 organizations, including academic institutions, NGOs, nonprofits, and community groups, governmental agencies, and private companies.

This outreach resulted in a diverse coalition of project partners and supporters.

Who could be a better steward for *Living with the Bay* than the project partners who have been successfully collaborating in the past three RBD phases and who are explicitly supporting *Living with the Bay*?

To implement *Living with the Bay* we propose to establish the Bay Alliance, a coalition composed of the public and private partners, communities and residents, who will continue to work together to:

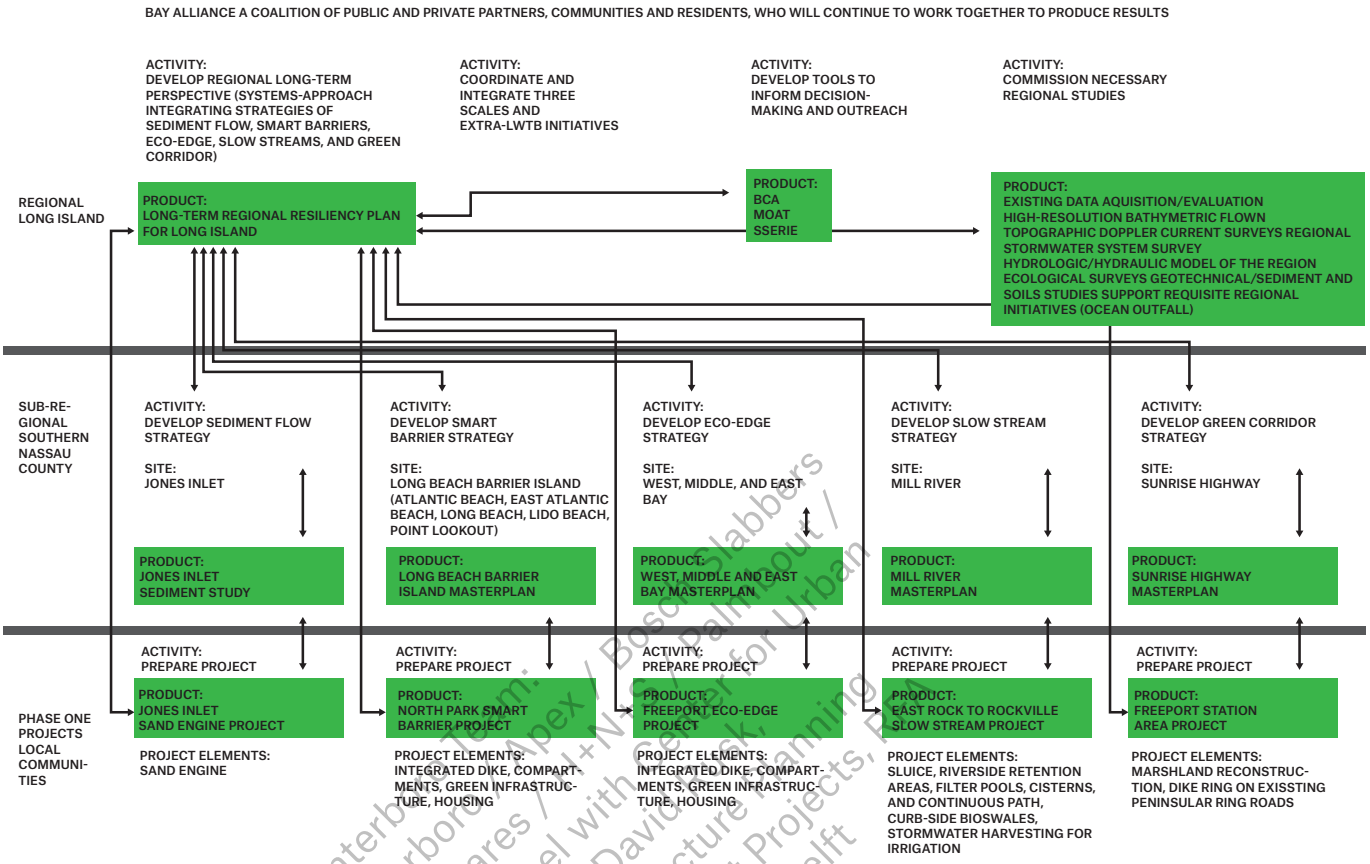
—steer and enable the development and implementation process
—ensure linkages between the regional scale, the sub-regional scale and the projects
—monitor the budgets and apply for funding
—stimulate information and experience sharing between projects
—deliver results

Our future efforts will work at three scales. While each scale has its own timeline, the activities of the different scales have important interdependencies. All efforts will build on the work conducted in *Rebuild by Design* Stages 2 and 3.

At the regional scale, there will be four primary tasks: to further develop the regional framework (which includes the five strategies of Sediment Flow, Smart Barrier, Eco-Edge, Slow Streams, and Green Corridor), to coordinate and integrate the design and planning efforts at the three scales and with initiatives outside of *Living with the Bay,* to commission necessary regional studies, and to develop tools to inform regional decision making and outreach.

At the sub-regional scale, after having established a conceptual plan and confirmed key stakeholder support (the future "owners")—tasks that we have already completed for most of the projects—we propose to develop master plans for these key, catalytic, and prototypical sub-regional sites. The development of these master plans will be rooted in a highly participatory process, engaging a wide range of community stakeholders. The master plan process will conclude with an approved plan.
At the project scale, after having established a conceptual plan, a preliminary budget, and draft BCA, and after having confirmed key stakeholder support (the future "owners"), we will prepare the selected Phase One projects. The preparation will include (but is not limited to) further design development, outreach, completing the design, and bidding the project, after which the project can be constructed. All Phase One projects will include the monitoring and measuring of impacts, which in most cases will begin before construction starts.

Interboro Team / Area / BOS / Slabscape / Deltares / H+N+S / Plan Bout / IMG Rotterdam / Carver for Urban Pedal / Dynamic Rust / NOM Infrastructure Planning / Dynamic Projects / Investments / TU Delft RFA



Interbo
Interbo
/ Deltares
IMG Rebel with
Pedagogy, Davi
NJIT Infrastructure Planning
Program, Project Projects,
Investments, TU Delft

Chapter 2: Process

Interboro Team:
Interboro / Apex / Bosch Slabbers
/ Deltares / H+N+S / Palmbout /
IMG Rebel with Center for Urban
Pedagogy, David Rusk,
NJIT Infrastructure Planning
Program, Project Projects, RFA
Investments, TU Delft

Interboro Team:
Interboro / Apex / Bosch Slabbers
/ Deltares / H+N+S / Palmbout /
IMG Rebel with Center for Urban
Pedagogy, David Rusk,
NJIT Infrastructure Planning
Program, Project Projects, RFA
Investments, TU Delft

Organizations Engaged

During Stage 3, the Interboro Team combined an outside-in, systems approach that sought to determine what is best for the region with an inside-out, community approach that sought to determine what is desirable and possible in the region. *Living with the Bay*'s proposals are located at the intersection of these two approaches.

For *Living with the Bay*, the Interboro Team engaged over 100 organizations, including academic institutions, NGOs, nonprofits, community groups, governmental agencies, and private companies. This outreach resulted in a diverse coalition of project partners and supporters.

The following organizations were asked to provide input on *Living with the Bay*:

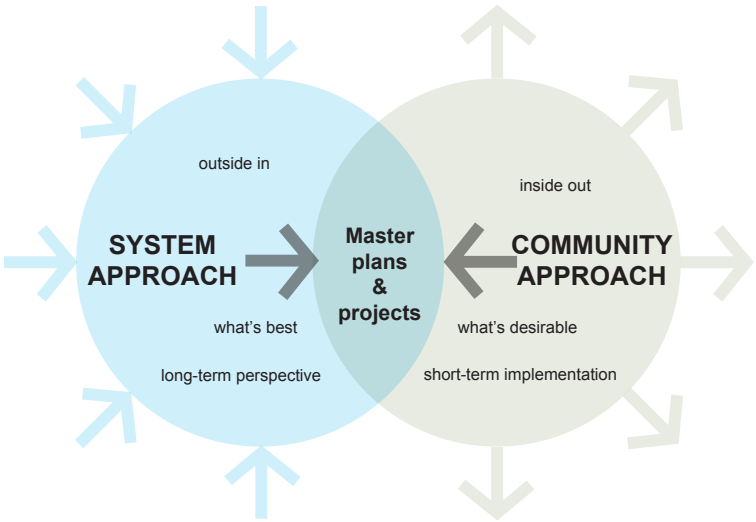
Academic

Adelphi University Environmental Studies Program
Hofstra University Suburban Studies Program
Stonybrook University Department of Geosciences

NGOs, Nonprofits, and Community Groups

Adelante of Suffolk County
American Red Cross
Association of Marine Industries
Baldwin Civic Association
Bellport High School Students for Environmental Quality
Brookhaven Baymen's Association
Brookhaven League of Women Voters
Captain Don's Nautical Adventures
Catholic Charities
Center for Estuarine, Environmental and Coastal Oceans Monitoring
Child Care Council of Long Island
Citizen's Campaign for the Environment
Coastal Research and Education Society of Long Island
Community Development Corporation of Long Island
Ecological Engineering
Empire Justice
ERASE Racism
Family Service League
FEGS
FEMA
Fire Island Association
Freeport Church of Wazerene
Freeport Schools
Garden Club of Long Island
Great South Bay Audubon Society
Hammer Magazine
Health and Welfare Council of Long Island
Islip Town Leaseholders Association
Kimmel Housing Foundation
Knights of Columbus
LIVOAD
LIVOAD Long Term Recovery Group
Local NY Laborers 66
Long Beach COAD
Long Island Association
Long Island Housing Partnership
Long Island Index
Long Island Sierra Club
Long Island Volunteer Center
Lutheran Social Services
Lutheran Counseling Center
Mastic Beach Property Owners Association
Merrick Fire Department
Nature Conservancy
New York Committee for Occupational Safety and Health
New York Sea Grant
New York Seafood Council
New York Sportfishing Federation
Operation SPLASH
Pattersquash Creek Civic Association
Peconic Land Trust
Presbyterian PBA
Presbytery of Long Island
Project Hope
Rebuilding Together of Long Island
Seatuck Environmental Association
Sheet Metal Workers Local 28
Society of Vincent de Paul

Interboro Team
Interboro / Mitex / Bosch Slabbers / Deltares / HH+S / Palmbout / IMG Rebel / Center for Urban Research Advantage / East Institute / Planning Program, Project Projects, RFA / Investments / TU Delft



South Bay Cruising Club
South Shore Audubon Society
South Shore Bayhouse Owners Association
South Shore Estuary Reserve
South Shore Waterfowlers Association
STF Group INC Eco Homes + Cleaning Tech Solutions
Suffolk Alliance of Sportsmen
Sustainable Long Island
Touro Law School
Trout Unlimited
United Methodist Church
United Way of Long Island
Vision Long Island
Western Bays Coalition

Government
Army Corps of Engineers
City of Long Beach
EPA
FEMA Community Planning and Capacity Building Department
Governor's Office of Storm Recovery
Long Island Railroad
Long Island Regional Economic Development Council
Long Island Regional Planning Council
Nassau County Executive Office
Nassau County Legislature
Nassau County Department of Public Works
New York State Department of Environmental Conservation
New York State Department of Transportation
New York Rising CRZ
Office of Senator Kirsten Gillibrand
Town of Hempstead Department of Conservation and Waterways
Town of Hempstead Department of Engineering
US Coast Guard Auxiliary
Village of East Rockaway
Village of Freeport
Village of Lynbrook
Village of Rockville Centre

Private
Arcadis
AVR Realty Company
Renaissance Downtowns
Cameron Engineering
Georgica Green Ventures
Jaral Properties
Land Use Ecological Services
Perkins Eastman
The LIRO Group
URS

Interboro Team / Boston Slalom
Interboro / Nixey / Dosch / Slalom / Deltares / Interface / Rapidout / IMG Rebuild Center / Urban Patanogy, Dauphinesk, NJ Transit, Infrastructure Planning Program, Project Projects, RFA Investments, TU Delft

Meetings Conducted

For *Living with the Bay*, the Interboro Team conducted over70 meetings, including community meetings, informational meetings, client presentations, presentations to partners and stakeholders, and other outreach events.

Here is a list of the meetings we conducted:

Community meetings

Presentation:
Project Partner Meeting

Date:
1/29/14

Location:
Nassau County Executive's Office, Mineola

Attendance:
Approximately 30 people, including representatives from City of Long Beach, Seatuck Environmental Association, The Nature Conservancy, Empire Justice, Governor's Office of Storm Recovery, LIRPC, Health and Wellness Council of Long Island, and residents from Long Beach, East Rockaway, Bay Park, Massapequa, and Wantagh/ Seaford

Summary:
Presented Stage 2 plan and Stage 3 progress; received feedback, especially from residents who wanted us to do more to protect them from surge; some spoke of the need to have a coordinated approach to land acquisitions; many residents had questions about coordination with CRZ process

Presentation:
Stakeholder Workshop: "Regional Resiliency: A Dutch Perspective"

Date:
2/4/14

Location:
Office of Emergency Management, Bethpage

Attendance:
34 individuals from 27 leading organizations in Long Island, including the Nature Conservancy, Peconic Baykeeper, Operation SPLASH, FEMA's Community Planning and Capacity Building Department, Long Island Regional Planning Commission, Long Island Regional Economic Development Council, and others

Summary:
Presented Stage 3 progress; received extensive feedback on marsh restoration, sediment flow, stormwater management, and protective barriers

Meeting:
Community Meeting I

Date:
2/22/14

Location:
Baldwin Senior High School

Attendance:
Approximately 60 people

Summary:
Presented *Living with the Bay*; conducted an open discussion; led breakout tables on each of our four strategies

Interboro Team: Interboro / ADX / Boston Scientific / Delaware / HR&A / Parsons Brinckerhoff / MC Realty / Ecotech / Urban Ecology, Davis Brook Integrated Planning / NYC Infrastructure Project Projects, RFA / Investment Tech / TU Delft

Meeting:
Community Meeting II

Date:
3/8/14

Location:
Operation SPLASH

Attendance:
Approximately 75 people

Summary:
Presented *Living with the Bay*; conducted an open discussion; led breakout tables on each of our four strategies

Interboro Team: Mosh Slabbers / Interboro / Apex / Paul Bout / / Deltares / H+N+S / Paul Van IMG Rebel with Center for Urban Pedagogy, David Rusk, NJIT Infrastructure Planning Program, Project Projects, RFA Investments, TU Delft

Other Outreach Events:

Event:
High School Resiliency Workshop

Date:
3/18/14

Location:
Lynbrook High School

Attendance:
Students from Lynbrook Sustainability Club

Summary:
Presented scaled-down version of *Living with the Bay*; discussed the threats of surge, sea level rise, and stormwater; discussed strategies for combating the threats

Event:
The Storm and the Norm

Date:
3/29/14

Location:
Operation SPLASH

Stakeholder Workshop: “Regional Resiliency: A Dutch Perspective”
2/4/14
Office of Emergency Management, Bethpage

Stakeholder Workshop: “Regional Resiliency: A Dutch Perspective”
2/4/14
Office of Emergency Management, Bethpage

Community Meeting I
2/22/14
Baldwin Senior High School

Interboro Team:
Interboro / Bosch Slabbers
/ Deltares / APS / Palmbout /
IMC / Center for Urban
Project Management
Investment Delft / DHA

Community Meeting I
2/22/14
Baldwin Senior High School

Community Meeting II
3/8/14
Operation SPLASH

Community Meeting II
3/8/14
Operation SPLASH

Interboro Team: Arup, Stantec, Rutgers University / Deltares / Pratt Center / IMG Rebel with Redagogy, David Rush / MIT Infrastructure Planning Program, Project Project Investments, TU Delft

Presentations to/meetings with government agencies

Meeting:
Nassau County Stage 3 Kickoff

Date:
11/21/13

Attendance:
Ken Arnold, Resi Cooper, Michael Martino, Laura Munafo, Shila Shah, Rob Walker

Summary:
Presented Stage 2 plan; outlined hopes for Stage 3; learned about the county's priorities

Meeting:
Nassau County DPW

Date:
11/27/13

Attendance:
Ken Arnold, Sean Sallie, Brian Schneider

Summary:
Received targeted feedback on Stage 2 plan and Stage 3 ideas; learned about current stormwater management practice; discussed feasibility of green infrastructure; discussed whether the area could really be protected against stuge and sea level rise

Meeting:
Army Corps

Date: 1
2/4/13

Attendance:
Lynn Bocamazo, Charlie Chestnut, David Rask

Summary:
Received targeted feedback on Stage 2 plan and Stage 3 ideas; discussed the conflict between our proposed channels and the Corps's dunes

Presentation:
Long Island Regional Planning Council

Date: 1
2/10/13

Location:
Molloy College, East Farmingdale

Attendance:
John Cameron, Cara Longworth

Summary:
Presented Stage 2 plan; received significant feedback from engineer John Cameron, especially on the proposed channels, which Cameron thought wouldn't work; discussed the need for affordable housing and rental housing; discussed the need for evacuation routes; discussed the importance of working with villages and the county

Meeting:
City of Long Beach

Date:
12/10/13

Attendance:
Patricia Bourne, Jim Lacarrubba, Jack Schnirman

Summary:
Learned about the city's priorities, including the redevelopment of the north shore

Meeting:
NY Rising CR

Date:
1/2/14

Attendance:
Laura Munafo, Zachary Richner, Jaime Rubin, lead Nassau-based NY CR planners

Summary:
Presented Stage 2 plan; heard presentation from each of the Nassau-based NY CR planners; discussed potential overlaps and opportunities to work together

Interboro Team: Dutch Slabbers / Deltares / HKS / Palmbout / IMC / Rebel / Arcadis / Urban Pentagogy, Dave Rose / MIT Infrastructure Planning Program, Project Phase RFA Investments, TU Delft

Meeting:
NY Rising CR

Date:
1/15/14

Attendance:
Laura Munafo, Zachary Richner, lead Nassau-based NY CR planners

Summary:
Discussed the selection of priority projects from the process

Presentation:
Long Island Regional Economic Development Council

Date:
1/23/14

Location:
LI Regional Office of Empire State Development, Hauppauge

Attendance:
Bob Brinkman, Marianne Garvin, Gilbert Hanson, Jim Morgo, Christopher Niedt, Rich Rotanz, Brian Scripture

Summary:
Presented Stage 2 plan and Stage 3 progress; received feedback, especially on what is presently our "Green Corridor" strategy; invited to return in March when the project is further along to get official support

Meeting:
City of Long Beach

Date:
1/23/14

Attendance:
Patricia Bourne, Michelle DiBenedetto, Scott Kemins, Jack Schnirman

Summary:
Discussed the city's interest in the land trust; Jack reiterated their interest in RBD doing something big like the bayfront redevelopment; learned that some on Long Beach oppose the outflow pipe

Meeting:
New York Department of Environmental Conservation

Date:
1/28/14

Attendance:

Summary:

Meeting:
Town of Hempstead

Date:
1/28/14

Attendance:

Summary:

Meeting:
Town of Hempstead

Date:
2/11/14

Attendance:
Jim Browne, Ron Masters, Bob, Mike

Summary:
Learned about regulation of the bay and rivers; learned about recent, ongoing, and planned Department of Conservation and Waterways initiatives; discussed possible sites for making more room for the river

Meeting:
Nassau County DPW

Date:
2/12/14

Attendance:
Sean Sallie

Summary:
Discussed the feasibility of doing green infrastructure, traffic calming, and TOD development along the Sunrise Highway corridor

Interboro Team: Arup / Bosch Slabbers / Deltares / H+N+S / Dalmbout / IMG / Rebecca Lewis / Urban Partners / H+M+S / Centers for Urban Progress / David Rusk, NJ Transit / Office of Planning Investments & Development Projects, RFA

Meeting:
Village of Freeport

Date:
2/14/14

Attendance:
Robert Kennedy

Summary:
Presented our Stage 3 ideas, none of which he like very much; he insisted that building a wall or raising homes was the only thing worth doing

Meeting:
NY Rising CR

Date:
2/21/14

Attendance:
Laura Munafo, Zachary Richner, Jaime Rubin

Summary:
Updated state on Stage 3 plan

Meeting:
City of Long Beach

Date:
2/24/14

Attendance:
Patricia Bourne

Summary:
Discussed the importance of working with locals; received feedback on our messaging

Meeting:
Superintendent at Rockville Center DPW

Date:
3/11/14

Attendance:
Harry Weed

Summary:
Discussed "Slow Streams" and "Eco-Edge" strategies

Presentation:
South Shore Estuary Reserve Council

Date:
3/11/14

Location:
Seatuck Environmental Association, Islip

Attendance:
South Shore Estuary Reserve Council

Summary:
Presented *Living with the Bay*; received feedback

Meeting:
Town of Hempstead Department of Conservation and Waterways

Date:
3/11/14

Attendance:
James Browne

Summary:
Discussed "Slow Streams" and "Eco-Edge" strategies

Meeting:
Town of Hempstead Department of Engineering

Date:
3/11/14

Attendance:
Jeffrey Tierney

Summary:
Discussed "Slow Streams" and "Eco-Edge" strategies

Meeting:
Village of Lynbrook Public Works Department

Date:
3/11/14

Attendance:
Phil Healey

Summary:
Discussed "Slow Streams" and "Eco-Edge" strategies

Interboro Team / Apex / Bosch Slabbers / Deltares / H+N+S / Palmbout / IMG Rebel with Center for Urban Pedagogy, David Rusk, MIT Infrastructure Planning Program, Project Projects, RFA Investments, TU Delft

Meeting:
City of Long Beach

Date:
3/18/14

Attendance:
Jack Schnirman, Patti Bourne, Jim Lacarrubba

Summary:
Updated Long Beach on status of the "Smart Barrier" strategy; received official stamp of approval from the city

Presentation:
Long Island Regional Economic Development Council

Date:
3/19/14

Location:
LI Regional Office of Empire State Development, Hauppauge

Attendance:
Long Island Regional Economic Development Council, members of the public

Summary:
Presented Living with the Bay; answered questions; council voted affirmatively to support the plan

Meeting:
Village of East Rockaway, Village of Rockville Centre

Date:
3/20/14

Attendance:
Mayor Francis Lenahan, Mayor Francis Murray, Superintendent Thomas Smith, Harry Weed, Director of Community Development Kathleen Murray, Rob Walker, County Supervisor Ed Mangano

Summary:
Discussed Stage 1 project idea for the "Slow Streams" strategy; meeting resulted in support for the sluice, swale, and retention landscape

Meeting:
Village of Freeport

Date:
3/21/14

Attendance:
Mayor Robert Kennedy, Chris Squeri

Summary:
Discussed Stage 1 project idea for the "Eco-Edge" strategy; debated whether bulkheading would be a better solution; debated appropriateness of housing in the downtown; meeting resulted in a willingness to work together going forward

Interboro Team: Alex Bosin Slabbers / Deltares / THINK / Paul Thout / IMG Research with Center for Urban Pedagogy, David Rush / MIT Infrastructure Planning Program, Project Projects, RFA Investments, TU Delft

Presentations to/meetings with private, nonprofit, and academic institutions

Meeting:
Health and Welfare Council of Long
Island

Date:
12/10/13

Attendance:
Gwen O'Shea

Summary:
Discussed demographics, discrimination, the lack of affordable housing and rentals; discussed health care and the idea of community-based comprehensive service delivery models

Meeting:
Long Island Housing Partnership

Date:
12/12/13

Attendance:
Peter Elkowitz

Summary:
Underlined the need for more affordable housing; discussed land trusts as a solution to the problem of rebuilding haphazardly (and not high enough)

Meeting:
Nature Conservancy

Date:
12/13/13

Attendance:
Carl Lobue, Nicole Maher, Nathan Woiwode

Summary:
Presented Stage 2 plan and Stage 3 ideas; discussed the importance of the outfall pipe, bay accessibility, education, marsh restoration, and other things; discussed the ratables chase as an impediment to withdrawal from the most vulnerable areas

Presentation:
LIVOAD Long Island Long Term Recovery Group
Date:
12/20/14

Location:
NYIT, Central Islip

Attendance:
Approximately 30 people, including representatives from

Summary:
Presented Stage 2 plan; answered questions about the process; received feedback

Meeting:
Arcadis

Date:
12/23/13

Attendance:
Ken Arnold, Peter Glus, Shila Shah, Rob Walker

Summary:
Discussed the possibility of adjusting the plans for the protective levee to accommodate stormwater storage

Meeting:
Mastic Beach Property Owners Association

Date:
12/23/13

Attendance:
Maura Spery

Summary:
Discussed the situation in Mastic Beach: lots of vulnerable homes along the bay, most of the homeowners looking to be bought out so that the land can be used for a park

Interboro Team: Apex / Bosch Slabbers / Deltaes / Palmbout / IMG Rebuild / N+S / Center for Urban Pedagogy, Pratt Center for Urban NJ Infrastructure Bank, Program, Project Planning Investments, TU Delft, RFA

Meeting:
Land Use Ecological Services

Date:
1/14/14

Attendance:
Charles Bowman, Dan Hall, Kelly Risotto

Summary:
Discussed their ongoing inventory of the marsh

Meeting:
Mastic Beach Property Owners Association

Date:
1/14/14

Attendance:
Dave Berg (Cameron Engineering), Tom Isles (Cameron Engineering), Maura Spery

Summary:
Toured Mastic Beach and discussed the possibility of an RBD project that bought out homes along the bay, moved them upland to empty homes, and restored the land to a park

Meeting:
Empire Justice

Date:
1/15/14

Attendance:
Maria Degennaro

Summary:
Learned about Empire's work around foreclosures; discussed incorporating foreclosed homes into our plan, for example by ensuring that foreclosed homes in less vulnerable areas get targeted for assistance

Meeting:
Nature Conservancy

Date:
1/31/14

Attendance:
Stephen Lloyd, Randy Parsons

Summary:
Learned about NC's online mapping service and discussed it as a potential host for MOAT

Meeting:
Baldwin Civic Association

Date:
2/12/14

Attendance:
David Viana

Summary:
Discussed TOD development opportunities in Baldwin and the need for a gentler Sunrise Highway corridor

Meeting:
ERASE Racism

Date:
2/14/14

Attendance:
Elaine Gross, Jennifer Simcovitch

Summary:
Discussed failure of most communities to do an analysis of impediments to fair housing; discussed misuse of Sandy funds; discussed school segregation; Elaine suggested Lynbrook as a good site for TOD

Meeting:
Operation SPLASH

Date:
3/15/14

Attendance:
Devorah Crupar, Jim Rucco, Rob Welter

Summary:
Discussed our Stage 3 plan; toured Meadowbrook corridor

Interboro Team: Mey / Bosch Stichers / Deltares / ARUP / Palmbout / IMG Rebel / Municipality of Urbanedaily, Davenport / MIT Infrastructure Planning Program, Project Projects RFA Investments, TU Delft

Presentation:
Sustainable Long Island

Date:
3/19/14

Location:
Sustainable LI Office, East Farmingdale

Attendance:
Amy Engel and Sustainable LI staff

Summary:
Presented *Living with the Bay*; discussed strategies; received approval and support

Meeting:
Jaral Properties

Date:
3/21/14

Attendance:
Rob Salvatico

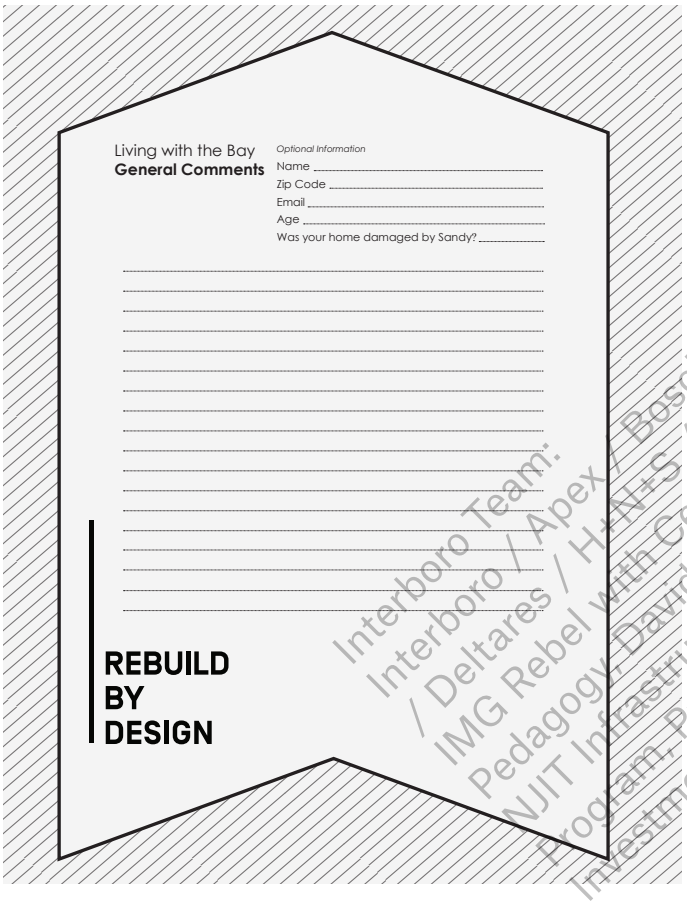
Summary:
Discussed our "Green Corridor" strategy; discussed Freeport Plaza West development and how it could fit into our strategy; received support for working with developers to make the development more sustainable

Meeting:
Interboro Team:
Interboro / Arup / Bosch Slabbers / Deltec / H+N+S / Palmbout / IMG Rebuild with Center for Urban Research / David Rusk, NJ Transit Active Planning Program / Project Projects, RFA Investments / Delft

Interboro Team:
Interboro / Apex / Bosch Slabbers
/ Deltares / H+N+S / Palmbout /
IMG Rebel with Center for Urban
Pedagogy, David Rusk,
NJIT Infrastructure Planning
Program, Project Projects, RFA
Investments, TU Delft

Findings From The Community Meetings

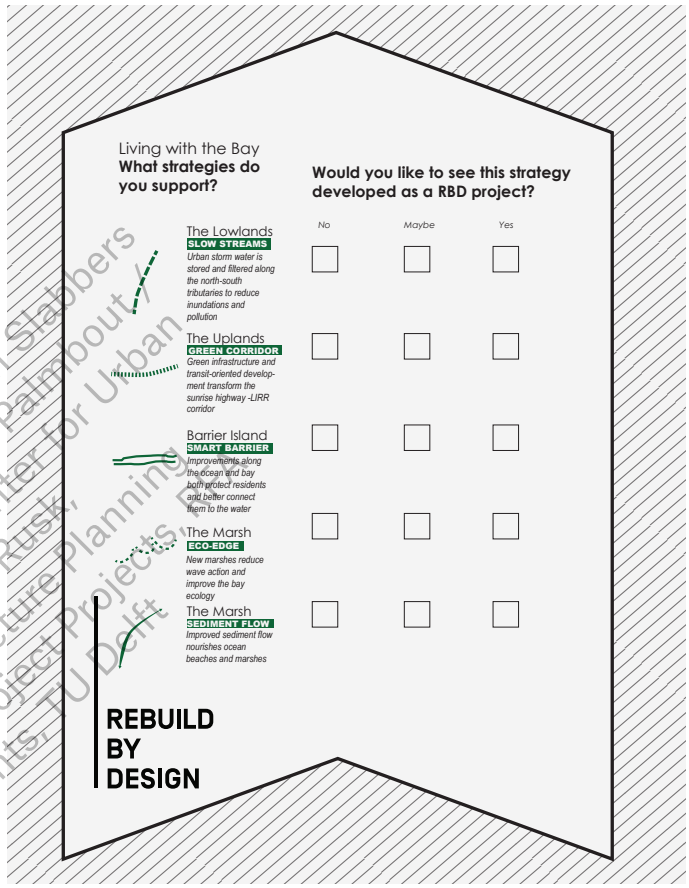
Surveys
For Community Meetings I and II, we distributed the following surveys:


Living with the Bay
General Comments

Optional Information
Name
Zip Code
Email
Age
Was your home damaged by Sandy?

REBUILD BY DESIGN

General Comments


Living with the Bay
What strategies do you support?

Would you like to see this strategy developed as a RBD project?

	No	Maybe	Yes
The Lowlands **SLOW STREAMS** *Urban storm water is stored and filtered along the north-south tributaries to reduce inundations and pollution*	☐	☐	☐
The Uplands **GREEN CORRIDOR** *Green infrastructure and transit-oriented development transform the sunrise highway -LIRR corridor*	☐	☐	☐
Barrier Island **SMART BARRIER** *Improvements along the ocean and bay both protect residents and better connect them to the water*	☐	☐	☐
The Marsh **ECO-EDGE** *New marshes reduce wave action and improve the bay ecology*	☐	☐	☐
The Marsh **SEDIMENT FLOW** *Improved sediment flow nourishes ocean beaches and marshes*	☐	☐	☐

REBUILD BY DESIGN

Survey of Strategies

Interboro Team: Interboro / Apex / Bosch Slabbers / Deltares / H+N+S / Palmbout / IMG Rebel with Center for Urban Pedagogy, David Rusk, NJIT Infrastructure Planning Program, Project Projects, Rotterdam Investments, TU Delft

We received the following comments in the "General Survey:"

1. "I feel that the "Green Corridor" and "Stream" part of the proposal are strong while the "Long Beach" and "flood gate" portions are weak. I feel soft scapes are better design solution than hard scapes regarding storm mitigation. Who would decide when the flood gate would be activated? One side would be dry, while the other would be flooded." (Shawn Nvzzo)

2. "I think the first thing we need to do is strengthen the critical infrastructure. First thing to make storm proof is the electrical and sewage plants. Secondly schools in low flood plain areas should relocate their backup generators and electrical gear rooms to a second flood location. Third thing is to establish a pre-approved local contractor disaster response list before we hire out of state contractors. Fourth make sure the NYS prevailing wage is upheld in the cleanup and recovery process" (Joe Montalbano, zip code 11792, age 52, house not damaged by Sandy).

3. "Assuming we need support of local municipalities and politicians, I'm afraid we may end up with "have's" and "have not's." Example, Long Beach City may fight for its share of projects while the town of Hempstead may not." "Retrofitting existing infrastructure—current check valves of storm drains do not function. Is there better technology to prevent flooding—both nuisance and catastrophic to prevent storm drains from backing up and flooding neighborhoods?" (Grace Zick, zip code 11510, age 52, home damaged by Sandy)

4. "One concern that I have is home owners are beginning to rebuild and raise their homes now, what will the time frame for your project? I wish the two projects (homeowners + your future) were working in tandem" (John & Mariann Howards, zip code 11520, age 55, home damaged by Sandy and Irene).

5. "South Shore needs to be developed as a recreational destination, maximize tourism opportunities, kayaking, fishing and boating." (Christina Flaherts, zip code 11520, age 38, home damaged by Sandy)

6. "We would love to see all of these plans happen. These concepts will help greatly, save millions of dollars in damage and economic impacts" (Rob Weltner, zip code 11520, age 57, home damaged by Sandy).

7. "It is absolutely a great idea to help with the lowlands situation. My block is also flooded when there is heavy rain" (Dolores Decabo, zip code 11793, age 49, home damaged by Sandy and Irene).

8. "What about Freeport's promises for tide gates/check valves on sewer outfalls for preventing local roads from flooding during every heavy rain?" (Louise Mardosq, zip code 11520, age 67)

9. "Awesome designs for smart management! It's about time!! " (Mergey Udell, zip code 11520, age 58, home not damaged by Sandy)

Interboro Team / Beach Sandbox / Deltares / Arup / Rambolt / IMG Rebuild by Design / Parsons Brinckerhoff / Urban Land Institute / Regional Plan Association / Insurance Institute / Dept. of Transportation / Dept. of Health / NYS Dept. of Environmental Conservation / Consultants, RFA

10. “Will these plans actually help reduce the surge of another storm?” (Jerome Mascwell, zip code 11553, age 23, home not damaged by Sandy)

11. “My concern is with how your plans may impact on property owners along the right of way. Do you see a need to use court orders to relocate home owners or local retail to make way for projects?” (Michael Reid, zip code 11566, age 52, home not damaged by Sandy)

12. “I think the rebuilding of marsh land in the bay is a great idea as long as the sand used is from existing channels. “
“I think rising the roads are a great idea. However, the homes on both sides of the street would have to be raised also”
“I do not like the idea of reducing Sunrise Highway to 2 lanes. Merrick Rd. has 2 lanes and is very dangerous!!!” (Hugh Mason, zip code 11710, age 49, home damaged by Sandy)

13. “I live in fear of the storm sewers! Please help.
Can black water tanks be used? Cap storm water drains to bay, place pump with elevated generator sets distributed in flood areas. Pumps can be used to fill black water tanks. Tanks can be placed in parks and water used for lawns/parks etc.
I am an engineer and we do this with all new buildings in NYC. Storm waters are used for toilets etc....” (Geoffrey Tevrts, zip code 11510, age 54, home damaged by Sandy).

14. “Many long term coastal residents do not want to leave their homes and life-style to move to higher ground. Others do not have the finances to do so. Others do not want to leave the good school systems and amenities they currently enjoy.”
“How will we assure the future protection of these residents and their properties?”
“How will we be directly involved in creating and maintaining a secure and safe costal lifestyle?”
“We are rebuilding our home but will not raise their elevations and have to climb 8 to 10 feet of steps in our old age every day. My wife is disabled and cannot do so now.”
“Do we have to leave our home and move to a strange community to avoid another “Sandy” that many not occur in our lifetimes?” (Bob Wahl, zip code 11758, age 66, home damaged by Sandy).

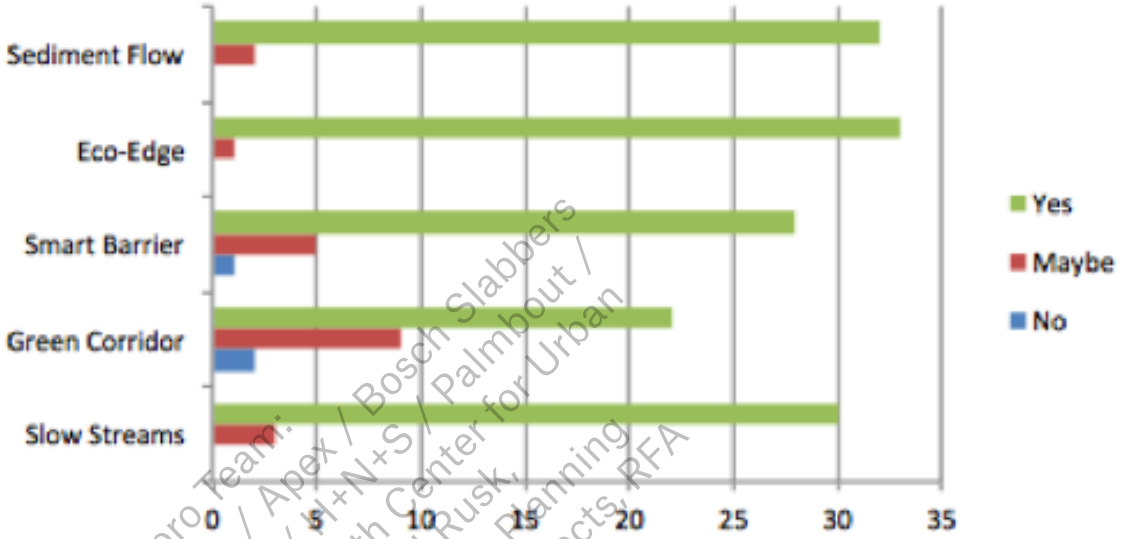
15. “We live in South Merrick, we had about 2 feet water in our house. We rebuilt 1st floor and crawl basement how we can improve safety and structure of our house, can we raise our house?” (John & Barbara Marezl, zip code 11566, ages 62 and 67, home damaged by Sandy).

16. “Cost vs. living, or moving away? To where? .... Next storm when? “ (John Cwrny, zip code 11561, age 62, home damaged by Sandy)

17. “Will there be an EIS? Lead agency?” (Stu Cohen, zip code 11520, age 66, home damaged by Sandy)

Interboro Team:
Interboro / AKF / Dewberry
/ Deltares / HDR / Rabbi Sabbo
IMG Sustainable Center for Coastal
Resilient Land Research
Urban Design Center
Landscape Architecture Planning
Program Projects TU Delft
Research Projects, RFA

The “Survey of Strategies” yielded the following results:



Interboro Team: Interboro / Apex / Bosch Slabbers / Deltares / H+N+S / Palmbout / IMG Rebel with Center for Urban Pedagogy, David Rusk, NJ Infrastructure Planning Program, Project Projects, RFA Investments, TU Delft

In the margins of the “Survey of Strategies,” we received the following comments:

1. “Focus on Dangerous areas, not encouraging people to move into these dangerous areas.” (in regards to Barrier Island)

2. “If we use sand dredged from the bay channels. Not if it is brought in from outside the bay” (in regards to Eco-Edge)

3. “As long as its federally funded” (in regards to Sediment Flow)

4. “I don’t support anything that will prevent my water-front home from seeing the water, raising it is ok, but not blocking the view” (general comment regarding all strategies)

5. “Pedestrian over passes! Keep 3 lanes in both directions” (in regards to the Green Corridor)

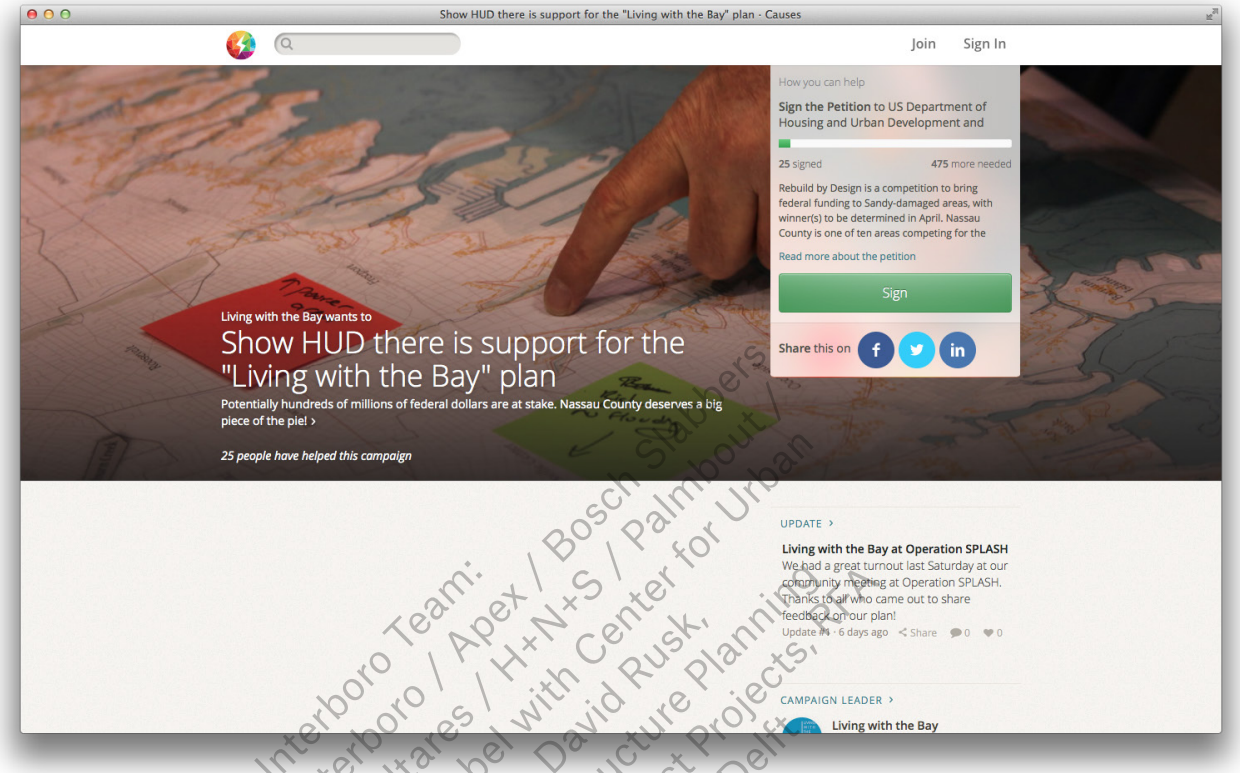
Facebook page

On February 24, we created a *Living with the Bay* Facebook page. The page is used to update our supporters on our progress and to let people know more about the plan and the authors of the plan. We regularly post updates about our events and lectures, have features on the different firms that are part of the Interboro Team, link to articles, and share facts about resiliency issues in Long Island. As of October 3, 2014, the Facebook page has 388 "likes."

Interboro Team: Interboro / Deltares / Apex / Bosch Slabbers / N+S / Palmbout / MG Rebel / Van Center for Urban Pedagogy, David Rusenko / Engineering NJIT Infrastructure Projects, FFA Program, Project Finance Investments TU Delft

Petition

On March 12, we set up a petition on causes.com. The petition asks supporters to “Show HUD there is support for the *Living with the Bay* plan.” The headline reads, “Potentially hundreds of millions of federal dollars are at stake. Nassau County deserves a big piece of the pie!” The petition has information about the plan and a link to an executive summary of the plan. When the petition closed in April, 2014, it had 294 signatures.



Interboro Team: Interboro / Apex / Bosch Slabbers / Deltares / H+N+S / Palmbout / IMG Rebel with Center for Urban Pedagogy, David Rusk, MIT Infrastructure Planning Program, Project Projects, Rotterdam Investments, TU Delft

Ellen Leftoff Lee

presented a terrific plan, hopefully to be implemented in Nassau County. It would provide innovative ways to deal with the problems Nassau County faces as a result of "living with the bay."

Like · Comment · 8 March at 15:16

Sarah Kusnet Weissberg Wiener

Wonderful and informative meeting. More people need to know about this group. You need to raise public awareness and get some publicity going!

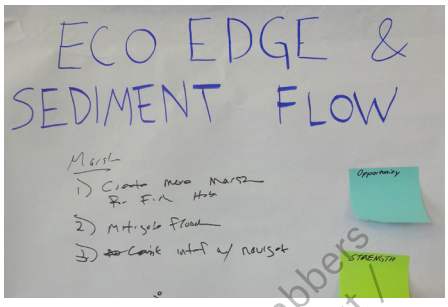
Like · Comment · 8 March at 21:47

Map activities

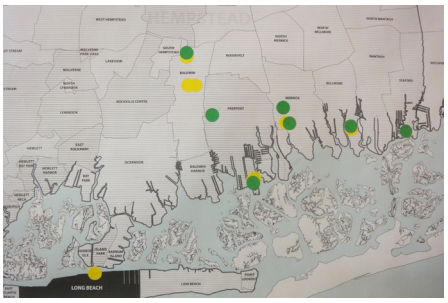
For Community Meetings I and II, in addition to the “General Survey” and “Survey of Strategies,” we asked community members to interact with various maps of Nassau County.

Here are some highlights:

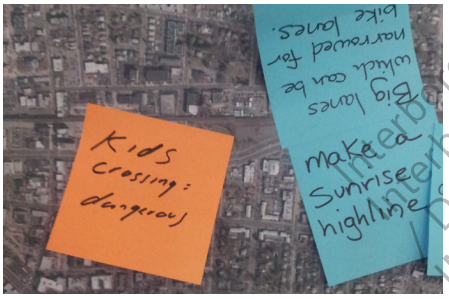
Zoom in on community members age group indicated during the community meeting.



Zoom in on the main points discussed between community members and the team regarding design possibilities and conditions in the bay.

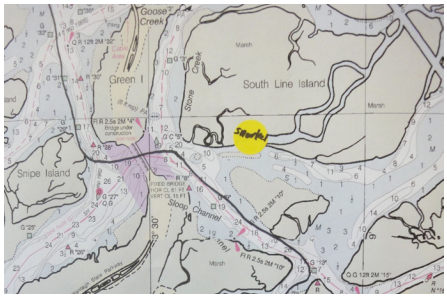


Map showing the different village, towns and cities which make up Nassau County with community members indicating where they live (yellow) vs. where they wish to live (green).



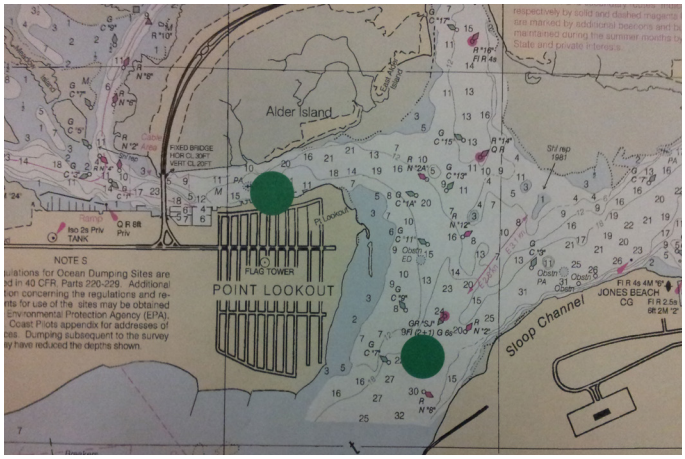
Community members indicating a ‘threat’ condition (orange) condition on sunrise highway.

Working with the team, community members were shown the specific vulnerability of long beach and indicated areas most at risk.



Community members were invited to mark their favorite pass time & locations in the bay.

Historical aerial map of Nassau county bay. Community members were invited to mark up what they like about the bay and where.

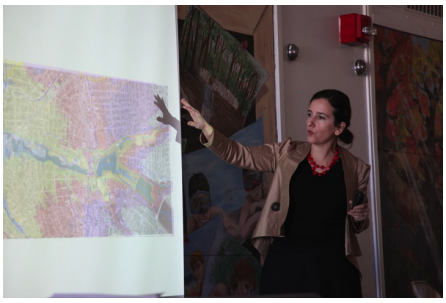


Community members indicated locations in which they enjoy / often use in the bay.

Interbro Team: Interborough Rx / Bosco Stabbers / Delta Beyond / HHLTS / Palm Out / NMCP Resilient Center for Urban Pedagogy / Rush / Planning Program Project / NYU Dept. Investment / RFA

Breakout tables

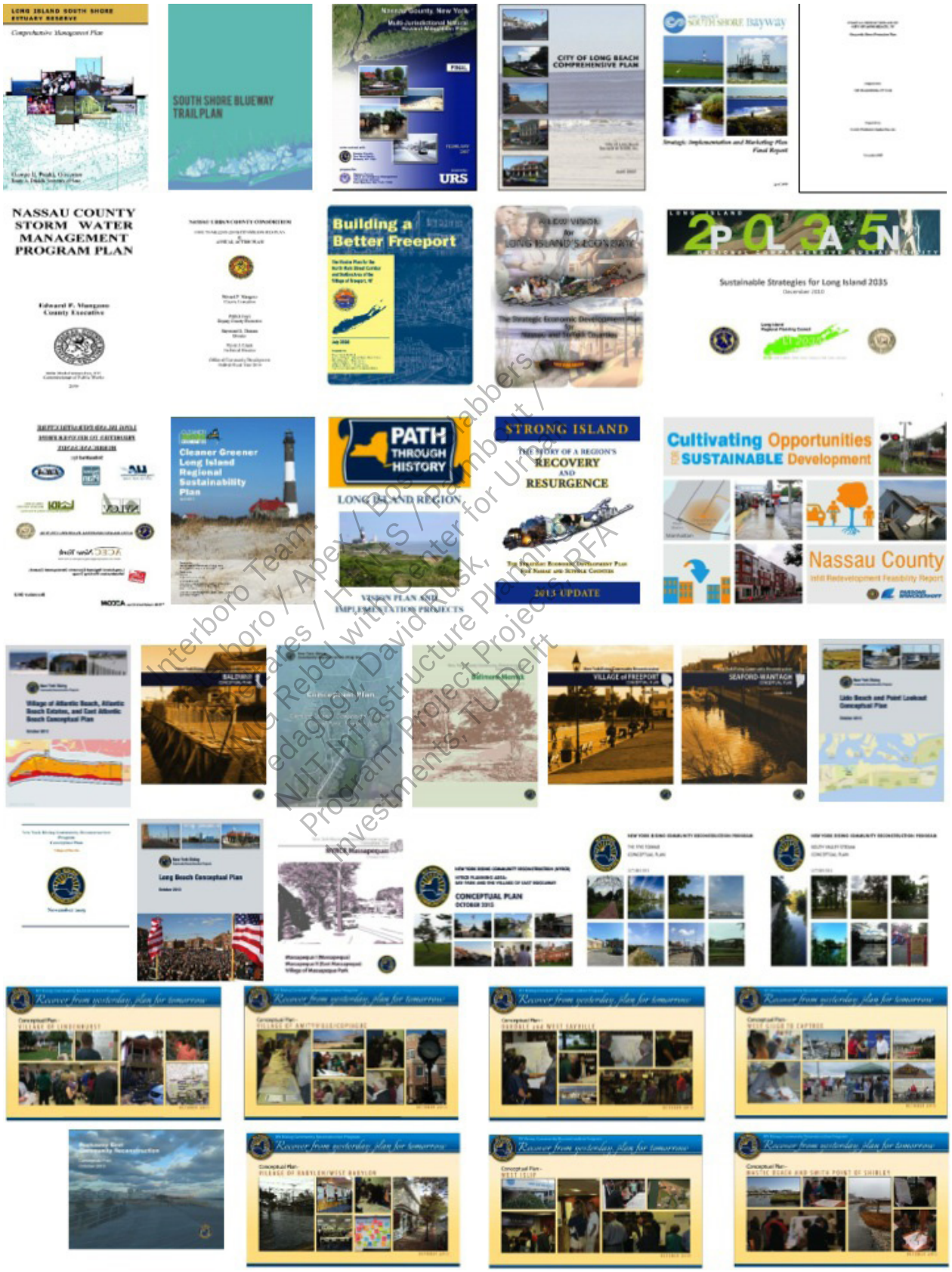
For Community Meetings I and II, we followed our presentation of *Living with the Bay* with breakout tables on each of the four strategies. Highlights from these breakout tables can be found in Chapter 5: The Plan.



Interboro Team:
Interboro / Apex / Bos
/ Deltares / H+N+S / Ma
IMG Rebel / Mass Center for Urban
Pedagogy, David Rusk
NUFFIC, Infrastructure Planning
Program, Project Projects, RFA
Investments, TU Delft

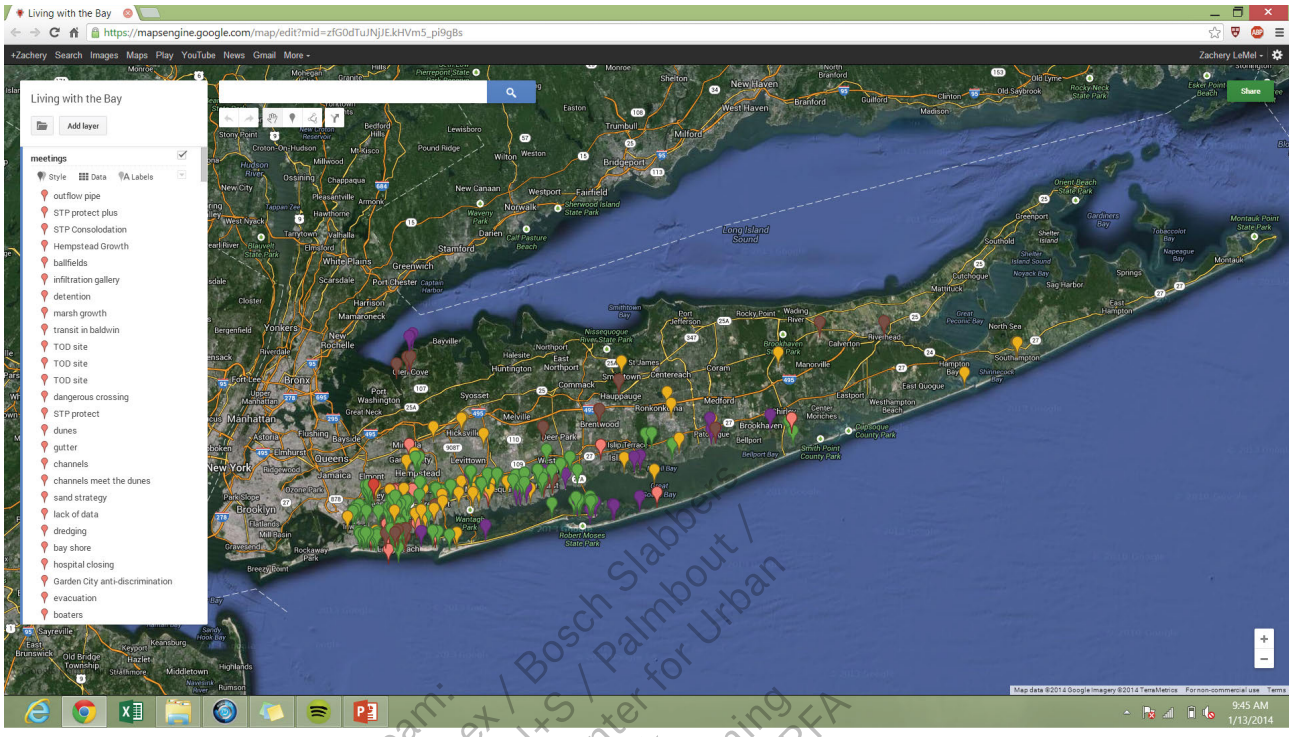
Literature review

As part of our research for *Living with the Bay*, we conducted an exhaustive literature review. We read the following reports and plans (this is not an exhaustive list):



Interboro Team / Apex / Bos / Rabbers / Interboro / Apex / HTS / Pambout / Wes Jones / Rebel with a Pen / Center for Urban Pedagogy, David Dusk, NJIT Infrastructure Planning Program, Project Projects RFA Investments, TU Delft

We worked closely with NY Rising to ensure that our efforts were complementary. One way we did this was by making a map of every NY Rising CR project, including projects that were identified as “priority projects.”



Where the Information Comes From:

- Proposals/strategies listed within CRZ Plans
- Proposals/strategies listed within additional plans (ex. regional plans)
- Anecdotal information taken from community members
- Projects/studies currently under way
- Reports/Studies

Interboro Team: Interboro / Apex / Bosch Slabbers / Dattores / H+N+S / Palmbout / IMG Rental with Center for Urban Pedagogy, David Rusk, NJIT Infrastructure Planning Program, Projects, RFA Investments, TU Delft

Chapter 3: Overall Challenge

Interboro Team:
Interboro / Apex / Bosch Slabbers
/ Deltares / H+N+S / Palmbout /
IMG Rebel with Center for Urban
Pedagogy, David Rusk,
NJIT Infrastructure Planning
Program, Project Projects, RFA
Investments, TU Delft

Interboro Team:
Interboro / Apex / Bosch Slabbers
/ Deltares / H+N+S / Palmbout /
IMG Rebel with Center for Urban
Pedagogy, David Rusk,
NJIT Infrastructure Planning
Program, Project Projects, RFA
Investments, TU Delft

In this chapter we will identify and examine some of Nassau County's vulnerabilities.

Site

Nassau County is one of two counties in Long Island. A suburb of New York City, Long Island is home to over one million people.

Our focus in this plan is Nassau County's South Shore, an area roughly defined by the Atlantic Ocean to the south, the Sunrise Highway to the north, the New York City border to the west, and the Suffolk County border to the east.

Interboro Team:
Interboro / Apex / Bosch Slabove
/ Deltares / H+N+S / Palmbout /
IMG Rebel with Center for Urban
Pedagogy, David Rusk,
NJIT Infrastructure Planning
Program, Project Projects, RFA
Investments, TU Delft

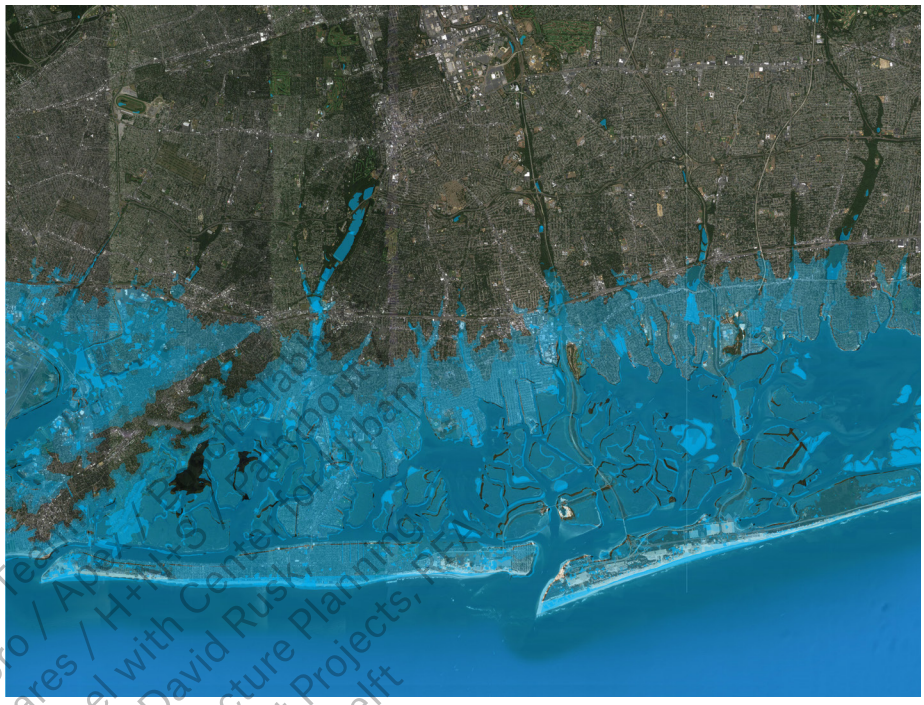
Interboro Team:
Interboro / Dutch Flex / Bosch Slabbers
/ Deltares / H+N+S / Palmbout /
IMG Rebel with Center for Urban
Pedology, David Rusk,
NJIT Infrastructure Planning
Program, Project Projects, RFA
Investments, TU Delft

From north to south, Nassau's South Shore consists of:
—Freshwater Creeks
—Saline Creeks
—Marshes & Mudflats
—Bay
—Barrier island

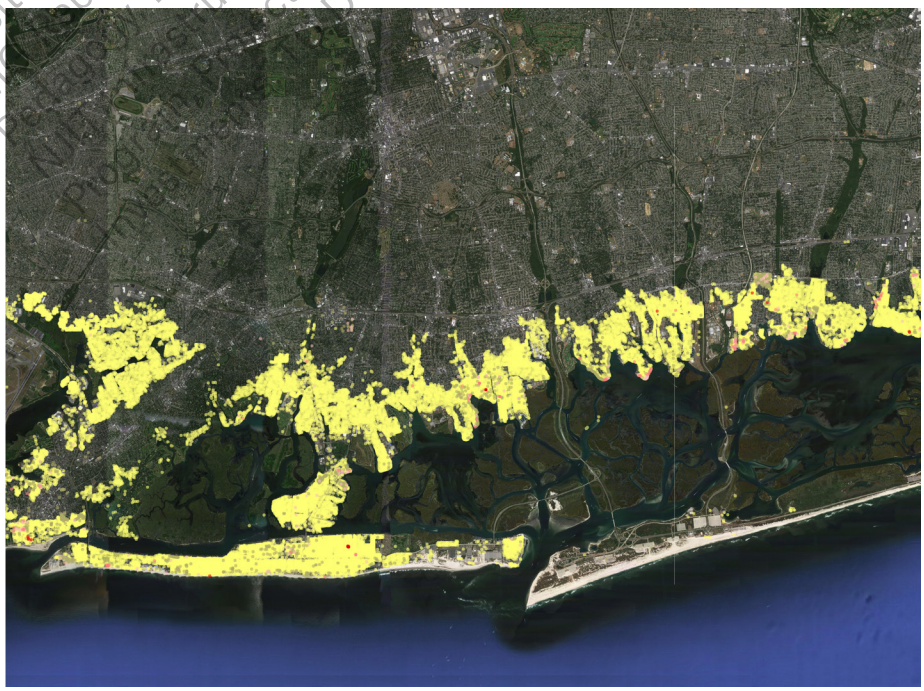
Threats Addressed

Storm Surge

The damage from Sandy was caused primarily by storm surge. In Nassau County, over 35,000 buildings are in the range of a category 1 storm surge.



A total of 113,000 buildings are in the range of a category 2 surge.



The damage fromSandy was caused primarily by storm surge. A total of 74,736 structures in Nassau County were flooded or destroyed by Sandy.

By all indications, the frequency of storms and storm surges will only increase in the future.

Interboro Team
Interboro / Apex / Bitch Slap
/ Deltares / H+N+S / Fairbout
IMG Isbel with Center for Urban
Pedagogy David Rusk,
Program Director Planning
Infrastructure Projects, RPA
Delft

Sea Level Rise

Sea level rise is a Sandy-like storm surge in slow motion—an inexorable, decade-by-decade phenomenon that never creates a sense of immediate crisis. Under normal, everyday circumstances, 3 feet separate the water level and the top of the quay. If even the most moderate sea level rise predictions are accurate, sea levels will rise 2 feet between now and 2100, leaving only 1 foot between the water level and the top of the quay. Less moderate predictions warn of a sea level rise of 6 feet.

6′ Sea Level Rise

Interboro Team / Interboro / Apex / Bosch Slabbers / Deltares / H+N+S / Palmbout Urban / IMG Rebel with Center for Urban Pedagogy, David Rush / NJIT Infrastructure Planning Program, Project Projects, IEA / Investments, TU Delft

Stormwater

Overdevelopment has led to an increase of stormwater runoff into Nassau's rivers and creeks. During heavy rain, the water in these creeks and rivers rises above the level of the outflow pipes, causing major backups at upland storm drains.

Stormwater runoff is also a major source of pollution that directly threatens the quality of the ecological system of the bay.

Wastewater

Presently the Bay Park Sewage Treatment Plant releases its partially treated effluent into the bay, exacerbating nitrogen levels that cause harmful algae blooms, hypoxia, and excessive Ulva seaweed growth and that deteriorate the bay's salt marshes.

Over the past three decades, Long Island's bays have been harmed by pollution from neighboring Suffolk County's septic systems: algal blooms have destroyed thousands of acres of underground grass and contributed to the fall of the local shellfish industry.

Interboro Team
Interboro / Apex /
/ Deltares / H+N+S
IMG Rebel with Center
Peapod by David Rusk,
Infrastructure Planning
Investment Projects, RFA
TU Delft

Spotlight on the Bay Park SewageTreatment Plant

Sewage treatment plants are particularly susceptible to storm surges and coastal flooding because they are typically located near water in low-lying areas—thus allowing sewage to be piped to the plant via gravity and for the discharge of treated sewage into nearby waters. Exposure to contaminated water (through swimming in it, drinking it, or consuming pathogen-carrying fish or shellfish) can result in serious health problems. Furthermore, the depletion of available oxygen and imbalance of nutrients dramatically affect aquatic ecosystems.

The largest spill in New York State took place at the Bay Park Sewage Treatment Plant. Located in East Rockaway, the plant normally serves 550,000 people and treats 40% of Nassau County's waste. After Sandy flooded its pumping and electrical systems, the facility was knocked out of service for at least 42 hours, resulting in approximately 100 million gallons of untreated sewage to be released into Hewlett Bay. During the 44 days it took to fully restore the plant's operations, a total of 2.2 billion gallons of partially treated sewage overflowed into the bay. Some residents complained of wastewater spilling out of their toilets and flooding their homes.

Built in 1949 without an outfall pipe to carry treated water far into the ocean, the plant (even before Sandy) degenerated the surrounding salt marshes that would normally act as a natural barrier against water and wind surges. It has, in addition, left nearby waters too toxic for swimming and nearly destroyed fish and shellfish populations. Occasionally, heavy rains have resulted in sewage leaks. Residents of low-lying areas have for years complained of sewage flooding the streets and even their homes. Others have reported regular spillages of biosolids into areas where people swim, boat, and fish. In 2011, Nassau County was fined $1.5 million for illegally pumping 3.5 million gallons of partially treated sewage into East Rockaway Channel.

Two weeks after the storm, the EPA collected water samples throughout Nassau County and measured concentrations of bacteria and dissolved oxygen. Although fecal coliform levels remained below the EPA's established limits for boating and fishing, swimming was deemed unsafe. EPA spokesperson Elias Rodriguez advised residents to stay away from the waters near the Bay Park plant. The EPA also issued a ban on shellfishing for most of Long Island.

As of January 2014, FEMA had approved $810 million in funds to fix the plant. New York Senator Charles Schumer called it "the largest FEMA project for a sewage treatment plan ever." The repairs will also include upgrades to prevent future storm damage. However, this sum did not fund an extension of the outflow pipe into the Atlantic Ocean, which is an essential component of any resiliency-building initiative.

Conclusion 1: We have to change our flood-risk strategy from evacuation and patching to mitigation and prevention.

Interboro Partnership / Bay Park Sewage Treatment Plant / Deltares / Pathways / Dam Safety / IMCA Report with Coastal Ocean Institute and Rutgers / Pathways to Urban Resilience / Planning Department / Resilient Projects, RFA

Problems Addressed: Resiliency of the Natural System

Ecological quality

The marshes are the ecological and economic engine of the bay area and are a major part of the area's cultural life. The marshes are of great ecological value, harboring a variety of vegetation (from fresh to brackish to saline) and animal species (from river otter to seal). The marshes are a highly productive system—a nursery area for all kinds of fish, clams, mussels, and oysters. Here ecology and economy really go hand in hand. But the marshes are threatened by pollution and the disturbance of the sediment balance.

Sedimentation

Urbanization has led to a smaller bay with less sedimentation and, hence, fewer marshes. This not only threatens the ecological, economic, and spatial quality of the region, but it also affects the safety of the mainland, since those marshlands play an important role in protecting the highly urbanized mainland. We have to find a way to stop the erosion of the plates and let them grow again with the sea level rise.

Water quality

All of Long Island's tap water is pumped from the aquifer. But because groundwater is insufficiently recharged, saltwater intrusion is contaminating the aquifer. Surface water quality is also a problem: water coming down from the region's rivers and creeks is so polluted that it threatens the ecological quality of the bay area. We have to find a way to refill the aquifer system and feed the bay with high-quality fresh water.

Conclusion 2: The nursery of the US northeast coast is under pressure due to sea level rise and urban contamination. We need a more connected and open system.

Interboro Team, Alex Wilson, Stephen Stephens / Deltaic Alliance / Institute for Urban Ecology, Dutch Ministry of Infrastructure and Water Management / IMG Rebuild by Design, Pedagogy, Data, Process, Planning, NJIT Infrastructure Planning Program, Project Phase RFA Investments, TU Delft

Problems Addressed: Accessibility

South Nassau County is a great place to live, but many of the things that make it great are inaccessible to some people.

Lack of apartments and rentals

Long Island has a vast shortage of apartments and rentals. In 2012, the Regional Plan Association reported that 21% of Long Island's households live in rentals. This percentage is substantially lower than neighboring suburban areas such as Western Connecticut (34%) and Northern New Jersey (37%). When Sandy struck, Long Island's rental vacancy rate was just over 4%: neither displaced residents nor relief workers were able to find suitable temporary housing, a point that was very recently made in a *Newsday* headline: "Displaced by Sandy, LI Renters Long for Home." As the Regional Plan Association has pointed out, between 2000 and 2011, about 17 new rental units were built on Long Island for every 1,000 residents, compared with an average of more than 26 for the rest of the region (excluding New York City). The same study showed that Long Island has an average of 1 rental unit available for every 107 households (similar New York–area suburbs have an average of 1 available rental unit for every 42 households).

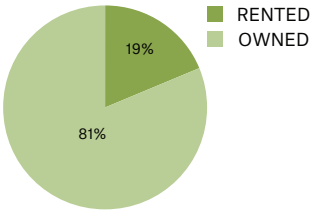
Lack of affordability

Long Island has a vast shortage of affordable housing. Because Long Island's vacancy rate is relatively low, at 4% (an average of 1 rental unit for every 107 households in Nassau and Suffolk Counties), rentals that are available are prohibitively expensive. Such problems originate in the island's nearly 100 town governments, many of which have employed restrictive zoning to prevent expansions in multifamily housing.

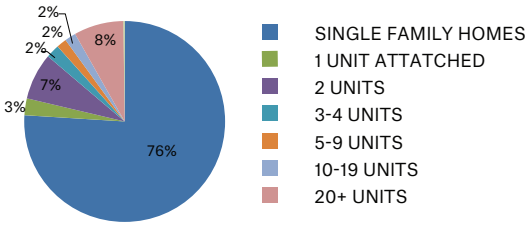
Like much of New York State, housing costs in Nassau County have spiraled upward in the past 30 years. The Nassau County Consortium has identified a series of obstacles to building more affordable housing, including "lack of vacant land; high cost of land; limited availability of funds; limited number of Section 8 certificates and vouchers; local opposition; limited non-profit funding and capacity; and high construction costs."

Interboro Tract / Nassau Stations / Deltec / Rail Yard / IMC Rebuilding / Peninsula / Rail Yard / NJIT / Metropolitan Urban Program, Rockaway Investments / Delta / RFA

RENT VS OWNER OWNED HOUSING



SINGLE FAMILY VS. MUTLIFAMILY



Average home value Nassau County	**$467,500**
Average home value New York State	**$295,300**
Average home value U.S. of A	**$181,400**

Racial segregation

A 2012 study by the Long Island Index found school segregation on Long Island to be double the national average. Within Nassau County, it is triple. While black/white school segregation is the worst, Hispanic/white segregation has been rising since the 1980s. Importantly, segregation mostly exists on the level of school districts. Schools within the same district do not display such stark demographic divisions. Thus, segregation by district boundaries reflects Long Island's segregated neighborhoods.

In the 2010 census, Long Island ranked tenth in the nation for black/white residential segregation and nineteenth for Hispanic/white. Ten years earlier, a study by David Rusk found Long Island to be the nation's most segregated suburb. Another Long Island Index report from 2013 noted that while poverty has increased on Long Island since 2006 and especially since 2009, percentages of students receiving free and reduced lunches have only increased at mid- and high-poverty schools. This implies widening inequality.

Lack of access to public space and natural amenities

Because of overdevelopment and the lack of public access to the region's natural amenities, on the bayside people have a first-class amenity, but farther away people feel less connected with the bay area. We have to find a way to strengthen the connection between the hinterland and the bay area.

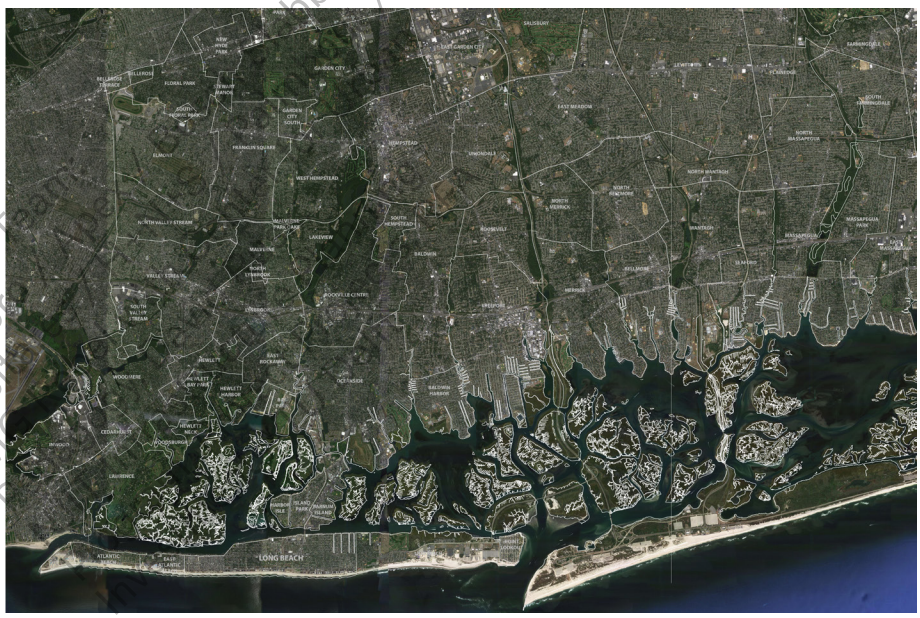
Conclusion 3: We need to increase access to the South Shore's amenities. We need to create more affordable housing options that suit a greater cross section of the population. We need to create more public access to the bay and the rivers and creeks that feed into it.

Interboro Team / Alex Ubbens / Hans Sandberg / Deltares / NJIT / Hans Schoots / IMG Rebel / Michael Stacey / Pedagogy, David Hess / Urban NJIT Infrastructure Planning Program, Project Planning & Investments, TU Delft RFA

Problems Addressed: Governance

Because planning and land use regulation in New York is local, Long Island's many municipalities have the power to effectively chart their own course, often without having to consider the consequences their land use decisions have for neighboring municipalities. As we know, Long Island's municipalities are interdependent and are connected in innumerable ways. Imagine two municipalities located on the same creek: the upland community's decision to zone for big-box retail means more impermeable surfaces. This will generate more stormwater runoff in the creek, resulting in an increased flood hazard for the lowland community. Is this fair? Unfortunately, New York's system of "home rule" creates a barrier to the kind of regional decision making that is required to adequately address regional issues that don't respect municipal lines, even though regional decision making is required to create a built environment that is socially, economically, and environmentally sustainable and just.

Conclusion 4: We need to find ways to work together successfully across municipal lines.



Interboro Team
Interboro / Delta Urbanism / Members
IMC / Delta Urbanism

Chapter 4: Regional Perspectives and Hydraulic Model

Interboro Team:
Interboro / Apex / Bosch Slabbers
/ Deltares / H+N+S / Palmbout /
IMG Rebel with Center for Urban
Pedagogy, David Rusk,
NJIT Infrastructure Planning
Program, Project Projects, RFA
Investments, TU Delft

Interboro Team:
Interboro / Apex / Bosch Slabbers
/ Deltares / H+N+S / Palmbout /
IMG Rebel with Center for Urban
Pedagogy, David Rusk,
NJIT Infrastructure Planning
Program, Project Projects, RFA
Investments, TU Delft

Hydrodynamic Modeling

In this chapter we describe four possible strategies to minimize hurricane and storm impacts on the southern Long Island and Nassau County shores. The strategies are based on simulations run with Deltares hydrodynamic models of northeastern United States and the New York coast. We describe the model set up, the scenarios we investigated, the results, and our four strategies for storm impact reduction.

To evaluate the effects of various measures on water levels and flooding duration in the bay areas in southern Nassau County, we set up a dedicated set of computer models.

First, a large-scale model (Figure 1) encompassing the area from Nova Scotia to Virginia was set up using Deltares' Delft3D software.

The model can compute tides, surge, waves, and currents and is driven by deterministic tides from the Topex-Poseidon database and local wind and pressure fields (NOAA's NCEP-NAM reanalysis winds). This model is rather coarse and is used to compute boundary conditions to drive a smaller-scale but higher-resolution area model that is "nested" in the larger model.

Interboro Team:
Interboro / Apex / Bosch Slabon /
/ Deltares / H+N+S / Palmbout /
IMG Rebel with Center for Urban
Pedagogy, David Rusk,
NJIT Infrastructure Planning
Program, Project Projects, RFA
Investments, TU Delft

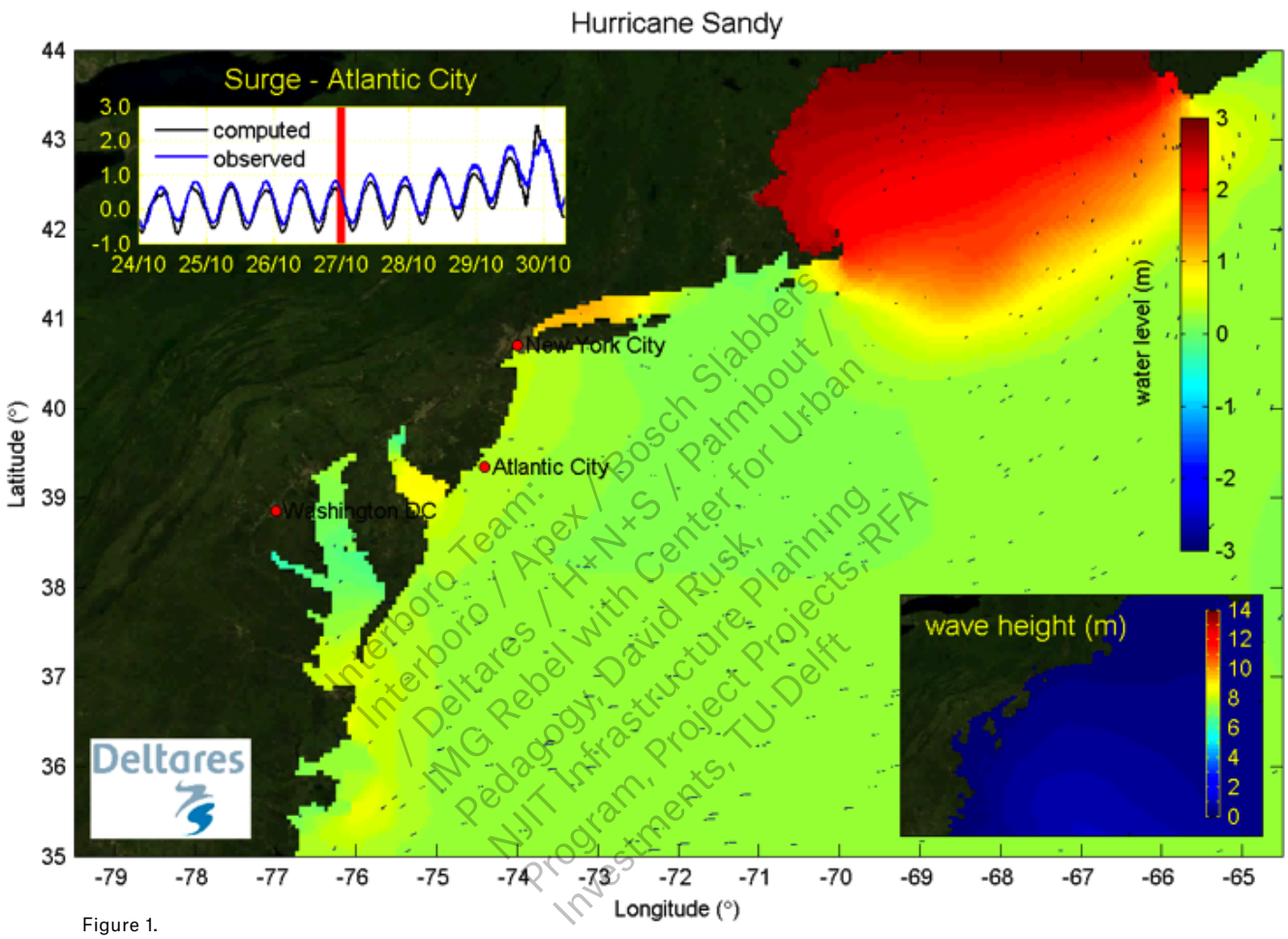


Figure 1.

Figure 1: Outline of Delft3D model for the northeastern United States. The colors indicate the water level (tide and surge; in meters) at a moment well before the impact of Sandy. The top panel shows the observed (blue) versus the computed (black) water level (in meters) at Atlantic City, as well as the instant when this snapshot was taken (vertical line). The bottom panel shows the wave height (in meters) at this instant.

This higher-resolution model, which encompasses the New York area including Long Island (Figure 2), uses Deltares' Delft3D Flexible Mesh software. It is able to accurately represent complex river, estuarine, and coastal systems, such as the New York and Nassau County shorelines and bays. It does not take into account the effect of waves; it only considers tides and the effect of wind on the water level (i.e., the surge).

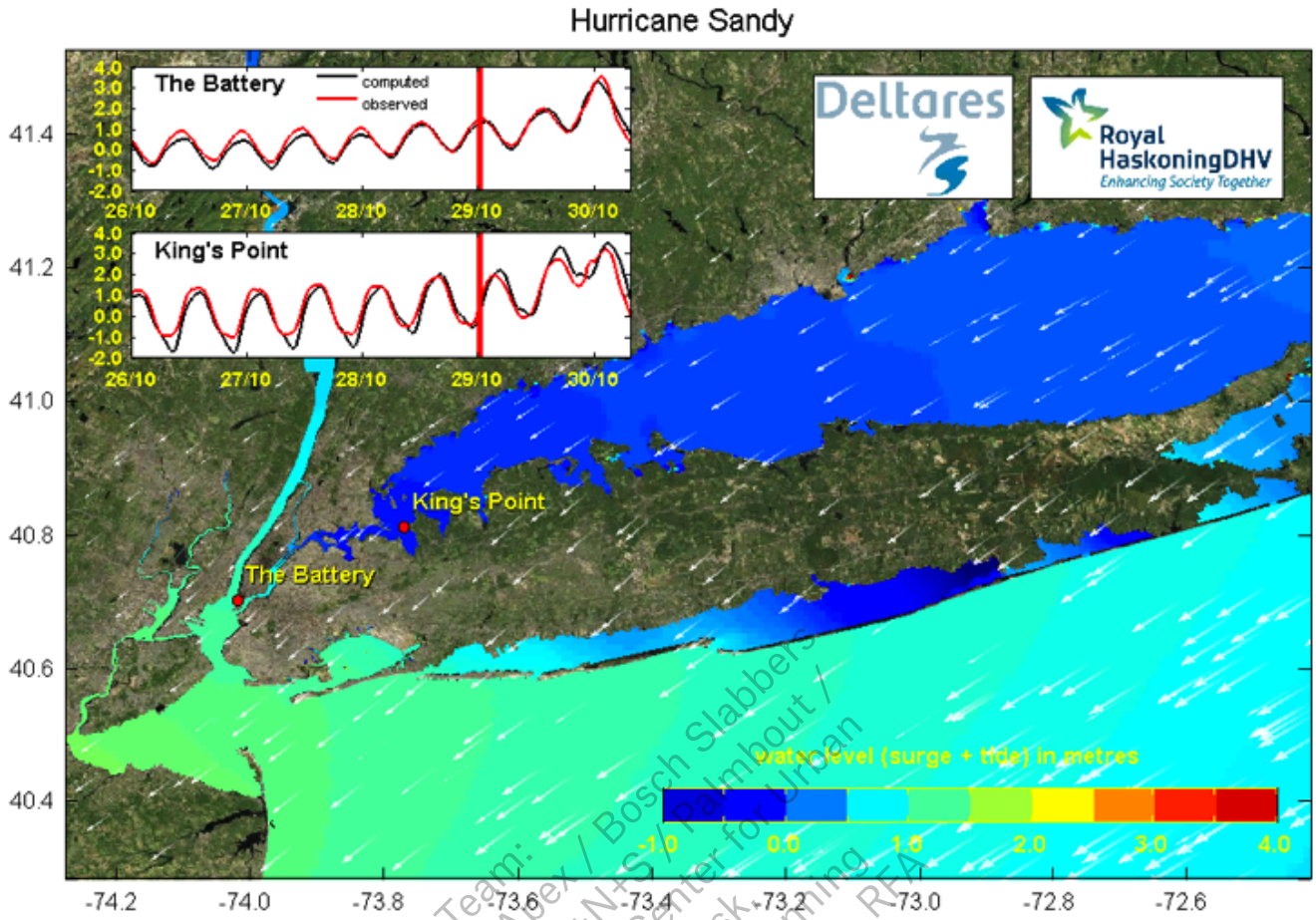


Figure 2.

Interboro Team: Interboro / Apex / Bosch Slabbers / Deltares / H+N+S / Palmhout / IMG / Rotterdam with Center for Urban Resilience and Sustainability, David Rusk, Urban Planning Investments, TU Delft Pilot Projects, REA

Figure 2: Snapshot of the Delft3D Flexible Mesh model of New York showing the surface elevation (tide and surge) and the wind vectors an instant before the landfall of Sandy. The top plots indicate the observed water level (red) and computed water level (black) at two observation stations at the Battery in Manhattan and King's Point in Long Island (location indicated in main plot).

The grid resolution used in this model is about 1 km, with local refinements on some locations down to about 50 m. For the area of interest (Nassau County bays), the grid was locally fined up to a resolution of about 100 m (Figure 3). The model requires a bathymetric data set that was mainly taken from the NGDC Coastal Relief Model. For the Nassau bays, we made use of a recent digital elevation model based on Lidar measurements by the USGS. Since this dataset only provides accurate information for locations above MSL and the NGDC CRM does not have sufficient resolution in space, the channels and gullies within the bays were adjusted by hand based on nautical charts.

Local wind fields (wind speed, direction, and atmospheric pressure) to drive the surge were obtained from the NCEP-NAM model, a large-scale meteorological model set up for North America that is operated by NOAA. The water levels at the model boundaries were computed using the large-scale model described above.

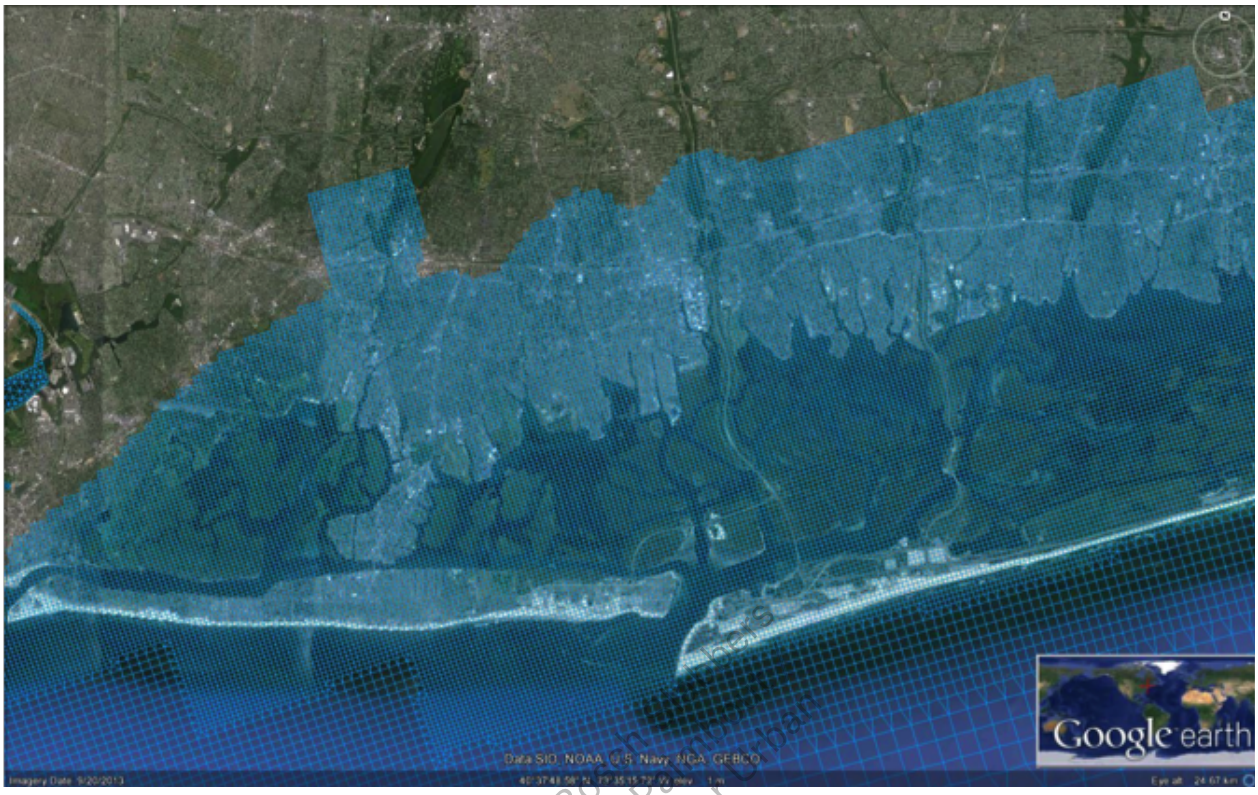


Figure 3. Zoom on (refined) model grid for area of interest.

Interboro Team / Interboro / Apex / Bolton / Deltares / H+N+S / Parsons / IMG Rodgers / Pennoni / Pedaliogy, David Rusk, Dept. of Infrastructure Planning Program, Project Investments, TU Delft / Projects, RFA

Model scenarios and results

The model was used to run four scenarios:

Scenario 0: Reference scenario. This scenario uses the existing bathymetry and topography and the Sandy wind field—in other words, it is a rerun of Sandy. We verified that the model accurately reproduces the observed water levels at the Battery and King's Point NOAA water level stations (see Figure 2). The model captures the surge history at these stations well, giving confidence that it can be applied in this case. A qualitative comparison of the computed surge with the measured surge on a USGS station within the bay (USGS station at Freeport, NY) confirmed this.

Scenario 1: The edges of the marshes are artificially raised until they are 12 feet above MSL.

Scenario 2: The tidal inlets between the barrier islands are closed off by a storm surge barrier system (with a height of MSL + 18 feet).

Scenario 3: Two of the current causeways crossing the Nassau bays are closed down using a storm surge barrier (with a height of MSL + 17 feet). In the model, this was represented by cross dams along Meadowbrook State Parkway, Loop Parkway, and Robert Moses Causeway.

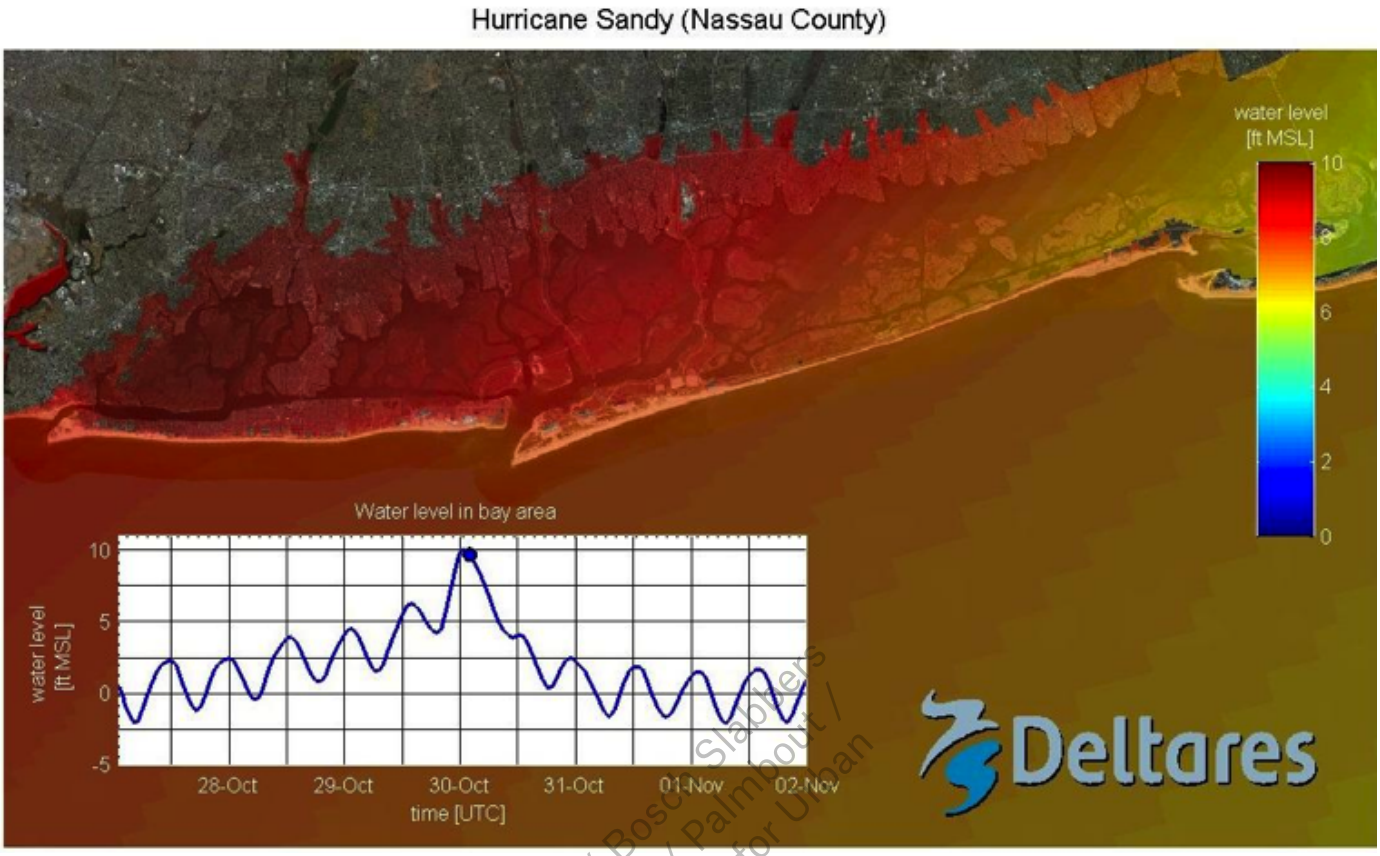


Figure 4. Maximum water level during Sandy computed by the model for the reference situation (without measures).

Interboro Team: Interboro / Apex / Boscolo Slabbers / Deltares / H+N+S / Palmbout / IMG Rotterdam / Center for Urban Pedagogy / David Rusk, Infrastructure Planning Department, Projects, RFA Investments / TU Delft

In Figures 4 through 6, some results for the reference scenario are shown. Figure 4 makes clear that the dominant easterly wind during Sandy resulted in relatively steep water level gradients, which in turn resulted in a large water level setup or surge in the western part of the Nassau bays. Locally, the computed water levels reach values of over 10 feet above MSL, which is in line with the surge found in the USGS measurement mentioned above. The main reason for this high surge was that the Nassau bays form an almost closed system where the water was pushed to the west but could not flow out of the bays (via the tidal inlets) rapidly enough. In Figure 5, a zoom on the area is shown with a more detailed color scale indicating that for the area of interest the maximum water level varies spatially from about 9 to 10.5 feet above MSL.

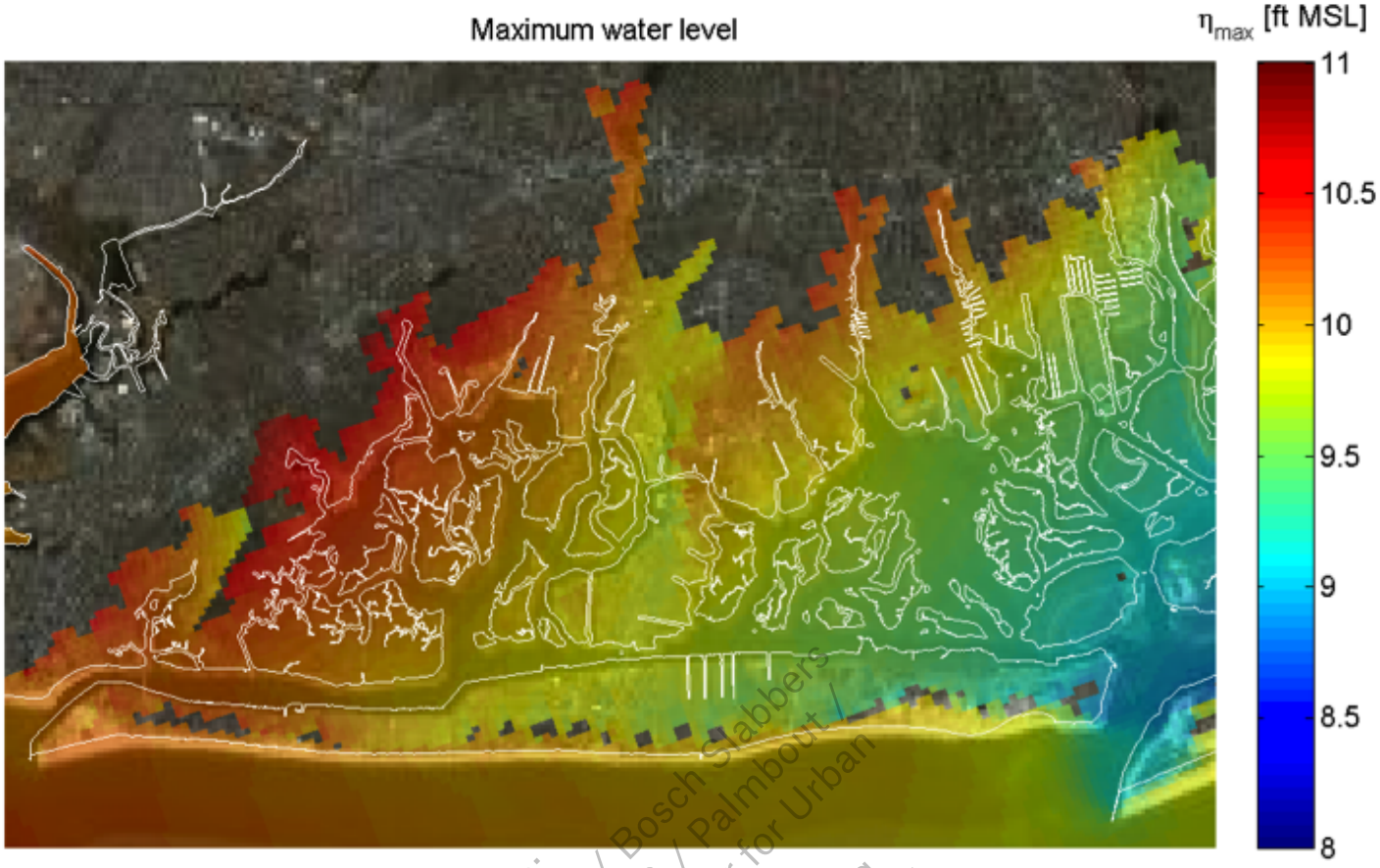


Figure 5. Maximum computed water level during Sandy (zoom on area of interest; I)

Interboro Team: Interboro / Apex / Bosch Slabbers / Deltares / H+N+S / Palmbout / IMG Rotterdam / David Rusk, Paradigm / with Center for Urban Infrastructure Planning / Urban Investments / Delft Projects, RFA

In addition to the maximum water level reached during Sandy, the duration of the flood is shown. The proposed measures ideally should not only lower the water level (and thereby reduce the flooding area) but also reduce the flood duration. Figure 6 shows the total duration that the water depth exceeded 1 foot, as computed by the model for the reference situation. For the areas with buildings and other developments, the flood duration ranged from a few hours to more than 15 hours. The tidal bays, which are always inundated, are in dark colors.

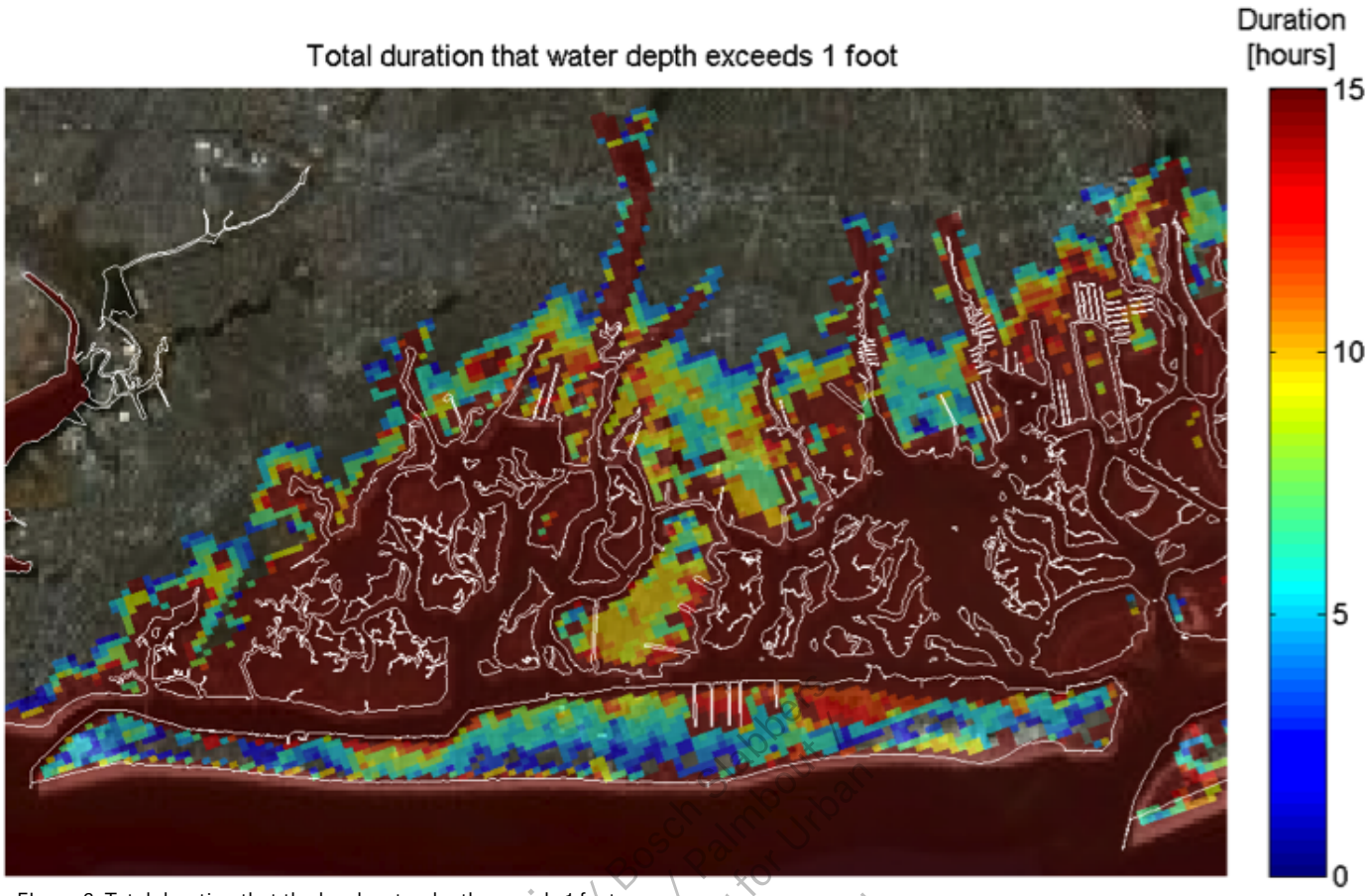


FIgure 6. Total duration that the local water depth exceeds 1 foot.

Interboro Team / Interboro / Apex / Bosch / Palmbout / Deltares / H+N+S / Palmbout / IMC Worldwide with Center for Urban Resilience / David Rusk, Institute for Urban Infrastructure Planning / Stantec / Projects, RFA / TU Delft

In the following figures, we assess the effect of three potential measures (see scenario description). Figure 7 shows the maximum water level for all four scenarios (note that the color scale differs from Figure 4). For all three investigated measures, a clear effect can be seen.

The marsh developments (top right) lead to a local reduction of the surge directly landwards of the marshes (bluish spots on the northern parts of the Nassau bays). The closeable inlets (bottom left) lead to a situation that is worse than the reference situation; the maximum water levels in the western part of the bays become higher. This is because the water is being pushed westward by the wind and has no way to flow out of the bay into the ocean. The “valve” function of the inlet is shut down. In the reference situation, at least part of the water could still flow out via the inlets. Note that this is only valid with dominantly easterly winds, which were present during Sandy. When southerly winds, for example, are dominant, closeable inlets will likely lead to a much more favorable situation. Still, in a hurricane event with winds circulating counterclockwise around the hurricane eye, the winds will be predominantly strong from the east in Nassau County when a landfall occurs to the west and south of the area of interest.

The closeable cross dams (bottom right) ensure that the Nassau bays area becomes comparted during a high water event and therefore the water level in a singular compartment can be kept relatively low. In this case, the model shows much lower water levels for the entire Nassau bays area.

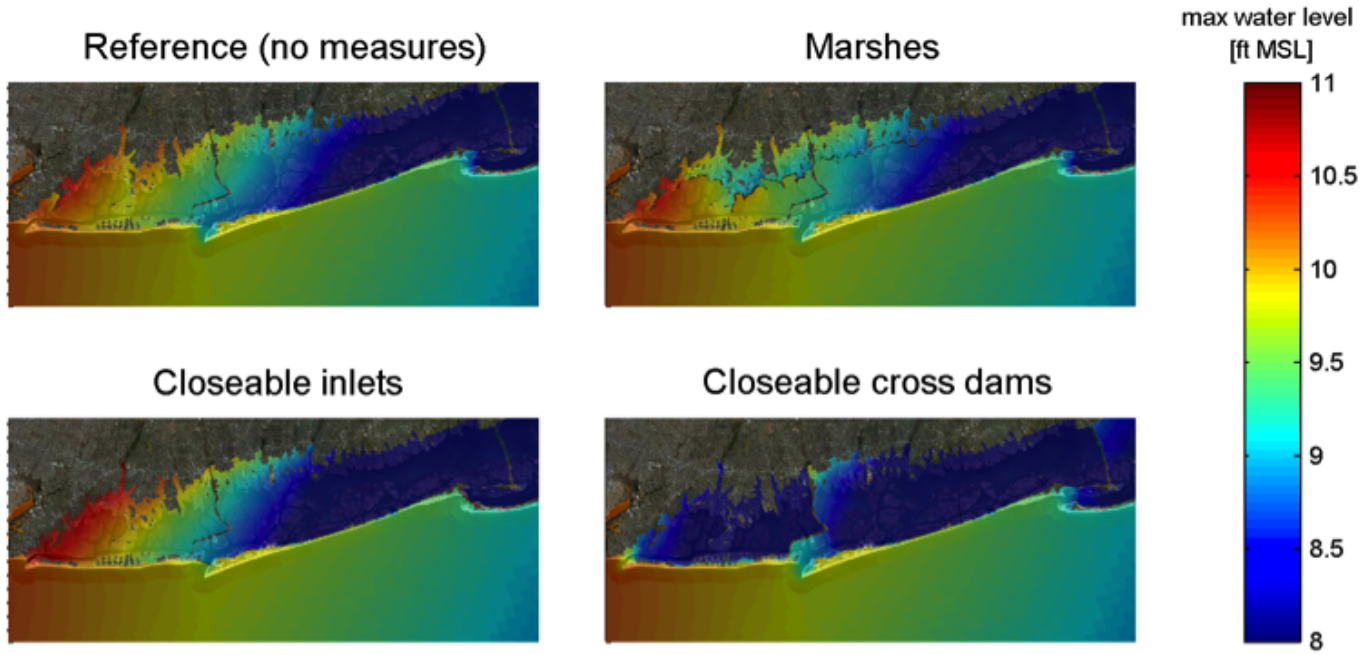


Figure 7. Maximum computed water levels for all four scenarios: Scenario 0 (reference case, top left), Scenario 1 (marsh development, top right), Scenario 2 (closeable inlets, bottom left) and Scenario 3 (closeable cross dams, bottom right).

Interboro Team: Interboro / Apex / Bosch Slabbers / Deltares / H+N+S / Palmbout / IMG Rebel with Center for Urban Pedagogy, Housing Urban Planning, NIIT Infrastructure Projects, KA Program, Project Investments, TU Delft

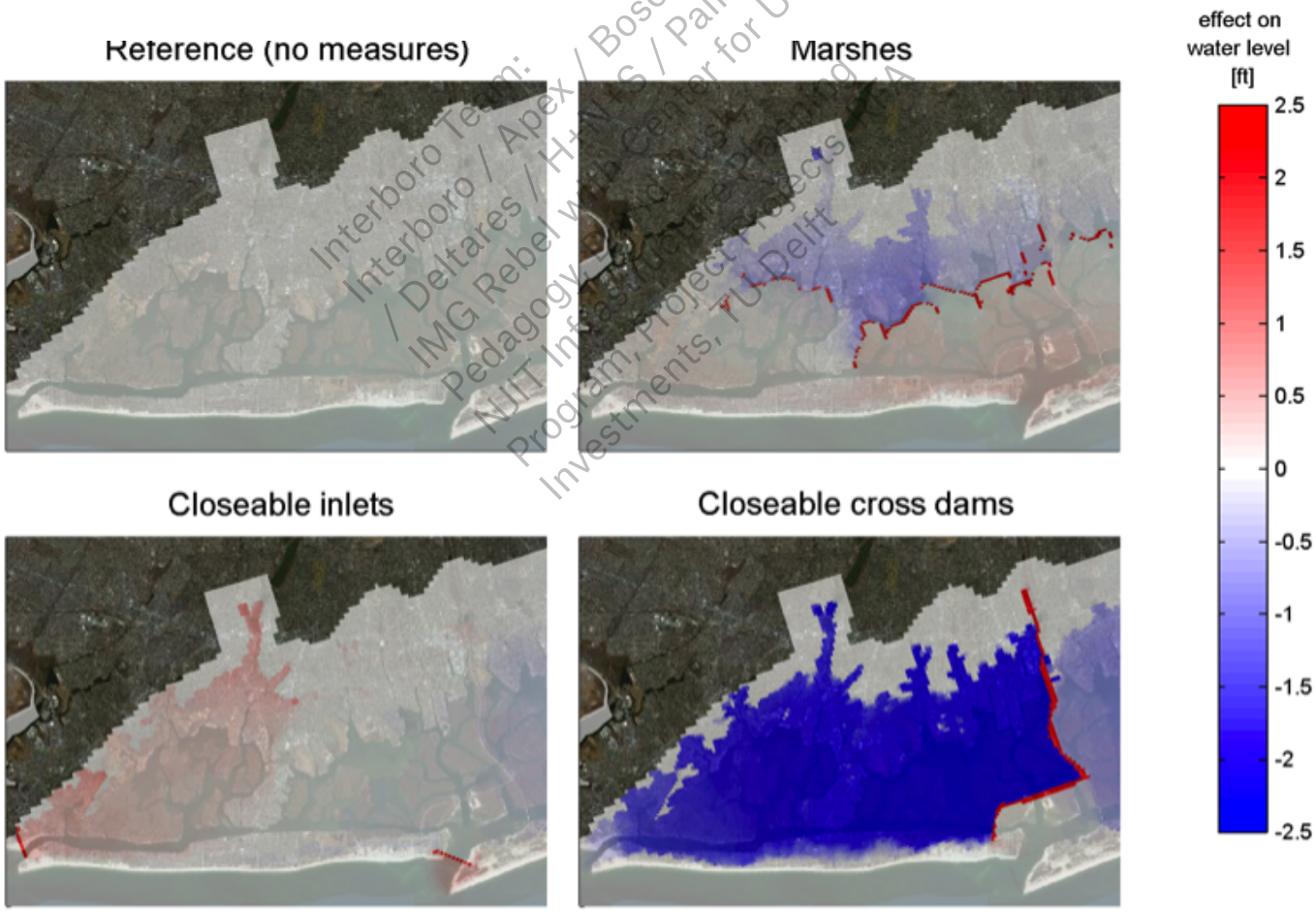


Figure 8. Effect on the maximum water level for each scenario. The panels indicated the difference of the computed water level for a particular scenario relative to the reference (blue is a lower water level)

Figure 8 shows the effect on the maximum water level for each scenario. The panels illustrate the difference between the computed water level for a particular scenario relative to the reference (blue is a lower water level). The figure confirms the observations from Figure 7 and shows the amount of actual increase or reduction in maximum water level. For the marsh development, the reduction in water level is mainly found locally (directly landwards of the marshes) and is about 1 foot. For the cross dams, the reduction reaches values of up to 3 feet, while the inlets increase the maximum water level by about 0.5 foot, mainly in the most western part of the bays.

For the duration (Figure 9) it can be seen that the marshes (top right) have some local effect in that the computed flood duration significantly increases in some locations and decreases in others. Since the effects seem to be very local, it is difficult to be conclusive about this. In general it can be expected that the effect will be minimal because water will always be able to flow back around the higher parts of the marshes. For the cross dams the overall flood duration decreases somewhat, whereas the closed inlets increase the flood duration significantly. The latter has to do with the water being unable to flow back through the ocean when the inlets are closed. When the inlets are operated in such a way that they can be opened after the peak of the storm, it is expected that the flood duration will decrease significantly.

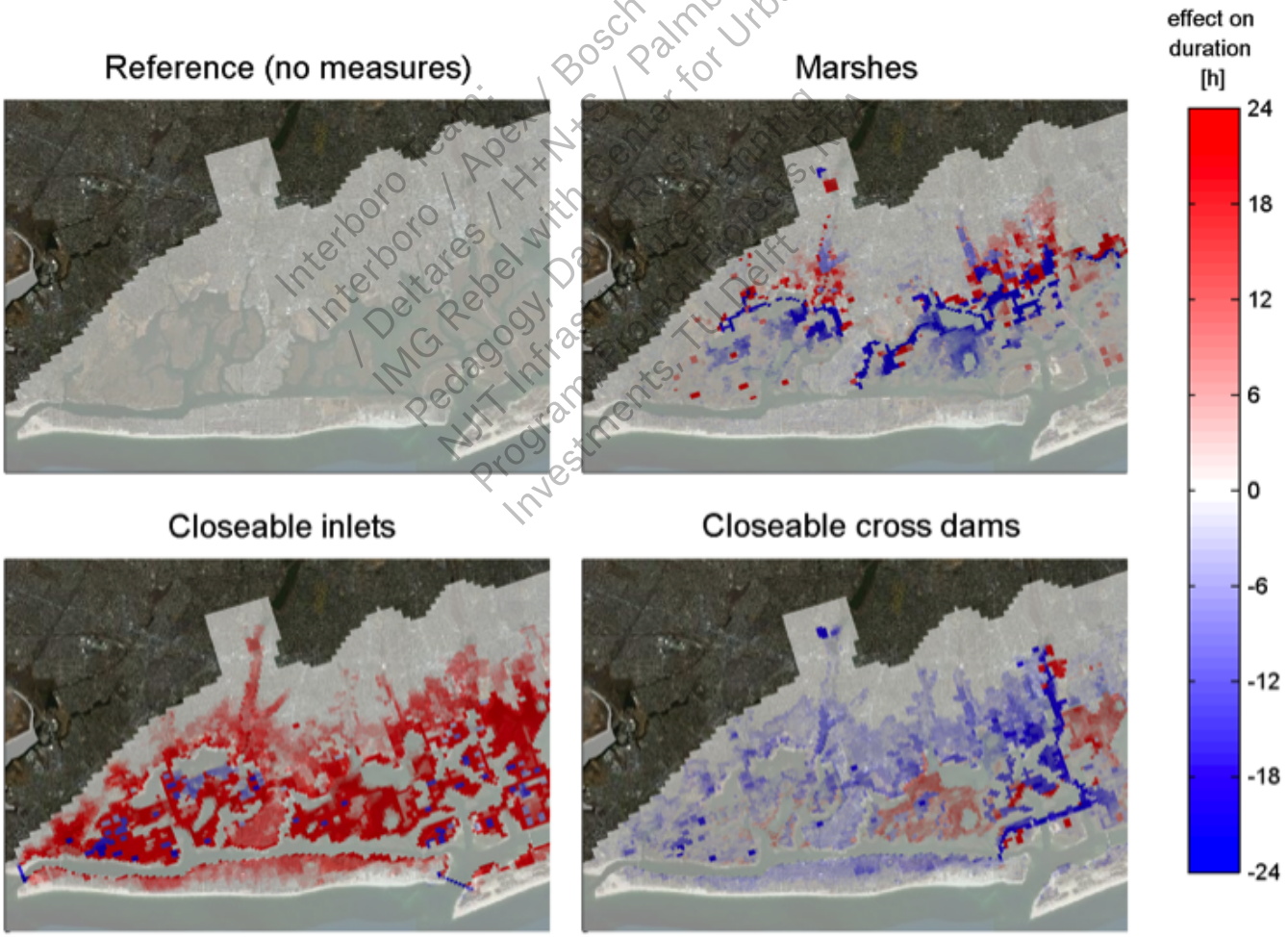


Figure 9. Effect on the flood duration (h >1 foot) for each scenario. The panels indicated the difference of the computed duration for a particular scenario relative to the reference (blue indicates a reduction of the duration.

In short, these results suggest that for increasing coastal safety, (temporarily) closing down the causeways (and thereby creating cross dams) has the best potential. The water level in the compartments that are formed by these closures can be better controlled, leading to a significant reduction of water level. Raising part of the marshes results in a more local effect in which the water can still flow around the marshes but in which a reduction of about 1 foot in maximum water level can be expected directly landwards. Closing the inlets will trap the water even more (water is pushed westward and cannot go anywhere but up) and will lead to higher maximum water levels and longer flood durations.

Note that waves are not included in these simulations. It is expected that the effect of the closeable inlets and cross dams will be negligible with respect to wave impact. For the marsh developments, a decrease in wave impact is expected mainly depending on the height of the marsh with respect to the occurring water level and the distance between the marshes and the shore. By strategically placing the marshlands, we expect that wave impact reductions of about 50% can be achieved.

Interboro Team:
Interboro / Apex / Bosch Slabbers / Deltares / H+N+S / Palmbout / IMG Rebel with Center for Urban Pedagogy, David Rusk, NJIT Infrastructure Planning Program, Project Projects, RFA Investments, TU Delft

Three perspectives for Long Island

In this chapter, we present three main perspectives for the Long Island area and show which perspective is most feasible based on the simulations run with the Deltares hydrodynamic models of the northeastern United States and New York coast and the impacts on daily quality.

For the feasible perspective "the buffered bay," we describe the four strategies that minimize hurricane and storm impacts on the southern Long Island and Nassau County shores. The strategies were developed based on the results of simulations run with the Deltares hydrodynamic models of the northeastern United States and New York coast. First we describe the three main perspectives and the preferred perspective based on the model results, and then we describe the model set up and how the perspectives were implemented in the model and the results. To conclude, we provide some insights on further research and input for the Long Island and Nassau County Strategies.

If we look at the Long Island south shore, we can define two extreme perspectives on water safety for the long term. The first is to keep an open bay with individual protection at the water's edge. This results in a defend-only strategy, reduces the bay quality, affects vulnerable populations who can't afford to move or strengthen their homes, and results in high costs. The effect of superstorm Sandy on the area shows that this strategy is not stormproof and that the long-term resiliency of the area is not ensured with individual measures just at the water's edge. (See Figure 10 of the Deltares model, which clearly shows the impacted areas and the high surge levels in the bay.)

The other extreme perspective is the closed bay. This seems like a feasible solution for increasing the water safety, but closing off the bay completely has negative impacts on the water quality of the bay. The results from the model show that closing the inlet might do more harm than good. Figures 13 and 14 show that the surge impact in the west of the bay would become even higher, as the water in the bay would not be able to flow out through the inlets. the bay will become even higher as the water of the bay can not flow out through the inlets.

Interboro Team / Interboro / Deltares / IMG Rebuild by Design / TU Delft / Arcadis / Rapidscan / Boom Shaper / Rebuilding Strategies for Urban Ecologies / Infrastructure Planning / Investments / Delft / RFA

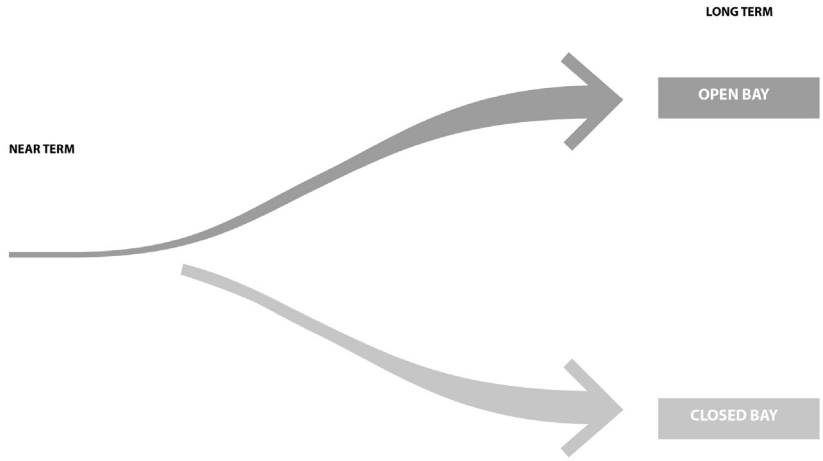
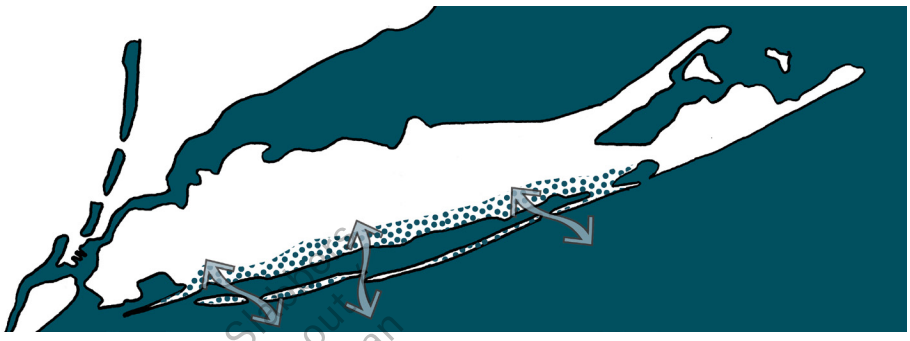
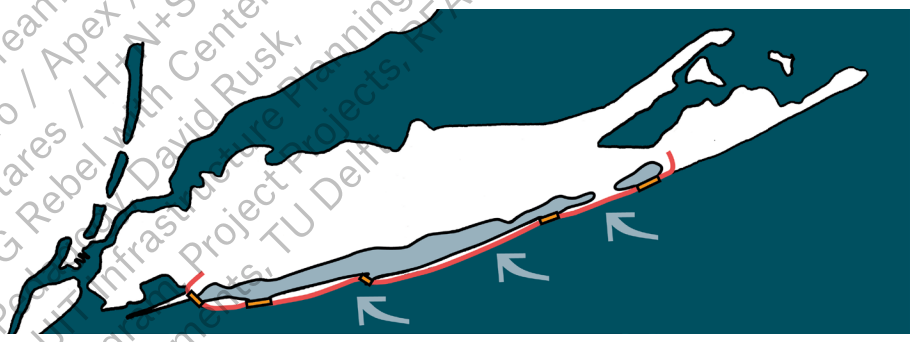


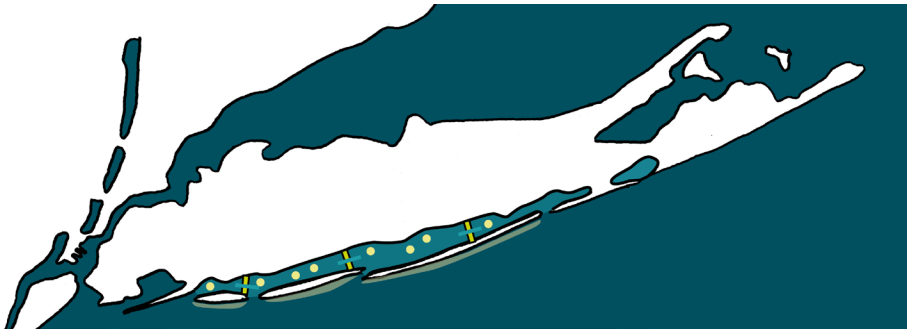
Figure 1. Two extreme long term water safety perspectives; either keep an Open Bay with individual protection at the water edge or an Open Bay which implies a large scale collective measure as the inlets will be closed to protect the mainland.



When the bay is kept open, the water can flow in freely through the inlets and the impact of a storm is only mitigated by local measures.



By closing the inlets and creating a high dune or levee at the ocean side of the barrier islands, the bay is closed off from the ocean. The bay will become a freshwater bay and will not grow along with sea level, and storm impact will be surge from the freshwater body itself.



The buffered bay works with the natural system to reduce storm impact but maintain a healthy and pleasant bay environment. By adding sediment at the oceanfront, water safety increases and both the bay and barriers can grow with sea level rise. The compartment dams (yellow dams) allow us to create smaller waterbodies during a storm, which reduces the surge impact, while the marshes (yellow circles) mitigate the wave run up and impact on the marsh communities.

Interboro Team:
Interboro / Apex / Bosch Slabbers
/ Deltares / H+N+S / Palmbout
IMG Rebel with Center for Urban
Policy / David Rusk,
NJ Infrastructure Planning
Program, Project Projects, RFA
Investments, TU Delft

We studied two measures within the Deltares model that are based on the buffered bay: the construction of marshes around the edge of the developed marshlands and the construction of closable cross-dams at the location of the roads that connect the barrier islands with the mainland. Figures 13 and 14 show that both measures have an impact on the surge levels. Where the marshes have a more local effect, the cross-dams have a significant impact on the surge level in a larger area of the bay.

The buffered bay is a strategy that

—Connects human interventions with natural processes

—Enables a long-term development plan that can be implemented step by step using interventions that enhance one another and adapt to changing circumstances

—Integrates water safety for the oceanfront, bay, and mainland

—Controls water levels in the bay (storm surge and tidal reduction) and protects against high water levels at the water's edge (levee/high ground construction)

Combined with the notion that these measures will maintain and even enhance the quality of the bay, we conclude that the best solution is the buffered bay.

The section below gives more insight in the hydrodynamic model and the results of the different perspectives. To show the impact of the different possibilities within the buffered bay, the marshes and closable inlets were tested individually. When both scenarios are combined, they have an additional effect.

Interboro Team / Interboro / Apex / Bosch Slabbers / Deltares / IMG Rebel / N+O / Palmbout / Pedagogy, Design Desk, NJIT Infrastructure Planning Program, Project Finance, RFA Investments, TU Delft

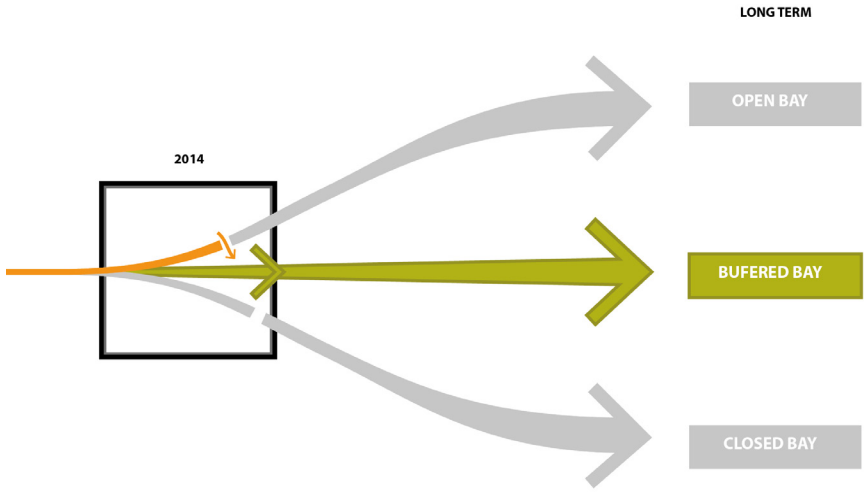


Figure 5. The buffered bay is a perspective that fits between the two extremes and provides a more feasible alternative.

Interboro Team:
Interboro / Apex / Bosch Slabbers
/ Deltares / H+N+S / Palmbout /
IMG Rebel with Center for Urban
Pedagogy, David Rusk,
NJIT Infrastructure Planning
Program, Project Projects, RFA
Investments, TU Delft

Additional Measures to Improve the Integrated Water Safety Challenge

The hydrodynamic models show the effect on the larger scale and the impact on the water level during a storm. As described in the previous paragraph, the marshes provide water safety by not just reducing the surge but also by reducing the wave run up. To deal with the regular tide, local wave run up, and eventually a higher sea level, local measures need to be taken. The marshes already provide a reduction in the tidal differences and wave run up, but additional measures for the low-lying communities need to be taken. Constructing a levee to protect these communities seems a wise and necessary action.

The tables below shows each of the interventions and their impact on the surge, wave run up, sea level rise, and the natural dynamics.

The marsh ridges grow with sea level rise and will continue to provide local safety for the far future. They also create a new habitat and ensure the existence of the marshlands and their ecosystem for the future.

The cross-dam reduces the surge as it comparts the bay and reduces the water body that will create the surge during a storm. By creating an cross-dam that is only closed during a storm, the natural habitats and dynamics stay intact. Construction methods might also allow the dam to create new natural habitats, but this is not by definition the case.

The inlet barrier is designed as a closeable inlet that is open under regular conditions and closes during storm. The closure during a storm leads to greater surge impact as the water in the bay cannot be drained through the inlet. If the inlet is permanently closed, the bay will turn into a freshwater lake with a completely different natural habitat.

The levees directly protect the hinterland from surge, sea level rise, and wave run up. The natural dynamics will not be impacted by the levees.

Within the strategies for the buffered bay, we combine these interventions in such a way that the water level can be influenced, the water safety is increased, and the natural values increase.

Interboro Team / Delta Urbanism / IMG Rebel / Lagoon Design / Urban Ecology / Bosch Slabbers / Delft University of Technology / Urban Planning / Investments, Port of Delft / RFA

Measure Hazard	Marsh ridges	Cross dam	Inlet Barrier	Levee
Sea level rise	+ (allows bathymetry to follow SLR)	0	0 (++ if permanently closed)	++ (protects hinterland)
Surge	0 /+ locally (because of openings)	+ (suppresses local wind set up)	0 (suppress flow from ocean to bay, but also from bay to ocean)	++ (protects hinterland)
Wave impact	+ (reduces wave height and thus run up)	0 (wind fetch still large; waves grow locally)	0 (wind fetch still large; waves grow locally)	++ (protects hinterland)

Figue 15. Measures and impacts on safety levels

Interboro Team:
Interboro / Apex / Bosch Slabbers
/ Deltares / H+N+S / Palmbout /
IMG Rebel with Center for Urban
Pedagogy, David Rusk,
NJIT Infrastructure Planning
Program, Project Projects, RFF
Investments, TU Delft

Measure Nature	Marsh ridges	Cross dam	Inlet Barrier	Levee
Dynamics	+	0	-- (if permanently closed)	0
Habitat	++ (because of high grounds)	0/+ (depends on structure)	- (fresh water habitat)	-/0

Figue 16. Measurer and impacts on natural systems

The research on the possible safety perspectives presented in the previous discussion shows that the buffered bay is our preferred perspective. In the following section, we demonstrate the effect and implementation of the buffered bay on two levels: Long Island scale and Nassau County scale. The main interventions are shown on the Long Island scale, and the possible implementation is shown on the Nassau County scale. The latter provides suggestions for the far future and a way to structure thinking about the interventions on the lower scale levels; it is not a fixed plan.

The perspective of the buffered bay is explained on these two scale levels through the different landscapes and water bodies: 1) the ocean side of the barrier islands, 2) the water edges in the bay, 3) the waterbody and marshes of the bay area, and 4) the urban mainland. Each requires a different approach towards water safety. We have therefore defined four strategies that represent the layers within the buffered bay:

1) The Ocean Side - Resilient sediment management

2) The Water Edges - Local Protection

3) The Bay Area - Water Level Buffering

4) Urban Water - Delay, Store, Drain

Interboro Team / Alex Gil Stabile / Deltares / Pitt+Co / Dan Brown / IMG Rebel with Centre for Urban Redacoy, David Rust / MIT Infrastructure Planning Program, Project Projects, RFA Investments, TU Delft

1) Ocean side: resilient sediment management

This strategy will result in a dynamic coastline in east Long Island and a more fixed coastline in the western part of the island. The dynamic coastline will develop into a coastline that is only nourished seaward of the developed areas and will become more natural and dynamic while the fixed coastline of Long Beach and Rockaway Beach is kept in place by dune construction, beach, and foreshore nourishment. The two main ingredients for this strategy are the sediment nourishments and the (natural) sand engines. The nourishments are placed on the ebb-tidal delta and in the channels, after which sediment is transported toward the bay and along the shore through natural processes of waves and currents. Stimulating wash overs in natural areas will allow sediment to be transported toward the bay.

Figure 17. Dynamic processes, nourishments, overwashes are the main ingredients for resilient sediment management of the ocean shores on the scale of Long Island.

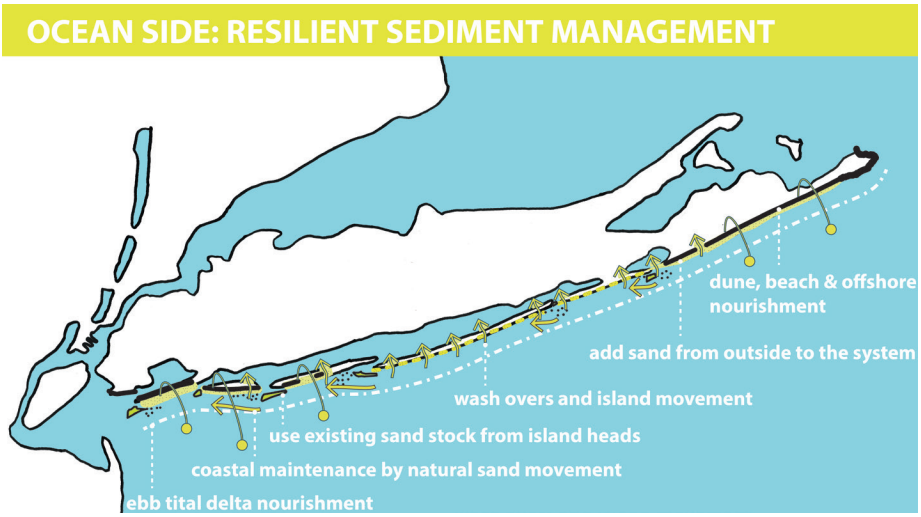
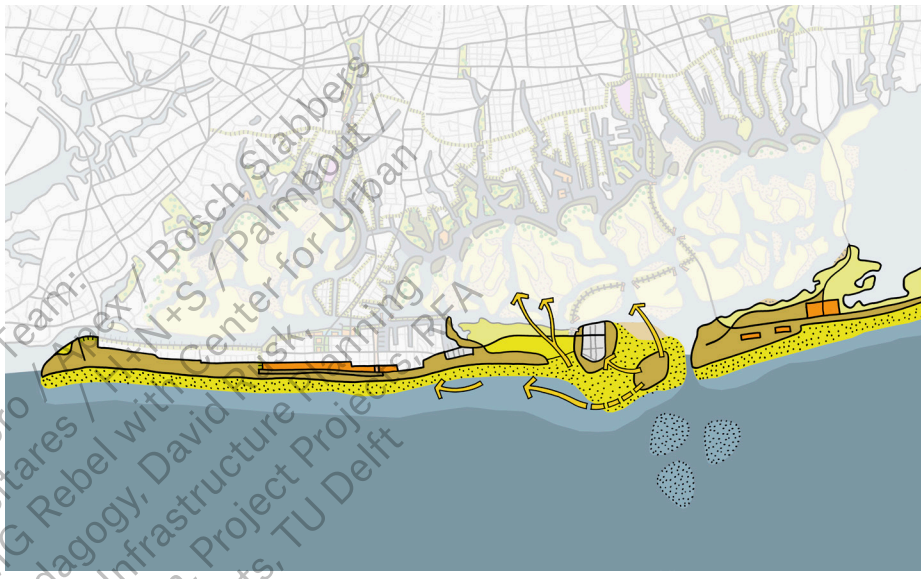


Figure 18. The implementation of the strategy for resilient sediment management within Nassau County results in a broad ocean beach with dunes. The relocation of the Jones Inlet (between Long Beach and Jones Beach) toward the east would allow the accumulated sediment to nourish the eroding beach of Long Beach. A wash over between Point Lookout and Malibu Park would allow more sediment to be transported toward the bay. Nourishment of the ebb-tidal delta would provide sediment for the coast and the bay on the long term.



Interboro Team: Interboro / Vlex / Bosch Slabbers / Deltares / H+N+S / Palmbout / IMG Rebel with Center for Urban Pedagogy, David Trask, NJIT Infrastructure Planning Program, Project Projects, REA Investments, TU Delft

It is necessary to add extra sediment to the "active system," geographically defined as the area from approximately 10 m of ocean depth to the landside dune toe. Sediment needs to be mined from the deeper ocean sources and transported to the nourishment locations. These locations can be the ebb-tidal delta, the channels, the foreshore, the beach, or the dunes, as mentioned above. When nourishing directly on the beach or constructing dunes, the right sediment diameter and composition is needed to create a natural and efficient dune or beach. When nourishing the foreshore and channels, the sediment particles will spread across the active system by natural processes and, by this natural selection process, end in the "right" location.

The proposed sand engines are the former ends of the barrier islands that have been kept in place by groins and artificial structures and therefore accumulated large amounts of sand. By creating a new eastward inlet, these sand accumulations can become part of the active system once again. Overall, this strategy is focused on using the available amount of sediment within the active system in a smart way so that it can move around the system and strengthen it and, upon adding sediment from outside the active system, allow the area to grow along with the rising sea level.

Figure 19. A protective strategy for the urban areas at the water edges.

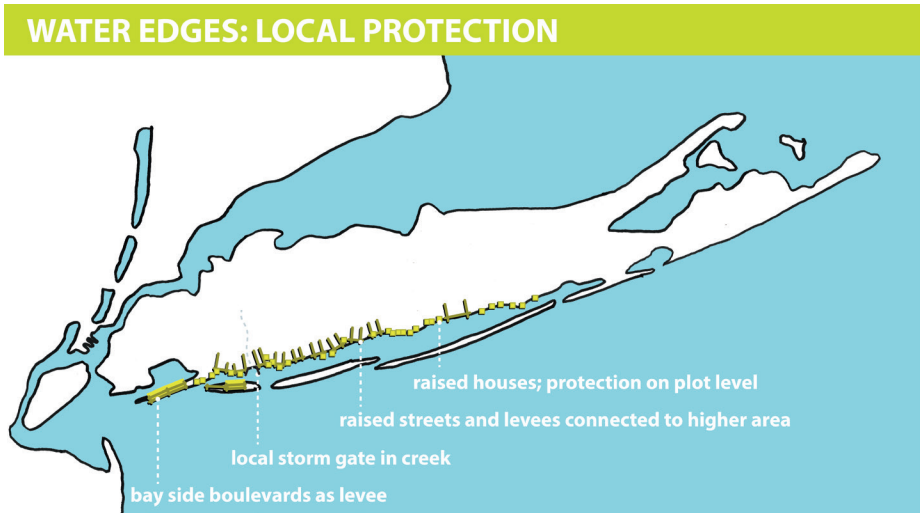
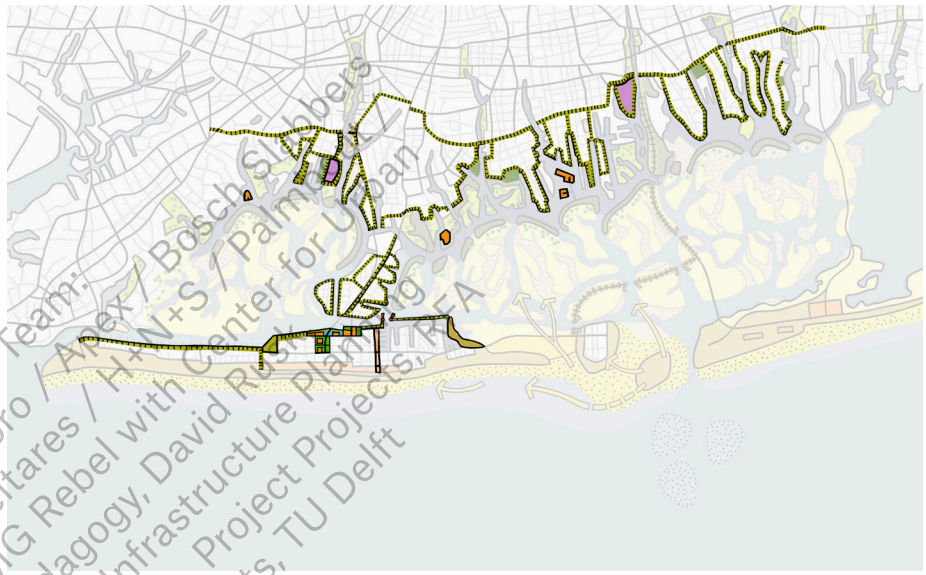


Figure 20. The resilient water edges in Nassau county implicates that the water edges in the Bay need more protection and new levees will be constructed. The Barrier island is strengthened at the oceanfront by nourishments, but a levee within the new dune will ensure the water safety to a higher level. As back bay flooding resulted in major damage during Sandy the reconstruction of the bay side boulevard into a levee that can withstand a 12 ft surge is essential. The reconstruction of this area allows room for new residential or recreational developments. The low residential marshlands within the bay will also need to be protected by levees. We propose to raise crucial roads which are connected to the higher roads that run parallel to the coast. This ensures safety and new evacuation routes for whole communities.



Interboro Team: Interboro / Apex / Bosch Slabbers / Deltares / A+N+S / Palmbout / IMG Rebel with Center for Urban Pedagogy, David Rusk / NJIT Infrastructure Planning Program, Project Projects, IAFA Investments, TU Delft

2) The Water Edges: Local Protection

Within this strategy, three main directions can be defined.
A local storm gate within the creeks ensures water safety for a large part of the urban areas next to the creeks as during a storm the surge is pushed far inland through the creeks. Urban stormwater can be stored behind the closed gate when the bay water level is too high to drain into the bay.
Levee ring construction. Constructing dike compartments that are closed by either the dunes at the oceanfront (barrier island) or the higher grounds/road structures (mainland) creates safety for the urban areas. Due to the construction of the marshlands as proposed in the bay strategy (see the next strategy), the crest of the levees can be lower, thus limiting the spatial impact of the dikes. The main roads will be raised 2 to 4 feet, which allows a good integration in the existing urban layout. The protection level of the areas will increase as they protect for a surge of 10 feet. Floodplain developments (outside the levees) or reconstruction of the parcels is a strategy that fits with the current measurement of NY Rising. Developing an integral strategy for the heightening of the houses. This allows for a long-term approach and communal view. It can lead to new types of flood-proof developments on higher parcels or stilts or even floating homes.

Figure 21. Lowering the surge levels and increase natural resilience of the bay area by the construction of compartment/cross dams and marsh ridges along the bay coastline

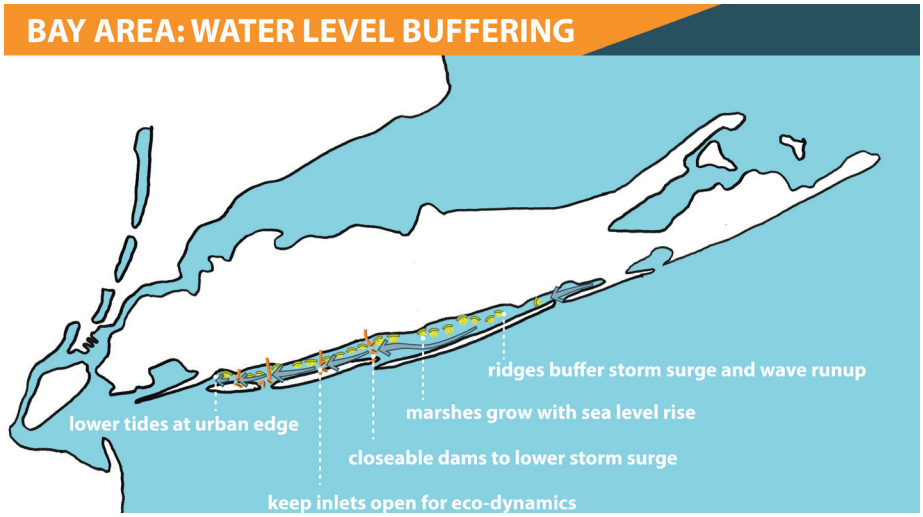


Figure 22. For Nassau County, the marsh ridges provide safety for the low-lying urban marshes and introduce a new ecological gradient in the marsh. The ridges enhance the edge between the urban and natural marshes and thus provide a natural boundary between natural and recreational/urban functions, next to reducing the wave and surge run up. The marsh ridges strengthen the natural marshes and allow new marshes to develop. The Meadowbrook State Parkway and the Loop Parkway can be redesigned as a cross dam to reduce the surge in the Middle Bay and provide a safe evacuation route from Long Beach.

Interboro Team: Interboro / Arup X / Bosch Slabbers / Deltares / H+N+S / Bureau Buitenhout / IMG Rebel with Center for Urban Pedagogy, David Rusk / NJIT Infrastructure Planning Program, Project Projects, Rijk Investments, TU Delft

3) Bay Area: Water Level Buffering

For the bay area, the challenge is to provide safety against flooding for the urbanized areas while also preserving and even restoring the ecological quality and natural dynamics of the bay. To find this balance, we propose to construct new marsh ridges that were investigated in the Scenario 1 model from Deltare. This results in new natural habitats, a minimal lowering of the storm surge for the hinterland, a larger reduction in the wave run up and impact on the mainland coast, less marsh erosion, and an increase in marsh area. In addition, the cross dams, which are constructed at the location of the current causeways (as shown in the scenario 3 model by Deltares), will control the surge during storms and maintain the natural dynamics during daily conditions. This strategic option is linked to the ocean shore strategy, which provides the sediment input that is distributed through natural processes into the bay area.

Figure 23. The prevention of flooding from urban stormwater is an important issue, as the urban areas have a large amount of impermeable surface. The strategy is to delay and store the water before it is drained in order to relieve the pressure on the drainage system. The availability of groundwater for urban and agricultural use is also an aspect, and we propose to take care of the source and recharge groundwater as much as possible.

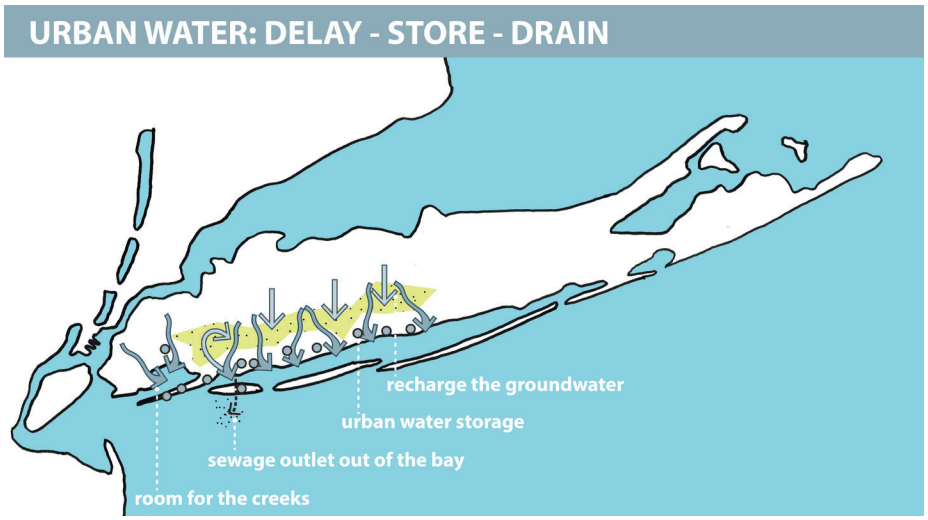
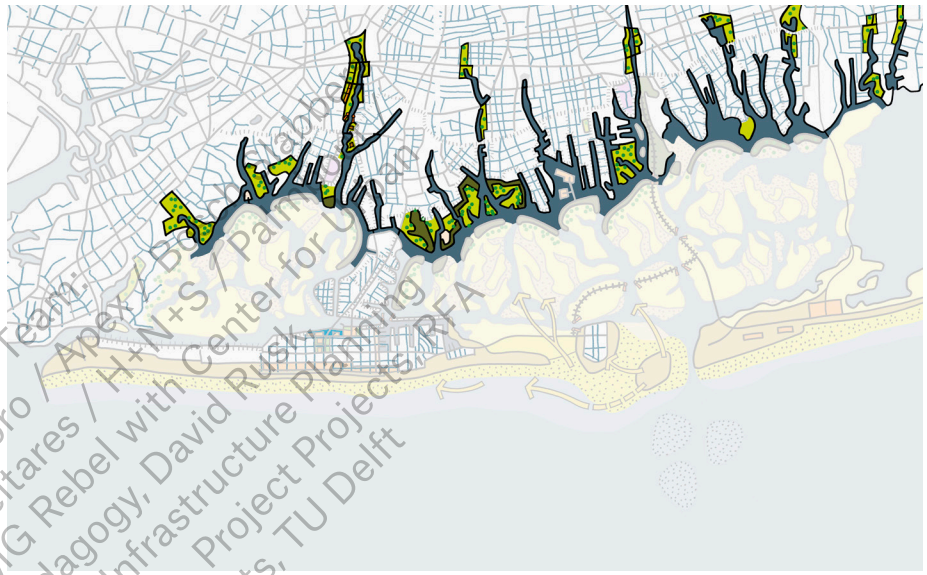


Figure 24. For Nassau County, the implementation of the urban water strategy implies giving more room to the creeks by creating more room in the direct surroundings of the creek for water storage or fluctuating water levels. The parks around the creeks and within the urban areas provide excellent water storage areas. Open drainpipes get valves that automatically close with high water levels. For some crucial spots (Mill River), sluices are proposed.



Interboro Team: Apex / Bo Landscapes / Deltares / H+N+S / Palmer & Lau / IMG Rebel with Center for Urban Pedagogy, David Rusk / NJIT Infrastructure Planning Program, Project Projects / RFA Investments, TU Delft

4) Urban water: delay - store - drain

Once upon a time, rivers and creeks fed Long Island's bays sediment and fresh water and simultaneously recharged the groundwater. Natural buffers once accommodated the occasional surge and offered access to scenic, recreational waterways. Today the rivers are crucial less for their natural or recreational functions and more for their capacity to drain and channel stormwater from upland communities through low-lying ones and then into the bay.

In this strategy, we propose to bring these challenges together in one comprehensive long-term perspective. In time, all of Nassau's rivers can serve as spines where more and more activities can be implemented to increase safety, water quality, stormwater storage, urban identity, ecological quality, and public access.

On the long term, we propose:

—Store more water in the urban areas—on abandoned parcels, roofs, parks, and/squares—to ensure less water hindrance in the surrounding neighborhoods.

—Adjust stormwater outflows to prevent back flooding and install valves and pumps to provide extra filter capacity to

improve the water quality. With regular maintenance, the streets that harbor the drains for the stormwater could gradually transform to blue-green streets that store and filter water.

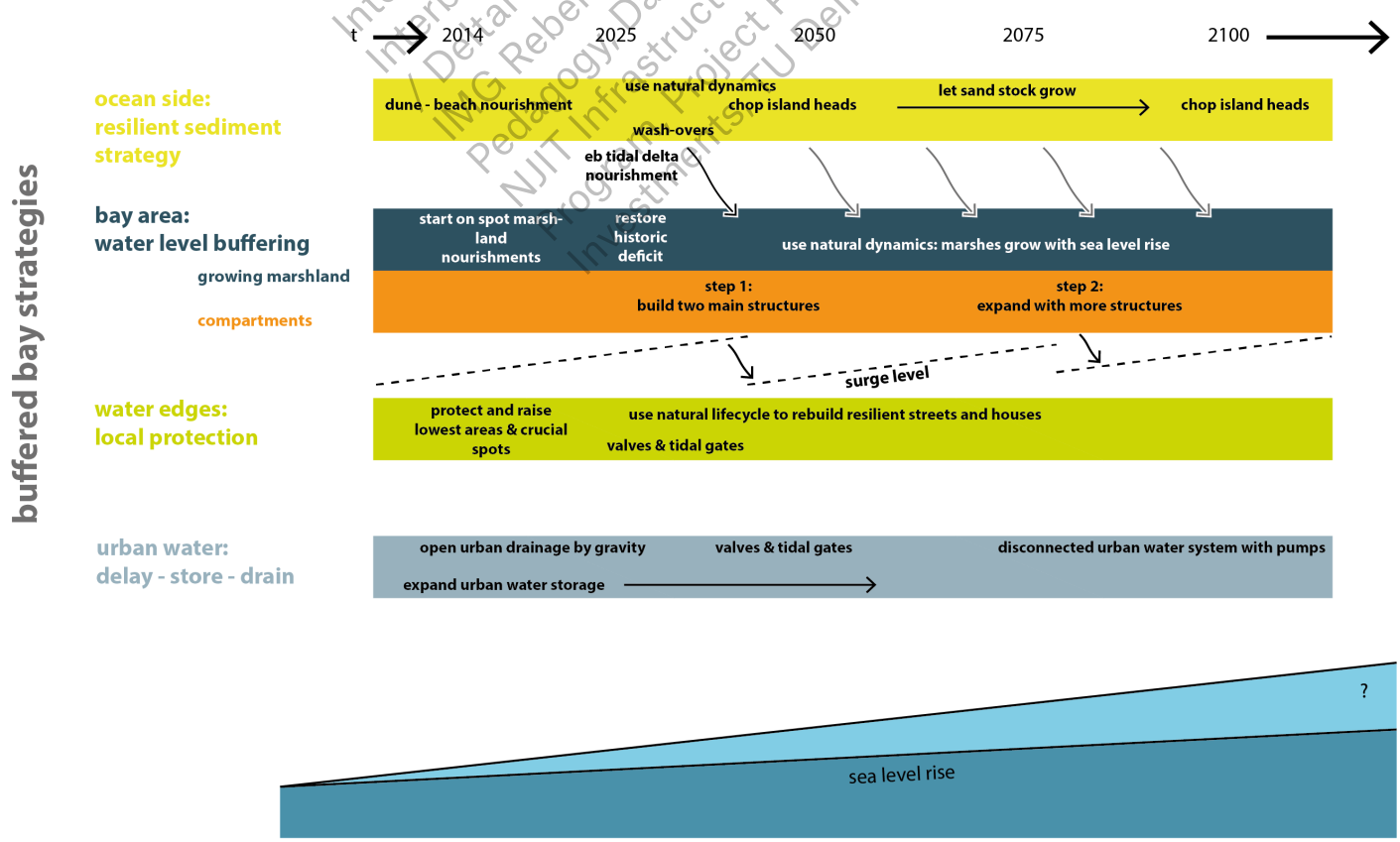
—Store/retain water via a cascade of ponds. With a better control of the flow of the river, it will be possible to slow down the stormwater; ponds could serve as water storage basins and cooling areas for the neighborhood but they could also recharge the aquifer.

—Reinfiltrate effluent where possible. With the scarcity of water, we have to treat effluent as a valuable resource that can feed our rivers.

—Where possible, remove dams to stimulate vertical sedimentation and relieve choke points in such a way that natural fresh/brackish/salt gradients will be optimized. For remaining dams that can't be removed, install fish passages.

—Control the outflow of the rivers by building sluices and pumps that can create extra storage capacity and cope with the effects of sea level rise. By extending a sluice, more room for water storage in the direct surroundings of the water body can be realized.

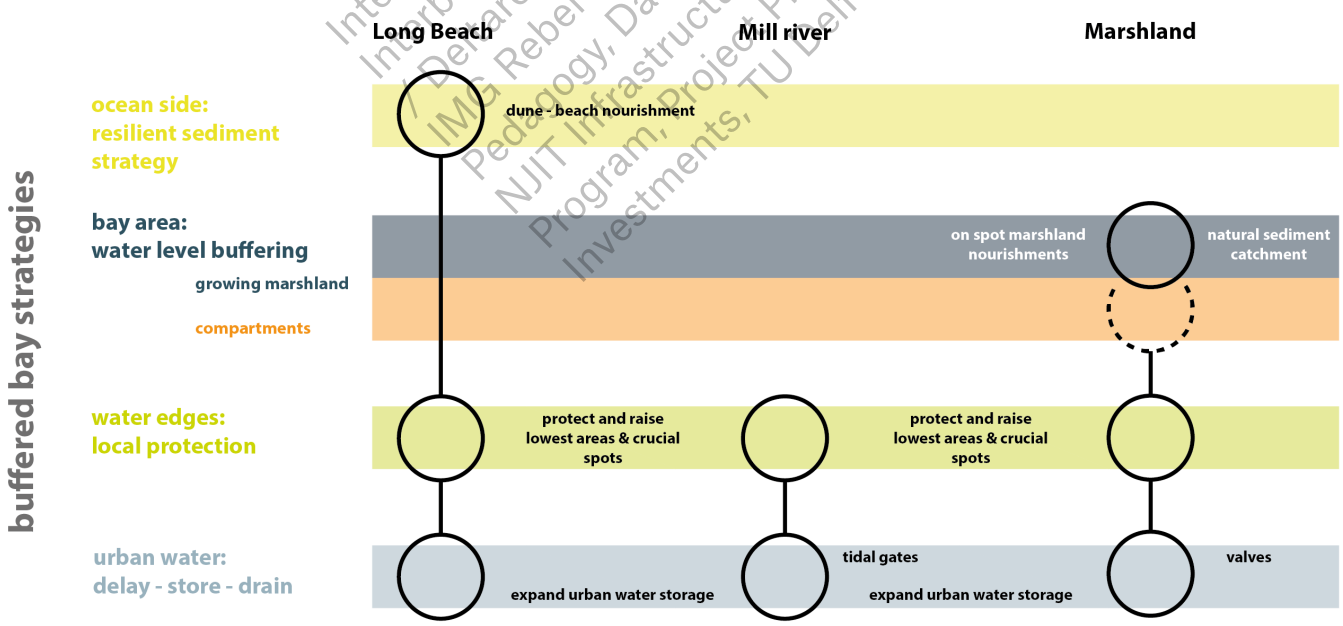
Figure 25. This scheme shows the phasing of the four combined strategies for the buffered bay. Improving the safety level of this area can start immediately and can be built upon as the adaptation to Sea Level Rise is an ongoing process.



Interboro Team:
Interboro / Apex / Bosch Slabbers / Dertares / H+N+S / Palmbout / IMG Rebel with Center for Urban Pedagogy, David Rusk, NJIT Infrastructure Planning Program, Project Projects, RFA Investments, TU Delft

Figure 26. Integral regional strategy for the Buffered Bay

Figure 27. Three Projects together cover the whole spectrum of strategies for the buffered bay. Each Project has its own focus as a result of the landscape types and the interaction between the strategies.



Interboro Team:
Interboro / Apex / Bosch Slabbers
/ Deltares / H+N+S / Palmbout /
IMG Rebel with Center for Urban
Pedagogy, David Rusk,
NJIT Infrastructure Planning
Program, Project Projects, RFA
Investments, TU Delft

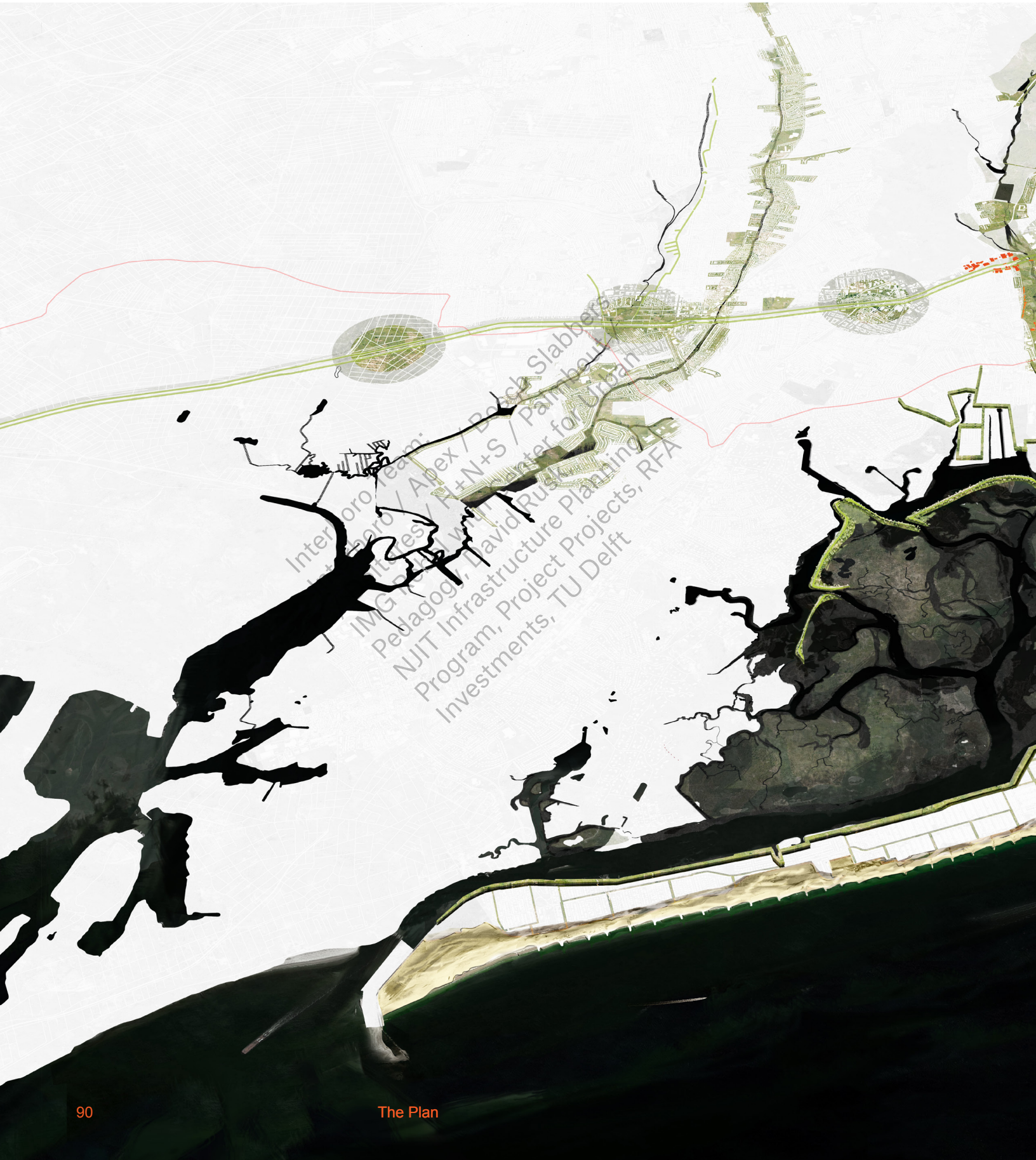
Interboro Team:
Interboro / Apex / Bosch Slabbers
/ Deltares / H+N+S / Palmbout /
IMG Rebel with Center for Urban
Pedagogy, David Rusk,
NJIT Infrastructure Planning
Program, Project Projects, RFA
Investments, TU Delft

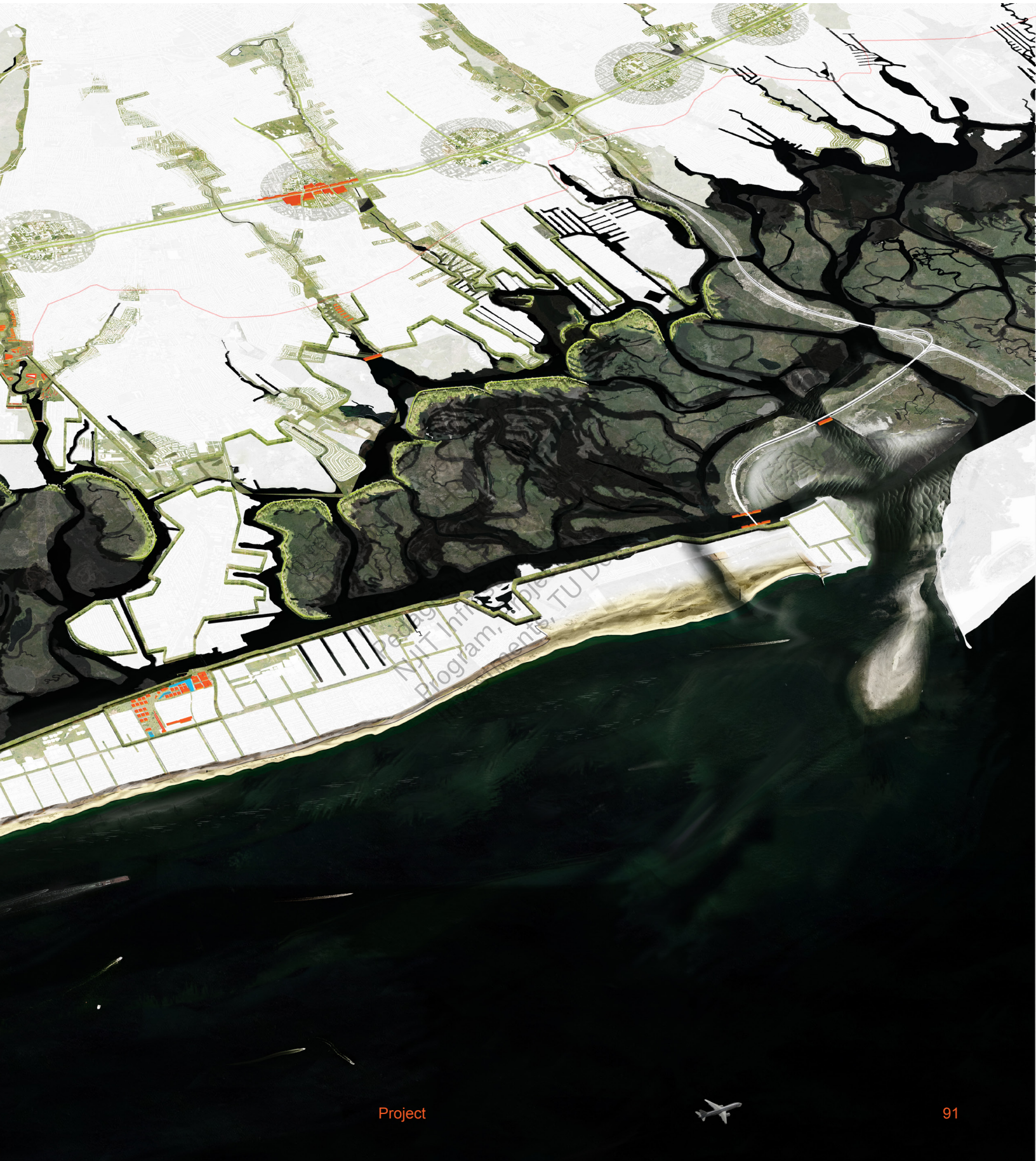
Chapter 5: The Plan

Interboro Team:
Interboro / Apex / Bosch Slabbers
/ Deltares / H+N+S / Palmbout /
IMG Rebel with Center for Urban
Pedagogy, David Rusk,
NJIT Infrastructure Planning
Program, Project Projects, RFA
Investments, TU Delft

Interboro Team:
Interboro / Apex / Bosch Slabbers
/ Deltares / H+N+S / Palmbout /
IMG Rebel with Center for Urban
Pedagogy, David Rusk,
NJIT Infrastructure Planning
Program, Project Projects, RFA
Investments, TU Delft

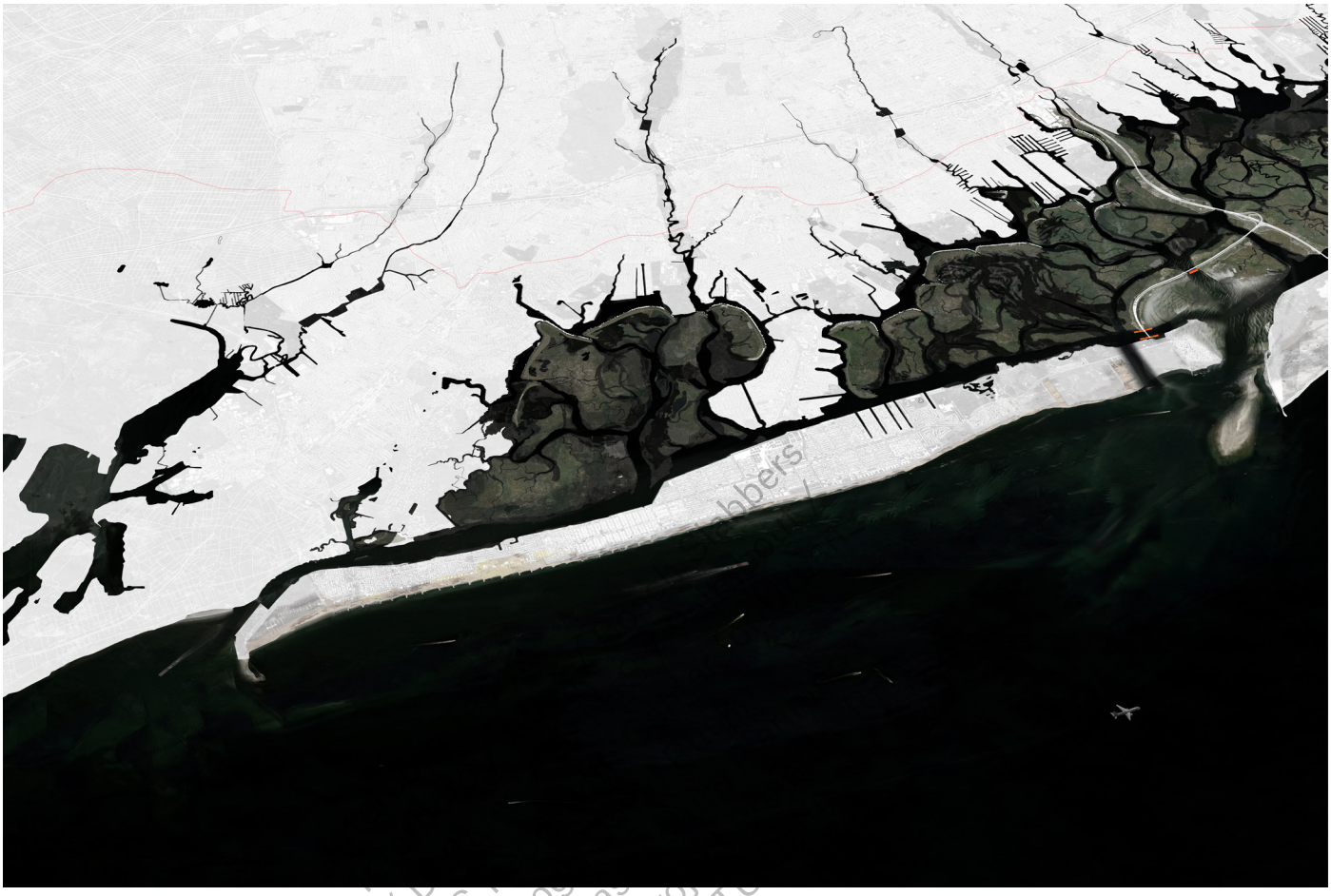
Longterm Regional Perspective





Pedagogical Framework
NIIT Infrastructure Project
Programme, TU Delft

Five Prototypical Conditions

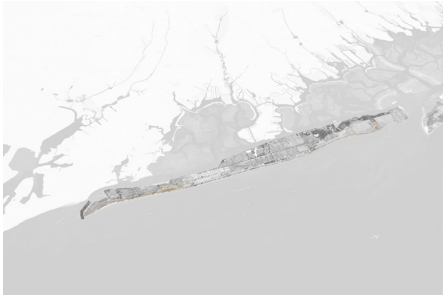


Living with the Bay takes a regional systems approach to Nassau's water-based problems.

Towards our favored scenario of the buffered bay, we have developed an integrated, tri-scalar approach, which includes planning and design efforts at the scale of the region, the sub-region, and specific sites.

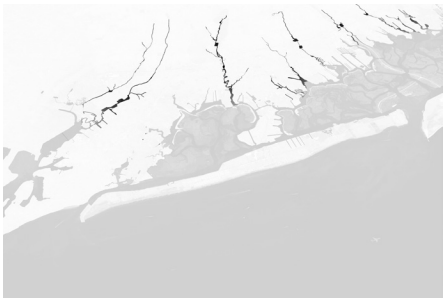
At the scale of the region, we have developed a draft, long-range, comprehensive, regional resiliency plan for Southern Nassau County. This plan includes research, planning and design, and the development of decision-making tools that address the interrelationships between the region's natural and human-made systems.

Ocean Front



Barrier Island

Marsh

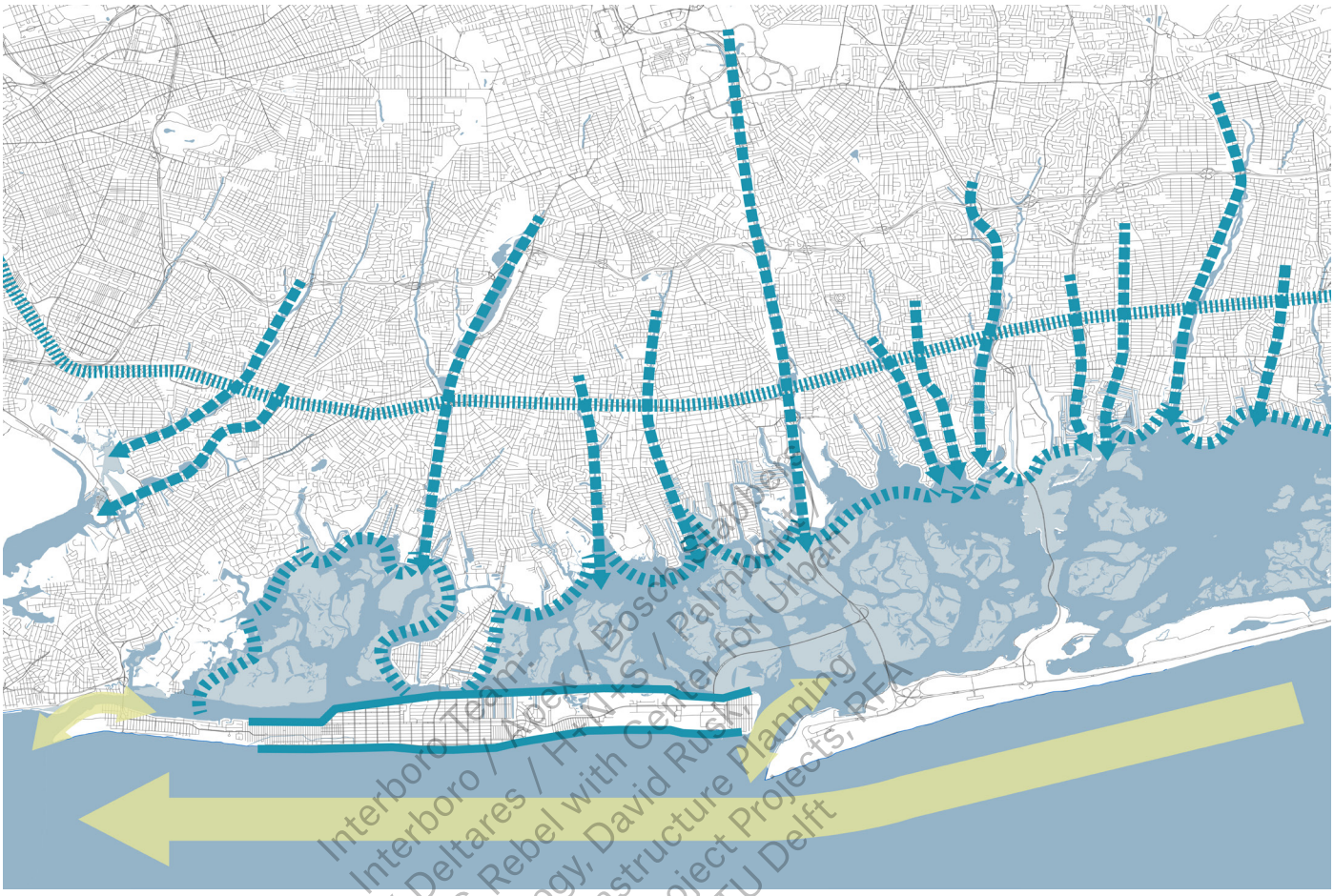


River And Stream Estuaries

Uplands

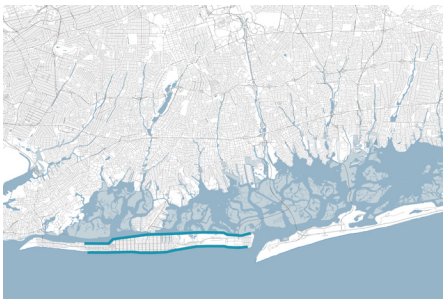
Interboro Team:
Interboro / Apex / Bosch Slabbers
/ Deltares / H+N+S / Palmbout /
IMG Rebel with Center for Urban
Pedagogy, David Rusk,
NJIT Infrastructure Planning
Program, Project Projects, RFA
Investments, TU Delft

Five Prototypical Strategies



Sediment Flow

Improved sediment flow nourishes ocean beaches and marshes.

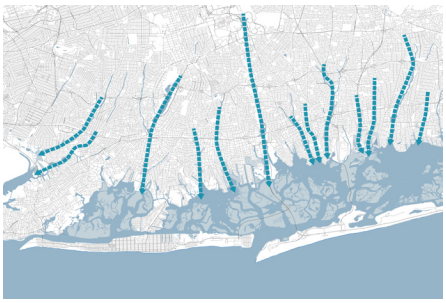


Smart Barrier

Improvements along the ocean and bay both protect residents and better connect them to the water.

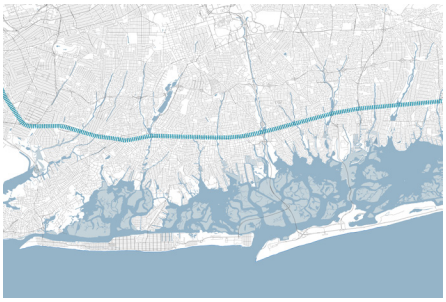
Eco-Edge

New marshes reduce wave action and improve the bay ecology. Ring dikes protect residents on the urbanized edge.



Slow Streams

Urban storm water is stored and filtered along the north-south tributaries to reduce inundations and pollution.

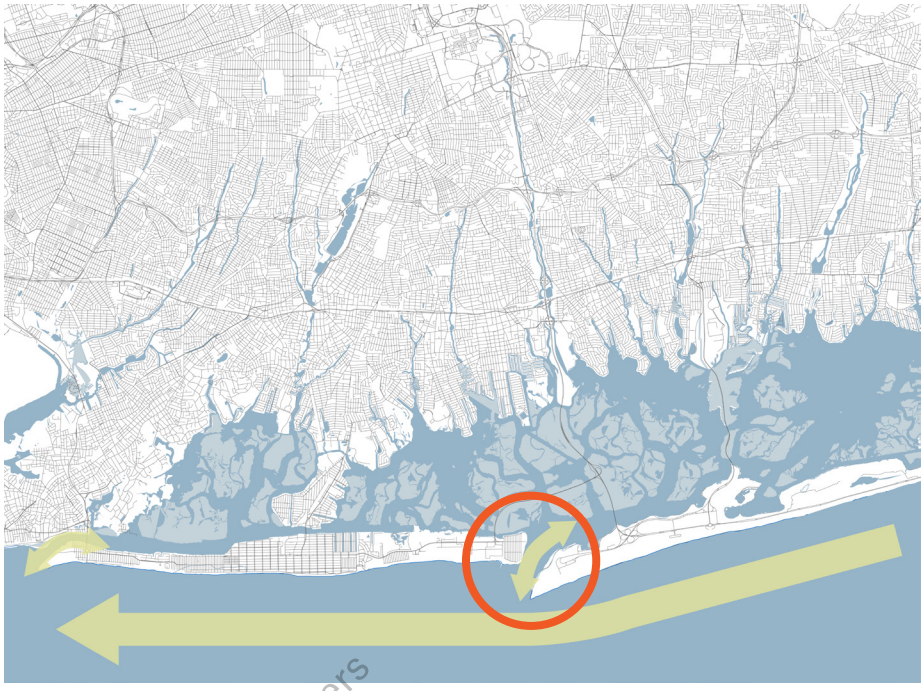


Green Corridor

Green infrastructure and transit-oriented development transform the sunrise highway -LIRR corridor.

Interboro Team:
Interboro / Apex / Bosch Slabbers
/ Deltares / H+N+S / Palmbout /
IMG Rebel with Center for Urban
Pedagogy, David Rusk,
NJIT Infrastructure Planning
Program, Project Projects, RFA
Investments, TU Delft

Sub-Regional Strategies and Phase One Projects



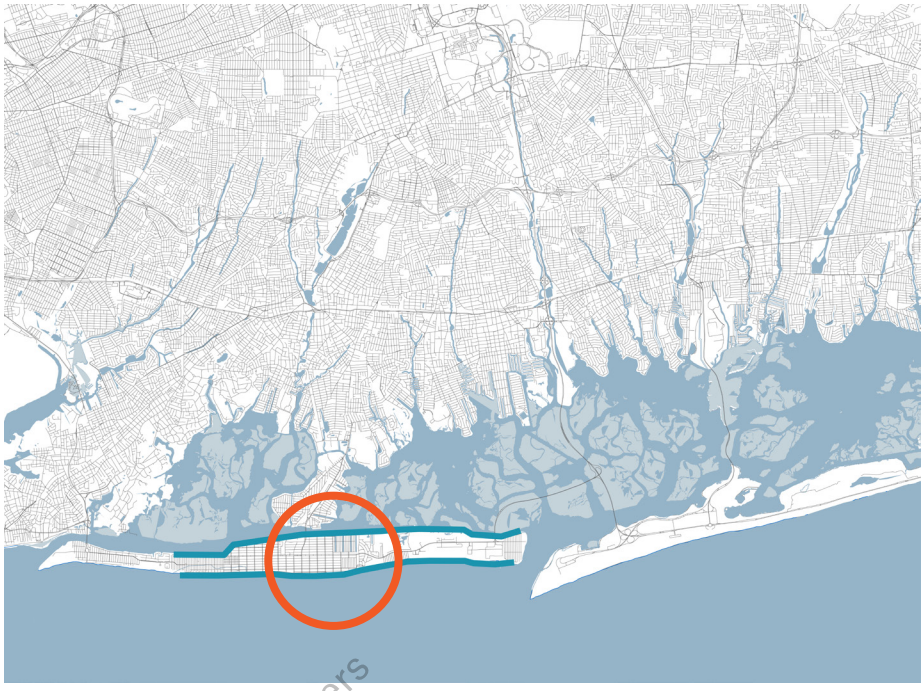
Strategies for the Ocean Shore: Sediment Flow

The drowning of the marshland will only be stopped when plates grow along with sea-level rise, and for this, we propose a multi-faceted approach to recovering the region's sediment system. Overall, this strategy is focused on using the available amount of sediment within the active system in a smart way, so that it can move around the system and strengthen it, adding sediment from outside the active system to allow the area to grow along with the rising sea level.

Specifically, we propose to
—work with ebb-tidal delta nourishments that function as local sand-engines
—stimulate natural distribution by currents by influencing the tidal prism
—create sediment catchment structures
—stimulate natural overwashes
—make use of the natural sediment transport along the coastline and the existing sediment surplus at the top of the barrier islands

As a Phase One project, we propose to install a sand engine in Jones inlet.

Interboro Team / Adam Nocito / Slaughter / Deltares / Arcadis / Bouwdienst / IMC Holland / Dutch Delta Committee / Urban Development Partners / Dutch Ministry of Infrastructure and Water Management / NJ Transit / Dutch Spatial Planning Agency / Rutgers University / Program Manager / Investment Projects, RFA



Strategies for the Barrier Island: The Smart Barrier

Due to their location and topography, Long Island's barrier islands are among the region's most vulnerable zones when it comes to sea level rise and storm surges. The City of Long Beach has some of the highest residential densities in Nassau County and is home to more than its fair share of the region's critical infrastructure. Long Beach also had some of the highest concentrations of damage during Sandy. Protecting the barrier island's population and its infrastructure from future storm events is therefore essential.

For Long Beach, we propose protective measures along the bay front to complement the ongoing work by USACE on the ocean side and create a comprehensive protective system. The goal of these measures is to protect residents and also to provide better connections to the water and simultaneously deal with stormwater flooding.

As a Phase One project, we propose a dike landscape and a water retention park to immediately protect the existing critical infrastructure and some of the most vulnerable areas of Long Beach.of Long Beach.

Interboro Team: ARUP / Porter Slaughers / Dethier / H-NTB / Balmbout / IMC Kelly / Mitchell Urban / Reading / Dan Kaplan / Planning Program / Infrastructure Projects, RFA Investment Strategies, LLC

Strategies for the Marsh: The Eco-Edge

Urban development has negatively impacted Nassau County's wetlands. Over the past 70 years, southern Nassau County's bay areas have lost a sizable portion of their wetlands. Wetlands—and, in particular, saltwater marshes—play a critical role in buffering coastal communities. Wetland eradication has left Nassau bay communities more vulnerable to storm surge.

In the West, Middle, and East Bays, we propose new marsh islands that reduce wave action, improve the bay ecology, and afford new recreational opportunities. A second component of this strategy is a system of ring levees that would further protect development along the urbanized edge.

As a Phase One project, we propose to build a marsh island and ring levee along the Freeport waterfront.

Interboro Team: Thomas Leslie / Marsh Slambers
Interboro / Alpa Patel / Jim Rambout /
/ Deltares / Hans Van Cooten / Urban
IMG Design / Jim Corner / Rusty
Pedagogy / Dr. Dennis Rodgers / Planning
Infrastructure / Project Prototyping
Investments, TU Delft, RFA

Strategies for the Lowlands: Slow Streams

Today, the north/south rivers that empty into Nassau's bay are crucial less for their natural or recreational functions and more for their capacity to drain and channel stormwater runoff. This runoff is a major contributor to the pollution of the bay, but it also causes flooding: when the rivers rise above the outflow pipes that channel the stormwater into the bay, as often happens in Nassau County, the pipes back up and cause flooding upland.

Along the north/south tributaries that drain into the South Shore's bays, we propose green infrastructure improvements to reduce inundations and pollution and also create publicly accessible greenways that connect the South Shore's communities. Proposed improvements include safety thresholds with sluices, stormwater swales for infiltration and water storage, fish ladders, and "aquaphilic" housing prototypes. We also propose a partial upstream re-infiltration of purified wastewater from the Bay Park Sewage Treatment Plant.

As a Phase One project, we propose to reduce tidal inundations and better manage stormwater in the Mill River watershed by 1) installing a sluice that would reduce surges during storm events and manage stormwater through compartmentalization, 2) making more room for the river by transforming an existing, undeveloped parcel into an attractive, accessible riverfront park that could filter stormwater, and 3) adding stormwater swales to the streets that are adjacent to the river.

Interboro Team: Alan Berger / Bosch Slabbers / Deltaspace / Hitchcock Fleming / IMG Design / Jamie Rabinowitz / Peabody Wilkinson Pasquarelli / Rebecca Lewis / Center for Urban Pedagogy / Wendy Poole / Dorling Kindersley / NJ Institute of Technology / Infrastructure Studio / Program Project / Investments / Tom Paul, RFA

Strategies for the Uplands: The Green Corridor

One of the best things we can do to create more resiliency in the region is to create affordable opportunities for people to live out of harm's way, and the underdeveloped Sunrise Highway corridor is a great place to do this. With its public transportation options, relative density, and mixture of uses, parts of the Corridor have the potential to be the dense, walkable, mixed-use environment that so many of today's Long Islanders—including those displaced by Sandy—are looking for. But the Corridor is also high and dry: just beyond the reach of a category 2 surge, a 6-foot sea level rise, and the FEMA flood zone, the Corridor is as close as you can get to the more vulnerable communities of the South Shore while still being safely out of harm's way.

Our proposed "green corridor" is a reimagining of the Sunrise Highway–LIRR corridor that would seek to do two things. First, we would target "high and dry" areas along the corridor for mixed-use, mixed-income housing within walking distance of select LIRR stations. Second, we propose to green the corridor itself by 1) improving the capacity of the highly impervious corridor to capture stormwater runoff, 2) relieving "choke points" (points when the north/south rivers and streams are channeled into a pipe that goes under Sunrise Highway) by selectively daylighting rivers and streams, and 3) bundling these green infrastructure improvements with pedestrian and bike safety improvements that would facilitate pedestrian connectivity and reduce automobile use.

As a Phase One project, we propose to implement a "show piece" of the reimagined Sunrise Highway corridor around the Freeport LIRR station.

Interboro Team / Bosco Slanbers
Interboro / Deltec / HDR / Parsons Brinckerhoff /
/ Deltec / HDR / Parsons Brinckerhoff / Interboro
IMG Rebuild by Design / Rutgers / Parsons Brinckerhoff / Interboro
Regional Plan Association / Dutch Delta Plan
Dutch Infrastructure Planning / Interboro / Deltec
Dutch Ministry of Infrastructure / Deltec / HDR / Interboro / RFA

project details

Regional Framework (Five Strategies)

- SEDIMENT FLOW STRATEGY
- SMART BARRIER STRATEGY
- ECO-EDGE STRATEGY
- SLOW STREAM STRATEGY
- GREEN CORRIDOR STRATEGY

Sub-regional Masterplans

JONES INLET SEDIMENT STUDY

Site:
Jones Inlet

LONG BEACH BARRIER ISLAND MASTERPLAN

Site:
Long Beach Barrier Island (Atlantic Beach, East Atlantic Beach, Long Beach, Lido Beach, Point Lookout)

WEST, MIDDLE AND EAST BAY MASTERPLAN

Site:
West, Middle, and East Bay

MILL RIVER MASTERPLAN

Site:
Mill River

SUNRISE HIGHWAY MASTERPLAN

Site:
Sunrise Highway

Phase One Projects

JONES INLET SAND ENGINE PROJECT

Site:
Jones Inlet

Partner:
tbc

Project Elements:
Sand Engine

NORTH PARK SMART BARRIER PROJECT

Site:
North Park Neighborhood, Ciry of Long Beach

Partner:
City of Long Beach

Project Elements:
Integrated dike, compartments, green infrastructure, housing

FREEPORT ECO-EDGE PROJECT

Site:
Freeport peninsula and bay

Partner:
Village of Freeport, Nassau County DPW

Project Elements:
Integrated dike, compartments, green infrastructure, housing

EAST ROCK TO ROCKVILLE SLOW STREAM PROJECT

Site:
East Rockaway, Rockville Centre, and Oceanside

Partner:
Villages of East Rockaway, Rockville Center, and Oceanside, Nassau County DPW

Project Elements:
Sluice, riverside retention areas, filter pools, cisterns, and continuous path, curb-side bioswales, stormwater harvesting for irrigation

FREEPORT STATION AREA PROJECT

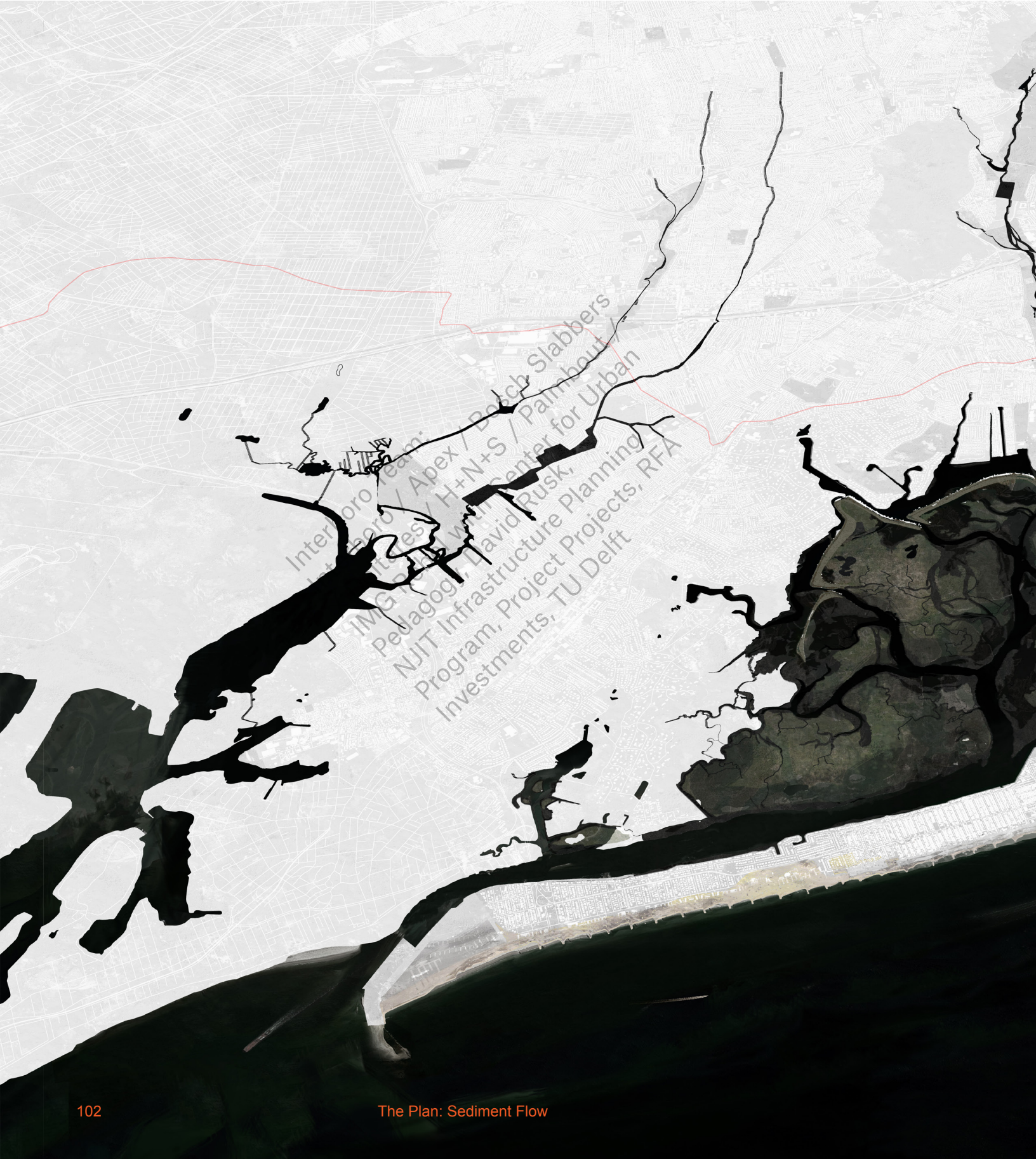
Site:
Freeport LIRR station area

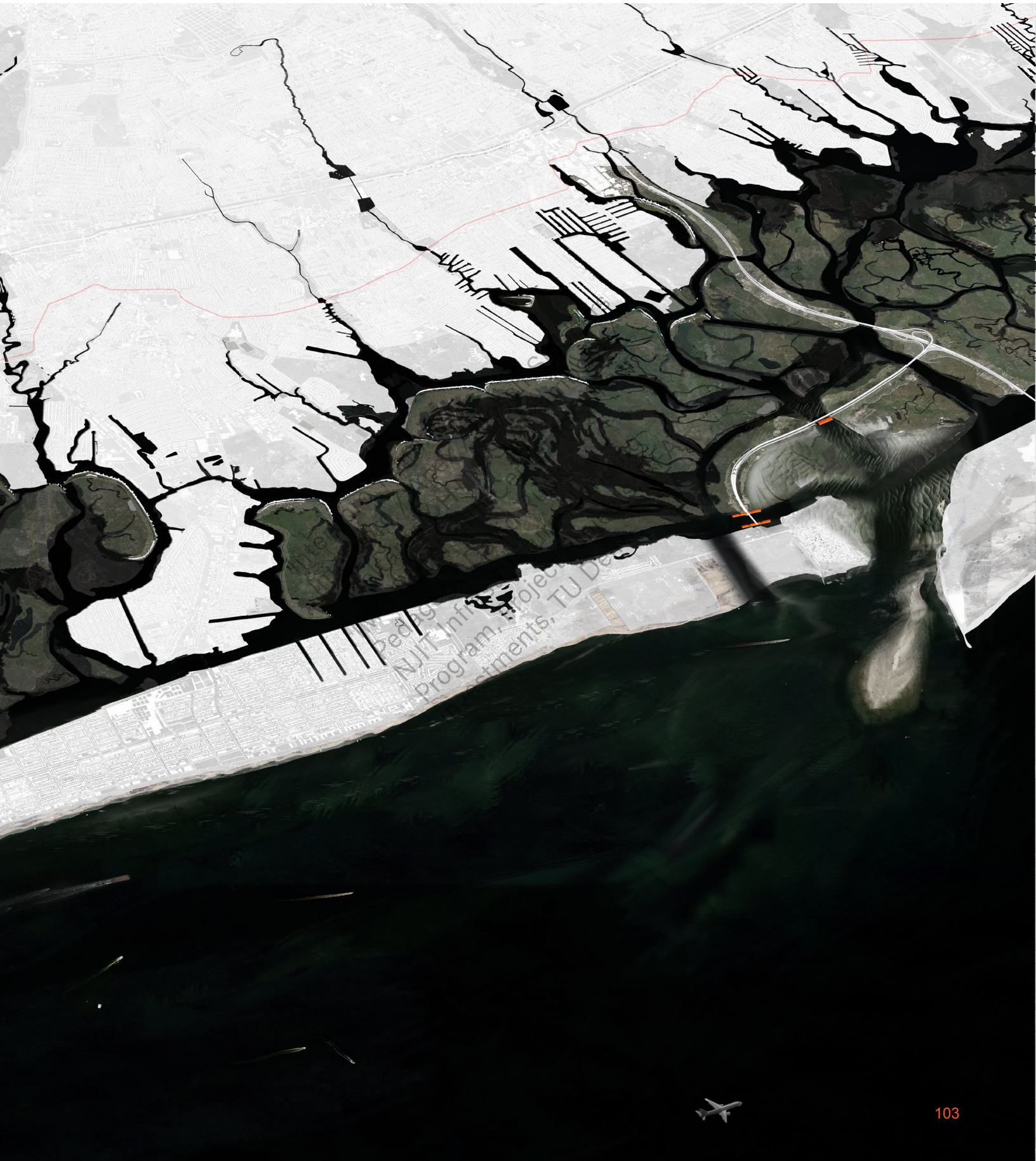
Partner:
Village of Freeport, Jaral Properties, Nassau County DPW, New York State DOT (tbc)

Project Elements:
Green infrastructure, mixed-use, mixed-income green development

Interboro Team / Interboro / Apex / Ross Slabbers / Voltares / H+N+S / Paul Out / IMC Rebel with Center for Urban Pedagogy, David Rusk, MIT Infrastructure Planning Program, Project Projects, RFA Investments, TU Delft

Strategies for the Ocean Shore: Sediment Flow





Design Research Lab
NJIT Infrastructure Project
Program, Departments, TU Delft

The drowning of the marshland will only be stopped when plates grow along with sea level rise, and for this, we propose a multi-faceted approach to recover the region's sediment system. Overall, this strategy is focused on using the available amount of sediment within the active system in a smart way, so that it can move around the system and strengthen it. We want to add sediment from outside the active system to allow the area to grow along with the rising sea level.

Specifically, we propose the following:

— Work with ebb-tidal delta nourishments that function as local sand-engines

— Stimulate natural distribution by currents by influencing the tidal prism

— Create sediment catchment structures

— Stimulate natural over-washes

— Make use of the natural sediment transport along the coastline and the existing sediment surplus at the top of the barrier islands

As a Phase One project, we propose to install a sand engine in Jones inlet.

Interboro Team: Interboro / Apex / Boom Slaboris / Deltares / H+N+S / Rapport / IMG Rebel with Center for Urban Pedagogy, David Rusk, NJIT Infrastructure Planning Program, Project Projects, RFA Investments, TU Delft

Longshore migration of sediment

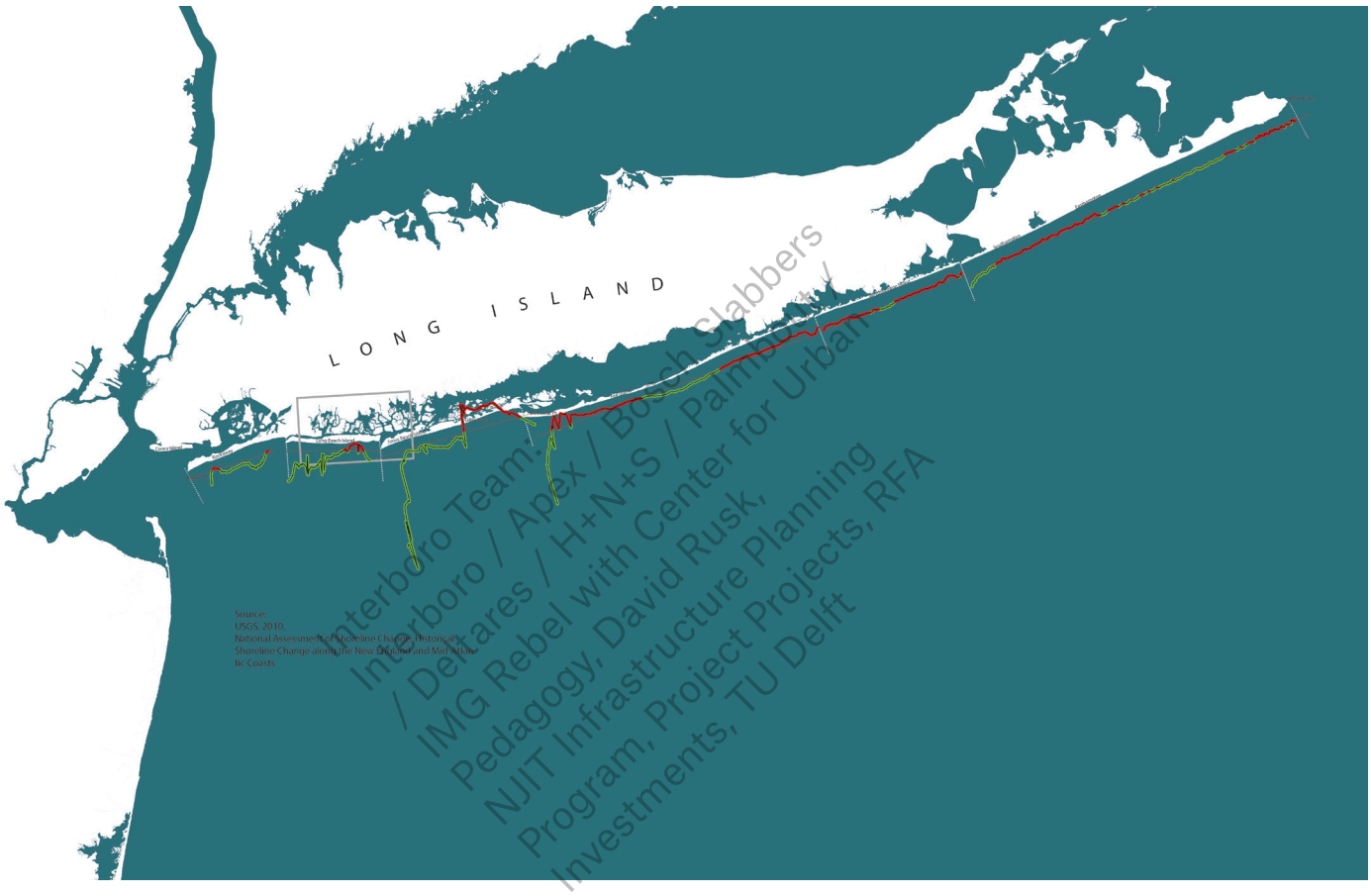
On the Long Island coastline, sediment moves from east to west along the coast due to wind and waves. This results in islands growing in a westward direction (red areas).

Inlets and breaches over time

Interboro Team:
Interboro / Apex / Bosch Slabbers
/ Deltares / H+N+S / Palmbout /
IMG Rebel with Center for Urban
Pedagogy, David Rusk,
NJIT Infrastructure Planning
Program, Project Projects, RFA
Investments, TU Delft

Due to the migration of the islands, the inlets also move along in a westward direction. Besides the inlet shifting, storms regularly form new breaches or inlets.

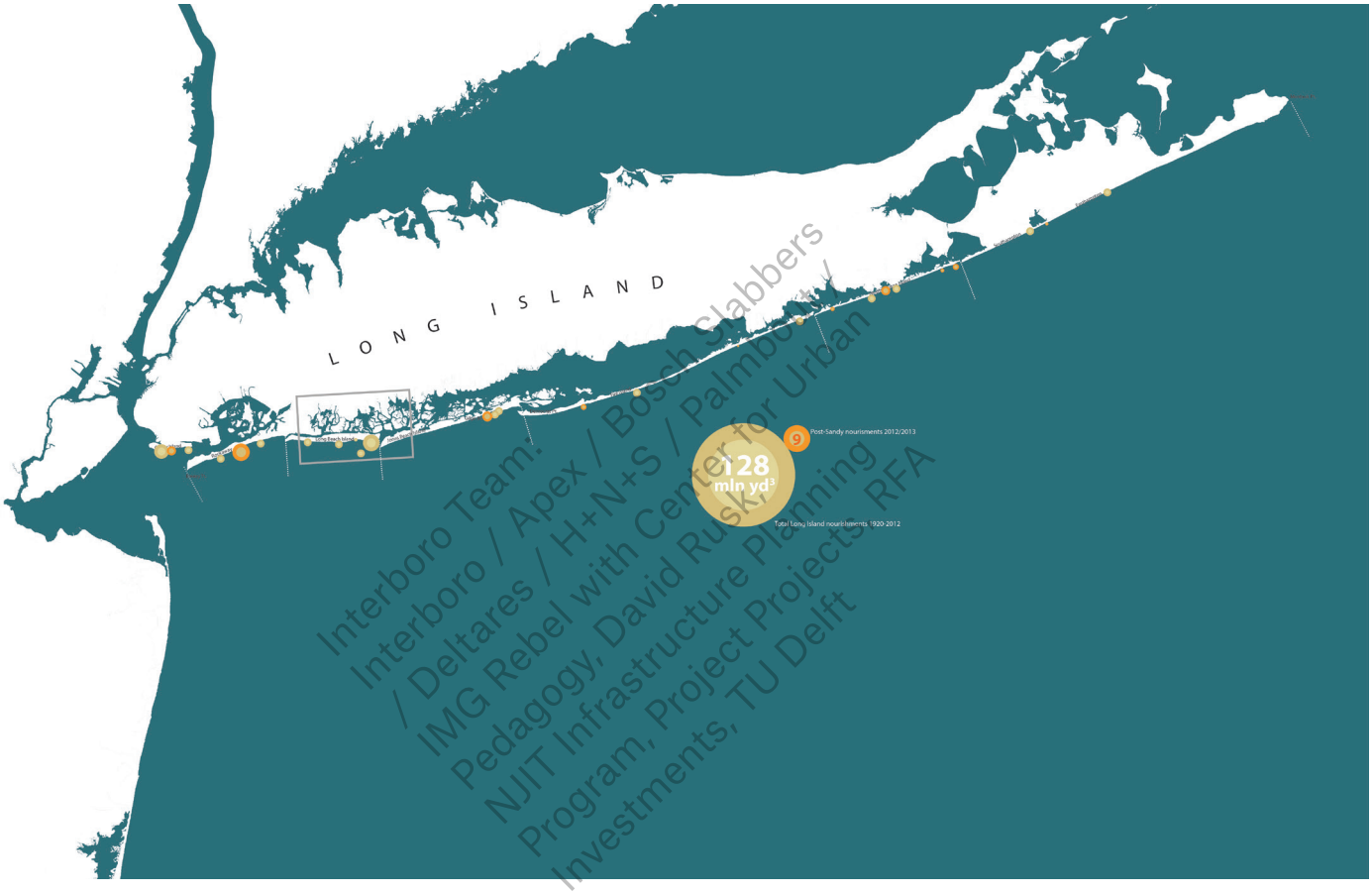
Accretion and erosion



Interboro Team / Interboro / Apex / Bosch Slabbers / Deltares / H+N+S / Palmbout / IMG Rebel with Center for Urban Pedagogy, David Rusk, NJIT Infrastructure Planning Program, Project Projects, RFA Investments, TU Delft

Manmade structures, such as jetties, have halted the longshore migration of sediment, resulting in accretion peaks at the western side of islands and erosion in the eastern areas, needing nourishments.

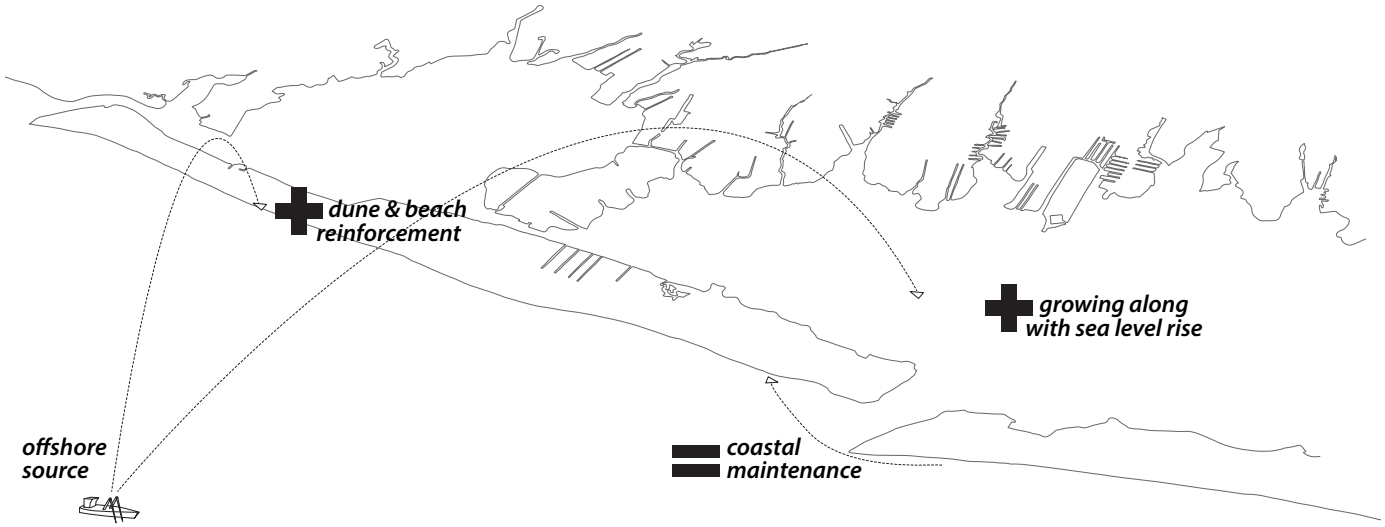
Nourishments since 1920



Interboro Team:
Interboro / Apex / Bosch Slabbers
/ Deltares / H+N+S / Palmbout /
IMG Rebel with Center for Urban
Pedagogy, David Rusk,
NJIT Infrastructure Planning
Program, Project Projects, RFA
Investments, TU Delft

Since the first beach nourishment in 1920 of Coney Island, over 128 million cubic yards of sediment have been replenished on the shores of Long Island, with nearly 9 million cubic yards of sediment nourished after Sandy hit the shore.

Accretion and erosion



There are three main challenges for the sediment system of Long Island (including Nassau County).

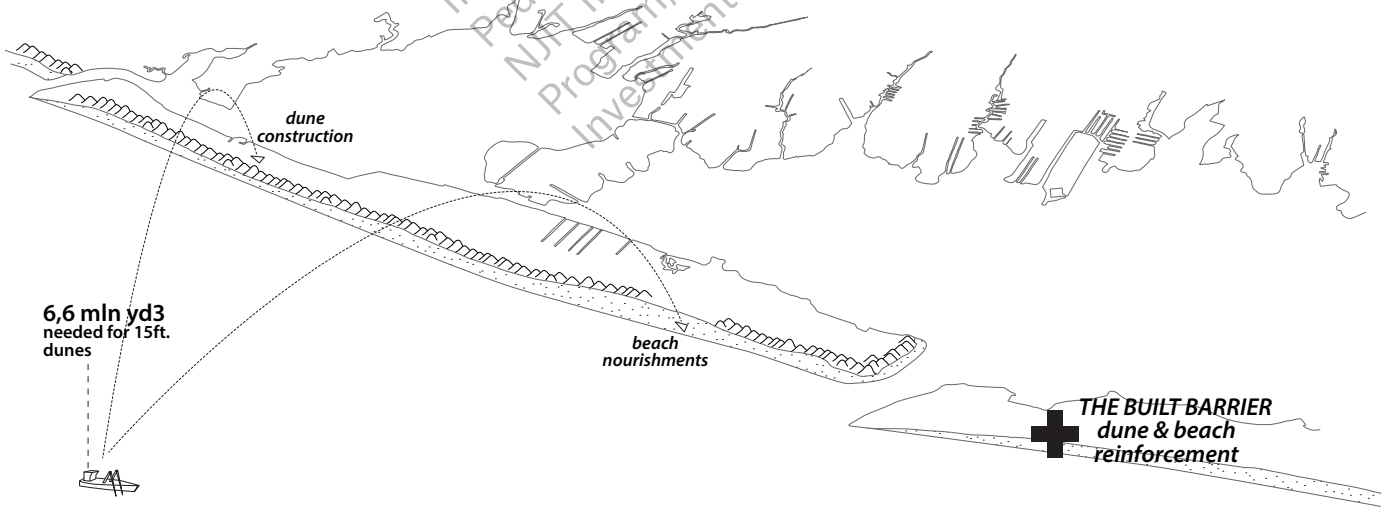
— First, the sandy coastlines of the urbanized areas need to be reinforced by adding sediment.

— Second, the coastal foundation and the bay bottom have to grow along with sea level rise by adding sediment.

— Third, the coastline should be able to maintain itself by reinstating the longshore transport through the smart use of existing sediment.

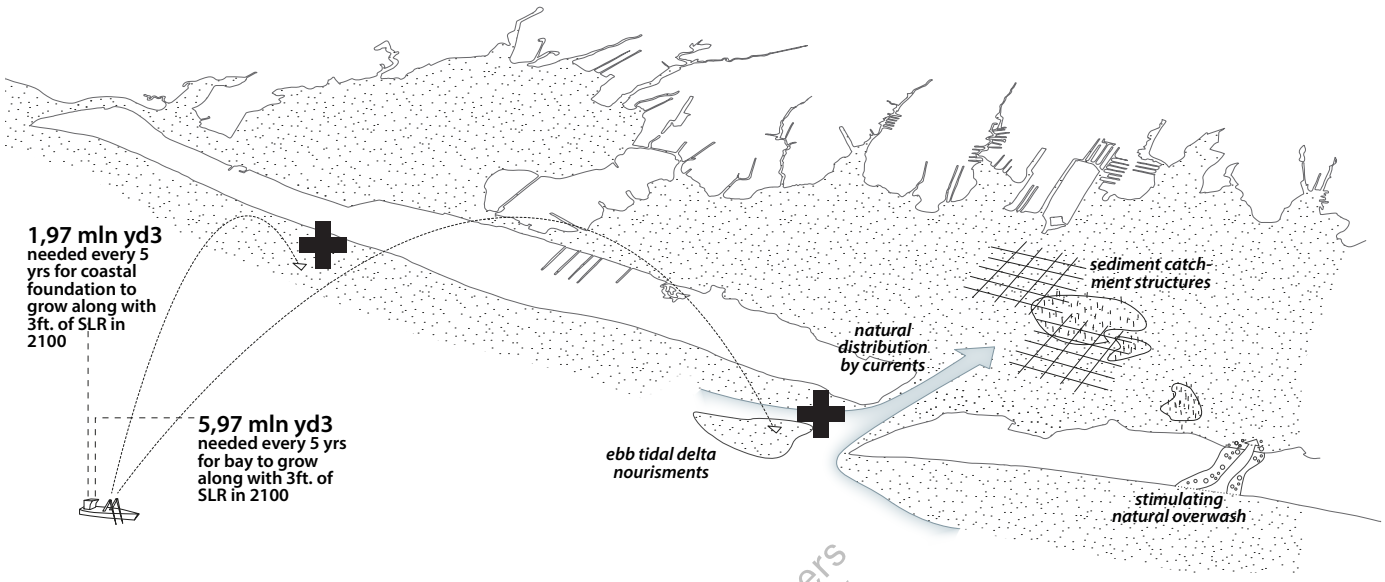
Interboro Team: Interboro / Apex / Bosch Slabbers / Deltares / H+N+S / Palmbout / IMG Rebel with Center for Urban Pedagogy, David Rusk, NJTT Infrastructure Planning Program, Project Projects, RFA Investments, TU Delft

Intervention 1: Dune and beach reinforcements



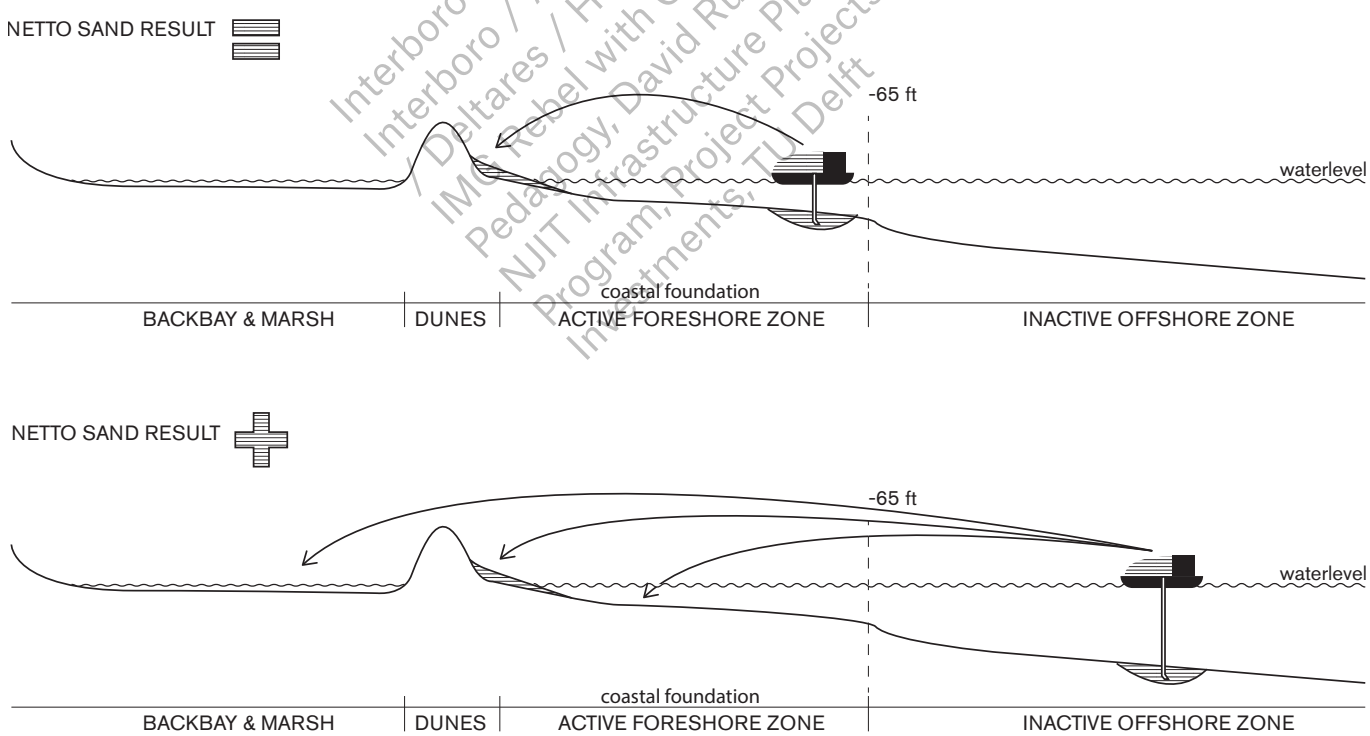
Nassau County's built barrier is to be protected by dune construction and beach nourishments, needing 6.6 million cubic yards for 15-foot dunes.

Intervention 1: Growing along with sea level rise



To grow along with 3 feet of sea level rise in 2100, both the coastal foundation that holds the beach and dunes in place and the bay bottom need extra sediment. The coastline protecting the urban areas will need 1.97 million cubic yards every 5 years and the bay demands 5.97 million cubic yards every 5 years to grow along, unless islands are allowed to shift landwards. Sediment inflow toward the bay can be stimulated by ebb-tidal delta nourishments, stimulating natural overwash and breaches, and by improving the catchment of sediment, for example by catchment structures.

Do not draw from your own stock

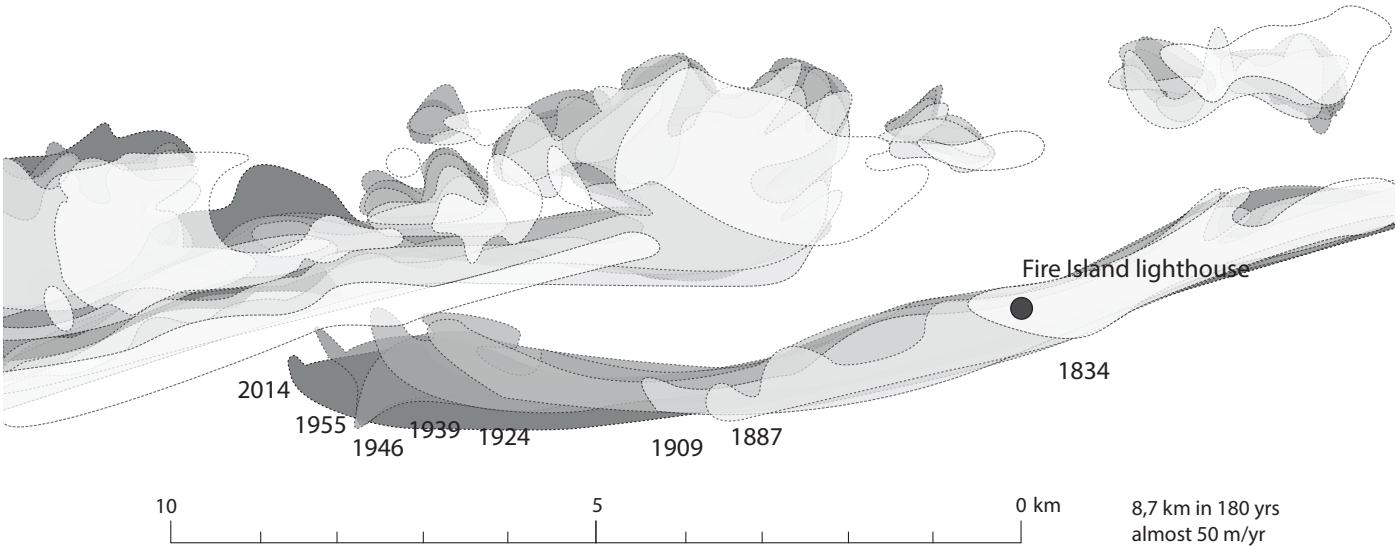


Interboro Team: Dirk Sijmons / Interboro / Apex / Sandy Hobbers / Deltares / H+N+S / Rotterdam / IMC Rebel with Center for Urban Pedagogy, David Rusk, NJIT Infrastructure Planning Program, Project Projects, RFA Investments, TU Delft

At present, beach nourishments are taken from the active foreshore zone and do not result in a net sand addition to the active zone.

Future nourishments are to be taken from the (inactive) offshore zone, which will result in a net sand addition to the active zone.

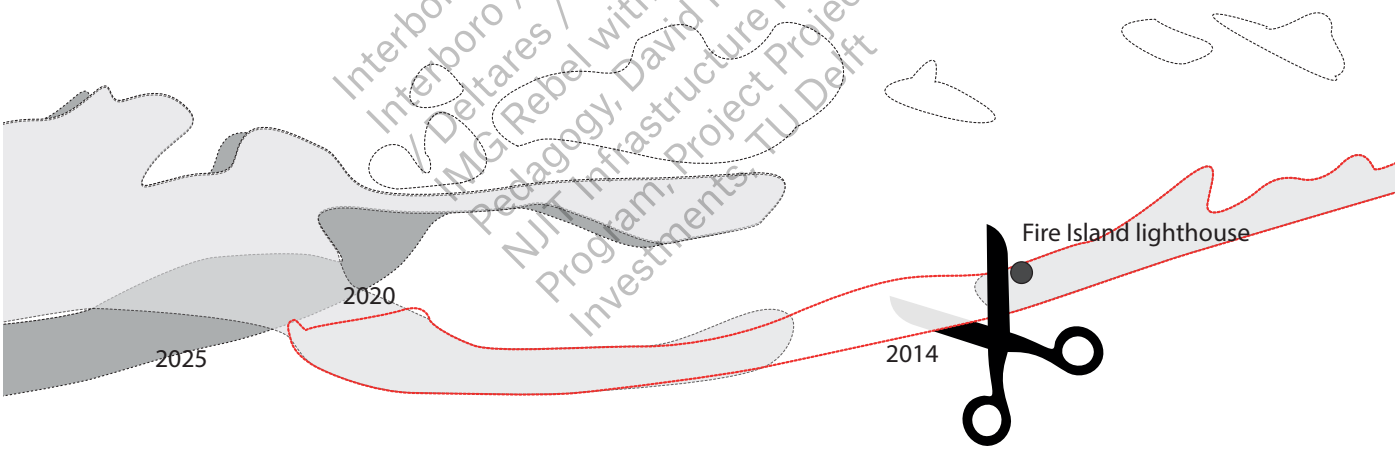
Longshore migration causing island growth



Over 180 years, Fire Island has grown 5.4 miles to the west, changing the inlet and leaving the lighthouse behind.

Interboro Team:
Interboro / Apex / Bosch Slabbers
/ Deltares / H+N+S / Palmbout /
MG Rebel with Center for Urban
Pedagogy, David Rusk,
NJIT Infrastructure Planning
Program, Project Projects, RFA
Investments, TU Delft

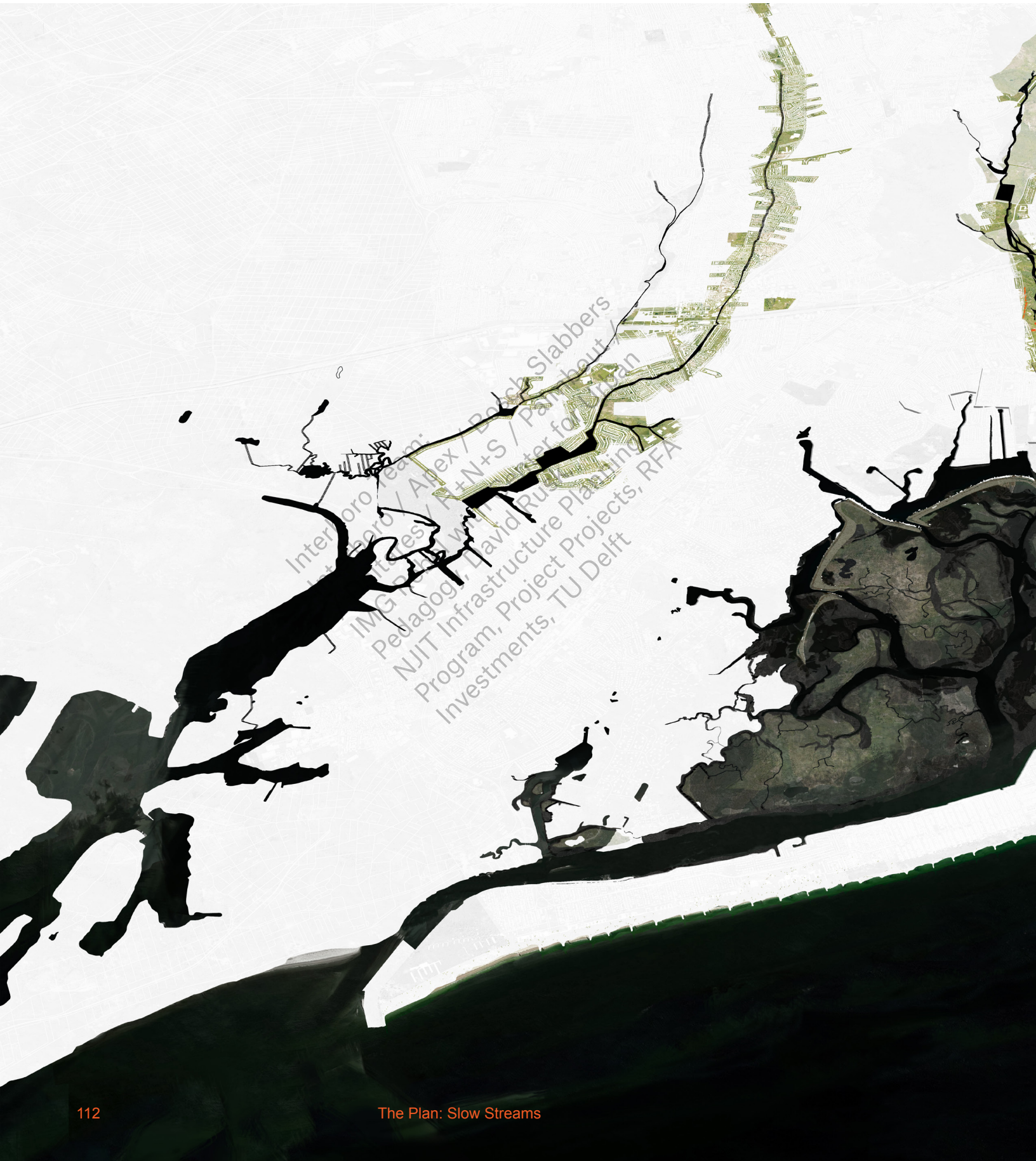
Surplus as new sediment buffer

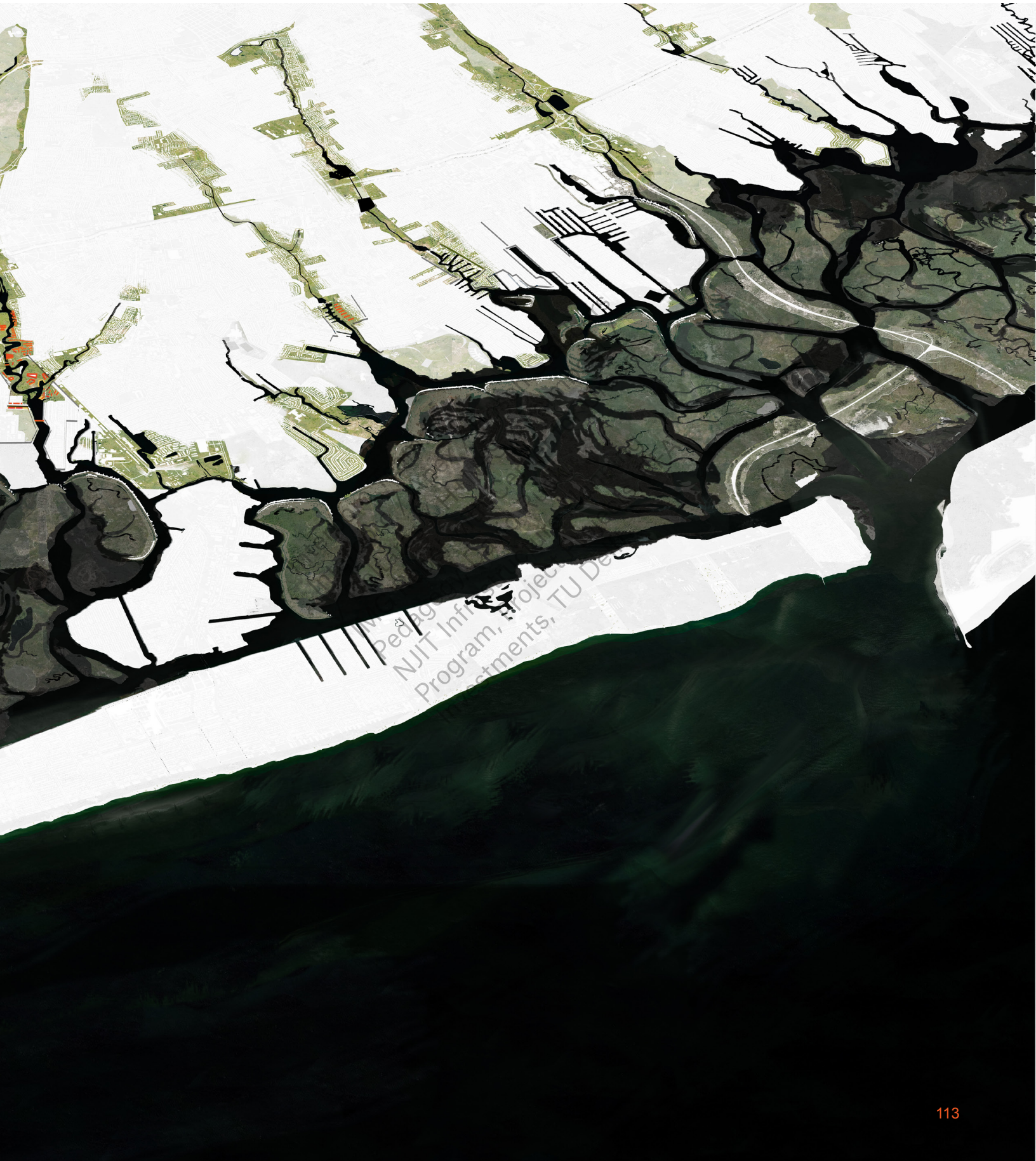


sand buffer for
next 50 years!

By giving nature a hand in the relocation of the inlet, this surplus is released and made accessible for natural coastal maintenance and accretion near weak spots.

Strategies for the Lowlands: Slow Streams





Pedagogical Use Only
NJIT Infrastructure Project Program, TU Delft Departments,

Strategies for the Lowlands: Slow Streams

Along the north-south tributaries that drain into the South Shore's Bays, we propose green infrastructure improvements to reduce inundations and pollution and also create publicly accessible greenways that connect the South Shore's communities. Proposed improvements include safety thresholds with sluices, stormwater swales for infiltration and water storage, fish ladders, and "aquaphilic" housing prototypes.

Like many natural watersheds in the northeast, Nassau County's Mill River watershed has over time become a human-controlled drainage basin. Once upon a time, rivers and creeks like the Mill River fed Nassau County's bays with sediment and fresh water and simultaneously recharged the groundwater. Natural buffers once accommodated the occasional surge and offered access to scenic, recreational waterways. Today the rivers are crucial less for their natural or recreational functions and more for their capacity to drain and channel stormwater from upland communities through low-lying ones and then into the bay. The natural buffers that kept people out of harm's way and kept the riverbed pristine have been developed with low-density suburban development, a fact that has increased the amount of stormwater runoff draining into the rivers. This runoff is a major contributor to the pollution of the bay, but it also causes flooding: when the rivers rise above the outflow pipes that channel the stormwater into the bay, as often happens in Nassau County, the pipes back up and cause flooding upland. Large infrastructure interventions like roads, bridges, and dams have exacerbated this situation, creating "choke points" that reduce the supply of sediment and reduce the resiliency of the system. However, water moves in the other direction, as well. These rivers are directly connected to the bay, and water moves up them on a daily basis though the tidal cycle. Furthermore, when bay water levels rise during a storm, the surge channels up through the river, inundating the communities adjacent to the river.

In this strategy we propose to bring these challenges together in one comprehensive long-term perspective. In time, we think all of Nassau's rivers can serve as spines where more and more activities could be implemented to increase safety, water quality, stormwater storage, urban identity, ecological quality, and public access.

We propose a number of short-term, "no-regret" measures informed by a long-term perspective.

Interboro Team / Alex / Posen Stanley / Deborah Pitts / Dominique / Michael Wright / Connie Zhou / Brian Rebecca Lewis / Ryan Dunn / Jonathan Rose / Nicholas Pinto / Nina Rappaport / Mathew Ritchie / Pamela Hanlon / Ann Buttenwieser / Kate Orff / Dennis Mcneill / Richard Plunz, RFA

Specifically, we propose to

—Control the outflow of the rivers by building sluices, which can create extra storage capacity. By extending a sluice, more room for water storage in the direct surroundings of the water body can be realized.

—Excavate underutilized and vacant areas along the rivers to store more water. Excavated sediment can be used to create levees, elevate streets, and elevate individual lots or even whole new developments.

—Adjust stormwater outflows to prevent back-flooding and to provide extra filter capacity to improve the water quality. The streets that harbor the drains for the stormwater could gradually transform with regular maintenance to blue-green streets that store and filter water.

—Build a network of dike rings to reduce flood risk.

—Build denser, "aquaphilic" housing developments near transit infrastructure.

—Where possible, and while being sure to maintain minimum water levels, remove dams to stimulate vertical sedimentation and relieve choke points in such a way that natural fresh/brackish/salt gradients will be optimized. For remaining dams that can't be removed, install fish and eel passages.

—Store/retain water via a cascade of ponds. With a better control of the flow of the river, it will be possible to slow down the stormwater; ponds could serve as water storage basins and cooling areas for the neighborhood, but they could also recharge the aquifer.

—Reinfiltrate effluent from the Bay Park Sewage Treatment Plant. With the scarcity of water, we have to treat effluent as a valuable resource that can feed our rivers and recharge the aquifer.

Interboro Team / Interboro / Alex / Bosch Slabbers / Deltares / H+N+S / Rampoult / IMG Stadt Land Fluss / Dutch Council for Urban Pedaling / Dutch Ministry of Infrastructure and Water Management / Dutch Ministry of Infrastructure and Environment / Dutch Ministry of Interior and Kingdom Relations / Dutch Ministry of Spatial Planning / Provincie Zuid-Holland / Programme Bureau Projects, RFA Investments, Dutch Delta Planning

Phase One

A Stormwater System for the Mill River Watershed

This Phase One project combines different elements as the first phase of a much larger project. In the first phase, we propose to better control stormwater in the Mill River watershed. The Phase One project consists of the following elements:

—A sluice to protect from large storm events. Remaining open and allowing for normal tidal movement during non-storm times, during storms, the proposed sluice will close at low tide to store stormwater and create extra buffer capacity.

—More room for the river. At the Village of Rockville Centre's temporary storage site just south of Bligh Field and the intersection of Riverside Road and Mill River Avenue, we propose excavating this underutilized parcel to make more room for the river. We propose redesigning the site as a public park that could provide access to the river. In addition to temporarily storing municipal materials such as street trees to be planted, mulch, and so on, the park would be redesigned to temporarily store water. Using retention ponds and reed/sand filters, the park could purify stormwater from the stormwater outlet along Mill River Avenue before it was released into the river. In an extreme event, stormwater would flow through this purifying park into the Mill River. By lowering the site, there would be more area to store water in the watershed in an extreme event.

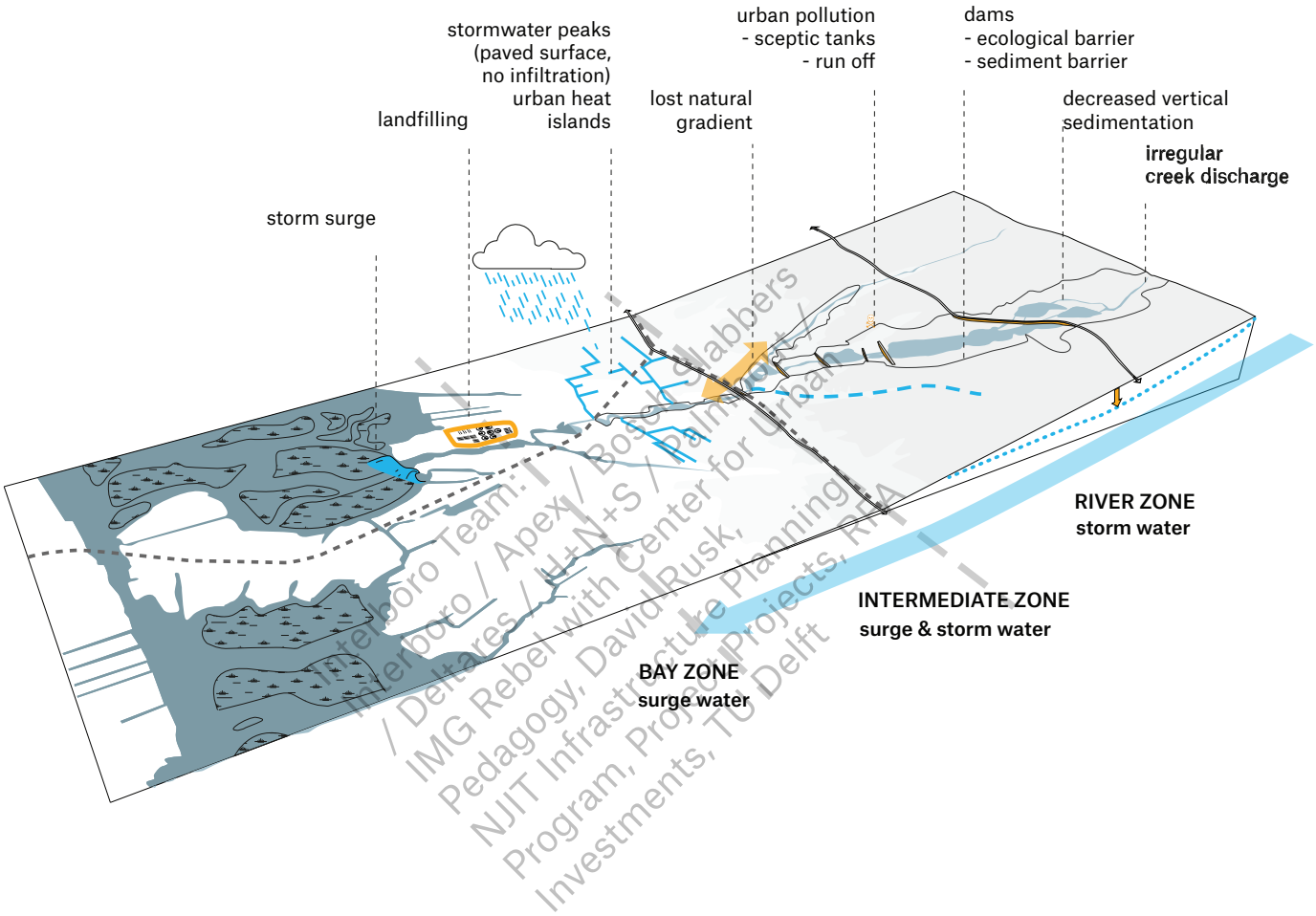
—A stormwater swale. To address stormwater problems along the Mill River, we propose to redesign the streets in order to store and filter more water (and of course enhance the quality and attractiveness of the street!).

Interboro Team
Interboro / Deltares / IMG Gebel / Pedestrian / OMA / Bosch Slabbers / Rambaud / Center for Urban Spatial Infrastructure Planning / TU Delft / Data Arts / RFA Transportation Planning / Delft

Interboro Team:
Interboro / Apex / Bosch Slabbers
/ Deltares / H+N+S / Palmbout /
IMG Rebel with Center for Urban
Pedagogy, David Rusk,
NJIT Infrastructure Planning
Program, Project Projects, RFA
Investments, TU Delft

Mill River is transformed into a green-blue corridor that both stores and filters water and provides accessible public space and room for new urban developments.

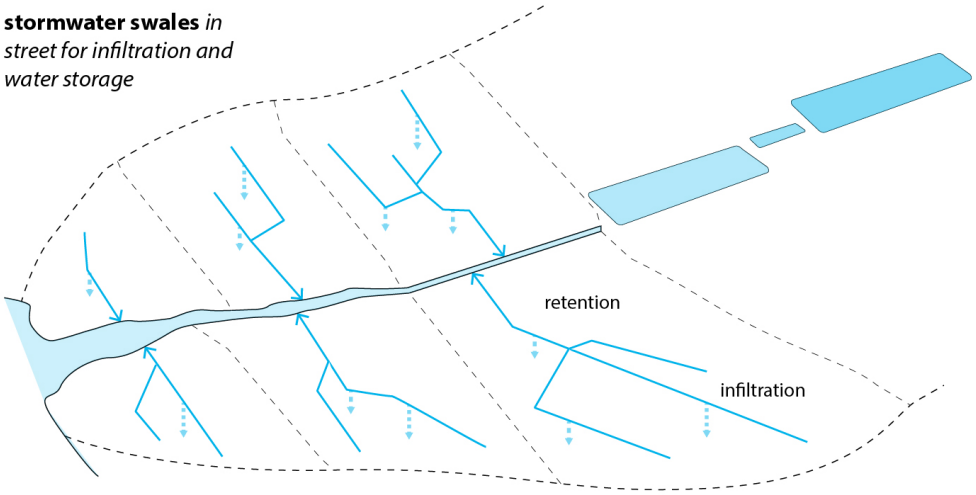
Challenges for the streams



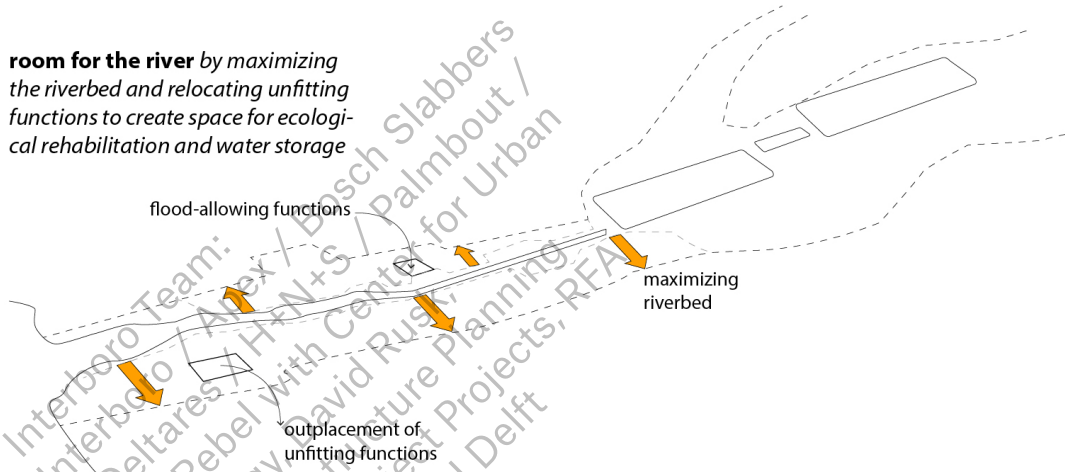
The challenges that have been described for the whole region are made site specific for the sub-region. The Mill River can be divided into three zones: one that deals mainly with surge water, one that deals solely with storm water, and an intermediate zone that deals with both. The challenge is to solve water safety problems and, while doing so, incorporate a multitude of other challenges, such as improving water quality, ecological recovery, and aquifer recharge.

Slow Stream Elements

stormwater swales *in street for infiltration and water storage*

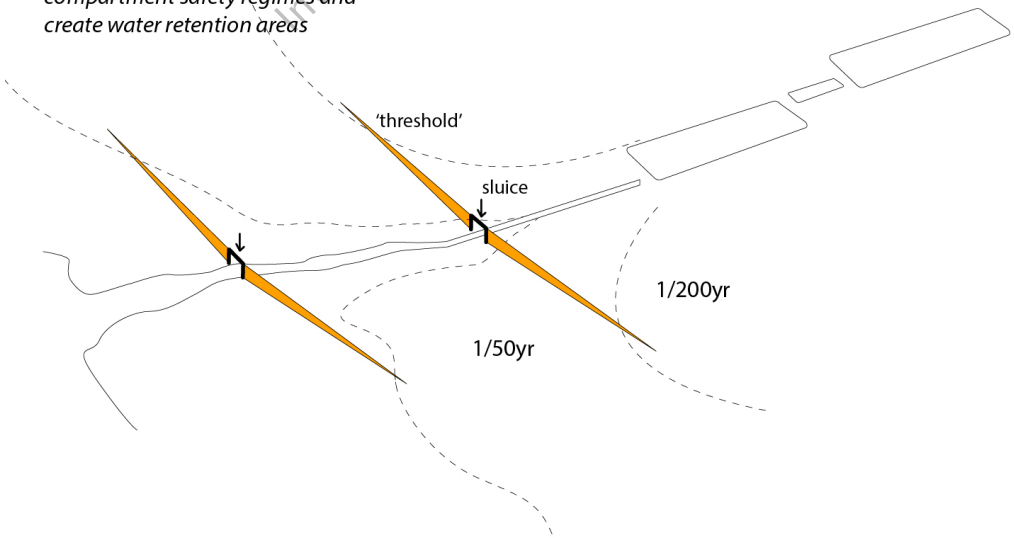


room for the river *by maximizing the riverbed and relocating unfitting functions to create space for ecological rehabilitation and water storage*

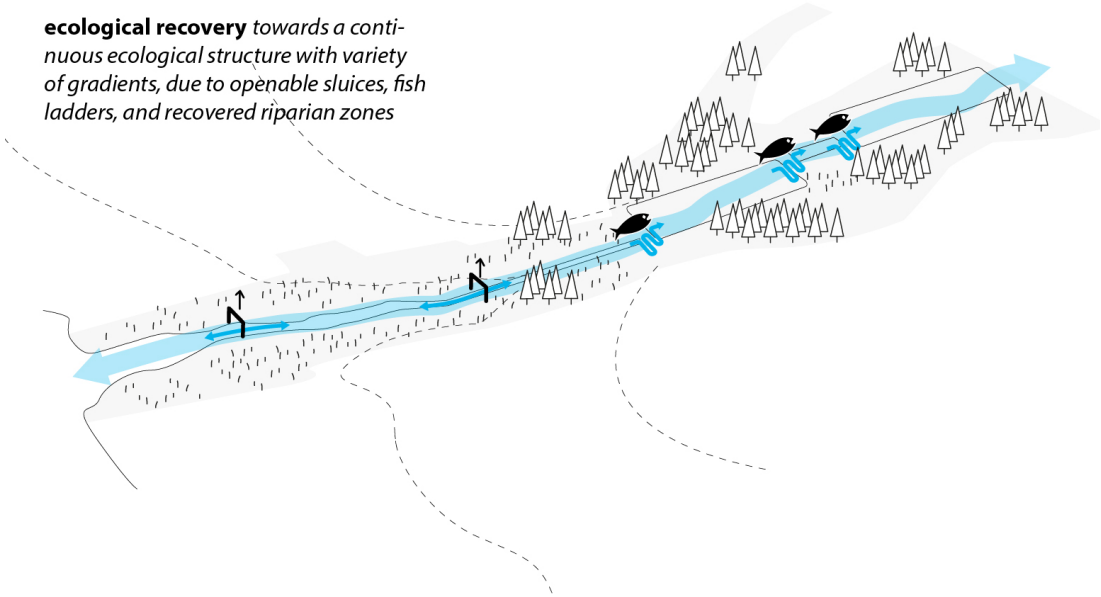


Interboro Team: Interboro / Arex / Bosch Slabbers / Deltares / H+N+S / Palmbout / IMG Rebel with Center for Urban Pedagogy, David Rush, NJIT Infrastructure Planning Program, Project Projects, REFA Investments, TU Delft

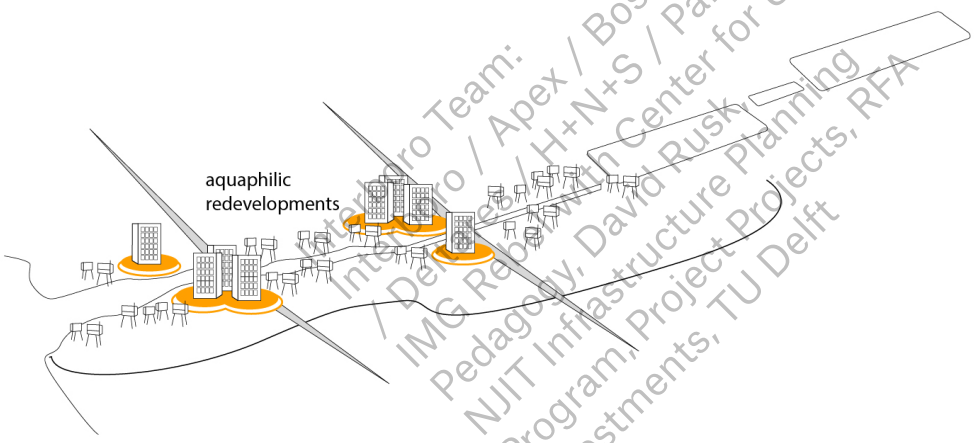
safety thresholds *with sluices compartment safety regimes and create water retention areas*



ecological recovery *towards a continuous ecological structure with variety of gradients, due to openable sluices, fish ladders, and recovered riparian zones*

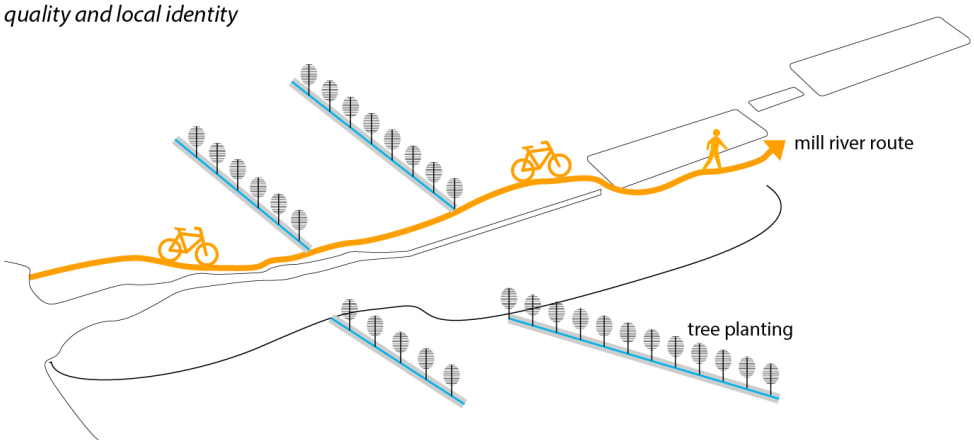


aquaphillic urban redevelopments; *affordable & flood-proof redevelopment of the river banks by building on mounds, stilts or floatable*

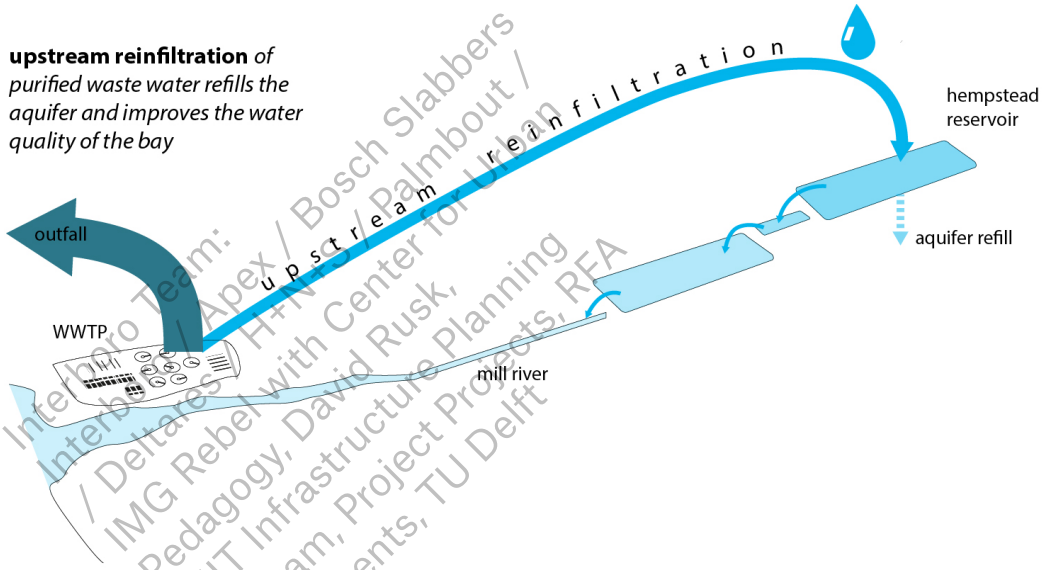


Interbro Team:
Interbro / Apex / Bosch Slabbers
/ Dekkers / H+N+S / Palmbout /
IMG Rebmann Center for Urban
Pedagogy, David Rush,
NJIT Infrastructure Planning
Program, Project Projects, RFA
Investments, TU Delft

continuous recreational river routes *connect bay to hinterland and urban area to the river, while swale planting improves urban quality and local identity*



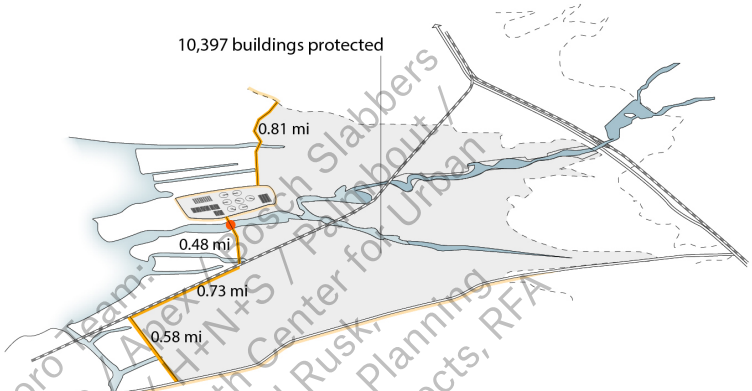
upstream reinfiltration *of purified waste water refills the aquifer and improves the water quality of the bay*



Interface Team: Interface / Apex / Bosch Slabbers / Deltares / H+N+S / Palmbout / IMG Rebel with Center for Urban Pedagogy, David Rusk, NJIT Infrastructure Planning Program, Project Projects, REA Investments, TU Delft

PHASE 3: OPTIONAL SECONDARY THRESHOLD
- following Atlantic Ave.
- 1 more sluice in Mill River

PHASE 2: PRIMARY THRESHOLD
- connecting WWTP to high ground
- connecting WWTP to rail
- connecting rail to long beach rd.
- 1 sluice in Mill River

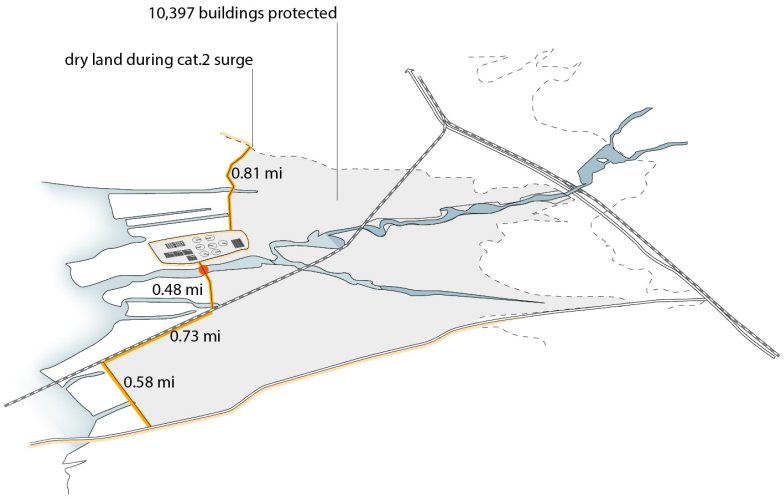


Interboro Team: Interboro / Anex / Bosch Slabbers / Deltares / H+N+S / Paul Knott / MG Rebel with Center for Urban Pedagogy, David Rusk, NJIT Infrastructure Planning Program, Project Projects, RFA Investments, TU Delft

PHASE 1: CRITICAL INFRASTRUCTURE (no-regret)
- ring levee around WWTP
- bringing car evacuation route up to flood-safe elevations
(- option: bringing train evacuation route up to flood-safe elevations)

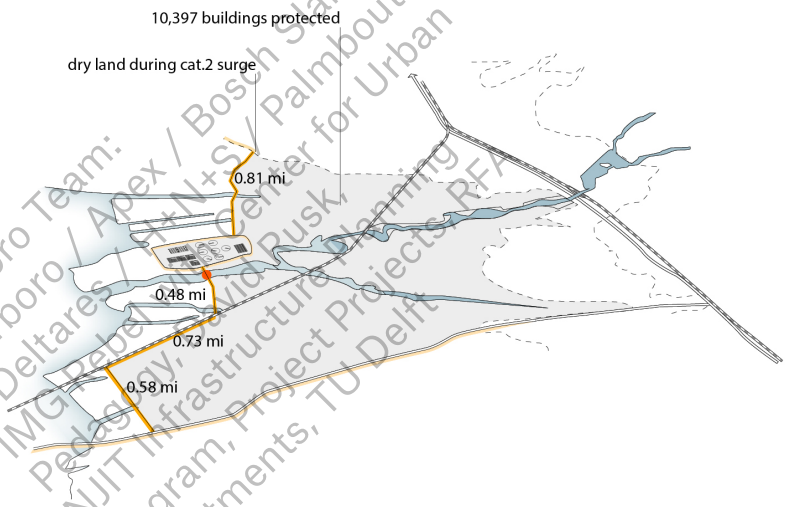
PRIMARY THRESHOLD

- connecting WWTP to high ground (dry land during cat.2 surge)
- connecting WWTP to rail
- elevating part of the railroad
- connecting rail to long beach rd (evacuation route).



PRIMARY THRESHOLD

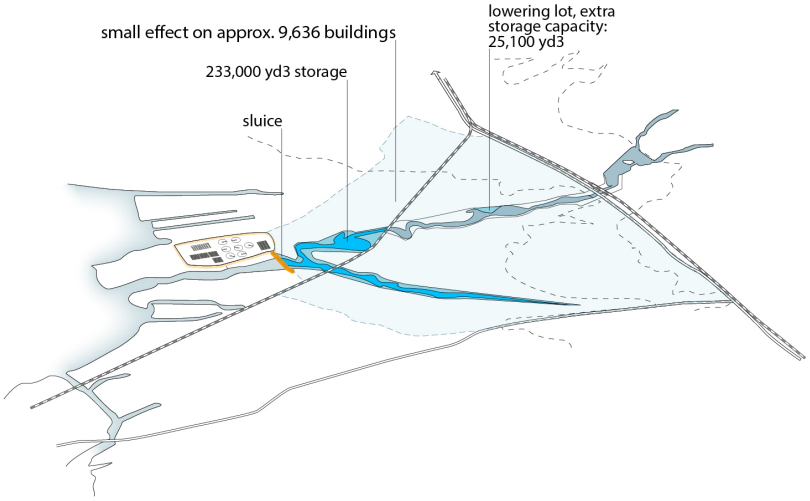
- connecting WWTP to high ground (dry land during cat.2 surge)
- connecting WWTP to rail
- elevating part of the railroad
- connecting rail to long beach rd (evacuation route).



Interboro Team: Interboro / Apex / Bosch Slabbers / Deltares / H+N+S / Palmbout / IMG Rebel / Center for Urban Pedagogy, David Rusk, NJIT Infrastructure Planning Program, Project Projects, RFA Investments, TU Delft

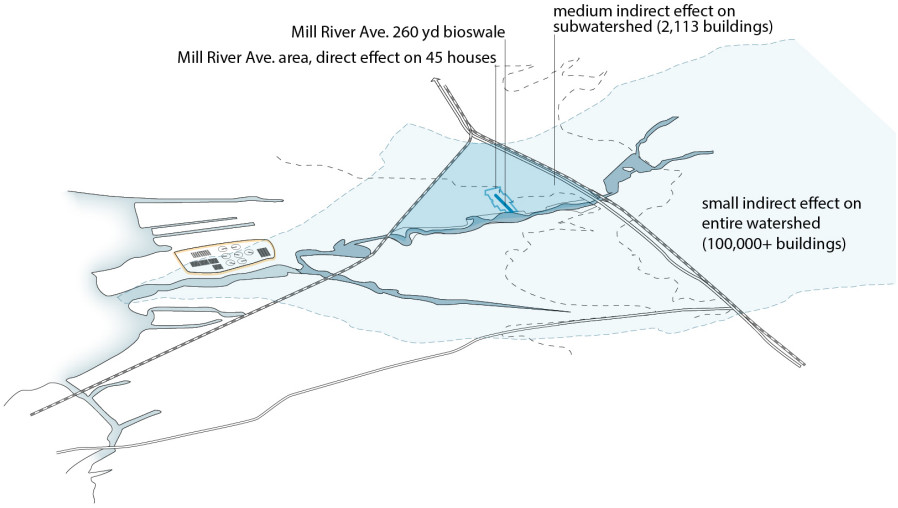
MILL RIVER SLUICE GATE

- 80 yd wide sluice gate near WWTP
- closed at low tide during storm event for max. storage
- 4ft x 175,000 yd2 = 233,000 yd3 of extra storage
- storage volume can be enlarged by lowering adjacent lots and adding upstream segments to the storage basin
- roughly an effect on 9,636 buildings



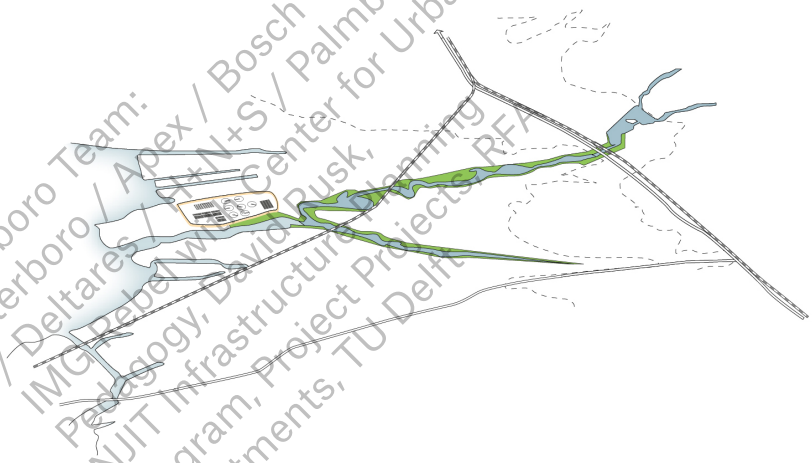
MILL RIVER AVENUE STORM WATER SWALE

- 260 yd stormwater swale in Mill River Avenue
- large direct effect on 45 houses
- medium indirect effect on subwatershed (2,113 buildings)
- small indirect effect on entire watershed (100,000+ buildings)



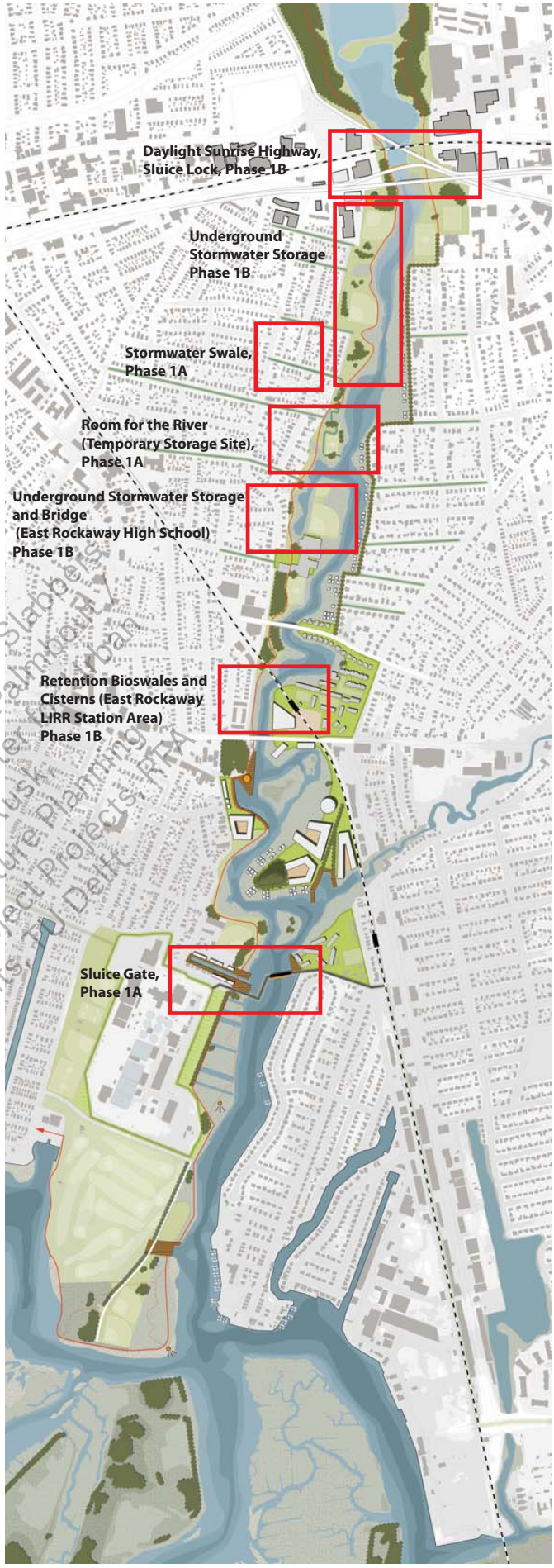
PHASE 2: PRIMARY THRESHOLD

- connecting WWTP to high ground
- connecting WWTP to rail
- connecting rail to long beach rd.
- 1 sluice in Mill River



Interboro Team:
Interboro / Apex / Bosch Slabbers / Deltares / H+N+S / Palmbout / IMG Rebel with Center for Urban Pedagogy, David Rusk, NJIT Infrastructure Planning Program, Project Projects, RFA Investments, TU Delft

Strategic plan for Mill River

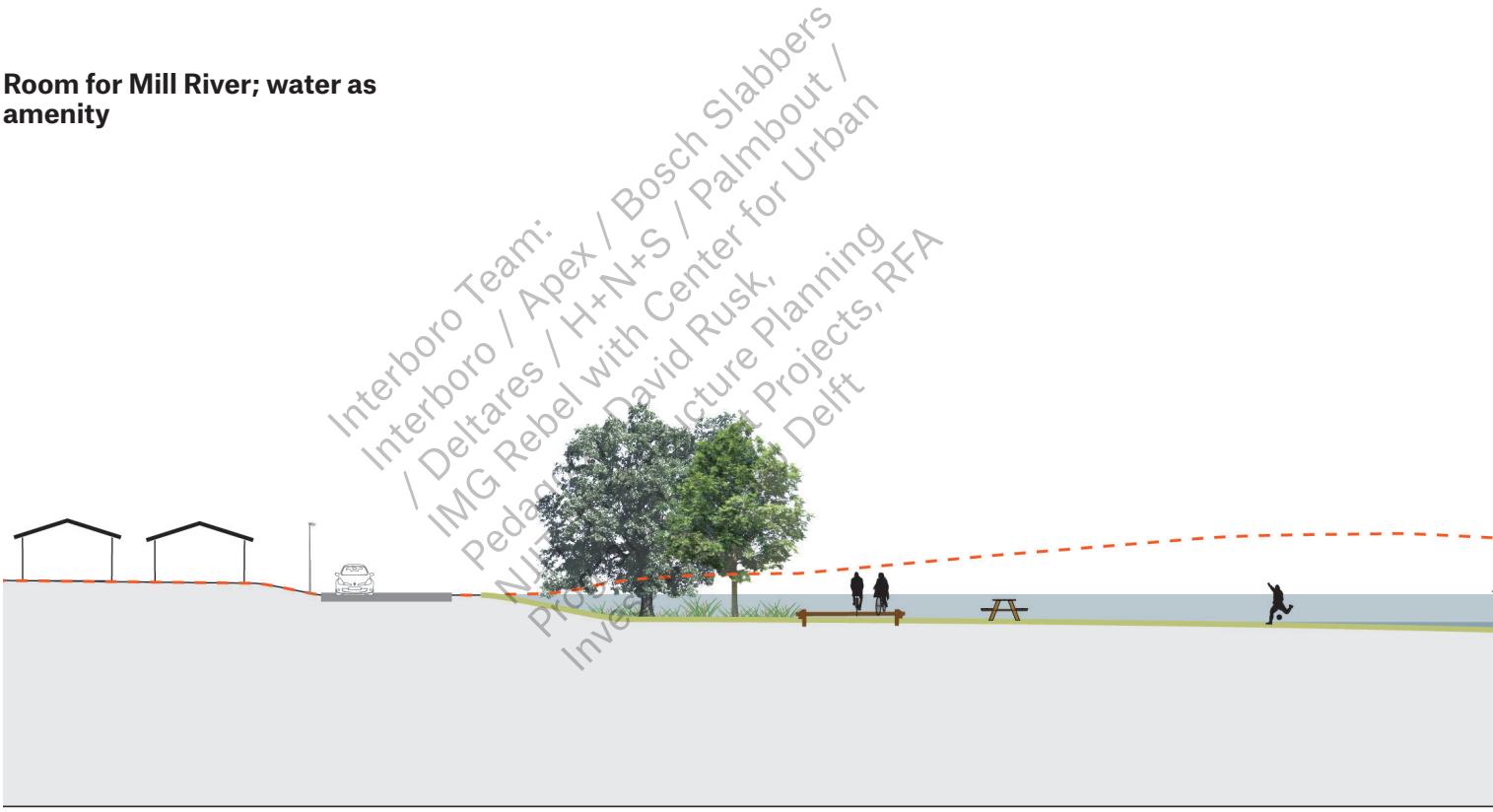


Interboro Team:
Interboro / Apex / Bosch Slabbers
/ Deltares / H+N+S / Palmbout Urban
IMG Rebel with Center for Urban
Pedagogy, David Rusk
NJIT Infrastructure Planning
Program, Project Projects, RFA
Investments, TU Delft

Mill river, connecting upland ponds to the bay, over time can change due to several strategic interventions. This map also identifies a number of Phase 1B interventions.

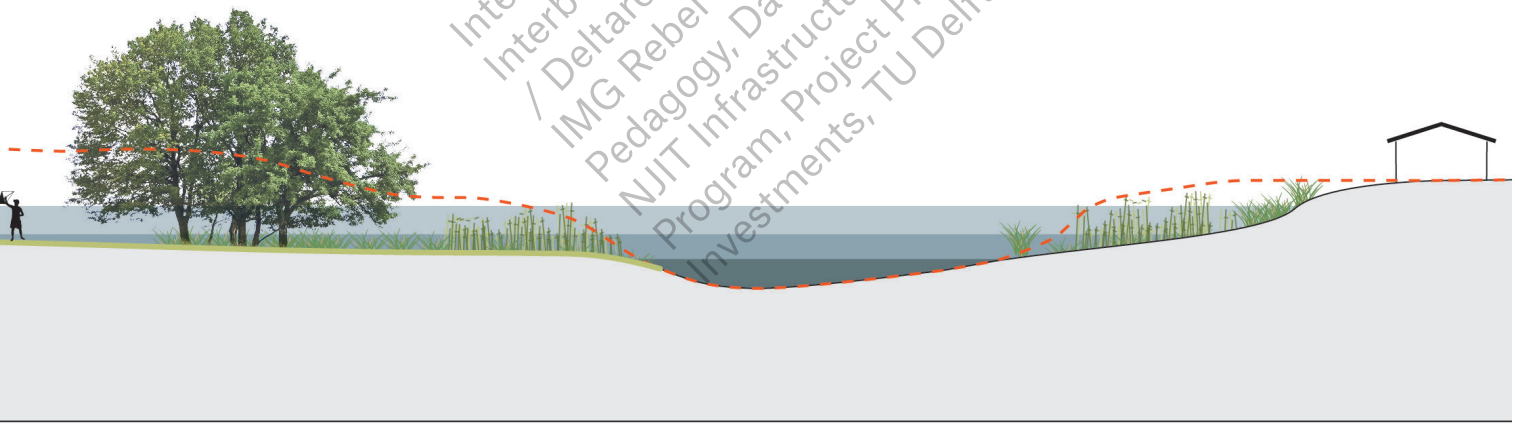
Street swale performing during a rain event

Room for Mill River; water as amenity



The former dumpsite, now lowered and recovered as river floodplain and accessible public space reattaches adjacent neighborhoods to Mill River.

Interboro Team:
Interboro / Apex / Bosch Slabbers / Deltares / H+N+S / Palmbout / IMG Rebel with Center for Urban Pedagogy, David Rusk, NJIT Infrastructure Planning Program, Project Projects, RFA Investments, TU Delft



The municipal dumpground of Rockville Centre will be transformed to a stretch of water park that can inundate during storm events and that helps purify storm water run-off from adjacent streets to improve water quality, while in the meantime providing a pleasant public place.

View of the future river park

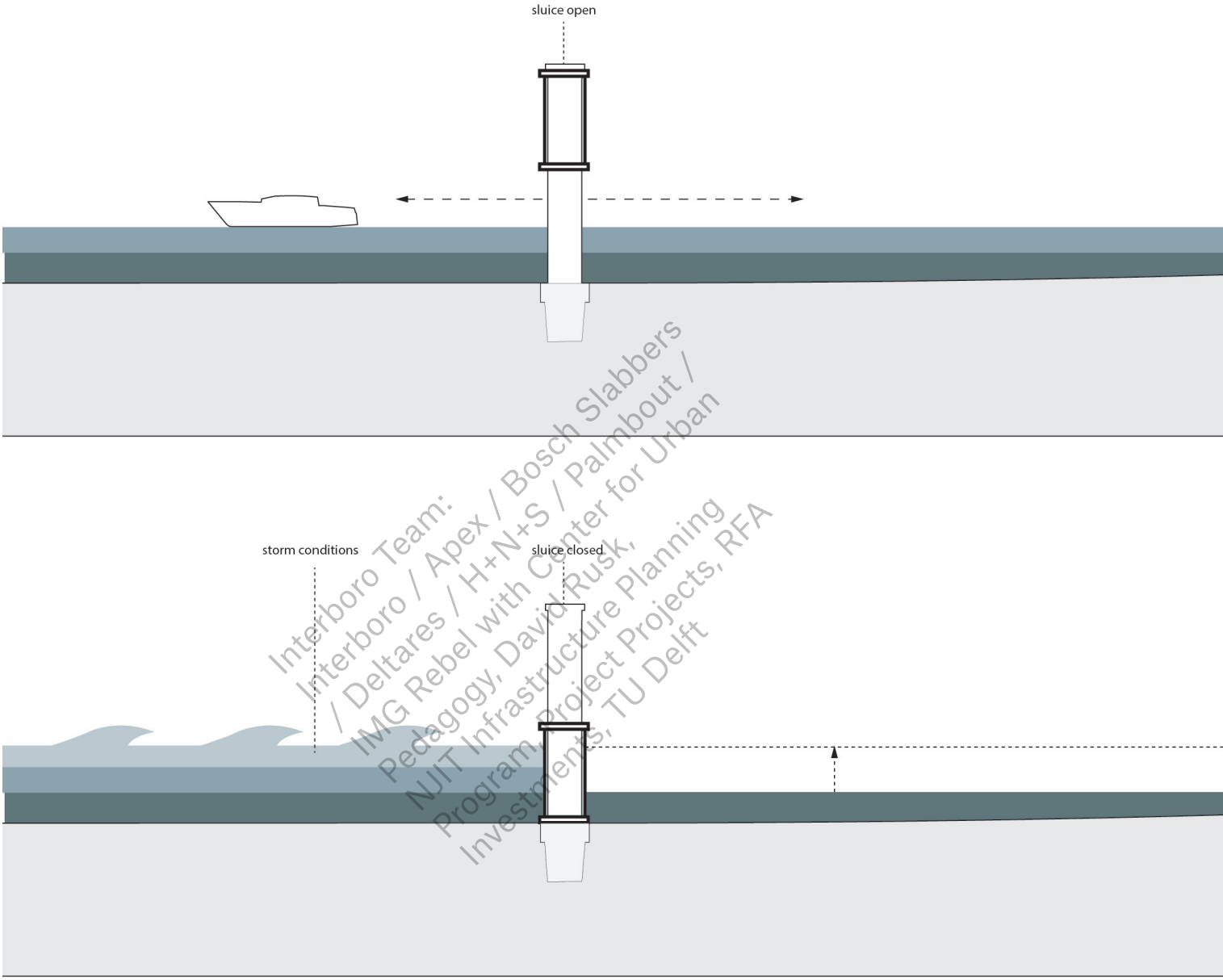
Mill River Ave. storm water swale

The bioswale as an amenity for the street, improving its everyday urban quality.

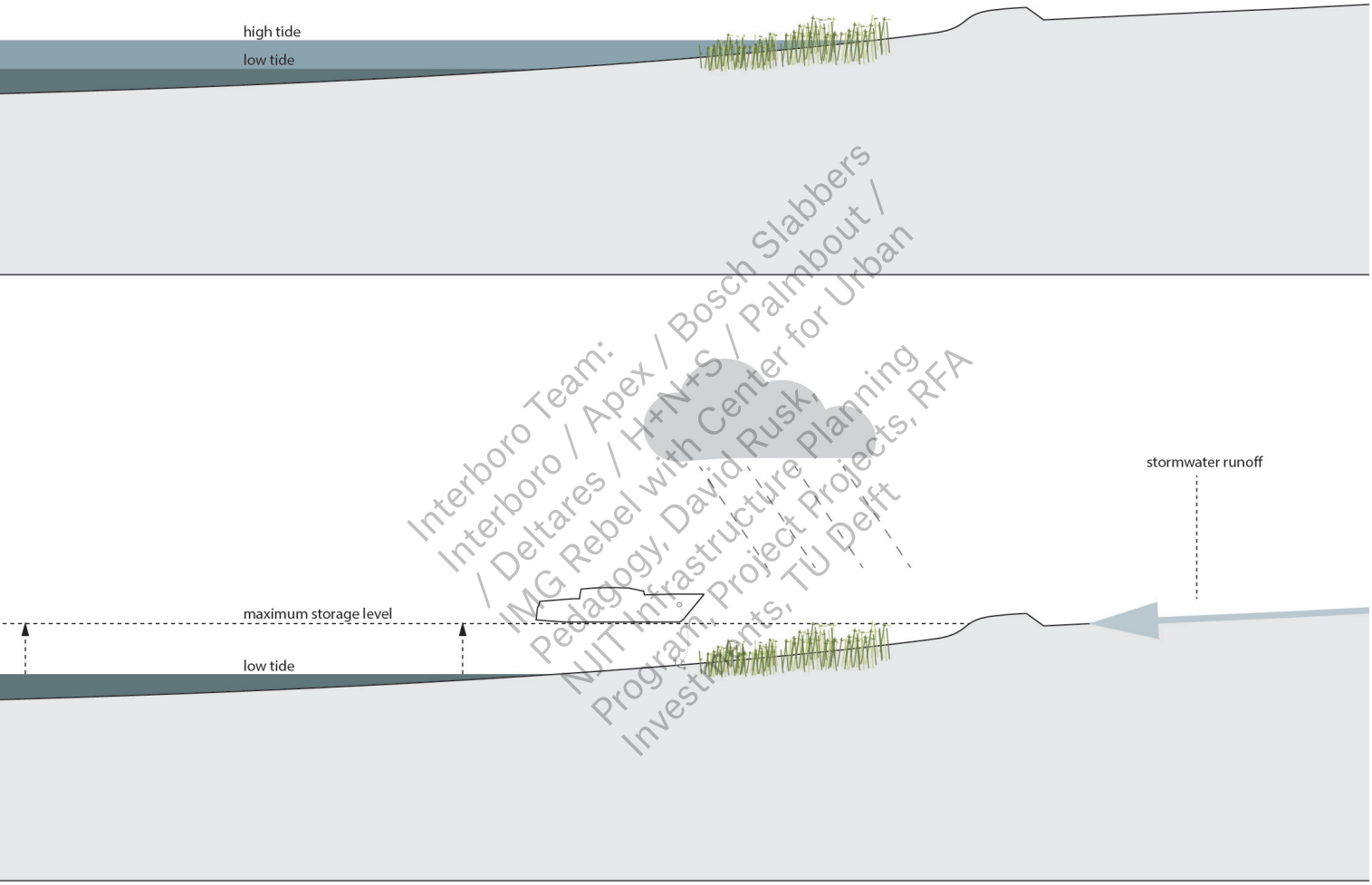
Bosch Slabbers
S / Palmbout /
nter for Urban
Rusk,
cture Planning
NJIT
Program, Project Projects, RFA
Investments, TU Delft

Presently, Mill River Ave is dominated by impermeable tarmac and water is discharged via grey infrastructure. After reconstruction of the street, the excess of tarmac has been replaced by a permeable berm for parking and a bioswale that helps infiltrate, clean and store stormwater.

Mill River Sluice



Interboro Team:
Interboro / Apex / Bosch Slabbers
/ Deltares / H+N+S / Palmbout /
IMG Rebel with Center for Urban
Pedagogy, David Rusk,
NJIT Infrastructure Planning
Program, Project Projects, RFA
Investments, TU Delft



Interboro Team:
Interboro / Apex / Bosch Slabbers
/ Deltares / H+N+S / Palmbout /
IMG Rebel with Center for Urban
Pedagogy, David Rusk,
NJIT Infrastructure Planning
Program, Project Projects, RFA
Investments, TU Delft

During everyday conditions, the sluice is open and both tide and boats can pass. During storm conditions, the sluice will be closed at low tide, allowing for a maximum storm water storage capacity in the basin behind the sluice, while the sluice itself keeps out storm waves.

Mill River: the norm

Interboro / Bosch Slabbers / Deltares / Palmbout / IMG Rebel / Urban Pedagogy, Delft University for Urban NJIT Infrastructure Planning Program, Project Investments, TU Delft

The Mill River recovered as a slow stream during everyday conditions. An open sluice allows tide to enter. River floodplains are recovered for natural gradients as well as for sport and leisure. New urban developments are flood-proof and focused toward the water.

Mill River: the storm

Interboro / Deltares / IMG Rebel with Co-Pedagogy, David Rush NJIT Infrastructure Planning Program, Project Delft Investments, TU Delft

The Mill River recovered as a slow stream during storm conditions. A closed sluice allows rainwater to be stored and keeps out surge and tides. River floodplains are flooded as stormwater is stored. Residents of new flood-proof urban developments experience this water spectacle from up close.

How did the research frame and provide a deeper understanding of the problem?

Sandy damaged approximately 2,200 buildings within the Mill River watershed. The Mill River watershed is a perfect example of a prototypical watershed in the Long Island region as well as New Jersey. Over time, the river has been transformed from a natural watershed to a human-controlled drainage basin. Rivers and streams like Mill River used to feed Nassau County's Bays with fresh water and sediment, crucial for a healthy environment. They also served as important habitats for a wide range of fish and wildlife. The rivers were fed from groundwater, which was continuously recharged by fresh water infiltration. Nowadays the rivers are crucial in mostly draining and channeling stormwater from upland neighborhoods through low-lying communities. They get their water almost entirely from rain. Most of the watershed is developed with low density urban sprawl, resulting in large paved areas. Large infrastructure interventions and dams have created bottlenecks. In some cases, the creeks are marginally used for water storage and ecological purposes. Public access to the river is limited, and the general water quality is poor. The Mill River water quality is extremely poor. Because of (former) groundwater extraction for daily use and the decrease in overall recharge (due to increases in impermeable areas), groundwater levels have dropped significantly. Since the river has an open connection to the bay and ocean, tide is of significant influence to the lower part of the watershed. During storms, a combination of tide and storm surge constitutes an imminent threat of flooding to the low-lying communities. Furthermore, this higher water level in the river makes it difficult for stormwater to drain into the river or even, in worst case scenarios (progressively increasing with sea level rise), pushes the water up into the stormwater drains, flooding higher grounds.

How did the research inform the proposed solution?

Flood vulnerability, ecology, urban quality, and stormwater issues are intertwined within our solution, as flood vulnerability is a result of the location and natural circumstances in which these residential areas were developed.

How did the research demonstrate new or improved ways of identifying, measuring, mapping, evaluating, understanding, and communicating risk?

Available information from different sources was filtered by experts to visualize the impact of the different challenges. Different techniques of visualization were employed, utilizing easy-to-read, accessible graphics, to explain the challenges to a very broad audience. The specific water threat challenges (surge from the bay and ocean, stormwater, sea level threat) were also visualised on georeferenced base maps with accurate elevation data. On a larger level, a calculating model that is tested based on actual data was implemented to validate the data and numbers.

Interboro Team: Alex Ely Stabers / Interboro / Architecture + Urbanism / Deltares / Hydrologic Consultants / IMPACT Public Relations / Rebecca Lewis Daniel / Research Institute for Urban Resilience / Delft University of Technology / Delft University of Technology, OFFA

How did the research demonstrate cascading impacts and interdependencies?

The watersheds of rivers like Mill River are areas where natural influences from the ocean, bay, upstream, and underground intertwine with urban challenges and ecological improvement. It is not as simple as taking one action to solve one problem. All interventions need to be weighed based on their influence and impact. Extensive monitoring (proposed in each project) will give better insight into the impact of the actions taken.

For the project we propose, this means there is a direct connection between the following steps:

— Development of a water retention zone by placement of a sluice. The sluice enhances ecology (gradient), provides accessibility for navigation, and is closable during storms to stop tidal surge and to accommodate stormwater.

— Making room for the river by redesigning a temporary municipal storage site to increase retention, storage, and drainage. This redesign will also improve access to the river, enhance ecological development (by optimizing gradients), and improve water quality by filtering stormwater before it is released into the river. It has the potential to make visible the importance of urban storm water management to its users.

— Developing bio-swales for water storage, infiltration, and purification on the adjacent Mill River Avenue. Besides water storage and purification, this swale will also replenish the groundwater and create an attractive street for the neighborhood. In addition, by adding trees, the urban heat island effect will be reduced.

How did the research represent a regional and comprehensive approach?

The multiple challenges for the watershed include the following:

— Increased level of protection for storms and sea-level rise

— Storage of river water and stormwater

— Infiltration of river water and stormwater

— Urban renewal, creating a new identity

— Ecological restoration for flora and fauna

— Public access

Some of these issues can be addressed and solved locally (e.g., stormwater), whereas others need to be implemented locally within a larger perspective (e.g., increased safety). Our approach simultaneously works on different scale levels with feedback loops. A long-term perspective consolidates a comprehensive approach for Long Island as a total; immediate actions on the ground feed the creation of this approach by delivering up-to-date information.

Furthermore, the approach for tackling the Mill River's issues is not unique; it can easily be replicated in different places. Of course, the process is replicable, but the actual design is not. Every watershed and river deserves its own specific design tailor made for the local situation.

Interboro Team / Area / Design Studio / Interboro / Deltares / H+N+S / Arcadis / IMG Rebel / Urban Centre for Urban Resilience / Dutch Rusk, Infrastructure Planning / Program Manager / Investment Projects, RFA

Demonstration of Participatory Design Process/Stakeholder Coalition

How did the team's participatory design process engage local stakeholder groups across sectors and interests?

For Living with the Bay, the Interboro Team engaged over 100 organizations, including academic institutions, NGOs, nonprofits, community groups, governmental agencies, and private companies.

Please see Chapter 2 for a complete list of organizations that we presented this strategy to.

Over the short time span of a few months, a fast-paced series of community meetings, workshops, and stakeholder meetings has brought together a remarkable coalition of project supporters, ranging from regional institutions such as the Long Island Regional Development Council to grass-roots advocacy groups such as Operation SPLASH.

In the case of the Slow Streams strategy, we had multiple meetings with Nassau County Department of Public Works, Town of Hempstead Department of Waterways and Conservation, and Operation SPLASH to develop a comprehensive understanding of the issue. We also worked directly with the Mayors and Superintendents of Public Works in the Villages of Rockville Centre and East Rockaway to understand their specific stormwater risks and needs.

We met with many members of the public during our community outreach events. At each public event, we presented the Slow Streams strategy and the project for the MIll River. Participants were introduced to the existing conditions, the threats, and innovative design solutions. In break-out groups, participants pored over maps and aerials of the Mill River and other Nassau County tributaries, such as the Meadowbrook, sharing their ideas in both discussion and drawing. It was remarkable and exciting that residents who lived alongside other rivers (besides the Mill) argued that the Phase One Slow Streams project should be implemented in their community! It was very easy for members of the public to understand the value of the Slow Streams strategy as well as its replicability.

We are especially proud of the larger coalition of supporters we were able to assemble through our participatory design process in a region that is notoriously fragmented.

How did the team's participatory design process facilitate collaboration among jurisdictions to understand shared problems and explore shared solutions?

Water knows no political boundaries. The north/south rivers and creeks that are the focus of the Slow Streams strategy run through many municipalities. The Mill River runs through the villages of West Hempstead, Lakeview, Lynbrook, Rockville Centre, Oceanside and East Rockaway, before emptying into the bay near Harbor Isle and Island Park. The entire watershed, which includes additional tributaries, encompasses more villages. Our proposed Phase One project includes the villages of Rockville Centre, Oceanside, and East Rockaway, and Baldwin. All municipalities acknowledge that the current stormwater system, in which stormwater runoff is channeled directly into the rivers and creeks, causes water pollution and flooding. The Nassau County DPW, the Town of Hempstead Department of Conservation and Waterways, and the mayors we spoke with understand that a shared solution is required. (Although the villages have "home rule" over their land, the water bodies themselves are regulated by the Town of Hempstead).

Specifically, we conducted the following key meetings with governmental officials about shared problems and solutions for the north/south rivers and creeks that are the focus of the Slow Streams strategy:

Interboro Team: Alex / Boston Society / Deltaform / Palmquist / IMC Consultants / Dalton, Dalton, Little / Cecilia Parkinson / Institute for Urban Planning / Investment Products, RFA / LIU Dept.

Presentation: Stakeholder Workshop: "Regional Resiliency: A Dutch Perspective"
Date: 2/4/14
Location: Office of Emergency Management, Bethpage
Attendance: Attended by 34 individuals from 27 leading organizations in Long Island, including the Nature Conservancy, Peconic Baykeeper, Operation SPLASH, FEMA's Community Planning and Capacity Building Department, Long Island Regional Planning Commission, Long Island Regional Economic Development Council, and others
Summary: Presented Stage 3 progress; received extensive feedback on marsh restoration, sediment flow, stormwater management, and protective barriers

Meeting: Town of Hempstead
Date: 2/11/14
Attendance: Jim Browne, Ron Masters
Summary: Learned about regulation of the bay and rivers; learned about recent, ongoing, and planned Department of Conservation and Waterways initiatives; discussed possible sites for making more room for the river

Meeting: NY Rising CR
Date: 2/21/14
Attendance: Laura Munafo, Zachary Richner, Jaime Rubin
Summary: Updated state on Stage 3 plan

Discussion: Superintendent at Rockville Center DPW
Date: 3/11/14
Attendance: Harry Weed
Summary: Discussed Slow Streams and Green Corridor strategies

Presentation: South Shore Estuary Reserve Council
Date: 3/11/14
Location: Seatuck Environmental Association, Islip
Attendance: South Shore Estuary Reserve Council
Summary: Presented Living with the Bay; received feedback

Discussion: Town of Hempstead Department of Conservation and Waterways
Date: 3/11/14
Attendance: James Browne
Summary: Discussed Slow Streams and Eco-Edge strategies

Discussion: Town of Hempstead Department of Engineering
Date: 3/11/14
Attendance: Jeffrey Tierney
Summary: Discussed Slow Streams and Eco-Edge strategies

Discussion: Village of Lynbrook Public Works Department
Date: 3/11/14
Attendance: Phil Healey
Summary: Discussed Slow Streams and Green Corridor strategies

Meeting: Village of East Rockaway, Village of Rockville Centre
Date: 3/20/14
Attendance: Mayor Francis Lenahan, Mayor Francis Murray, Superintendent Thomas Smith, Harry Weed, Director of Community Development Kathleen Murray, Rob Walker, County Supervisor Ed Mangano
Summary: Discussed Phase One project idea for the Slow Streams strategy; meeting resulted in support for the sluice, swale, and retention landscape

Interboro Team / Bosch Slabbers / Deltares / Arup / Pambout / IMC / Rebecca Chasan / Center for Urban Urban Policy, Development Program, Infrastructure Planning Investments, Project Delivery, RFA, TU Delft

How did the team's participatory design process solicit direct input from community members in the project area?

The Interboro Team very clearly explained the shared problems of stormwater runoff and very clearly presented our proposed solutions in numerous project partner, stakeholder, and community meetings. In clear, easy-to-understand drawings, we showed how the current stormwater system, in which stormwater runoff is channeled directly into the rivers and creeks, causes water pollution and flooding and then showed how our proposed solutions would mitigate pollution and flooding and also result in more quality public space. The current design is the product of the extensive dialogue we had with community members.

Specifically, we conducted the following meetings with community groups about shared problems and solutions for the north/south rivers and creeks that are the focus of the Slow Streams strategy:

Meeting: Community Meeting I
Date: 2/22/14
Location: Baldwin Senior High School
Attendance: Approximately 60 people
Summary: Presented Living with the Bay; conducted an open discussion; led breakout tables on each of our four strategies

Meeting: Community Meeting II
Date: 3/8/14
Location: Operation SPLASH
Attendance: Approximately 75 people
Summary: Presented Living with the Bay; conducted an open discussion; led breakout tables on each of our four strategies

Event: High School Resiliency Workshop
Date: 3/18/14
Location: Lynbrook High School
Attendance: Students from Lynbrook Sustainability Club
Summary: Presented scaled-down version of Living with the Bay; discussed the threats of surge, sea level rise, and stormwater; discussed strategies for combating the threats

Event: Boat and Bus Tour of Living with the Bay
Date: 3/29/14
Location: Operation SPLASH
Attendance: TBD

In Community Meeting I and II, we led breakout tables on the Slow Streams strategy.

Interboro Team: Mies / Bosch Stadius / Deltares / Arup / Rambow / IMG Rebel with Center for Urban Pedagogy, David Rockefeller NJIT Infrastructure Planning Program, Project Projects RFA Investments, TU Delft

How well did the team's participatory design process result in the formation of a coalition of support?

Many individuals in Nassau County are aware of stormwater mismanagement and its relation to flooding and water quality. Our conviction that this was a major issue that needed to be addressed, regardless of the fact that it was only indirectly related to storm surge, really resonated with people, many of whom had experienced flooding from storm drains. In our community meetings, we have overwhelming support for the Slow Streams strategy:

The Slow Stream strategy was relatively easy to get support for politically as well. The county supervisor, Nassau DPW, the Town of Hempstead Waterways and Conservation Department, and the mayors of East Rockaway and Rockville Centre all expressed support for the project. In meetings, Mayor Francis Lenahan of East Rockaway and Mayor Francis Murray of Rockville Centre acknowledged that there are serious problems with the Mill River and that it made a lot of sense to try to slow down and capture the water and allow it to recharge the aquifer. Both were receptive to the idea of building swales, a retention park, and a sluice.

Interboro Team: Alex Bernstein, Robert / Deltze / Michael Kelly / IMG Rebecca Lewis / Urban Research / Happy Dolphin Studio / Planning Project / Investment Dept. / Dept. of Projects, RFA

Please see Chapter 1 for a complete list of project supporters.

Innovation

How does the project represent a higher-performing approach to reducing risk while providing multiple benefits and amenities?

In this sub-region, we bring the challenges together in one comprehensive long-term perspective. The most pressing theme is solving stormwater issues. By controlling the outflow of the river using a new sluice, it is possible to create extra storage capacity. In the extension of the sluice, more room for water storage in the direct surroundings of the water body will be realized. Unused or abandoned areas will be excavated to be able to store more water. The sediment that is excavated will be reused in elevating areas: new levees, streets, individual lots, or even whole new developments. In connection with the creek, adjustment to the stormwater outlets will be made to prevent back-flooding and provide extra filter capacity to improve the water quality. The streets that harbor the drains for the stormwater will gradually transform with regular maintenance to blue-green streets that store and filter water.

In time, the river will serve as a backbone where more and more activities will be implemented to increase safety, water quality, stormwater storage, urban identity, ecological quality, and public access. Therefore, a network of smaller and larger dike rings will be developed to ensure that the risk of flooding from another storm is reduced.
The sluice at the end of the river is therefore adequately dimensioned. At first, more room for the river is realized by redesigning more (semi-) public spaces like sports fields, parking lots, school properties, and public sites. "Making room" for the rivers will simultaneously transform them into attractive, accessible parks with continuous north/south trails A cascade of different elevations will serve as more space for the water, and the excavated sediment will elevate more properties and create more ring dikes. For new development or redevelopment of private properties, more of these initiatives will occur since the river and its embankments are highly appreciated by people as a public open space.

Interboro Team: Area / Design Studio / Deltares / HHS / Paumgut / IMG Rebel with Centre for Urban Pedagogy, Davis Brust / NJIT Infrastructure Planning Program, Project Project, RFA Investments, TU Delft

Different kind of trails will be developed that connect the newly designed streets to a whole framework of walking and biking routes in the neighborhood.
At intersections of larger infrastructure (train and car), new developments of higher density will ensure affordable housing and aquatic housing. At these intersections, bottlenecks will be resolved in such a way that natural gradients from fresh, brackish, and salt water will be optimized. Old dams will be removed to stimulate vertical sedimentation, and necessary dams will be fitted with fish passages. Since the flow of the river will be better controlled, it will be possible to slow down the fast drainage of water and store/retain water via a cascade of ponds. The ponds not only serve as water storage basins and cooling areas for the neighborhood, but they also ensure that the natural aquifer will be recharged. This is possible because the water quality will be improved by more filters, permeable streets that filter stormwater, and no more leaks from septic tanks. Within 20 years, the sewage treatment plant will be renewed to a higher purifying standard and the effluent water that exits the plant will be clean enough to be used as a source. The scarcity of water means that effluent water is a valuable resource for feeding our rivers and maintaining a sustainable environment that is safe at the same time.

The result is that the monotonous urban area is transformed into a place where not only natural connections but also strong new kinds of social connections develop. A new unique zip code within the creek makes it possible to create a wide variety of new types of sustainable, social housing. Young urban professionals who are socially aware of their footprint in the world can live in great harmony with the local residents and their offspring.

Interboro Team
Interboro / Arie Graafmans
/ Deltares / Rosali Stabile
IMC / Public Urban Development
Research Institute / Amphibious
Public Space / Urban Planning
Investments / Delta RFA

Design Quality/Excellence

How does the project Incorporate multiple scales, interests, objectives, and phases?

As explained above, Slow Streams is about considering a comprehensive, long-term approach to the entire watershed within a long-term regional perspective for Long Island. Scaling down this comprehensive approach on the stream to an actual site means implementation of a sub-regional srategies and phase one projects. This Phase One project combines different elements as a first step within a long-term solution.

The first step is to better control the stormwater issues within the Mill River watershed. The project includes the following elements:

— A sluice. The sluice is a stormwater intervention for a heavy storm event. Most of the time, the sluice will be open and there will be normal tidal movement, which is desirable for ecological reasons, nautical reasons, and biodiversity (e.g., fish). Only in cases of predicted heavy rain events will the sluice close at low tide to store the stormwater and create extra buffer capacity.

— Room for the river. The site at Riverside Road will be excavated to make more room for the river. The area will be redesigned as a public park and will be a neighborhood entrance point to the river (and, in the future, the whole park along the river). The park will also be redesigned as a filter to purify stormwater (by reed/sand filters) from the stormwater outlet of Mill River Avenue. The stormwater will flow in an extreme event (when the stormwater swale of Mill River Road is overburdened) via this purifying park into the Mill River. By lowering the site, there will be more space to store water in the watershed in an extreme event. Also, a path and area to recreate will be designed to enjoy the waterfront. The parking lot needs to be redesigned and will be done so with pervious soil at different location. It will also be floodable for emergency storage.

— A stormwater swale. The first step to tackle the stormwater issues in the neighborhood is to redesign the streets for more storage and more filtering of the water (and of course to enhance the quality of living!). In daily situations with normal rain events, the redesign of the street should provide extra storage.

How does the project perform as more than just a defense mechanism and represent a development-oriented and future-driven approach?

All of the measures are incorporated into this Phase One project at the short term, especially the stormwater storage issue. Over the longer term, the sluice could function (next step) to keep out water during extreme tidal movement, such as a northeastern storm. This would entail the sluice being a bit over-dimensioned in height and strength during construction.

How does the project represent a planning and design approach that is comprehensive and inclusive?

Our design philosophy is that every solution should

— Be both safe and attractive

— Be fed by local insights from the community (community approach)

— Work along with the natural system (system approach)

— Be short-term, replicable, no-regret measures that build toward a long-term perspective

Interboro Team: Alex Wheel, Stabbins / Deltares / Arcadis / Landscape Architecture / IMG Rebel / Landscape Urban Pedagogy, Data Business Intelligence / Urban Planning Infrastructure Planning Investments, TU Delft / Project Partners, RFA

Impact

How does the solution respond to the greatest/highest risks, vulnerabilities, and/or impacts identified?

Our solution

— Responds to flooding threats from storms on sea (annual and more severe) by implementing dike rings, thresholds, and sluices

— Responds to sea level rise (long-term perspective)

— Relieves the impacts of stormwater in the most vulnerable zones immediately by introducing the sluice

— Relieves the impacts of stormwater in the future by making room for the river

— Replenishes the lowering groundwater levels

How does the solution present the potential for broader applicability/replicability, either in approach or solution?

The Mill River watershed is a perfect example of a prototypical watershed in the Long Island region as well as in New Jersey.

How does the solution address one or more of the following key areas of focus: a) vulnerable populations, b) critical infrastructure (particularly energy and communications), c) potential for leveraging other federal investments?

a. Mill River was flooded during Sandy and is vulnerable to everyday flooding by stormwater.

b. The sewage treatment facility is located at the end of Mill River. Furthermore, there are several train stations alongside and in the watershed.

c. Other federal investments can come from the county, transportation sector, and Army Corps of Engineers.

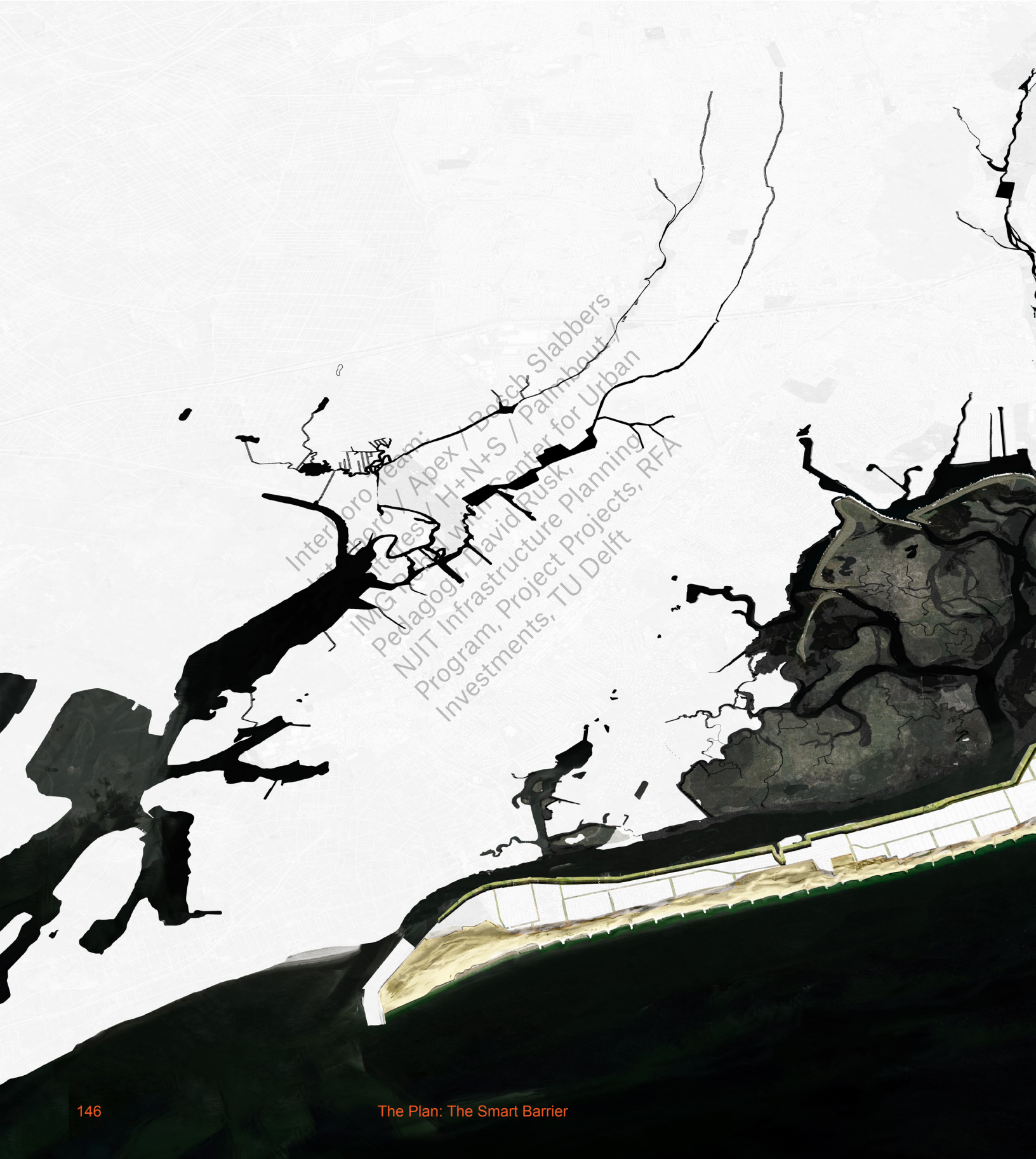
How does the solution Incorporate principles of sustainability, including water quality and energy efficiency?

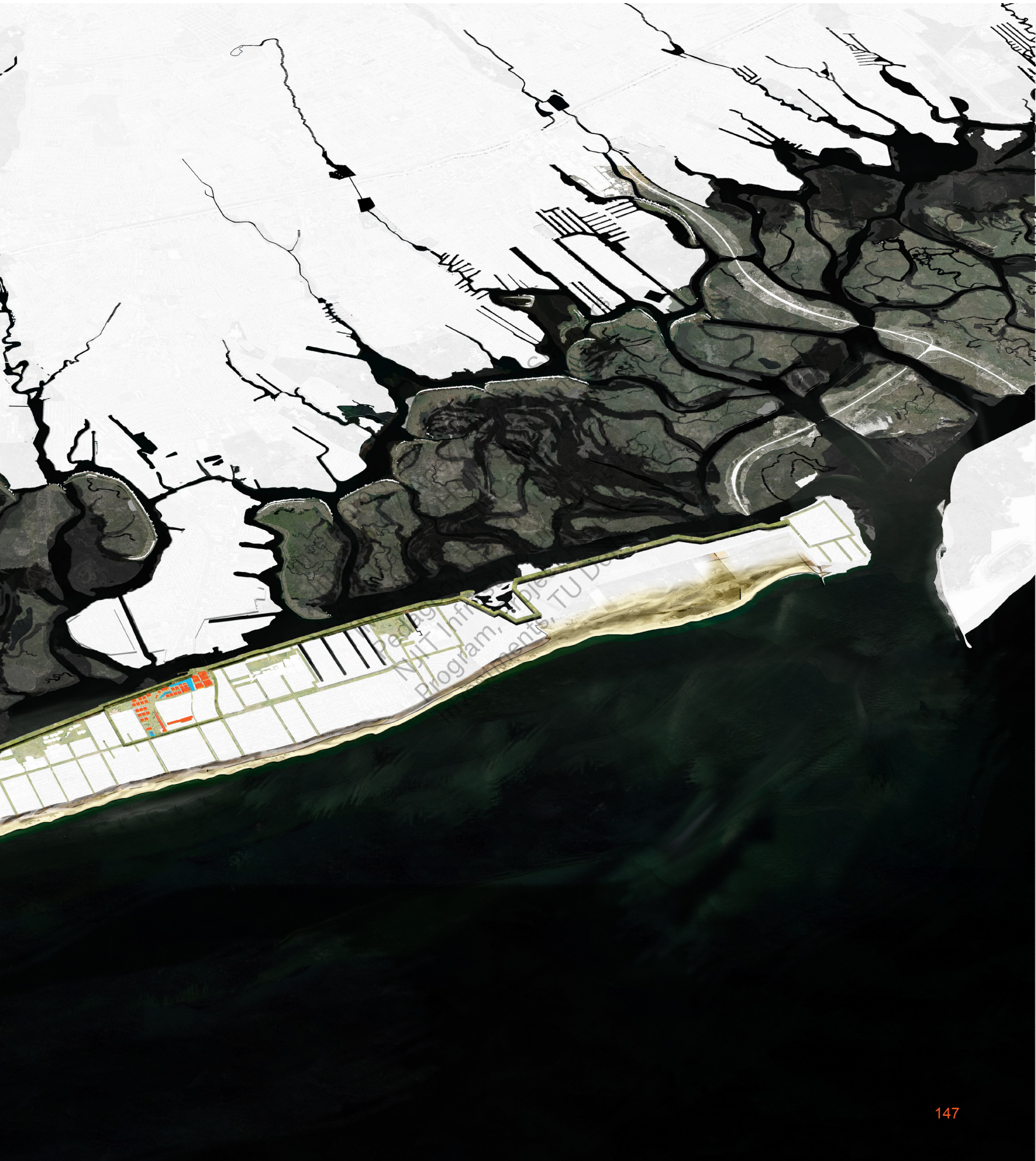
On a smaller scale, the water quality will be enhanced by filtering stormwater runoff in different stages: on streets, in parks, and in the river bed.

Replenishing the effluent water from the sewage treatment plant to recharge the aquifer requires more thorough treatment of the sewage water (which is more sustainable) and will, on the long term, be closing the water cycle instead of dumping the fresh water into the ocean.

Interboro Team: / Bosch Slabbers / Deltares / H+N+S / Palmbout / IMG Rebel / Urban Centre for Urban Pedagogy, David Rusk, NUT Infrastructure Planning Program, Project Projects, RFA Investments, TU Delft

Strategies for the Barrier Island: The Smart Barrier





Pedagogical Use Only
NIIT Infrastructure Program, Implementation, TU Delft

Strategies for the Barrier Island: The Smart Barrier

For the barrier island (Long Beach), we propose a system of protective measures along the bay front to complement the ongoing work by USACE on the ocean side and create a comprehensive protective system. The goal of these measures is to protect residents but also to provide better connections to the water and simultaneously deal with stormwater flooding.

Due to their location and topography, Long Island's barrier islands are among the region's most vulnerable zones when it comes to sea level rise and storm surges. The City of Long Beach has some of the highest residential densities in Nassau County and is home to more than its fair share of the region's critical infrastructure. Long Beach also had some of the highest concentrations of damage during Sandy. Most of the destruction in Long Beach occurred not on the ocean side but on the bay side, as a result of surge in the back bay and subsequent inundation of the city's stormwater system. Protecting the barrier island's population and its infrastructure from future storm events is therefore essential.

Given the proven risk of storm flooding, combined with the high population density and the location of critical infrastructure in the city, we consider Long Beach an area of high need. As a long-term strategy, we propose a comprehensive protective system for the barrier island that guarantees safety to a 12-feet protection and enhances resiliency and urban quality of the island. On the ocean side, we propose to build on the ongoing work by USACE and complement the beach replenishment and dune construction along the ocean shore. On the bay shore, we propose a smart recreational dike landscape that over time is able to protect the entire bay shore. The dike landscape consists of 6 to 8 protective compartments (ring levees) that over time can be built successively. The recreational landscape along the bay will add potential touristic highlights to Long Beach, which is now concentrated on the beach and on the central boulevard of the Island, Park Avenue.

In addition to flooding from the ocean and the bay, Long Beach also frequently experiences stormwater flooding during rain events. As a second component of our project, we propose a system of stormwater retention parallel to the beach and the bay, in the form of controlled open flooding areas that double as open space resources.

As a third component, we propose to improve the local network perpendicular to the beach, recreational levee, and central boulevard. We propose redesigning the streets to facilitate better walking and biking in between the beach and bay and so that the streets provide more water storage and more filtering water.

Interboro Team / Interboro / AECOM / Deltares / IMG Rebel / with Center for Urban Pedagogy / Dalia Reyes / Multi-Infrastructure Planning Workshop / Investment Project Portfolio, RFA / TU Delft

Phase One

The North Park neighborhood is one of two areas of Long Beach with the highest risk of flooding from the bay and during rain events. At the same time, the area is the location of critical infrastructure, such as the Long Beach sewage treatment plant, a LIPA substation, a water purification plant, and a control station for a major gas pipe that supplies a large portion of the northeast. Flooding presents both a direct risk to these elements of critical infrastructure and the indirect risk of contamination for the adjacent neighborhoods and the bay. The area is also home to a substantial portion of the City of Long Beach's public housing units. The area with the highest risk of flooding is simultaneously the area with the highest concentration of socially vulnerable residents.

Interboro Team / Rex / Dominique Hawkins / Deltares / NYC Parks / Parsons / IMG / Mayor's Office for Urban Planning / Pedal Power / Parsons Brinckerhoff / NJIT Institute for Sustainable Program, Market Projects, Investments, Design, RFA

As a Phase One project, we focus on the two sub watersheds between Long Beach Boulevard and Magnolia Boulevard. In this area, we propose the following:

1. A dike landscape along the bay shore to protect the existing critical infrastructure as well as the most vulnerable neighborhood of Long Beach. Combined with a proposed small levee in the median of Magnolia Boulevard and the existing elevation of Long Beach Boulevard and Park Avenue, this dike will complete the first protective compartment. The dike consists of a technical sea dike and a sculpted landscape that is sloped in a way to recreate a natural shoreline and make the bay shore accessible again. This new open space resource also includes a new marina and will connect to the existing city park to the west. The long-term goal is to create an accessible dike landscape along the entire bay shore.

Over the long term, we are proposing to elevate the current LIRR connection from Island Park to go over the dike landscape. In the short term, the opening at the rail line will be protected by temporary barriers.

In the long-term we are proposing to elevate the current LIRR connection from Island Park to go over the dike landscape. In the short term the opening at the rail line will be protected by temporary barriers.

2. A freshwater landscape behind the dike to create an open space amenity and provide space for water storage, infiltration, and purification. While some of the infrastructure behind the dike will remain in place for the foreseeable future, we propose relocating and/or consolidating some of the other infrastructure. The Long Beach sewage treatment plant can be decommissioned once the ocean outfall for the Bay Park sewage treatment plant is in place. The soil on some of the sites currently or previously occupied by industrial uses is contaminated and will have to be either capped or removed. Our proposal is to remove the soil and create water retention areas here. The freshwater landscape will be complemented by a system of bio swales and a "water plaza" on Kennedy Plaza in front of City Hall. Here we propose an open stormwater retention pond, where stormwater cleanup can be explained and experienced.

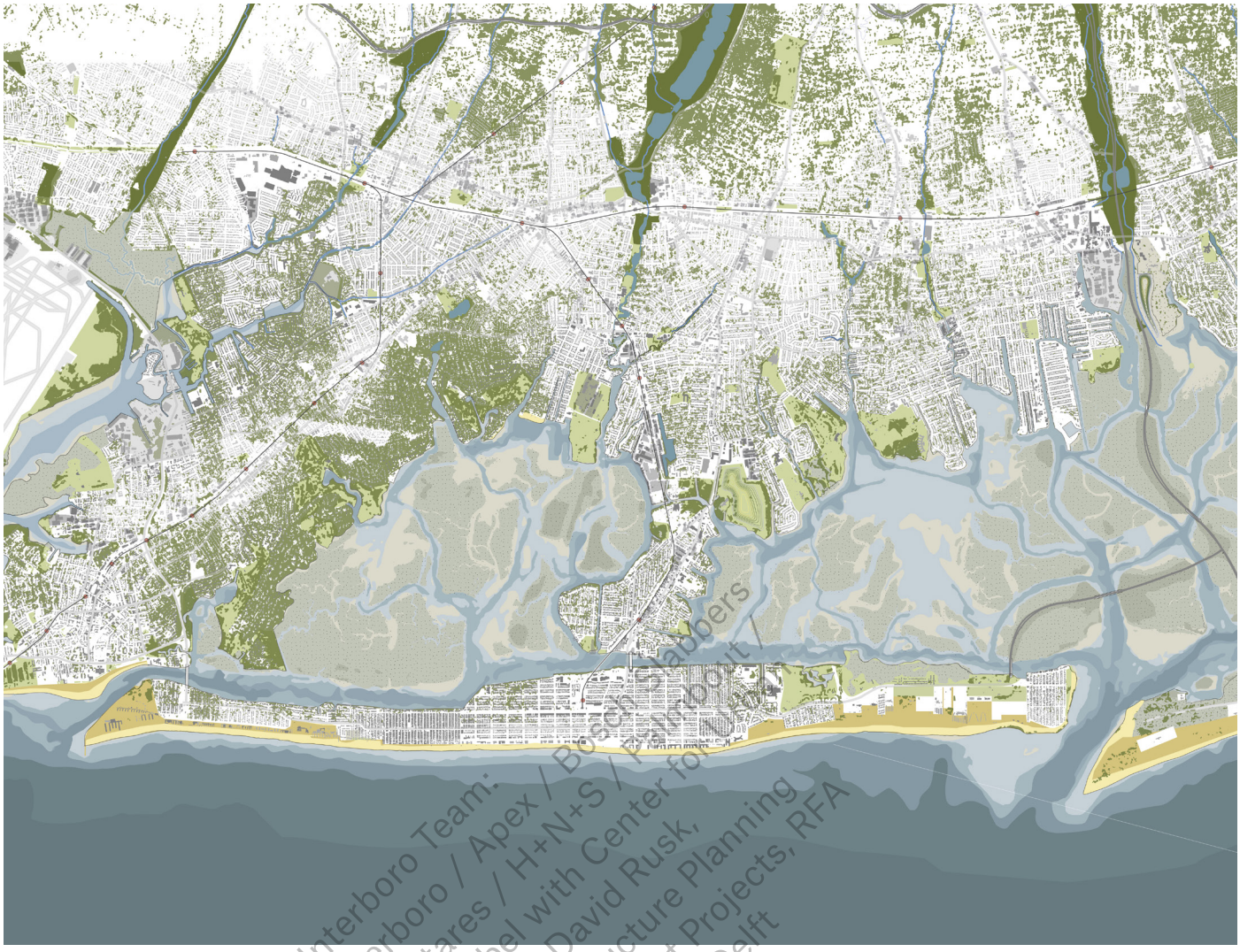
3. In conjunction with the dike landscape, we propose to build protected housing to replace some of the most vulnerable housing (110 public housing units) and to create an elevated site for mixed-use development in close proximity to the new open space amenities and the train station.

4. Once the ocean outfall for the Bay Park sewage treatment plant is in place, the sewage from Long Beach can be treated in Bay Park and the Long Beach sewage treatment plant can be decommissioned. The site of the current treatment plant would become available for new uses. As part of our project we propose the construction of a sewage return pipe from Long Beach to Bay Park and a pumping station on the site of the current Long Beach sewage treatment plant. As the pumping station requires the installation of power generators, we propose adding a small resilience center here that can take advantage of the power generation.

Interboro Team:
Interboro / Apex / Bosch Slabbers
/ Deltares / H+N+S / Palmbout /
IMG Rebel with Center for Urban
Pedagogy, David Rusk,
NJIT Infrastructure Planning
Program, Project Projects, RFA
Investments, TU Delft

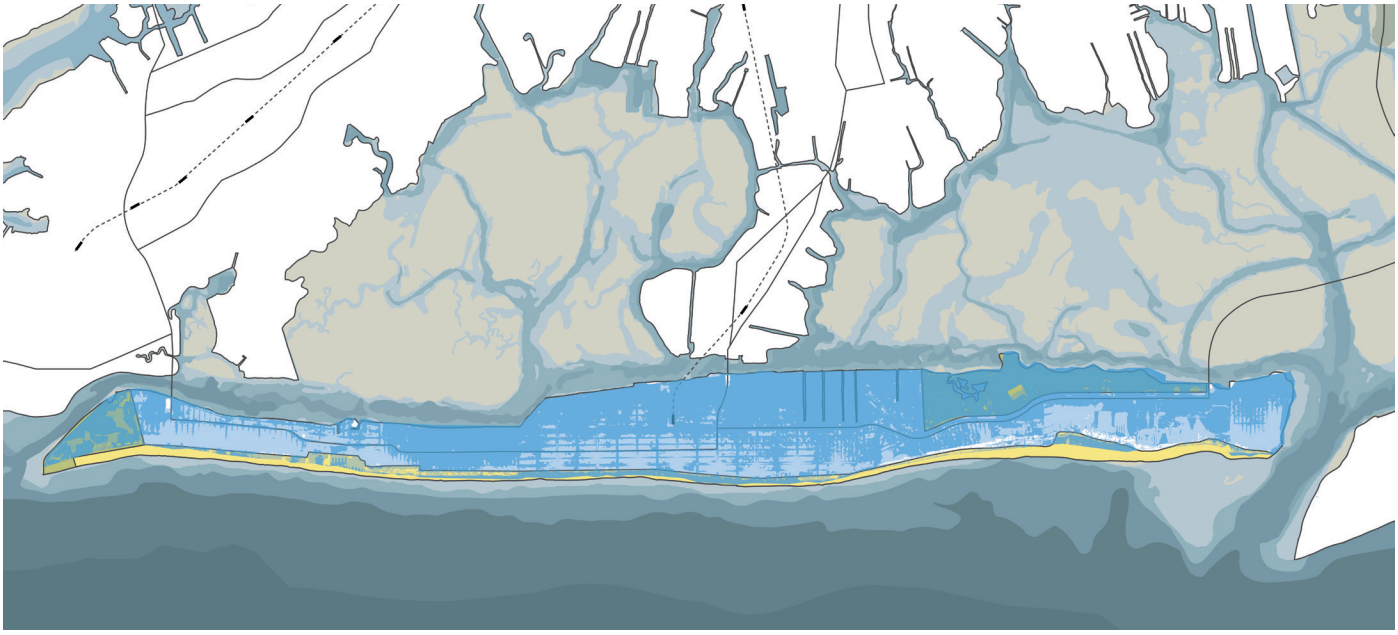
Interface Technology / Arup / Bosch Slabbers
/ Deltares / H+N+S / Palmbout /
MC Rebel with Center for Urban
Pedagogy / David Brain
MIT Infrastructure Planning
Program / Project Projects
Investment / Thoeth

A new dike landscape on the bay shore of the barrier island will protect residents and critical infrastructure, provide retention areas for storm water, and provide access to the bay.



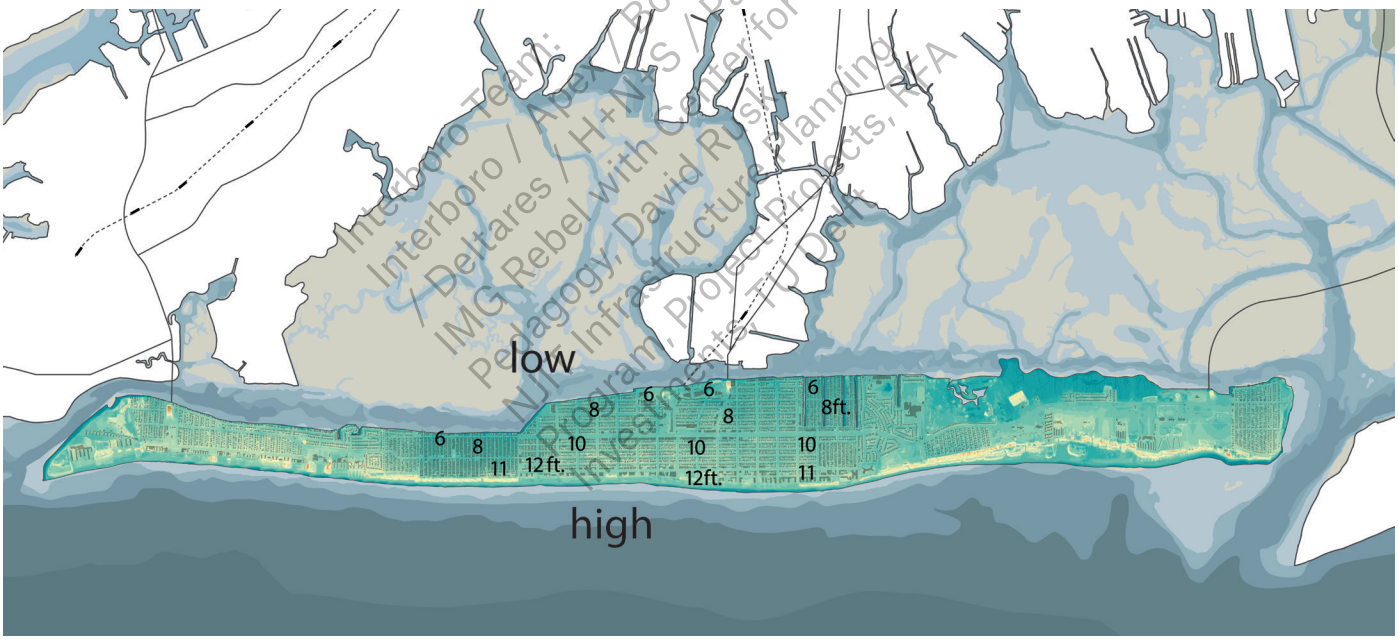
Interboro Team:
Interboro / Apex / Boccardo / Dewberry
/ Deltares / H+N+S / Parsons Brinckerhoff /
IMG Rebel with Center for Urban
Pedagogy, David Rusk,
NJIT Infrastructure Planning
Program, Project Projects, RFA
Investments, TU Delft

The Long Beach Barrier Island is located between the Atlantic Ocean at the south side and the western bay to the north. The Island is connected to the mainland by three infrastructure lines: The Nassau Expressway to the west, Long Beach Blvd and LIRR in the middle, and by Loop Parkway to the East. The island is home to about 40000 residents on a year-round basis. The island's population increases to about 100,000 during the summer months.

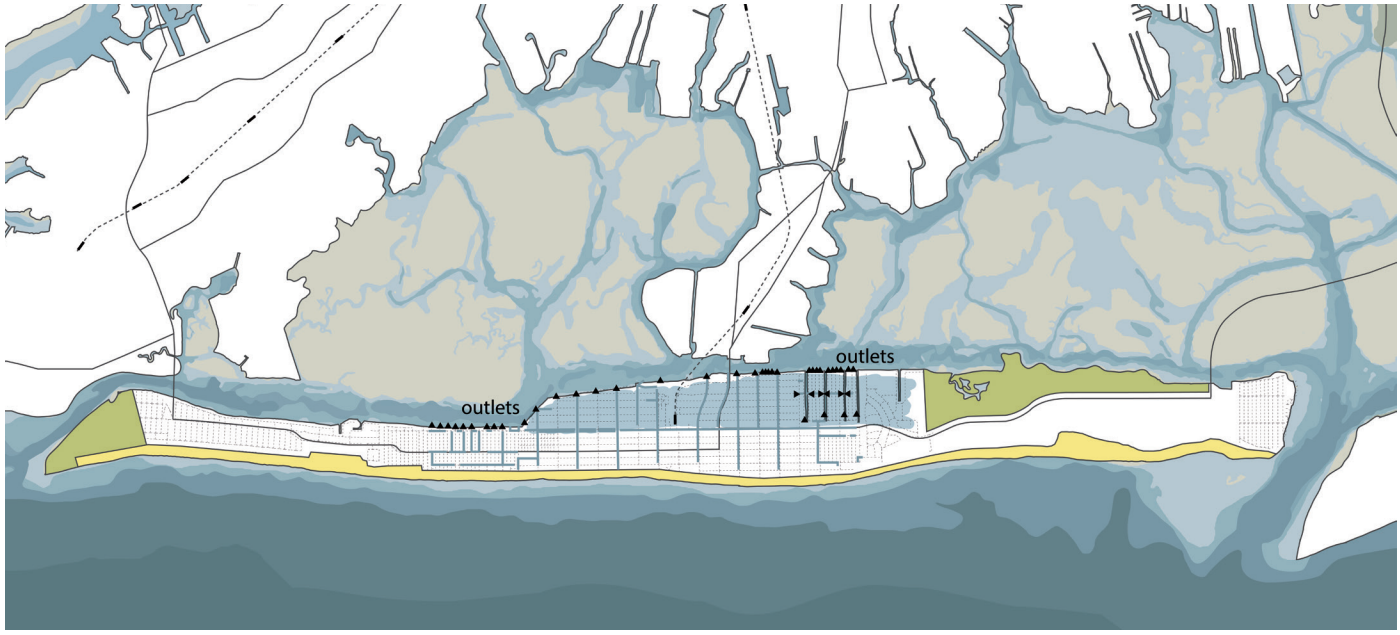


This maps shows the effect of a category 1 storm surge (dark blue) and category 2 storm surge (light blue) on the current Long Beach Barrier Island. Almost the entire Island is affected.

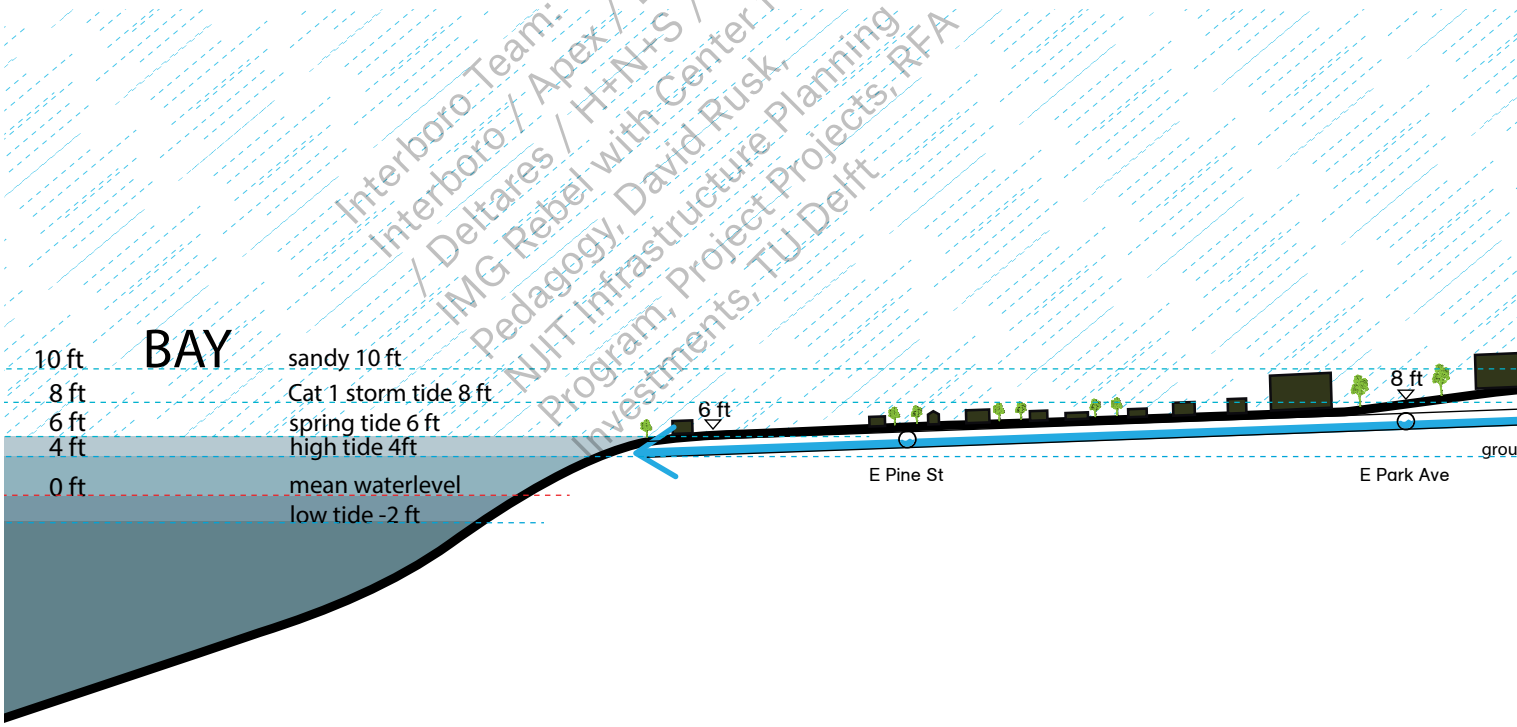
Interboro Team: Interboro / Ape / Bosch Slabbers / Deltares / H+N+S / Palmbout / IMG Rebel with Center for Urban Pedagogy, David Rush, Infrastructure Planning Program, Project Projects, REFA NJ Department



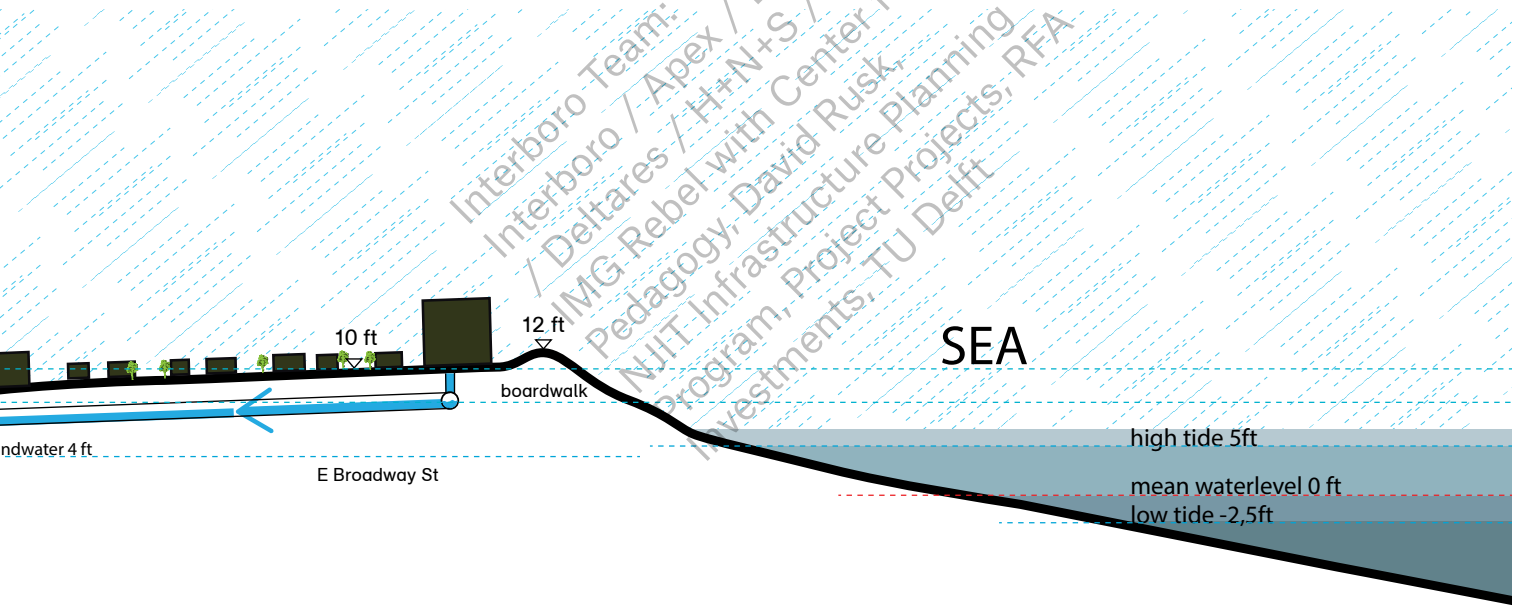
As this map illustrates, the Long Beach Barrier Island is highest at the Ocean side, with an elevation of approximately 12', and lowest at the bay-shore, with an elevation of approximately 6 feet, just barely above the high tide water level in the bay.



The current, gravity-based storm water drainage system drains storm water directly into the bay, but doesn't work properly when bay water levels in are elevated.

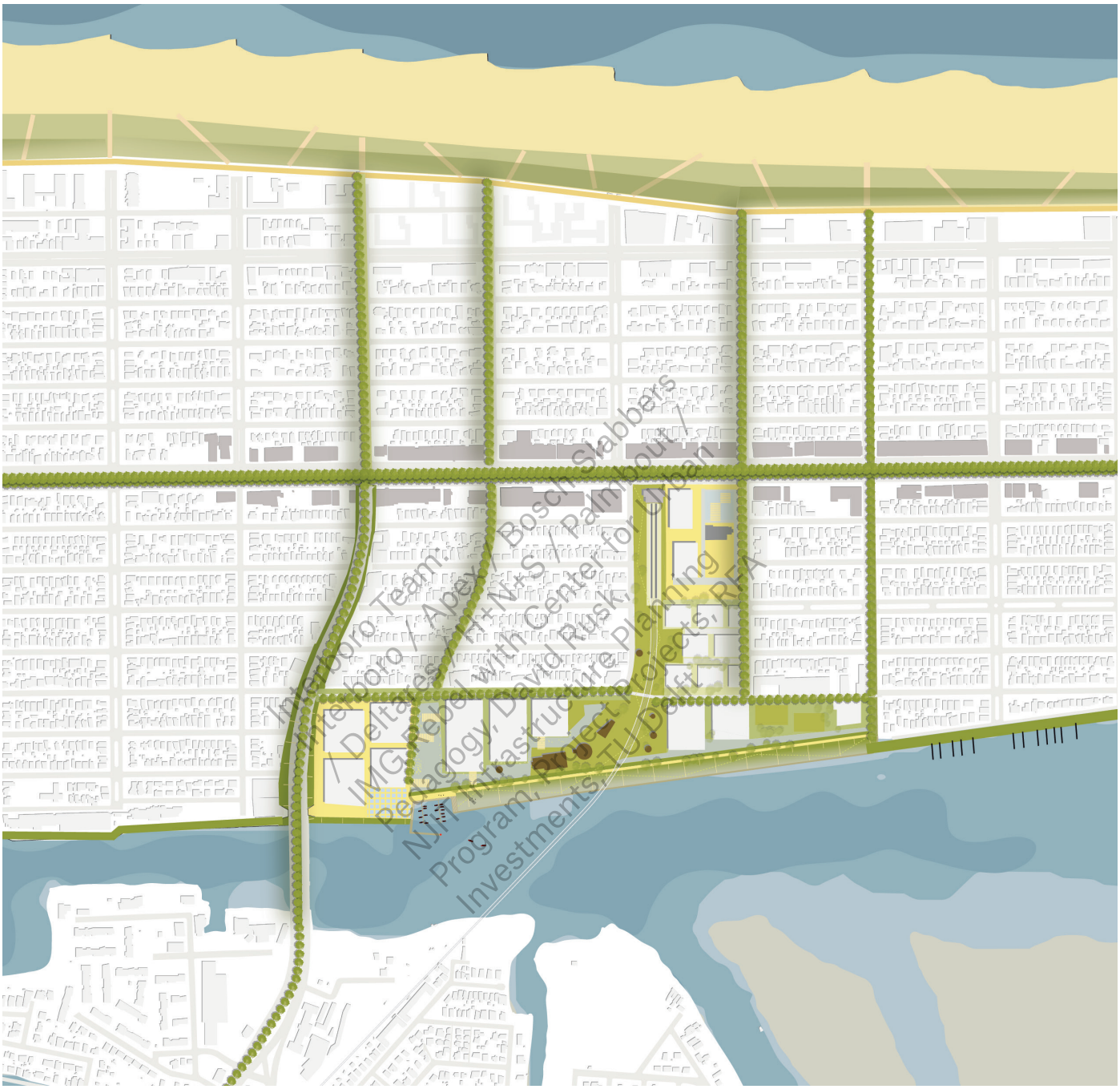


Interboro Team:
Interboro / Apex / Bosch Slabbers
/ Deltares / H+N+S / Palmbout /
IMG Rebel with Center for Urban
Pedagogy, David Rusk,
NJIT Infrastructure Planning
Program, Project Projects, RFA
Investments, TU Delft

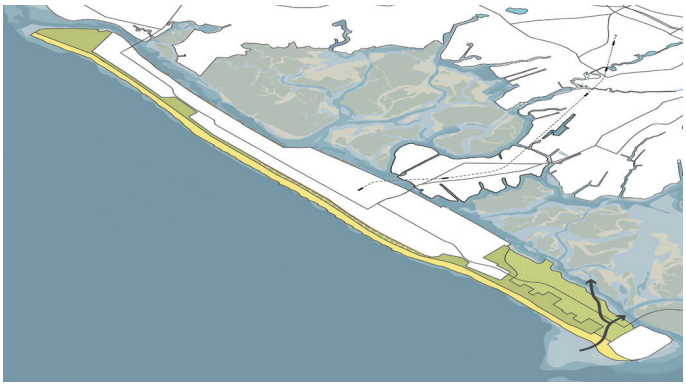


Interboro Team:
Interboro / Apex / Bosch Slabbers
/ Deltares / H+N+S / Palmbout /
IMG Rebel with Center for Urban
Pedagogy, David Rusk,
NJIT Infrastructure Planning
Program, Project Projects, RFA
Investments, TU Delft

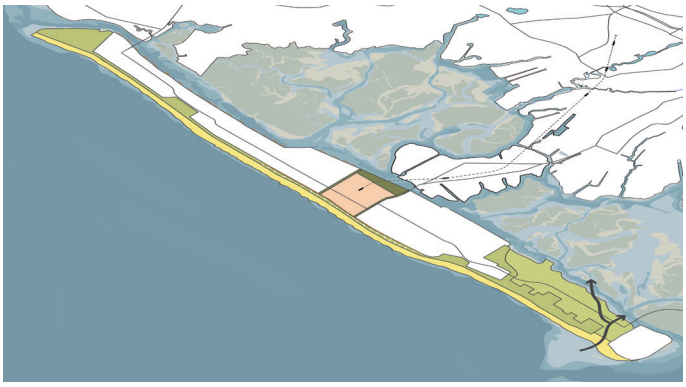
As this section illustrates, the Long Beach Barrier Island is highest at the Ocean side, with an elevation of approximately 12', and lowest at the bay-short, with an elevation of approximately 6 feet, just barely above the high tide water level in the bay. Stormwater is drained to the bay. In case of high tide water is not able to flow out or, worse, bay water will flow in the wrong direction.


Interbpro Team:
Arcadis / Deltares / Apex / Bosch Slabbers
IMG / Rebel with Center for Urban
Pedagogy, David Rusk, N+S / Palmbout /
NJT Infrastructure Planning
Program, Project Projects, REA
Investments, TU Delft

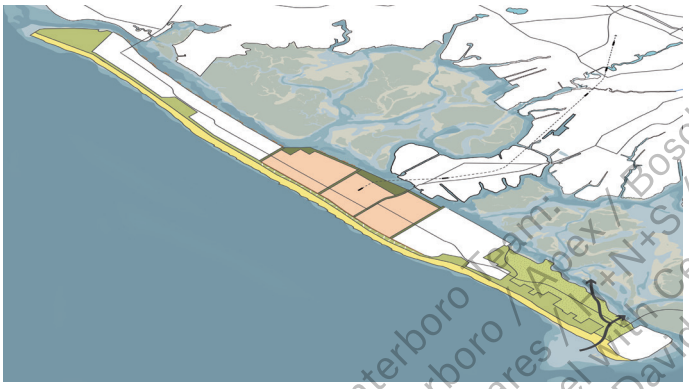
A Protective System for the Entire Barrier Island



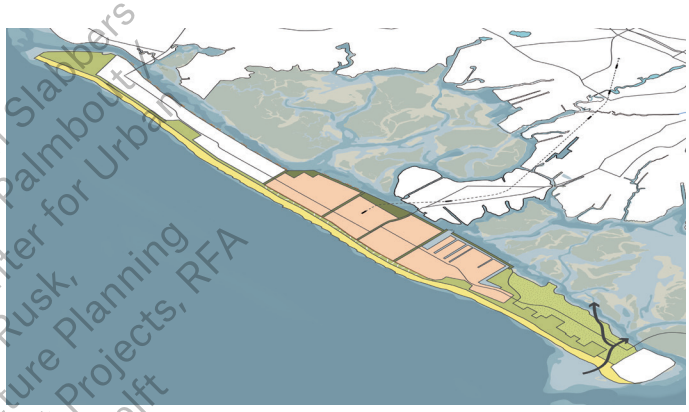
Protective compartments, phase 1



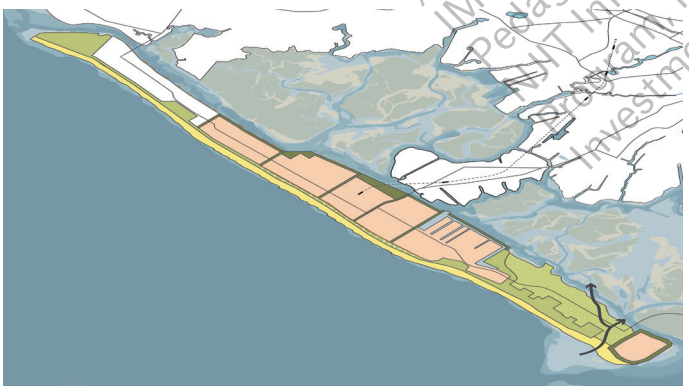
Protective compartments, phase 2



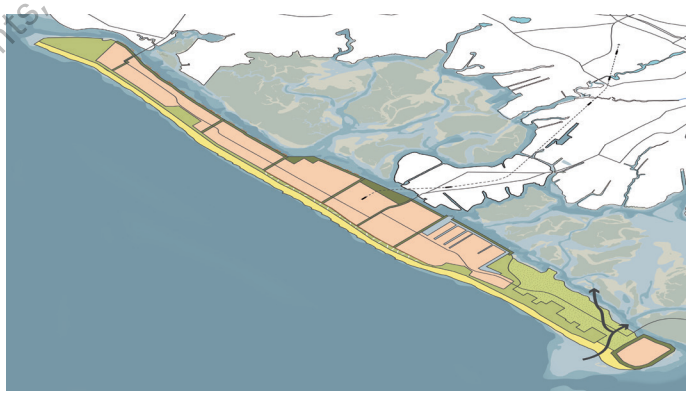
Protective compartments, phase 3



Protective compartments, phase 4



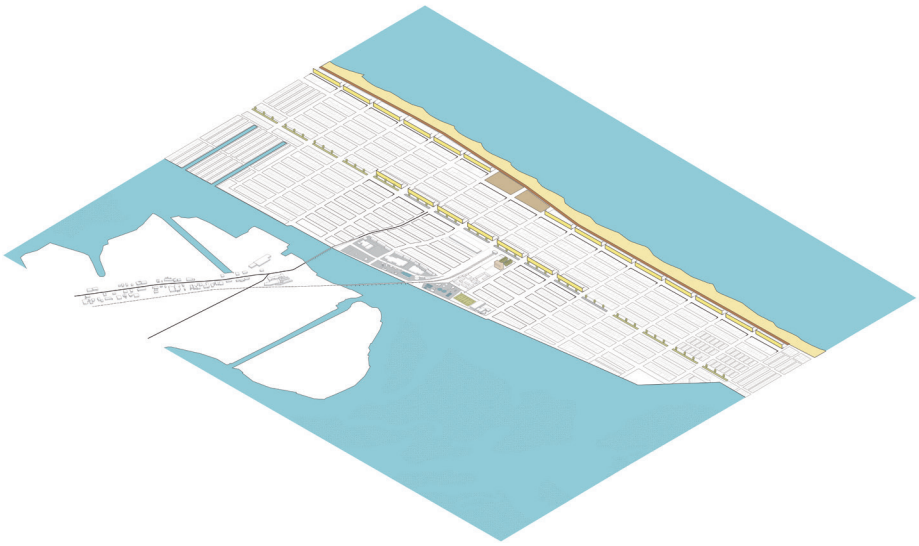
Protective compartments, phase 5



Protective compartments, phase 6

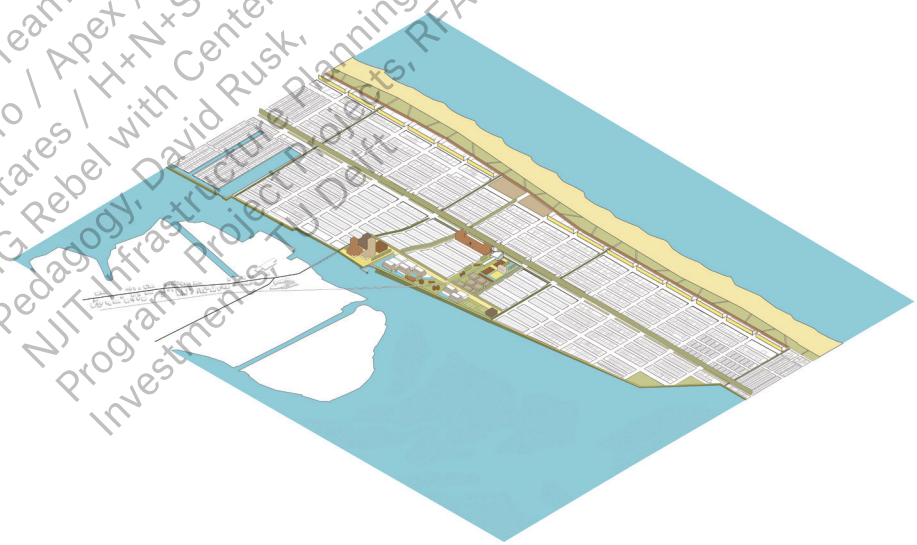
Interboro Team:
Interboro / Adex / Bosch Slabbers
/ Deltares / H+N+S / Palmbout /
IMG Rebel with Center for Urban
Pedagogy, David Rusk,
NWT Infrastructure Planning
Program, Project Projects, RFA
Investments, TU Delft

The Phase 2 project is a protective system for the entire barrier island. The system consists of compartments that can be built incrementally over time and that provide a full protection for a 12′ surge. With each successive compartment the overall strategy can be evaluated and adjusted.

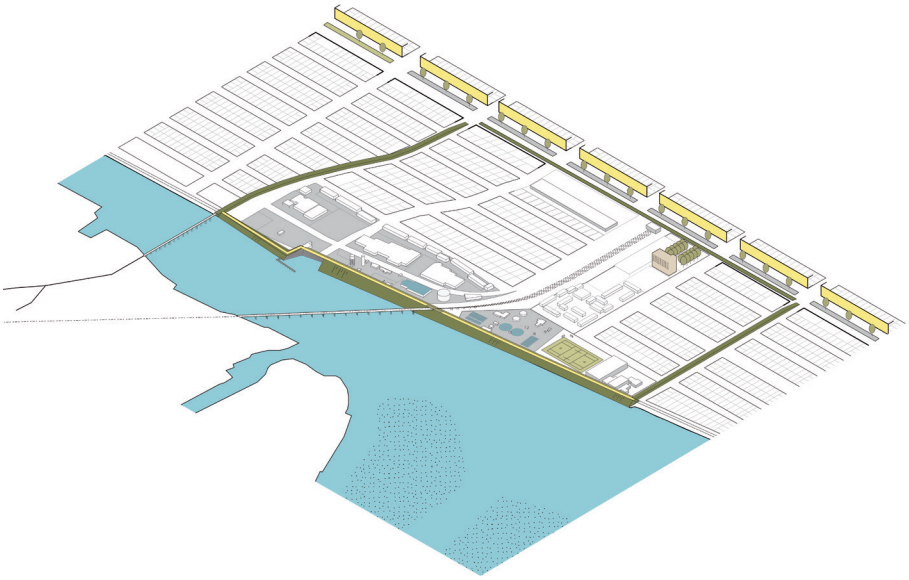


The North Park neighborhood is one of two areas of Long Beach with the highest risk of flooding from the bay and during rain events. At the same time, the area is the location of critical infrastructure, such as the Long Beach sewage treatment plant, a LIPA substation and a water purification plant. Flooding presents both a direct risk to these pieces of critical infrastructure and the indirect risk of contamination for the adjacent neighborhoods and the bay. The area is also home to a substantial portion of the city of Long Beach's public housing units. The area with the highest risk of flooding is simultaneously the area with the highest concentration of socially vulnerable residents.

Interboro Team:
Interboro / Apex / Ecorh Systems
/ Deltares / H+N+S / Pandosia /
IMG Rebel with Center for Urban
Pedagogy, David Rusk,
NJIT-Infrastructure Planning
Program / Project Projects, RFA
Investments / TU Delft

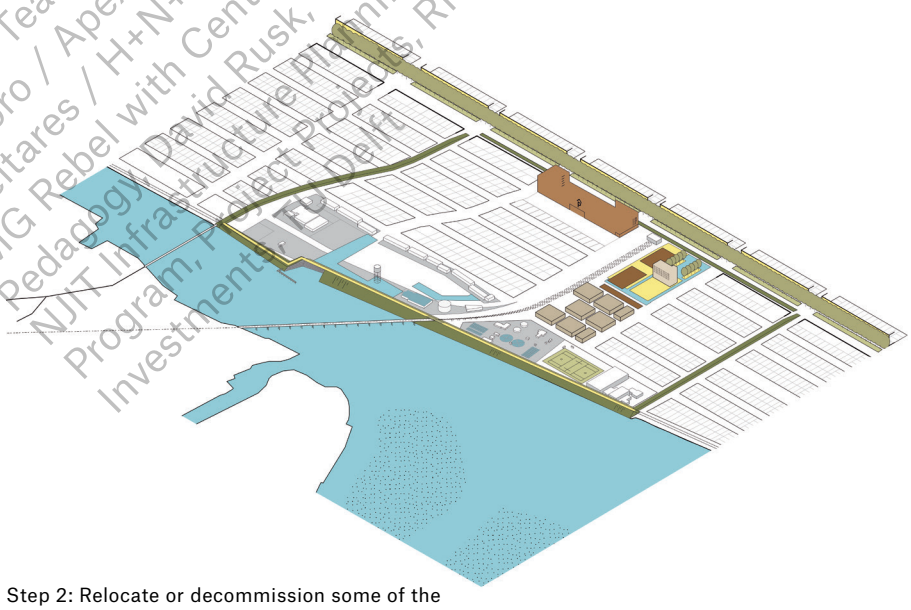


The compartiments offer the opportunity to create a couterpart to the baech at the bay: a new bayfront!

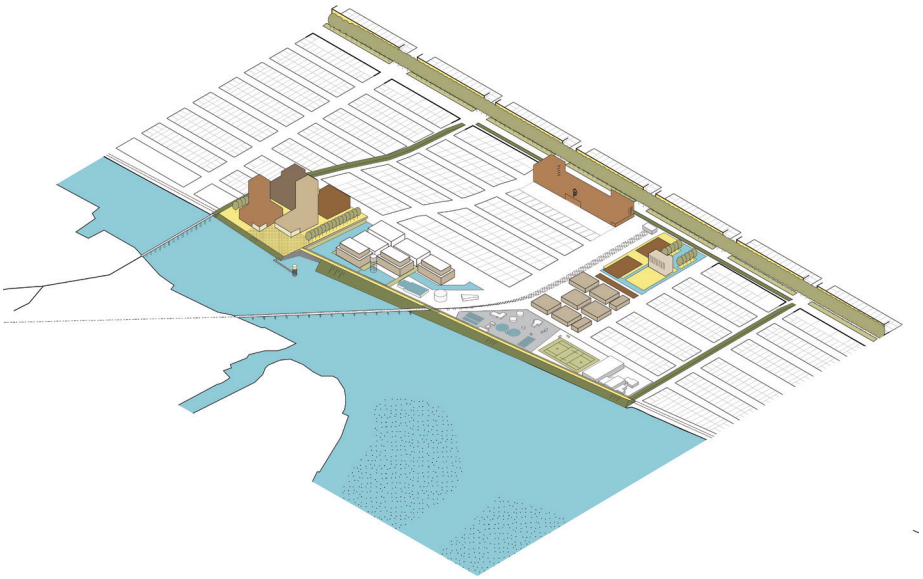


Step 1: Build a Dike Ring that protects the infrastructure as well as one of the most vulnerable neighborhoods of Long Beach. Along Long Beach Boulevard and Magnolia Boulevard the dike ties into the existing elevations.

Interboro Team:
Interboro / Apex / Bosch Slabbers
/ Deltares / H+N+S / Palmbout /
IMG Rebel with Center for Urban
Pedagogy, David Rusk,
NJIT Infrastructure Planning
Program, Project Projects, RFA
Investments, LLC, Dalt



Step 2: Relocate or decommission some of the infrastructure and clean up the contaminated land, replacing it with a fresh water retention landscape.



Step 3: Create a new, elevated site for a mixed-use development.

Interboro Team:
Interboro / Apex / Bosch Slabbers / Deltares / H+N+S / Palmbout / IMG Rebel with Center for Urban Pedagogy David Rusk, NJIT Infrastructure Planning Program, Port of Projects, RFA Investments, To Dale

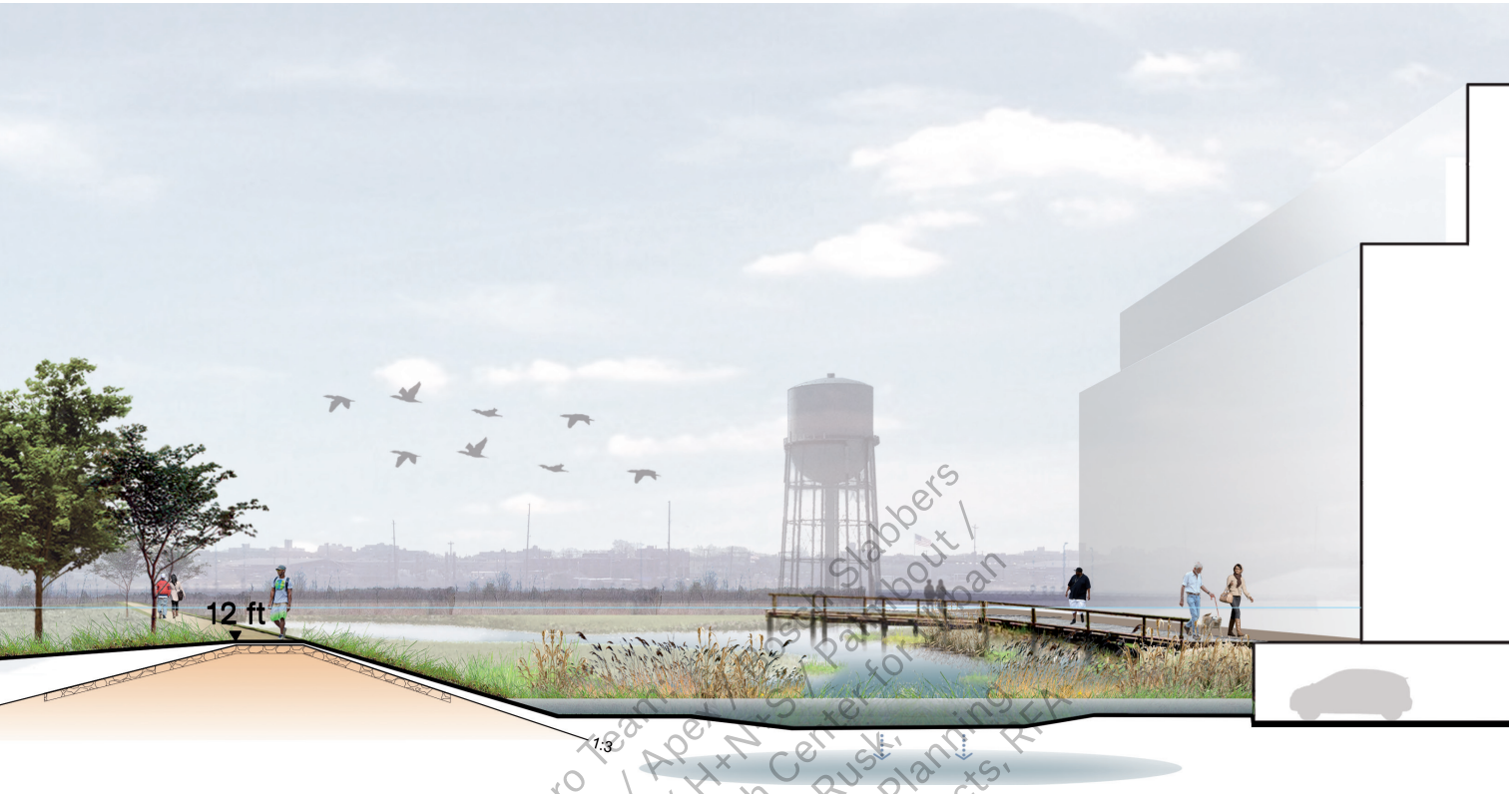
The project creates an accessible dike landscape along the entire bay shore. This new open space resource also includes a new marina and will create a new bay front for Longbeach.
A fresh water landscape behind the dike creates an open space amenity and to provide storm water storage areas.
We propose relocating some and consolidating some other critical infrastructure. Our proposal is to remove contaminated the soil and create water retention areas here, in combination with new, protected development sites for housing and mixed use.

Precedent images for the bay shore landscape and the water retention areas

Pedro Bosch Slabbers
NJIT / Palmbout /
Programmer / Project Planning
Investments, TU Delft

Section through the Dike Landscape

Interboro Team:
Interboro / Apex / Bosch Slabbers
/ Deltares / Hunts / Palmbout /
IMG Rebel with Ce[illegible] Urban
Pedagogy, David Rusk,
NJIT Infrastructure Planning
Program, Project Projects, RFA
Investments, TU Delft



Interboro Team: Apex / Joseph Slabbers
Interboro / Apex / Joseph Slabbers / Deltares / H+N+S / Parkbout / IMG Rebel with Center for Urban Pedagogy, David Rusk, NJIT Infrastructure Planning Program, Project Projects, REFA Investments, TU Delft

The dike will protect from 12' surges. On the bay side, the dike is sloped to create an accessible bayside park and promenade. Located behind the dike on the landside is a retention landscape that will store, clean and replenish storm water.

The New Marina and Dike Landscape

A view from the elevated development site.

A Water Plaza in front of City Hall

On Kennedy plaza, storm water retention will become visible and experiential.

The Dike Promenade

A view of the freshwater storm water retention landscape (left) and dike landscape (right)

Interboro Team:
Interboro / Apex / Bosch Slabbers
/ Rotterdam / H+N+S / Palmbout /
Nature Forward / Smith Center for Urban
Forestry / Ted Rusk,
Rutgers University / Planning
Design Projects, RFA

Interboro Team:
Interboro / Apex / Bosch Slabbers
/ Deltares / H+N+S / Palmbout /
IMG Rebel with Center for Urban
Pedagogy, David Rusk,
NJIT Infrastructure Planning
Program, Project Projects, RFA
Investments, TU Delft

How did the research frame a deeper understanding of the problem?

Safety, Flood Water
As shown by the enormous level of damage from the superstorm, the City of Long Beach is one of the most vulnerable spots in the Sandy-affected region. In addition to the general threats from storms and sea level rise, this high vulnerability results from Long Beach's location on an urbanized barrier island.

Fundamentally, a barrier island is a dynamic landform: if left alone, the barrier island would constantly change its form, following the movement of water, wind, and sediment (as described in detail in our Stage 2 report). With urbanization, the dynamic barrier island was turned into a static landform that needs to be fixed in place to protect residents, fixed assets, and infrastructure. As long as we permanently inhabit barrier islands, these islands need to be defended from the natural movement of water and sediment. Sandy has shown that the current systems of defense are not strong enough.

By far the greatest damage from Sandy occurred not on the ocean side but on the bay side. While beach and dunes on the ocean side reduced the immediate impact of the storm on the ocean side, the subsequent back-bay flooding devastated the lower-lying areas on the bay side.

A section through the center of the barrier island shows that elevations along the bay side are approximately 6 feet, while elevations at the ocean side are typically around 12 feet.

The high-tide water level in the bay is 4 feet, merely 2 feet below elevation of the land. There is an immediate need to protect this shore from springtide (6 feet) and storm surge (8, 12, 16 feet).

Ecology and resiliency: stormwater
The high level of urbanization on the barrier island has another effect: the vast amount of impervious surfaces (from buildings, parking lots, infrastructure) prevents stormwater from being absorbed quickly enough into the ground. The current stormwater drainage system is insufficient, and it drains into the bay by gravity. This gravity-based system doesn't work properly when water levels are elevated in the bay. Even an average rain event can lead to major stormwater flooding when it occurs during high tide. In the worst case scenario of a storm surge combined with elevated water levels from SLR, bay water could be pushed up into the stormwater drains and flood higher grounds.

Urban quality
The fact that Sandy caused so much damage in Long Beach is also a result of the fact that there is so much there to be damaged. In other words, whereas most of the barrier islands in the Sandy-affected region are urbanized at medium or low densities, Long Beach has densities that are high enough to support urban life, with a commercial downtown and regional train station in walking distance from a beautiful beach. An economically and racially diverse beach community in commuting distance to Manhattan, Long Beach is generally an attractive destination in the New York metropolitan area.

While the ocean beaches are very accessible, the bay side of the barrier island is in large parts inaccessible. Where there is (visual) access to the bay, this access is typically limited to the first row of homes. In particular, the stretch between the two main access points to the city, the train trestle and the bridge, and therefore the "door mat" of Long Beach, is currently inaccessible and occupied by infrastructure and vacant land.

Interboro Team / Alex Bell Studio / Deltares / Arup / Rambow / IMC / Rebel / Urban Strategies / Resilient Communities / Dutch Ministry of Infrastructure and Environment / Delft University, David Prosser, Urban Planning Project Partner RFA

Critical infrastructure and environmental justice
Looking at the entire Sandy-affected region, we can observe a staggering correlation: be it in the Meadowlands, on the New Jersey Shore, or along the coast of Connecticut, the low-lying areas most affected by flooding are frequently simultaneously 1) the locations of critical infrastructure such as sewage treatment plants and power substations, and 2) the home of the socially most vulnerable population (as described in detail in our Stage 2 report).

Long Beach is no exception: the area that is most vulnerable to back bay flooding and stormwater flooding is at the same time the location of critical regional infrastructure and of the most vulnerable and most disadvantaged population. This population (in this case the residents of North Park) lives with the threat not only of flooding but also of the potential contamination coming from flooded infrastructure next door.

How did the research inform the proposed solution?

The proposed solution addresses flood vulnerability, stormwater issues, ecology, urban quality, protection of critical infrastructure, and environmental justice simultaneously. We are proposing one major intervention that simultaneously reduces flood risks from both bay flooding and stormwater flooding during rain events; it provides direct social, environmental, and ecological benefits and creates opportunities for economic development.

The project reduces risk of flooding for the North Park community of color and for critical infrastructure (water purification plant) by creating a protective dike landscape. The dike landscape is designed in a way to not only provide protection but also recreate the natural shoreline along the bay and allow for direct access to the shore. Widening the dike landscape will also create a high-value elevated development site in close proximity to transportation and with direct access to the new open space amenity.

Safety goes hand in hand with urban quality and a smart, resilient way of dealing with stormwater. In the "unnatural" setting of an urbanized barrier island, flood issues cannot be addressed solely with natural measures. While hard infrastructure is necessary for protection, this infrastructure should be deployed in a smart way to get the most additional social, ecological, and economic value out of it.

How did the research demonstrate new/improved ways of identifying, measuring, mapping, evaluating, understanding, and communicating risk?

Reflecting the multidisciplinary and "bi-coastal" nature of our team, we approach identifying, measuring, and mapping risk from two directions: from "outside in," by assembling, reviewing, and visualizing all available data and modeling the region as a large natural and man-made system; and from the "inside out," by assembling anecdotal evidence on the ground and interviewing countless stakeholders and residents.

Visualization plays a crucial role, not only in mapping and measuring but also in communicating risk and the natural and manmade factors that influence risk—and that we in turn can influence if we understand them.

The state-of the-art digital model of the Western Bay that our team-member DELTARES employed to simulate and visualize a major storm event and the analog "sewer in a suitcase" model that our team-member CUP (center for urban

Interboro Team: AECOM / Dark Studios / Deltares / Interboro / Jonathan Rose Companies / IMG Rebuild with Science to Urban Resiliency, Design Research / Public Infrastructure Planning Program / Project Phoenix / Investment Delft, RFA

pedagogy) employs to explain sewage and stormwater issues to students are the two poles of a comprehensive and innovative approach to making risk from flooding visible, communicable, and negotiable.

How is the solution a representation of a regional and comprehensive approach?

The Smart Barrier Phase One project is part of a comprehensive regional strategy for the western bay that addresses flood surges, stormwater flooding, stormwater infiltration, water quality in the bay, life quality, and access. This regional strategy is comprehensive yet flexible, and it incorporates ongoing planning processes and initiatives.

The barrier island is the one area where the natural influences from sea and bay directly interact with the challenges of urbanization and environmental degradation.

While our proposed solution will provide immediate protection from surges, in the long term (and in light of sea level rise), this solution can only provide continued protection in concert with other interventions within a buffered bay. The effects of wetland restoration and marsh reconstruction will positively influence surge levels on the bay side of the barrier island; the construction of the Bay Park ocean outfall pipe will improve water quality in the bay and therefore have a positive effect on the ecological and environmental quality of the dike landscape and will allow for the decommissioning of the Long Beach sewage treatment plant. The flood protection and decommissioning of infrastructure at the Long Beach site, in turn, will have a measurable effect on the water quality in the bay and the life quality at its edge. Our approach is to work simultaneously at different scale levels in the region and to provide regular feedback loops.

For the Long Beach Phase One project, we are proposing one major intervention that simultaneously reduces flood risks from both bay flooding and stormwater flooding during rain events; it provides direct social, environmental, and ecological benefits and creates opportunities for economic development. Each protective measure has an everyday use value (for example, stormwater storage areas double as freshwater parks; the resilience center will double as a community center and flexible workspace). The components of the project are synthetic and interdependent, but the interdepencies are of different degrees. For example, the creation of new development sites depends on the implementation of a protective dike landscape. On the other hand, the implementation of the dike landscape does not necessarily depend on the new development site, even though the new development might be important to generate revenue. The most important component is the protective dike landscape, but the dike landscape can change its shape, depending on which pieces of infrastructure can be relocated or decommissioned.

All of the Phase One interventions we are proposing at this point are “low-risk, no-regrets” solutions that can be studied, evaluated, and compared over time. Our Phase One project in Long Beach will provide a “protective compartment” (formed by the new dike landscape, a small levee in the median of Magnolia Boulevard and the natural elevation of Long Beach Boulevard and Park Avenue). We understand this first compartment both as a protection for the most vulnerable neighborhoods and as a sub-regional scale for a long-term strategy of compartmentalization

Interboro Team:
Interboro / Apex / Bosch Slabbers
/ Deltares / H+N+S / Palmbout /
IMG Rebel with Center for Urban
Pedagogy, David Rusk, Planning
UJT Infrastructure Projects, RFA
Program, Project
Investments, TU Delft

that can be constructed, evaluated, and adjusted incrementally over time. With each new compartment, time will have passed and new knowledge will have become available. By the time the last compartments will come up, people might have decided to actually retreat from these parts of the barrier island and move to a more densely developed central compartment instead. Our no-regrets approach allows for those changes in strategy as time goes on. In addition to setting up a phased process for Long Beach, the sub-regional scale also provides a Phase One project and test case for many other barrier islands.

A long-term perspective consolidates a comprehensive approach for Long Island as a whole; actions on the ground now feed the creation of this approach by delivering up-to-date information.

Interboro Team:
Interboro / Apex / Boston Harbors / Deltares / H+N+S / Paumanok / IMG Rebel with Center for Urban Pedagogy, David Rusk, NJIT Infrastructure Planning Program, Project Projects, RFA Investments, TU Delft

Demonstration of participatory design process / stakeholder coalition

How did the team's participatory design process engage local stakeholder groups across sectors and interests?

For *Living with the Bay*, the Interboro Team engaged over 100 organizations, including academic institutions, NGOs, nonprofits, community groups, governmental agencies, and private companies.

Please see Chapter 2 for a complete list of organizations that we presented this strategy to.

Over the short time span of a few weeks, a fast-paced series of community meetings, workshops, and stakeholder meetings has brought together a remarkable coalition of project supporters, ranging from regional institutions such as the Long Island Regional Development Council to grass-roots advocacy groups such as Operation SPLASH. We are especially proud of the larger coalition of supporters we were able to assemble through our participatory design process in a region that is notoriously fragmented.

How did the team's participatory design process facilitate collaboration among jurisdictions to understand shared problems and explore shared solutions?

We conducted the following key meetings with governmental officials about shared problems and solutions for the north/south rivers and creeks that are the focus of the Smart Barrier strategy:

Meeting: Nassau County Stage 3 Kickoff
Date: 11/21/13
Attendance: Ken Arnold, Resi Cooper, Michael Martino, Laura Munafo, Shila Shah, Rob Walker
Summary: Presented Stage 2 plan; outlined hopes for Stage 3; learned about the county's priorities

Meeting: Nassau County DPW
Date: 11/27/13
Attendance: Ken Arnold, Sean Sallie, Brian Schneider
Summary: Received targeted feedback on Stage 2 plan and Stage 3 ideas; learned about current stormwater management practice; discussed feasibility of green infrastructure; discussed whether the area could really be protected against stuge and sea level rise

Meeting: Army Corps
Date: 12/4/13
Attendance: Lynn Bocamazo, Charlie Chestnut, David Rask
Summary: Received targeted feedback on Stage 2 plan and Stage 3 ideas; discussed the conflict between our proposed channels and the Corps's dunes

Presentation: Long Island Regional Planning Council
Date: 12/10/13
Location: Molloy College, East Farmingdale
Attendance: John Cameron, Cara Longworth
Summary: Presented Stage 2 plan; received significant feedback from engineer John Cameron, especially on the proposed channels, which Cameron thought wouldn't work; discussed the need for affordable housing and rental housing;

Interboro Team: Rebecca Bell Sharpe / Interboro Partners / Deltares / Dutch Institute for Urban Pedagogy, David Rask / IMG Rebel / NJIT Infrastructure Planning Program, Project Projects, RFA Investments, TU Delft

discussed the need for evacuation routes; discussed the importance of working with villages and the county

Meeting: City of Long Beach
Date: 12/10/13
Attendance: Patricia Bourne, Jim Lacarrubba, Jack Schnirman
Summary: Learned about the city's priorities, including the redevelopment of the north shore

Meeting: NY Rising CR
Date: 1/2/14
Attendance: Laura Munafo, Zachary Richner, Jaime Rubin, Lead Nassau-based NY CR planners
Summary: Presented Stage 2 plan; heard presentation from each of the Nassau-based NY CR planners; discussed potential overlaps and opportunities to work together

Meeting: NY Rising CR
Date: 1/15/14
Attendance: Laura Munafo, Zachary Richner, Lead Nassau-based NY CR planners
Summary: Discussed the selection of priority projects from the process

Presentation: Long Island Regional Economic Development Council
Date: 1/23/14
Location: LI Regional Office of Empire State Development, Hauppauge
Attendance: Bob Brinkman, Marianne Garvin, Gilbert Hanson, Jim Morgo, Christopher Niedt, Rich Rotanz, Brian Scripture
Summary: Presented Stage 2 plan and Stage 3 progress; received feedback, especially on what is presently our Green Corridor strategy; invited to return in March when the project is further along to get official support

Meeting: City of Long Beach
Date: 1/23/14
Attendance: Patricia Bourne, Michelle DiBenedetto, Scott Kemins, Jack Schnirman
Summary: Discussed the city's interest in the land trust; Jack reiterated their interest in RBD doing something big like the bayfront redevelopment; learned that some on Long Beach oppose the outflow pipe

Meeting: Nassau County DPW
Date: 2/12/14
Attendance: Sean Sallie
Summary: Discussed the feasibility of doing green infrastructure, traffic calming, and TOD development along the Sunrise Highway corridor

Meeting: NY Rising CR
Date: 2/21/14
Attendance: Laura Munafo, Zachary Richner, Jaime Rubin
Summary: Updated state on Stage 3 plan

Meeting: City of Long Beach
Date: 2/24/14
Attendance: Patricia Bourne
Summary: Discussed the importance of working with locals; received feedback on our messaging

Presentation: South Shore Estuary Reserve Council
Date: 3/11/14
Location: Seatuck Environmental Association, Islip
Attendance: South Shore Estuary Reserve Council
Summary: Presented *Living with the Bay*; received feedback

Meeting: City of Long Beach
Date: 3/18/14
Attendance: Jack Schnirman, Patti Bourne, Jim Lacarrubba
Summary: Updated Long Beach on status of the Smart Barrier strategy; received official stamp of approval from city

Presentation: Long Island Regional Economic Development Council
Date: 3/19/14
Location: LI Regional Office of Empire State Development, Hauppauge
Attendance: Long Island Regional Economic Development Council, members of the public
Summary: Presented *Living with the Bay*; answered questions; council voted affirmatively to support the plan

Interboro Team / Joseph Salvo / Interboro / AKRF / Parsons / Deltares / Mott MacDonald / IMC / Rebel with Consent / Pratt Institute for Urban Planning / David Brown, Urban Infrastructure Project, RFA / Investments, TU Delft

How did the team's participatory design process solicit direct input from community members in the project area?

The Interboro Team discussed North Park's vulnerability and presented our proposed solutions in numerous project partner, stakeholder, and community meetings. In our presentations, we exposed how vulnerable Long Beach's poorest residents and Long Beach's most critical pieces of infrastructure are to back bay flooding.

The current design is the product of the extensive dialogue we had with community members.

Specifically, we conducted the following meetings with community groups about shared problems and solutions for the north/south rivers and creeks that are the focus of the Smart Barrier strategy:

Meeting:
Community Meeting I
Date: 2/22/14
Location: Baldwin Senior High School
Attendance:
Approximately 60 people
Summary: Presented *Living with the Bay*; conducted an open discussion; led breakout tables on each of our four strategies

Meeting:
Community Meeting II
Date: 3/8/14
Location: Operation SPLASH
Attendance: +/- 75 people

Summary: Presented *Living with the Bay*; conducted an open discussion; led breakout tables on each of our four strategies

Event: High School Resiliency Workshop
Date: 3/18/14
Location: Lynbrook High School
Attendance: Students from Lynbrook Sustainability Club
Summary: Presented scaled-down version of *Living with the Bay*; discussed the threats of surge, sea level rise, and stormwater, and discussed strategies for combating the threats
Event: Boat and Bus Tour of *Living with the Bay*
Date: 3/29/14
Location: Operation SPLASH
Attendance: TBD

In Community Meeting I and II, we led breakout tables on the Smart Barrier strategy.

Highlights from the breakout tables include:

Highlights from Meeting I
At the public meeting in Baldwin, the discussion of the Interboro Team's RBD proposal revolved primarily around the question of new development in the North Park neighborhood of Long Beach. One participant in the discussion questioned if—given sea level rise and the expected increased frequency of storms—any new development on the barrier island should be encouraged at all. The Interboro Team's response was that new development in North Park was primarily intended for Long Beach residents interested in moving to protected, elevated housing while remaining in Long Beach. Crystal Lake, a North Park resident, pointed out the history of the neighborhood as an environmental justice community. Mrs. Lake stated that any new development along the north shore of Long Beach should primarily protect the most vulnerable current residents instead of bringing in new high-end housing.

Highlights from Meeting 2
At the public meeting in Freeport, two couples from Long Beach discussed the Interboro Team's long-term proposal for a protective system along the bay shore of Long Beach. Both couples live adjacent to the bay shore, in the canal area and in the west end, respectively. Both couples stated that they would not have liked to see a dike, bulkhead, or seawall block their view of the bay but that the flooding during superstorm Sandy has fundamentally changed their attitude. They expressed

Interboro Team:
Interboro / Nitsch / Boston Seaports / Deltares / Arup / SWA / Parsons / IMG Rebel with Center for Urban Resilience / David Rusk, NJ Transit / Program Manager / Investment Projects, RFA / Delft

strong support for the concept of protective compartments. How did the team's participatory design process result in the formation of a coalition of support?
While it wasn't very difficult to assemble a coalition of enthusiastic supporters in the geographically defined city of Long Beach, we are especially proud of the larger coalition of supporters we were able to assemble through our participatory design process in a region that is notoriously fragmented.

In community meetings, support for the Smart Barrier strategy was overwhelmingly positive

Please see Chapter 1 for a complete list of supporters for this project.

Interboro Team:
Interboro / Apex / Bosch Slabbers / Deltares / H+N+S / Palmbout / IMG Rebel with Center for Urban Pedagogy, David Rusk, NJIT Infrastructure Planning Program, Project Projects, RFA Investments, TU Delft

How does the project represent a higher-performing approach to reducing risk while providing multiple benefits and amenities (physical, social, economic, environmental)?

All of our design proposals are guided by the principle that each investment in flood protection (during the emergency) should also have positive effects during the rest of the year (during the "every day"). What we do to reduce flood risks should always also have multiple other physical, social, economic, and environmental benefits.

With the Long Beach Phase One project, we are proposing one major intervention that simultaneously reduces flood risks from both bay flooding and stormwater flooding during rain events; it provides direct social, environmental, and ecological benefits and creates opportunities for economic development.

The project reduces risk of flooding for the North Park neighborhood of Long Beach and for critical infrastructure (water purification plant) by creating a protective dike landscape. The dike landscape is designed in a way to not only provide protection but also re-create the natural shoreline along the bay and allow for direct access to the shore. Widening the dike landscape will also create a high-value elevated development site in close proximity to transportation and with direct access to the new open space amenity.

While some of the infrastructure behind the dike will remain in place for the foreseeable future, we propose relocating and/or consolidating some of the other infrastructure. The soil on some of the sites currently or previously occupied by industrial uses is contaminated and will have to be either capped or removed. Our proposal is to remove the soil and create a water retention park just behind the dike landscape. This freshwater park will provide a retention area for stormwater, habitat, and open space.

The most significant piece of infrastructure currently located on the project site is the Long Beach sewage treatment plant. Once the ocean outfall for the Bay Park sewage treatment plant is in place, the sewage from Long Beach can be treated in Bay Park and the Long Beach sewage treatment plant can be decommissioned. We propose that the necessary pumping station on the site of the current Long Beach sewage treatment plant will be designed to double as a resilience center, taking advantage of the pumping station's power generators. In this case, the "every day" infrastructure of the pumping station will provide a different benefit during the "emergency."

How does the solution employ new design approaches, construction methods, materials, or technology to significantly enhance resilience?

Designing for a more resilient bay also means employing a resilient design approach. Our overall design approach is not about a "silver bullet" solution—be it a sea wall or managed retreat—but a field of interdependent low-risk/no regrets interventions within the larger perspective of the "buffered bay" that can be evaluated and adjusted over time. Our approach is characterized not by generalization but specific analysis on each scale.

The result of collaboration, conversation, and fierce discussion among world leaders in hydrology, coastal engineering, financing, and benefit-cost analysis, landscape architecture, planning, and urban design, our proposed solutions represent the state of the art in innovative and implementable resilient design.

Interboro Team: Interboro / Alex / Design Studio / Deltares / SWECO / Dr. Stephen Shaw / IMG Rebuild / H+S / Rutgers / Rebuild by Design / Center for Urban Resilient Design / Hydraulic Institute / Urban Investments / Project Finance / Urban Planning / Design Consultants, RFA

Design quality / excellence

How does the solution incorporate multiple scales, interests, objectives, and phases?

The Smart Barrier Phase One project is part of a comprehensive regional strategy for the western bay. It addresses different scales and constituencies by
Protecting the most vulnerable neighborhood in the city that was most affected by superstorm Sandy (scale: North Park)

—Protecting a significantly larger portion of the City of Long Beach from stormwater flooding and providing a resiliency center for the city (scale: Long Beach)

—Providing a test case and first phase for a multi-phased protective strategy of compartmentalization for the entire barrier island (scale: barrier island)

—Protecting or relocating infrastructure that is of critical regional importance (scale: region)

How does the solution perform as more than just a defense mechanism and represent a development-oriented and future-driven approach?

As with all of our *Living with the Bay* proposals, the purpose of the Smart Barrier Phase One project is not only to protect from multiple risks but also to amplify what is attractive and valuable about *living with the bay*. The dike landscape not only protects but also harnesses an opportunity for economic development by

Enhancing regional tourism by providing an open space amenity and direct access to a re-naturalized bay shore, allowing visitors to experience both the ocean beach and the bay shore within a 10-minute walk, and in direct proximity to the Long Beach LIRR station
Preparing a very attractive protected development site for high-density mixed-use development in direct proximity to the new open space amenity
Creating a new gateway for the City of Long Beach at a highly visible site between the two main access bridges

Interboro Team: Interboro / Arup / Dosch Sanders / Deltares / H+N+S / Palmbout / IMG Rebel with Centre for Urban Pedagogy, David Rusk, NJIT Infrastructure Planning Program, Project Projects, RFA Investments, TU Delft

How does the solution represent a planning and design approach that is comprehensive and inclusive? How does it articulate the complexity of the problem and solution in a clear and understandable way?

The Smart Barrier project is prototypical for many barrier island locations along the coast. At the same time, the specific site we chose for the Phase One project is not interchangeable.

We chose to work in Long Beach because of its high vulnerability (the city with the most damage from superstorm Sandy) and high population density.

The specific site of our intervention in North Park, on the bay shore of Long Beach, combines within a small geographic area many of the flood-related issues addressed in RBD: the lowest-lying area of Long Beach, with the highest risk of back-bay flooding and stormwater flooding, is at the same time the location of industrial production (thus adding the additional risk of contamination after a flood); of infrastructure that is of critical regional importance; and of the most vulnerable and most disadvantaged population (the environmental justice community of color in North Park).

By designing a protective system for the neighborhood and infrastructure that doubles as a rainwater retention area and an open space amenity for this specific site, the Phase One project provides one comprehensive answers to this set of issues.

How does the solution represent the highest quality of 21st century design while also catalyzing a process to raise awareness of resilience issues?

The goal of our proposal is not only to protect from surges and stormwater flooding and to simultaneously create ecological, economic, and environmental benefits, but it is also about creating awareness of the bay as a natural system. The dike landscape will make it possible to access and experience the bay shore. The stormwater storage landscape and the “water plaza” on Kennedy Plaza in front of City Hall will allow residents to experience stormwater retention and stormwater cleanup.

Interboro Team: Alexander Felson Stakeholders / Deltares / Vertex / Dewberry / IMG / Rebecca Lewis / Stakeholder Outreach / Rutgers University / Urban Planning Collaborative / NJ Institute of Technology / Program Management / Capital Project Delivery / Investment Strategies, RFA

Impact

How does the solution respond to the greatest/highest risks, vulnerabilities and/or impacts identified?

Our Phase One project in Long Beach will provide a "protective compartment" (formed by the new dike landscape, a small levee in the median of Magnolia Boulevard and the natural elevation of Long Beach Boulevard and Park Avenue). This compartment will provide protection from 12-foot storm surges. The level of protection can be increased by further elevating the protective compartment, or the level of risk from back-bay flooding can be decreased through other interventions in the bay.

This first compartment will perform as a protection for the most vulnerable neighborhoods and some critical infrastructure and as a sub-regional scale for a long-term strategy of compartmentalization that can be constructed, evaluated, and adjusted incrementally over time.

Aside from the risk presented by major surges, the project addresses the "every day" problem of stormwater flooding by providing stormwater retention areas.

How does the solution reduce vulnerabilities, minimize consequences/losses, and increase the ability to withstand and rapidly recover from future disaster impacts/disruptions?

The proposed strategy of compartmentalization will contain and reduce the impact of failure. The incremental process of compartmentalization over time will create a "learning" system that can respond to failure and adjust. Even within the protective compartment, new development will be designed to minimize damage from flooding.

Most immediately, we not only propose the construction of a protective dike landscape but we also propose the relocation of most of the critical infrastructure that currently still occupies the site. Moving regionally critical infrastructure (such as a sewage treatment plant) out of harm's way will be an important step in increasing the region's ability to withstand and rapidly recover from future disasters.

We propose to turn the pumping station that will become necessary when the Long Beach sewage treatment plant gets relocated into a resilience center, taking advantage of the pumping station's power generators. The resilience center will help residents to more rapidly recover from future storms.

How does the solution present the potential for broader applicability/replicability, either in approach or solution?

Our Phase One project in Long Beach will provide a "protective compartment" (formed by the new dike landscape, a small levee in the median of Magnolia Boulevard and the natural elevation of Long Beach Boulevard and Park Avenue). We understand this first compartment both as a protection for the most vulnerable neighborhoods and as a sub-regional scale for a long-term strategy of compartmentalization that can be constructed, evaluated, and adjusted incrementally over time. With each new compartment, time will have passed and new knowledge will have become available. By the time the last compartments will come up, people might have decided to actually retreat from these parts of the barrier island and move to a more densely developed central compartment s instead. Our no-regrets approach allows for those changes in strategy as time goes on. In addition to setting up a phased process for Long Beach, the Phase One project also provides a sub-regional scale project and test case for many other barrier islands.

How does the solution contribute to the overall recovery and

Interboro Team / Alex Ferrari / Residents & Neighbors
Interboro / Alex Ferrari / Residents & Neighbors
/ Delta Urbanism / Rotterdam / Delft
IMG Rebel / H+N+S / Rotterdam / Delft
Redagogy / David Rush / Rotterdam
NJIT Infrastructure Planning Program, Project Resilient Urban Investments, TU Delft
NJIT Infrastructure Planning Program, Project Resilient Urban Investments, TU Delft, RFA

rebuilding of the area/community and have the potential to catalyze transformative change?

For one, we see the transformative potential of the Smart Barrier Phase One project in its catalytic and prototypical nature: it starts an adaptive process of transformation on the barrier island, and it provides an innovative prototype for other barrier islands.

At the same time, we see the transformative potential of the project in the fact that it is part of a comprehensive, regional approach of interdependent interventions, which will catalyze a new level of regional collaboration in the face of a shared risk.

How does the solution address one or more of the following key areas of focus: a) vulnerable populations, b) critical infrastructure (particularly energy and communications), c) potential for leveraging other federal investments?

In the Sandy-affected region, many of the low-lying areas most affected by flooding are frequently simultaneously 1) the locations of critical infrastructure and 2) the home of the socially most vulnerable population. In Long Beach, the area that is most vulnerable to back-bay flooding and stormwater flooding is at the same time the location of critical regional infrastructure and of the most vulnerable and most disadvantaged population. This population (in this case the residents of North Park) lives with the threat not only of flooding but also of the potential contamination coming from flooded infrastructure next door.

The first and most direct impact of the Phase One project will be the protection or relocation of critical infrastructure and the protection of the most vulnerable population in Long Beach, namely the resident of North Park.

The proposed strategy of compartmentalization leverages the ongoing work of beach replenishment and dune construction by the USACE, complementing this project on the bay side to create a comprehensive protective strategy.

How does the solution incorporate principles of sustainability, including water quality and energy efficiency?

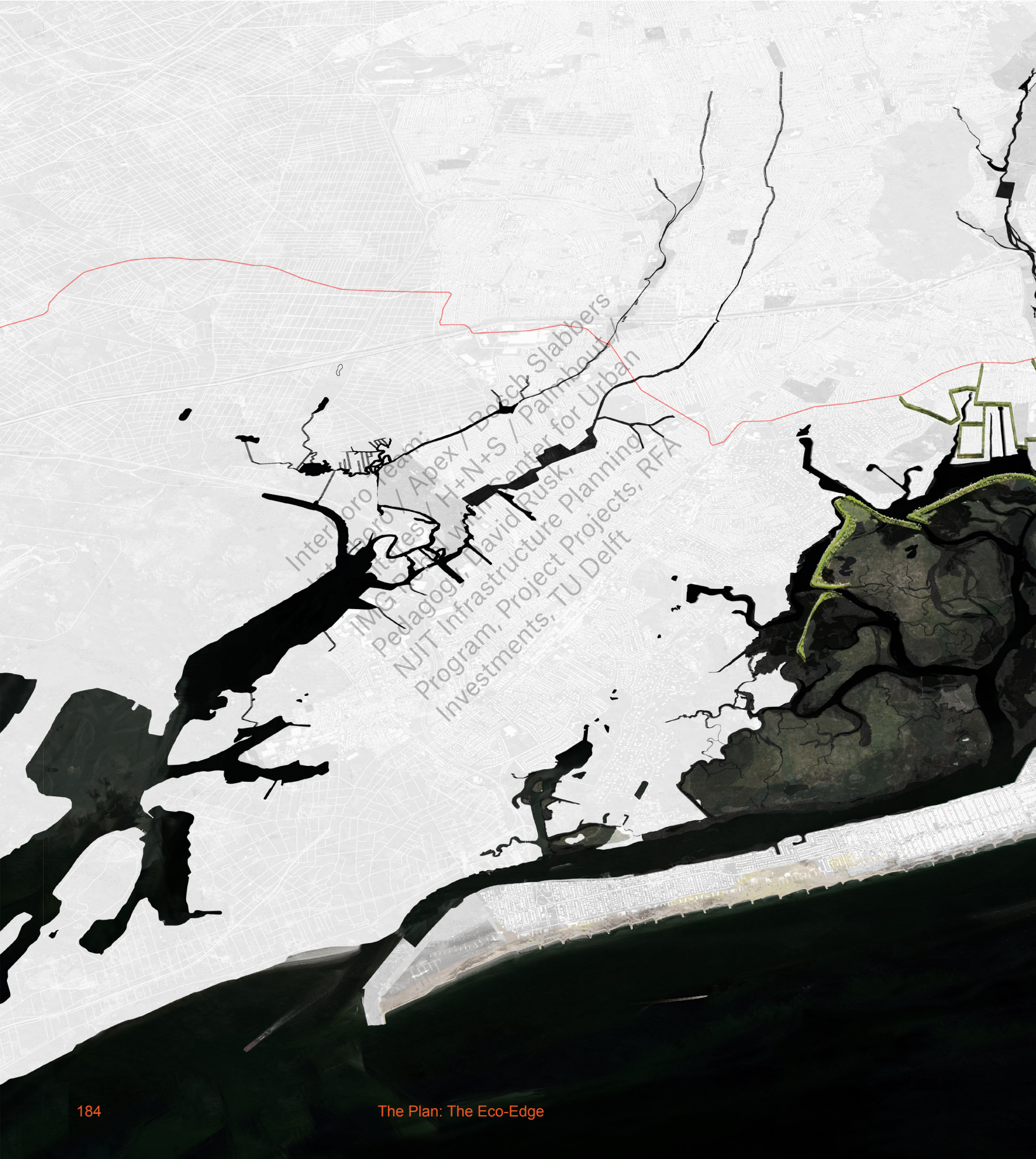
By creating a stormwater landscape, a stormwater plaza, and additional bio swales, we propose to make space for water storage, infiltration, and purification. Besides water storage and water purification, these areas will also replenish the groundwater and create attractive open space amenities. Replacing paved surfaces with open landscape and adding trees will reduce the urban heat island effect and affect air quality.

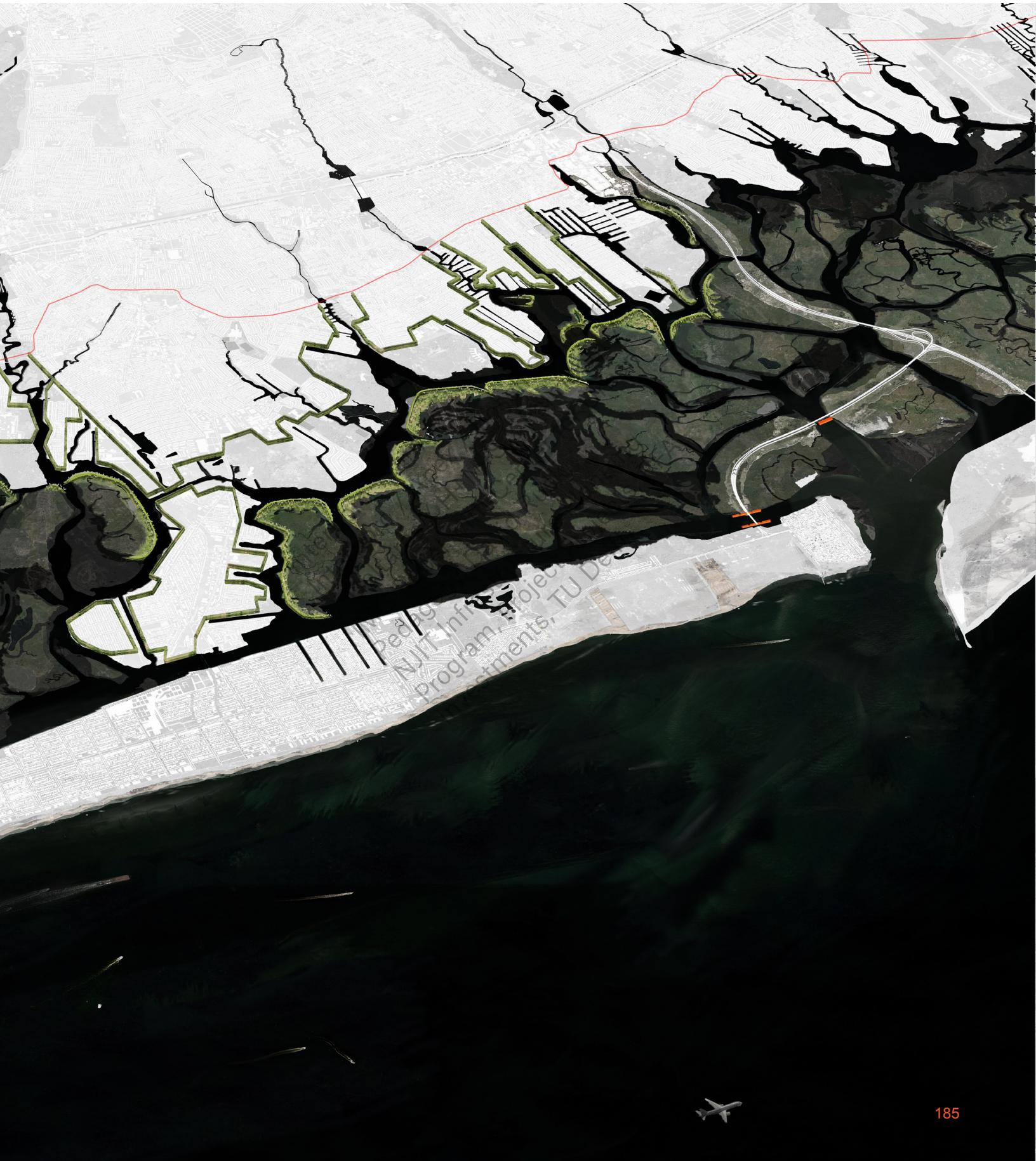
The re-creation of a natural coastline on the bay shore and the water retention landscape will replace pervious pavement to recreate natural habitat.

Interboro Team / Interboro / Apex / Bosch Slabers / Deltares / M+N 3 / Pamphilius / IMG Rotterdam / Center for Urban Pedagogy / Urban Risk, Urban Infrastructure Planning / Dutch Ministries of Infrastructure and Environment / Delft Technical University / Deltares, RFA

Interboro Team:
Interboro / Apex / Bosch Slabbers
/ Deltares / H+N+S / Palmbout /
IMG Rebel with Center for Urban
Pedagogy, David Rusk,
NJIT Infrastructure Planning
Program, Project Projects, RFA
Investments, TU Delft

Strategies for the Marsh: The Eco-Edge





Design Research Laboratory
NJIT Infrastructure Project
Program, TU Delft
Departments,

Strategies for the Marsh: The Eco-Edge

In the West, Middle, and East Bays, we propose new marsh islands that reduce wave action, improve the bay ecology, and afford new recreational opportunities. A second component of this strategy is a system of ring levees that would further protect development along the urbanized edge.

We propose a multi-layered, multi-faceted approach to protect vulnerable bay-front communities from storm surge and sea level rise, improve water-quality conditions in the bay, and provide new recreational opportunities.

Our proposal includes the following elements:

Wooded Marsh Islands

Wooded marsh (is)lands are a natural element of the South Shore's bays that have historically served as protection for the urbanized edge. However, many of these wooded marshlands have been developed with low- and medium-density housing, and many more are declining due to poor surface-water quality conditions and a loss of sediment due to unbalanced sedimentation migration conditions. (The poor water quality conditions are mostly related to the ongoing discharge of treated sanitary waste associated with the Bay Park Sewage Treatment, as well as contaminants associated with poorly or untreated stormwater runoff from the associated urban neighborhoods.)

We propose building constructed Wooded Marsh Islands directly in front of vulnerable bay-front communities (while still maintaining vessel navigation channels). Preliminary hydrologic modeling indicates that these islands could reduce wave run up and reduce back-bay flooding on the order of 2 to 3 feet. A passive system that would require only minor upkeep, the islands would protect without fear of system failures. Beyond protection, the islands could significantly improve the ecology of the bay, including increases in areas for ospreys and waterfowl, shellfish, and finfish. Moreover, the islands themselves would provide excellent recreation opportunities for Nassau County residents. Accessible by small boats, the islands are great sites for picnicking, fishing, clamming, and other recreational activities.

Ring Levee Road System for Bayside Communities

TThe second component of the Eco-Edge strategy is a proposed raising of the bay-front ring roads (on the order of 4 to 5 feet) that are so common along the urbanized edge. The raised roadways would be improved/equipped with stormwater detention systems to ensure that the interior of the

Interboro Team / Bruce Slabbers
Interboro Partners / Palmbout /
/ Deltares / Palmbout / Center for Urban
IMC Bay Planning Coalition / Bay Planning
Pedestrian Bridge / Coalition / Urban
Water Infrastructure / RFA
Nassau Parks Project / RFA
Nassau Parks Project

rings do not flood. In addition to this, we propose the following components:

—Homes on the bay side of the road that are not protected by the newly elevated infrastructure would be raised, either on stilts or on engineered/compacted backfill materials

—To protect their view sheds and allow for passive stormwater best management practices such as grassy swales, the first row of landward homes along the elevated road would be raised on engineered back materials

The third row back from the bay and residents/structures beyond would be protected from flooding by the raised road network, and the ring-diked communities would be connected via selected east-west roadways to provide a fully resilient coastline.

The primary benefit of this intervention strategy is that literally thousands of homes and businesses would be protected from back-bay flooding. This intervention strategy would also provide protection to the highly vulnerable communities from anticipated sea level rise associated with global climate changes. A final benefit is that stormwater would be detained and treated within the newly constructed detention BMPs associated with the raised roadway networks, resulting in improved surface water quality in the bay.

Floodplain Parcels and Public Space Resilience

The parcels located directly in the floodplain of the bay at the water's edge will be brought to the same safety level as the houses behind the level by a strategy that incorporates individual raising of the parcels or houses.

Interboro Team / Bay / Post Slabbing / Deltares / Lynch / Pamphout / IMG Rebel / Dutch Water Sector / Rebel / Dutch Delta Approach / Urban Water Management / Dutch Infrastructure Planning Institute / Planet Projects, RFA

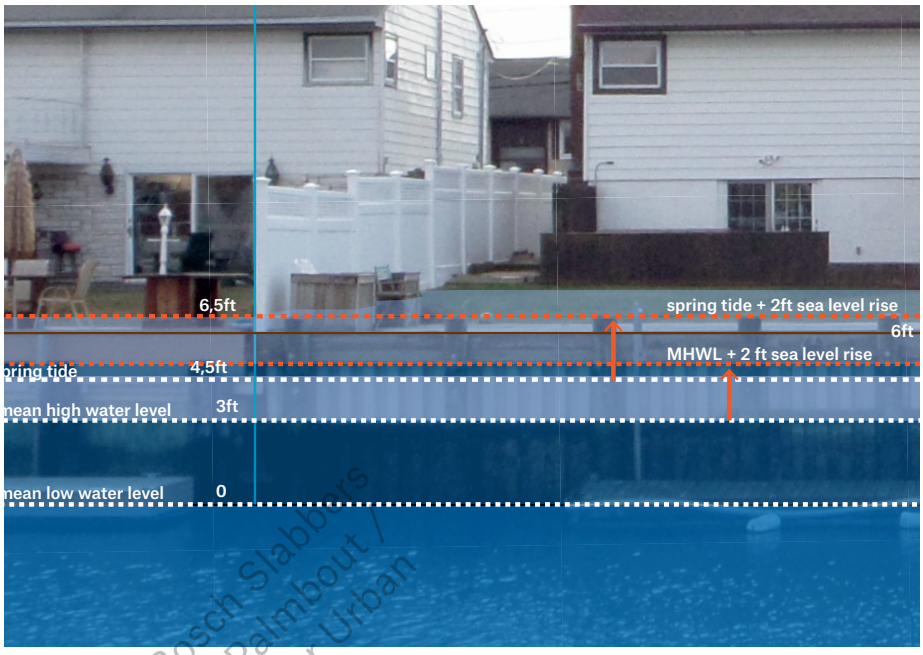
Phase One

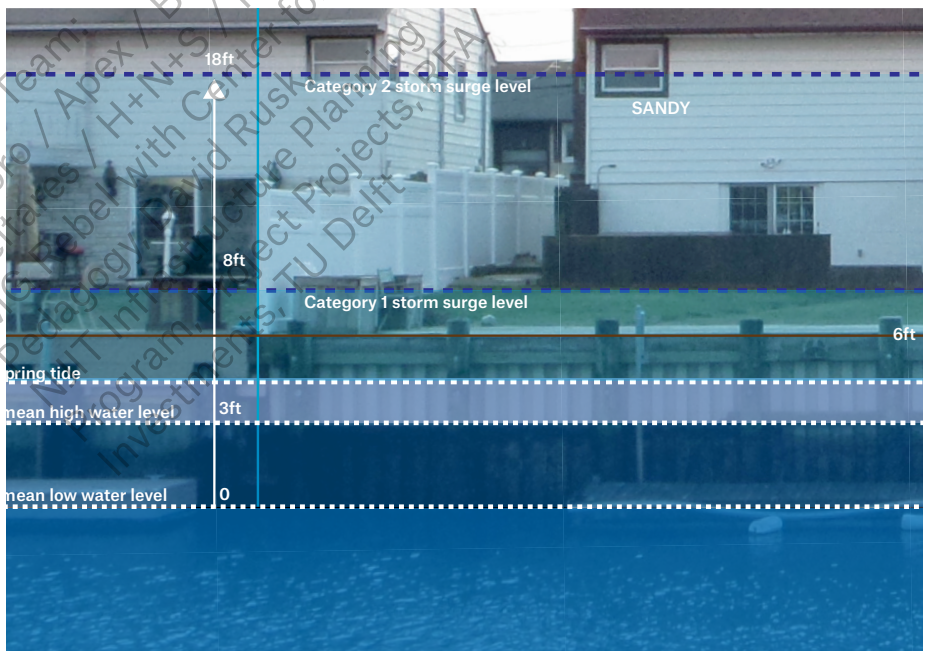
As a sub-regional scale project, we propose building a slice of the Eco-Edge in Freeport.

Bird's-Eye View Of The Freeport Region

Interboro Team:
Interboro / Apex / Bosch Slabbers
/ Deltares / H+N+S / Palmbout /
IMG Rebel with Center for Urban
Pedagogy, David Rusk,
Infrastructure Planning
Program, Project Projects, RFA
Investments, TU Delft

Projection Of The Storm Levels And Effect Of Sea Level Rise For Bedell Street Area

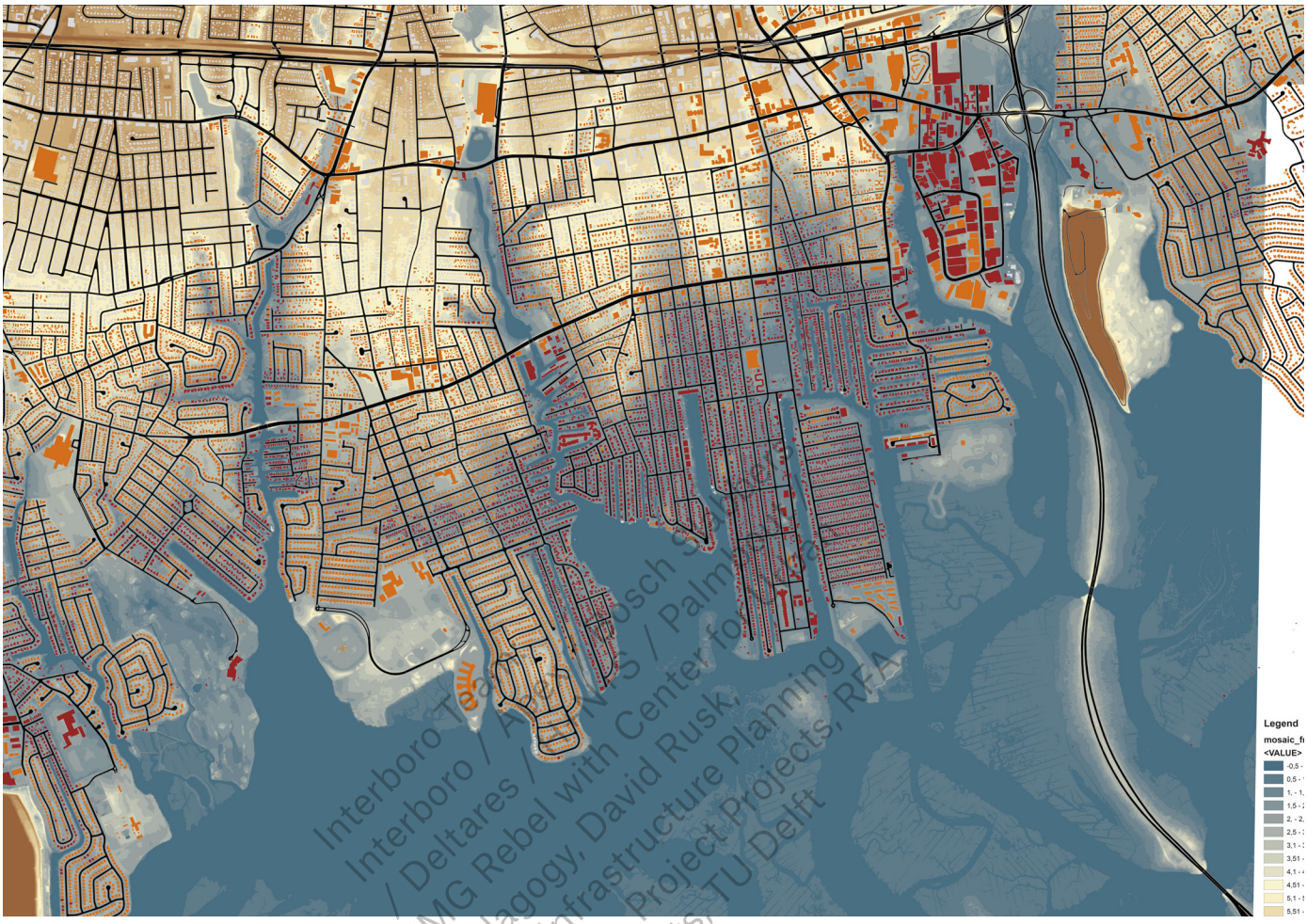




Interboro Team:
Interboro / Apex / Bosch Slabbers
/ Deltares / H+N+S / Palmbout /
IMG Rebel with Center for Urban
Pedagogy / David Rush
MIT Infrastructure Planning
Program / Project Projects, EA
Investments, TU Delft

These projections show not only that this area is vulnerable to storm flooding but also that only a few feet of sea level rise will make daily live far harder, as even the spring tide will cause water to flow over the bulkheads.

The Threat



Interboro Tour
Interboro / AMS / Bosch S
/ Deltares / Palm
IMG Rebel with Center fo
Pedagogy, David Rusk,
NJIT Infrastructure Planning
Program, Project Projects, RFA
Investments, TU Delft

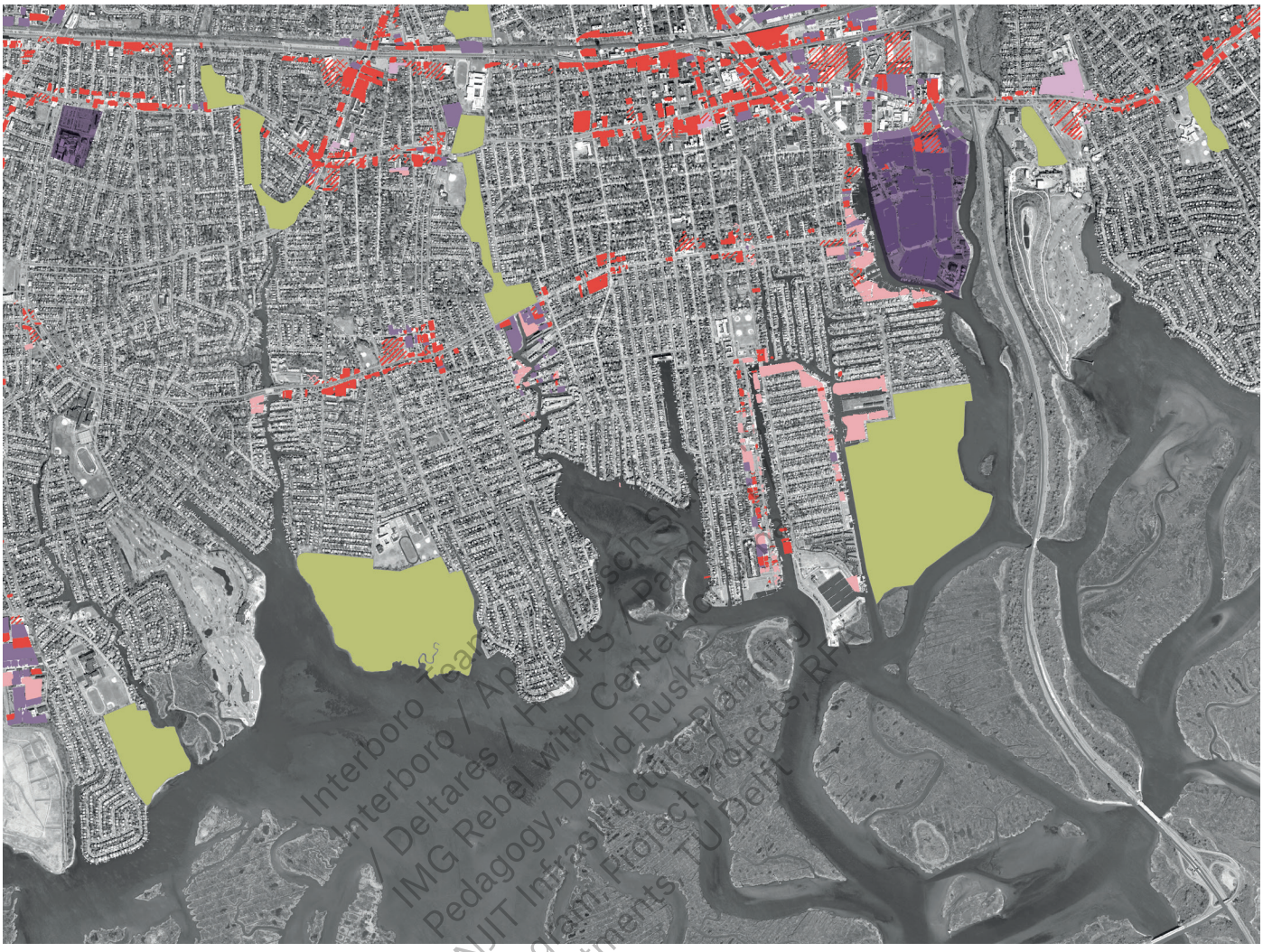
The low lying areas of Freeport are vulnerable to flooding and storm damage due to a category one storm (red houses) or to a category two storm (orange houses). The LIDAR data shows that the impact of the storm is directly linked to the height of the areas.

Natural Habitats Within The Bay Of Freeport And Baldwin

- Land
- Tidal Marsh
- Unconsolidated sediment
- Submerged aquatic vegetation
- Unknown benthic habitat

Due to the diversity in sediment, land height, water depth, and flood frequency, many different ecological habitats are present within this area.

The Economic Values Within The Flood Zone (Apart Form Housing)



The red areas are commercial developments; the concentration around the highway and at the Waterfront Mile in Freeport is clearly defined. The industry cluster around Meadowbrook is a large, flood-prone area.

Inundation Due To A Category 1 Storm

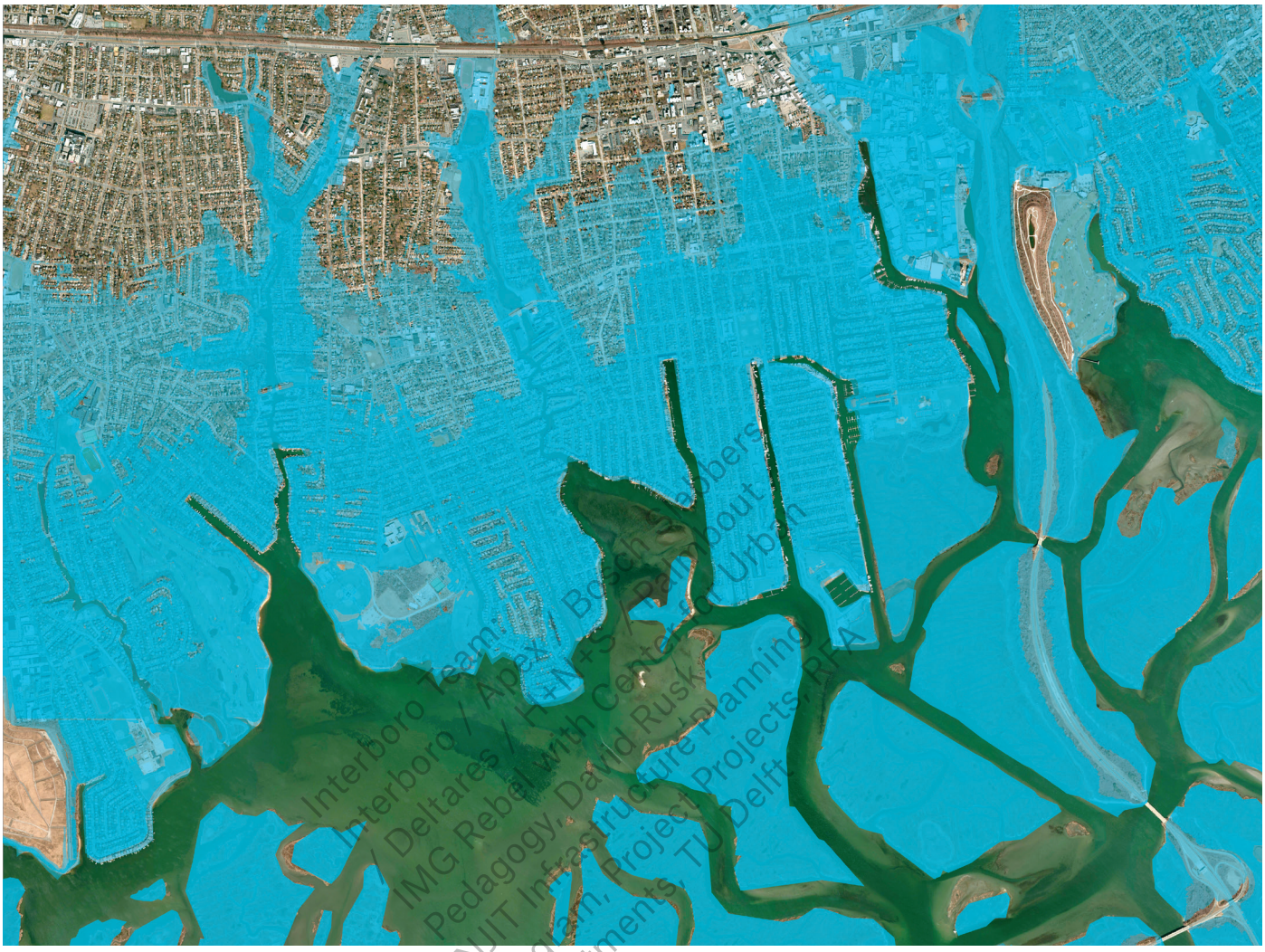
Interboro Team
Interboro / Arup / Stantec / Dewberry
/ Deltares / HR&A / Rutgers University
IMG Rebar with Center for Urban
Pedagogy, David Rusk, Urban Planning
NJIT Infrastructure Planning
Program, Project Projects, RFA
Investments, TU Delft

During a category 1 storm, all of the marshes and low-lying developments within the marshes—a large part of Freeport—will flood.

Inundation Due To A Category 2 Storm

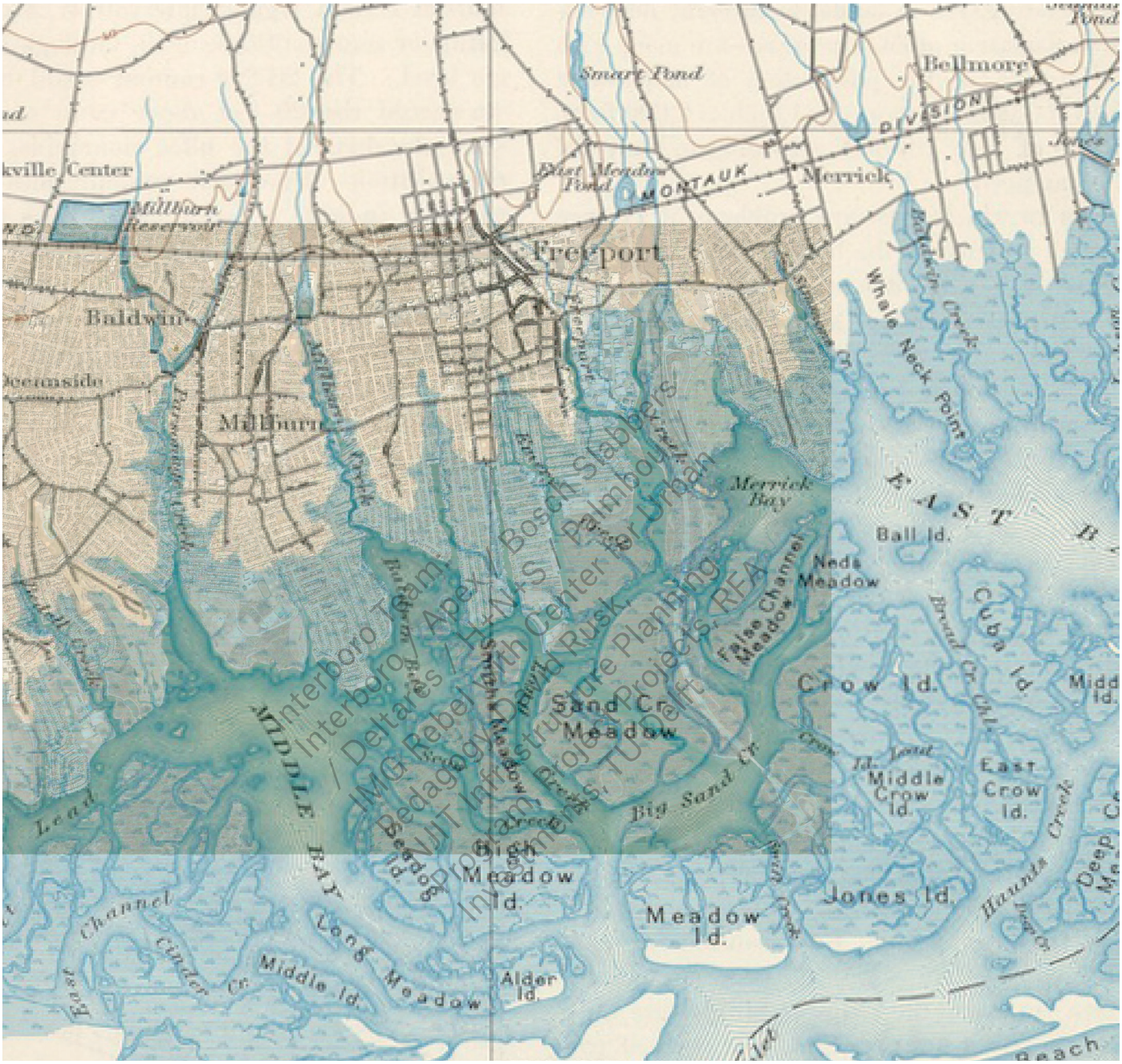
During a category 2 storm, all of the marshes and developments within the former marshes will flood.

Inundation Due To Sandy



During Sandy, the residential areas within the marsh were severely affected, as was the industry next to Meadowbrook and the developments along the creeks.

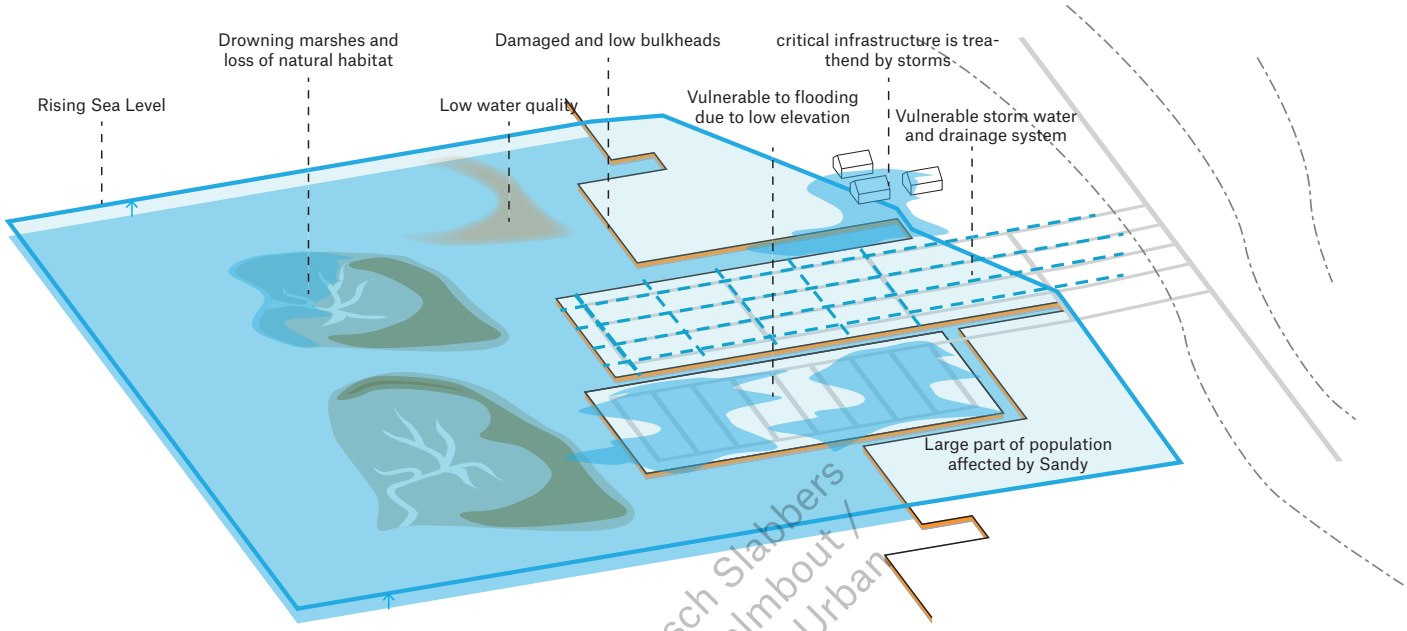
The Marshes Have Been Developed Into Housing Areas



Interboro Team
Interboro / Apex / H+N+S / Bosch Slabbers / Palmbout
/ Deltares / IMG Rebel / Urban Redaktion / Center for Urban Pedagogy / David Rusk / Strategic Planning
NUIT Infrastructure Projects, REA
Project Projects, TU Delft
Inventarisatie, TU Delft

The newest land reclamation and housing developments are situated on the former marshlands, which are naturally just a few feet above sea level and thus vulnerable to flooding. The development of these areas has resulted in an unbalanced natural system.

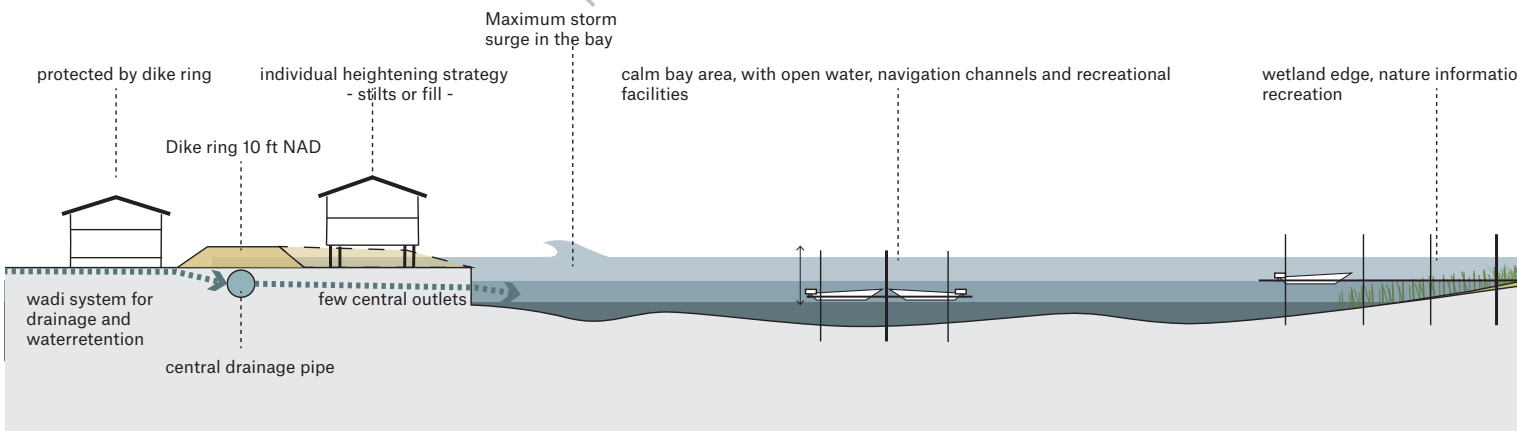
Challenges For The Marshes



The challenges that have been described for the whole region are made site-specific for the sub-region. Currently the loss of marshes leads to loss of natural habitat and thus species. In addition, there are water safety threats because the bulkheads are in poor condition and are not high enough regardless. The water drainage is also vulnerable, as there are many outlets that can only drain at low tide.

Interboro Team: Interboro / Apex / Bosch Slabbers / Deltares / L+N+S / Palmbout / IMG Rebel / Urban Center for Urban Pedagogy, Risk, NJIT Infrastructure Planning Program, Projectgroep, RFA Investments, TU Delft

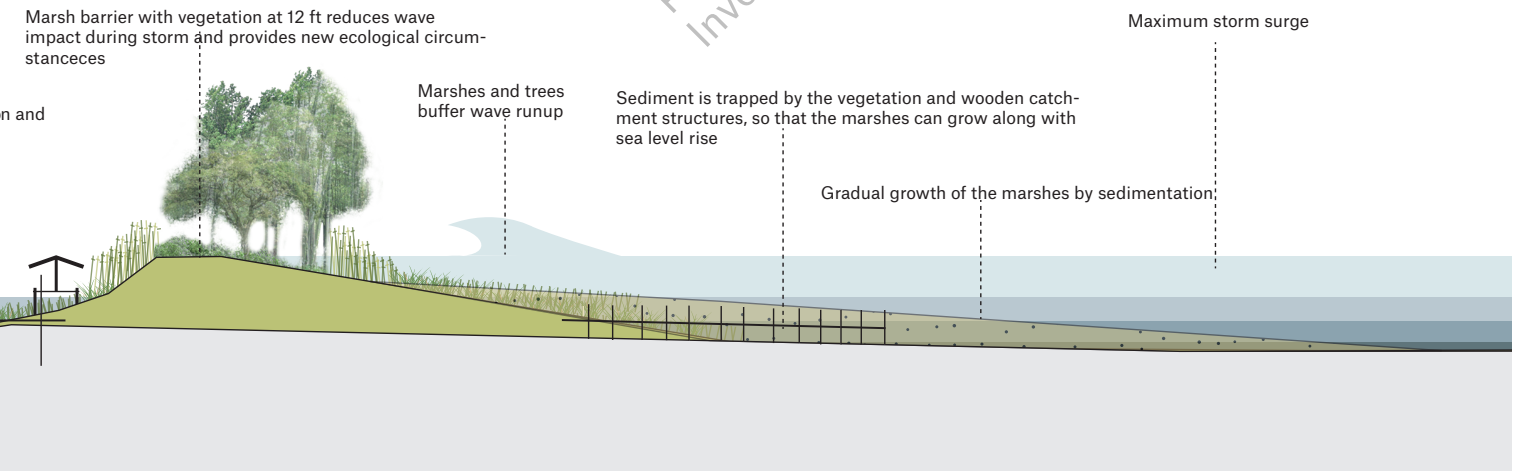
Cross Section Of Dike Ring And Wooded Marsh Ridge



Plan Of Dike Rings And Wooded Marshes

This plan shows a future bay edge in which all measures are integrally designed, leading to a safer and more attractive environment (for both humans and nature).

Interboro Team: Interboro / Apex / Bosch Slabbers / Deltares / H+N+S / Palmbout / IMG Rebel with Center for Urban Pedagogy, David Rusk, NJIT Infrastructure Planning Program, Project Projects, RFA Investments, TU Delft

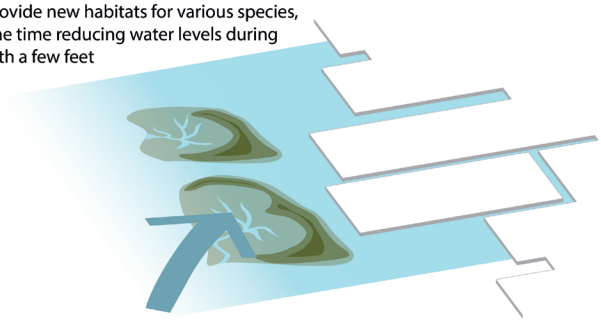


This simplified cross-section shows how all of the measures are interlinked and cumulatively result in a safer and more attractive environment.

Marsh Development

marsh development

new marshes provide new habitats for various species, while at the same time reducing water levels during storm surges with a few feet

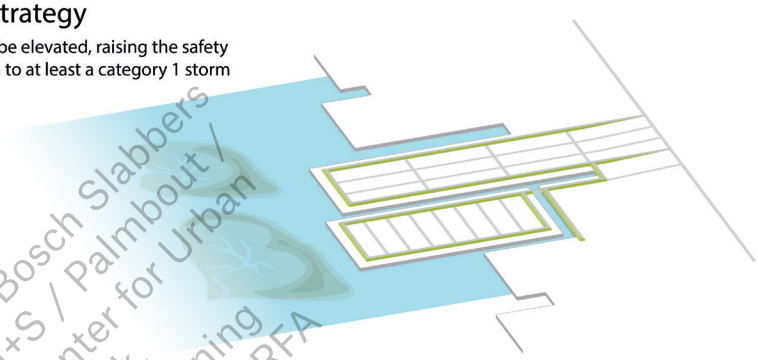


New marshes provide new habitats for various species while reducing water levels during storm surges by a few feet.

Marsh Development

dike ring strategy

main roads will be elevated, raising the safety level of this area to at least a category 1 storm



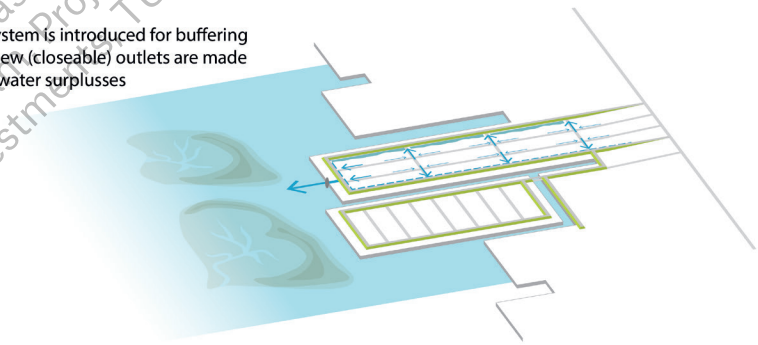
The main roads will be elevated, raising the safety level of this area to at least a category 1 storm.

Interboro Team:
Interboro / Apex / Bosch Slabbers / Deltares / H+N+S / Palmbout / IMG Rebel with Center for Urban Pedology, David Rusk, NJ Infrastructure Planning Program, Project Projects, RFA Investments, TU Delft

Drainage

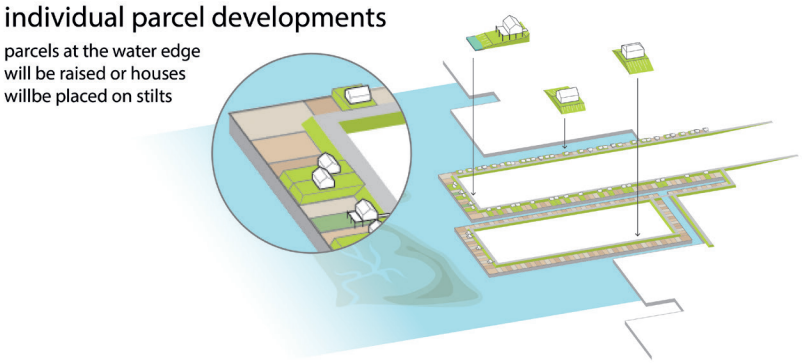
drainage

an open wadi system is introduced for buffering rainwater, and new (closeable) outlets are made for discharging water surpluses



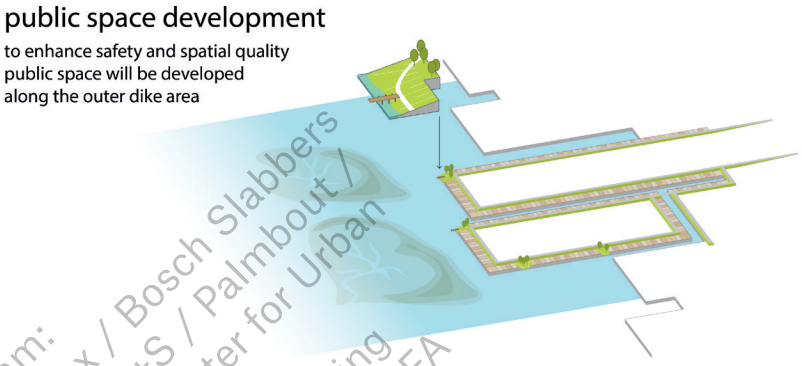
An open wadi system is introduced for buffering rainwater, and new (closeable) outlets are made for discharging water surpluses.

Individual Parcel Development



Parcels at the water's edge will be raised or houses will be placed on stilts.

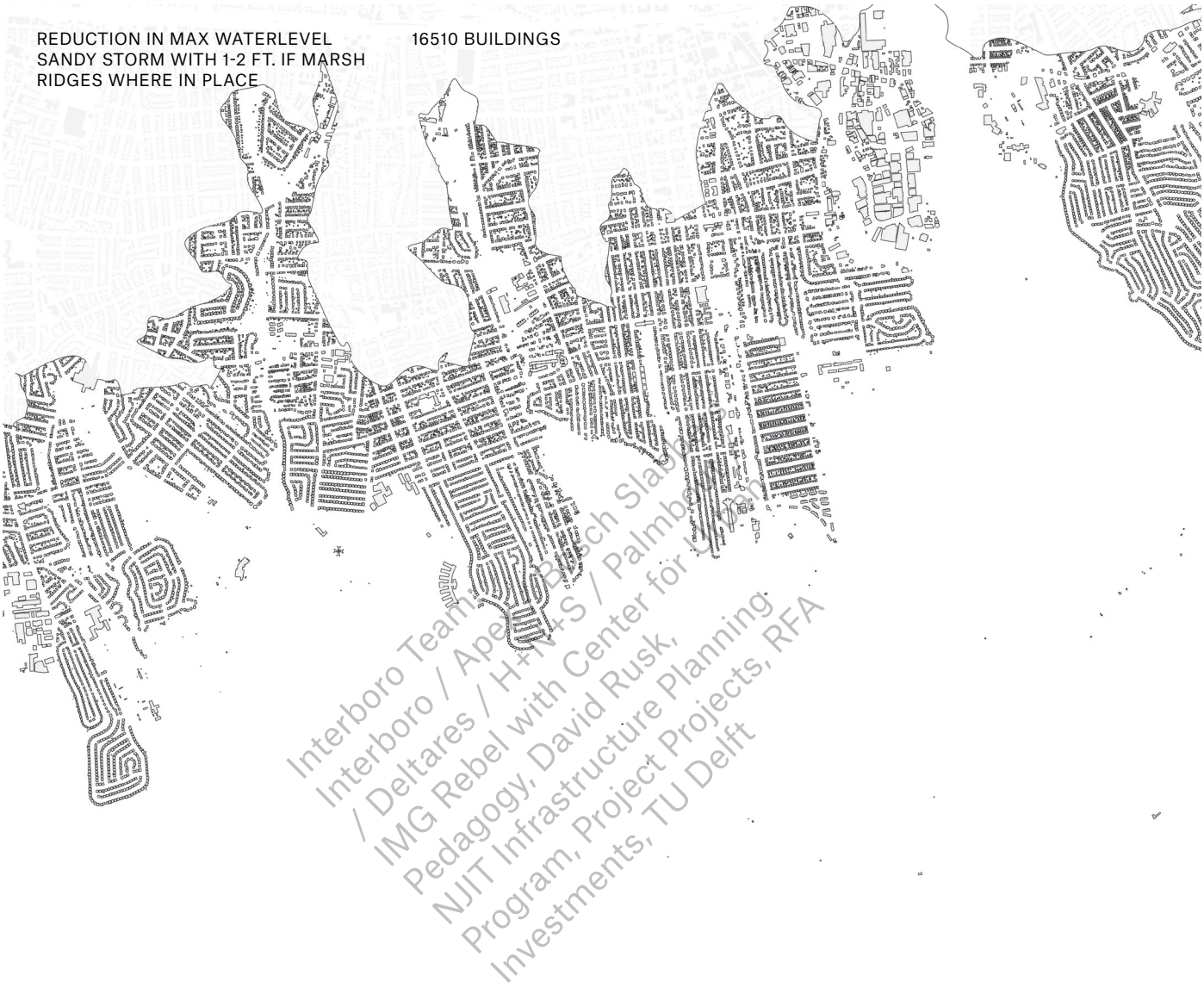
Public Space Development



To enhance safety and spatial quality, public space will be developed along the outer dike.

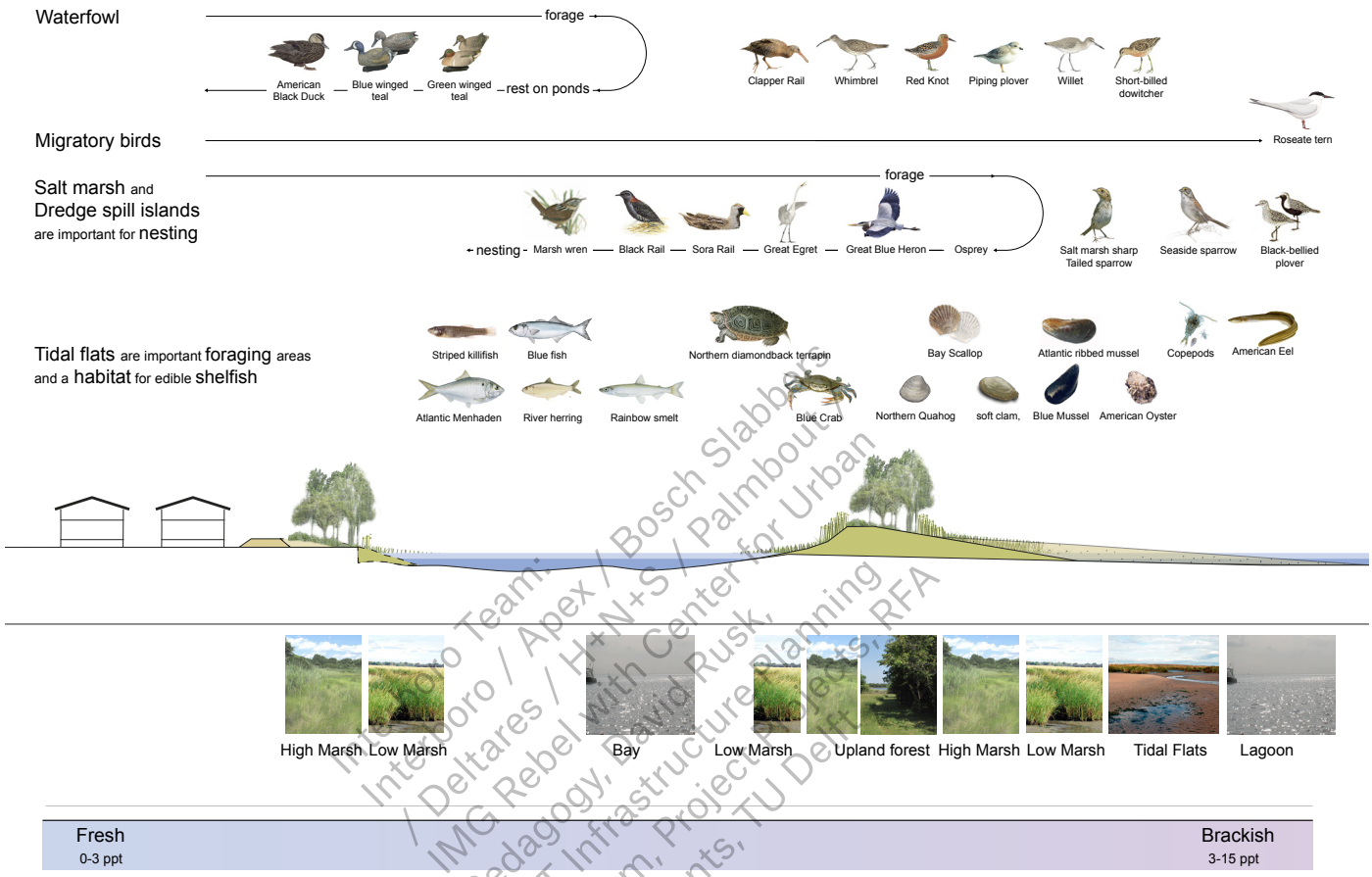
Interboro Team:
Interboro / Apex / Bosch Slabbers
/ Deltares / H+N+S / Palmbout /
IMG Rebel with Center for Urban
Pedagogy, David Rusk,
NJIT Infrastructure Planning
Program, Project Projects, RFA
Investments, TU Delft

Effect Of The Measures



Each measure protects a part of the area. The dike rings of 4 feet will contain a number of houses that will be protected from at least a category 1 storm.

New Ecological Habitats And Strengthening Threatened Habitats



Interface to Team: Interface / Apex / Bosch Slabbekoorn / Deltares / H+N+S / Palmboutique / IMG Rebel with Center for Urban Pedagogy, David Rusk, NJIT Infrastructure Planning Program, Projects & RFA Investments, TU Delft

The marshes have great ecological and economic potential. By adding wooded marshes, the natural habitats are expanded and will become more robust.

Interboro Team:
Interboro / Apex / Bosch Slabbers
/ Deltares / H+N+S / Palmbout /
IMG Rebel with Center for Urban
Pedagogy, David Rusk, Design
NJIT Infrastructure Planning
Program, Project Planners, EA
Investments, TU Delft

The outer road is slightly heightened, increasing the safety for the houses behind it. An open wadi system buffers the rainwater.

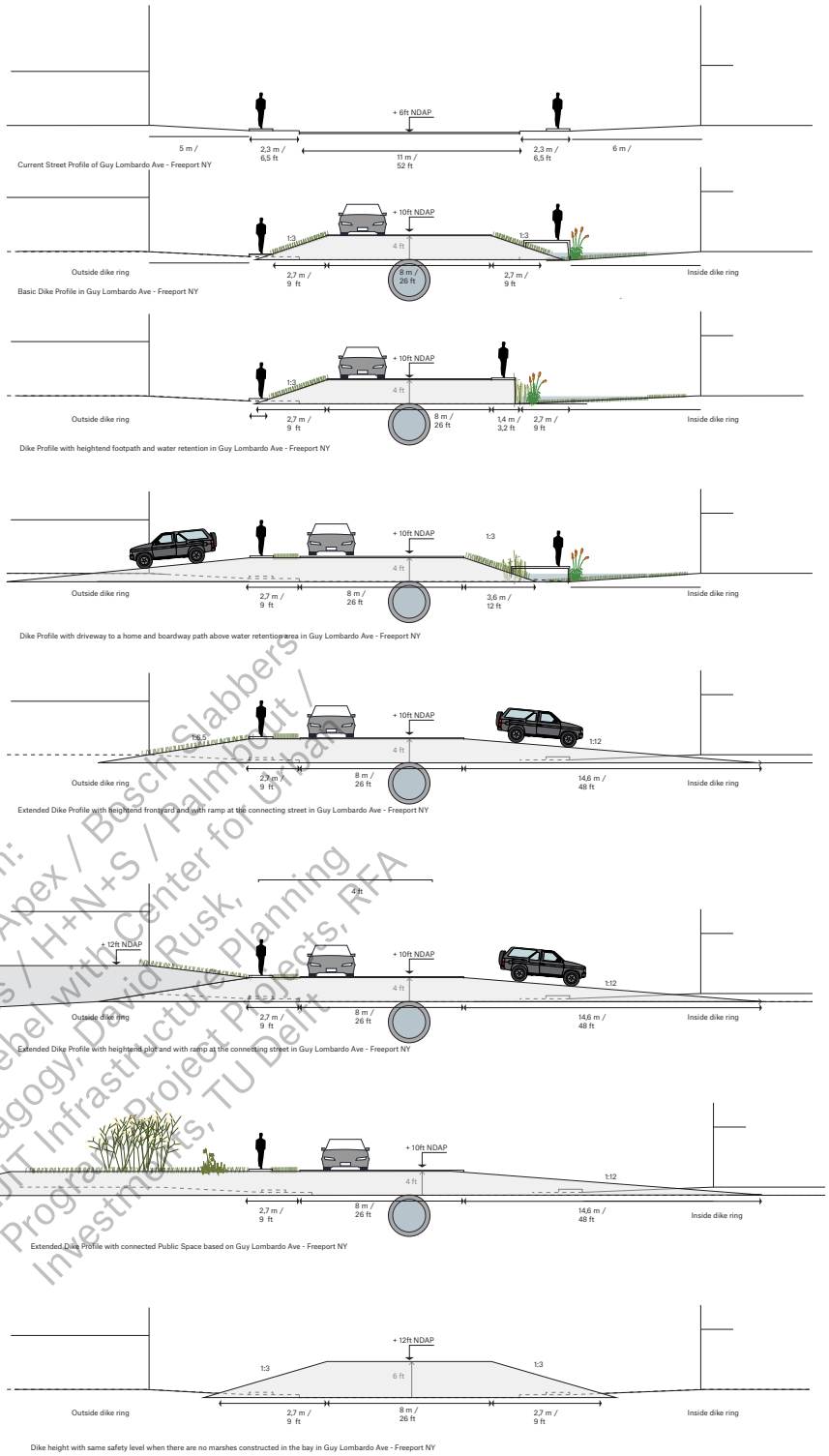
Public Space Along The Outer Dikes

The relation and connection between the marshlands and the urban areas can be restored and improved by developing public space along the outer dike areas, leading to a diverse and beautiful environment.

The Size Of The High Marsh Ridges

To create a safer environment, the high marsh ridges have to be constructed. These higher ridges will break the waves, create a new natural habitat, and catch sediment so that the lower marshes can grow and develop.

The Street As A Dike Ring



Interboro Team:
Interboro / Apex / Bosch Slabbers / Deltares / H+N+S / Palmbout / IMG Rebel with Center for Urban Pedagogy, David Rusk, NJIT Infrastructure Planning Program, Project Projects, RFA Investments, TU Delft

These sections show that a dike of 4 feet will have an impact on the profile of the street and therefore can improve the quality of the street.

How did the research frame a deeper understanding of the problem?

The challenges within the Eco-Edge regions can be defined by three main categories.
First of all, the flood vulnerability is a big concern; the low-lying residential areas, around 6 to 8 feet, were severely impacted by Sandy and will also flood during a category 1 storm. If we zoom into our sub-region, we can see that almost the entire sub-region will be impacted by an category 2 storm.

The drainage system of these areas will add to the flooding problem. The drainage pipes all individually drain into the bay and can only drain during low tide. During or right after a storm, it will be difficult to drain the area.

Second, the ecology of the bay and marsh areas is suffering from the low water quality and the disturbed sediment balance due to the urban developments within the marsh and the gradual rising sea level. The marshes and mudflats are shrinking as the channels demand more sediment due to the smaller amount of water that moves in and out of the bay with the tides. The area therefore loses much of the habitat that has great value for migrating birds, fish species, and shellfish that inhabit the bay. The tidal wetlands are of immense importance for the biodiversity in this area and the ocean as they function as a breeding ground for a large number of species. The challenge within this area is the restoration of the habitat for federal- and state-protected species (like the willet, rail and osprey), increasing the biodiversity and biological productivity, and reducing the amount of common reed.

The third challenge is the integration of the human habitat with the bay. Many people live within the bay communities; they deserve to be protected and be able to live within the bay. Currently the communities have little to no connection with the surrounding marshlands, and the open or public space at the water's edge is not always accessible or well maintained. Only the parcels directly at the water's edge have a direct connection with the water and marsh. The bay is, however, never far and the area has great potential to become a neighborhood that is connected to the bay in the broadest sense.

How did the research inform the proposed solution?

The three challenges mentioned above form the starting point and main focus for our solution. We believe that taking these three aspects into account results in an integrated and layered approach that not only increases the water safety but also daily lives and ecological biodiversity.

Flood vulnerability and ecology are intertwined within our solution. The vulnerability to flooding is a direct result of the location and natural circumstances on which these residential areas are developed. The residential areas lie within a former marsh, and when we want to create a safer living environment we have to be aware of that fact.

If we combine the demand for a more safe environment with the need for marsh restoration and increased biodiversity, we can work with the natural system to realize both. If we then combine this with the demand to live in a more attractive area, we can develop something that works for all three of these demands.

Interboro Team / Alex Ely / Elisabeth Shaloff / Deltares / Arthur Rijpkema / Pamela Rubinoff / IMC Rebecca Lewis / Dan Rosenberg / Jill Tadashi Kaufman / Urban Investment Project / Delft University of Technology / RFA

How did the research demonstrate new/improved ways of identifying, measuring, mapping, evaluating, understanding, and communicating risk?

Due to the combination of GIS data on Sandy's impact, historical maps, and the LIDAR data, we could identify the areas with high flood vulnerability. When we combined the number of houses that were affected by the different types of storm intensity (category 1/category 2/Sandy), we were able to develop a strategy that would reduce the impacted area or bring the whole area to a higher safety level.

By zooming in on one street that represented the area impacted by a category 1 storm, we could generate data that represented the whole zone within one photograph of the bulkhead and water levels for one parcel. It showed that there were two types of threats: storms and sea level rise. One is a high-intensity event and the other is a slow-moving transformation that has an enormous impact for which we can prepare ourselves.

How did the research address cascading impacts and interdependencies?

As said before, the marsh quality depends on the amount of sediment and the water quality. The amount of sediment depends on the sources, which are the sandy barrier islands, active ocean zone, and sediment from the creeks. There is a lack of sediment within both of these sources, which results in degrading marshes and mudflats. As there are fewer marshes to buffer wave run up and storm impact, the bulkheads of the urban areas are "attacked" by waves with a higher intensity/energy. The bulkheads will then need more maintenance, and as the waves have a higher run up, they need to be raised to maintain the same safety level.

How did the research represent a regional and comprehensive approach?

The sub-region is part of the large intertidal, marshland, and barrier system. Local interventions within the marshes (like the urban development within the marshes) has an impact on the other elements within this system. As the urban development has decreased the tidal prism, less water flows in and out of the bay. As a result, the system is still working toward a new (sediment) balance. As a part of this, the marshes are decreasing in size and the channels will become more shallow. Eventually the ebb-tidal delta will also react to this changing situation.

This changing system also affects the developed marshes and increases their vulnerability to flooding.

In order to live with the bay, measures need to be taken that create both a higher safety level for the urban areas and a more resilient bay area. The restoration of the salt marshes can restore the sediment balance and create more biodiversity but also reduce the surge level and wave impact. Hereby both humans and nature benefit. To create a high safety level, restructuring of the urban tissue is necessary by creating a more resilient edge with a natural gradient. Creating levees as a last step allows us to enhance water safety and develop a freshwater retention and drainage system.

Interboro Team / Architecture / Design Studios
Interboro / Architecture / Urbanism / Design
/ Deltares / Rebecca Shapiro
IMG Rebel / Wim Cofeno / Ron Cofeno
Pelagos / David Rosenberg
TU Delft Infrastructure Planning
Project Project / Project RFA
Students, TU Delft

Demonstration of Participatory Design Process/Stakeholder Coalition

How did the team's participatory design process engage local stakeholder groups across sectors and interests?

Over the short time span of a few weeks, a fast-paced series of community meetings, workshops, and stakeholder meetings has brought together a remarkable coalition of project supporters, ranging from regional institutions such as the Long Island Regional Development Council to grass-roots advocacy groups such as Operation SPLASH. We are especially proud of the larger coalition of supporters we were able to assemble through our participatory design process in a region that is notoriously fragmented.

How did the team's participatory design process facilitate collaboration among jurisdictions to understand shared problems and explore shared solutions?

Water knows no political boundaries. Many municipalities have frontage on the saltwater marsh that is the location of the Eco-Edge strategy, and many more are affected by its behavior. There is some acknowledgement by these neighboring municipalities that shared problems (flooding, pollution, habitat loss, etc.) require shared solutions, but some officials we spoke to were clearly (and somewhat understandably) looking out for their own communities. (Higher levels of government obviously have a more holistic view: the Town of Hempstead Department of Conservation and Waterways, Nassau County DPW, and certainly the regional bodies like the Long Island Regional Economic Development Council understand that shared solutions are required.)

Specifically, we conducted the following key meetings with governmental officials about shared problems and solutions for the north/south rivers and creeks that are the focus of the Eco Edge strategy:

Presentation: Stakeholder Workshop: "Regional Resiliency: A Dutch Perspective"
Date: 2/4/14
Location: Office of Emergency Management, Bethpage
Attendance: Attended by 34 individuals from 27 leading organizations in Long Island, including the Nature Conservancy, Peconic Baykeeper, Operation SPLASH, FEMA's Community Planning and Capacity Building Department, Long Island Regional Planning Commission, Long Island Regional Economic Development Council, and others
Summary: Presented Stage 3 progress; received extensive feedback on marsh restoration, sediment flow, stormwater management, and protective barriers

Meeting: Town of Hempstead
Date: 2/11/14
Attendance: Jim Browne, Ron Masters
Summary: Learned about regulation of the bay and rivers; learned about recent, ongoing, and planned Department of Conservation and Waterways initiatives; discussed possible sites for making more room for the river

Meeting: Nassau County DPW
Date: 2/12/14
Attendance: Sean Sallie
Summary: Discussed the feasibility of doing green infrastructure, traffic calming, and TOD development along the Sunrise Highway corridor

Meeting: NY Rising CR
Date: 2/21/14
Attendance: Laura Munafo, Zachary Richner, Jaime Rubin
Summary: Updated state on Stage 3 plan

Meeting: Superintendent at Rockville Center DPW
Date: 3/11/14
Attendance: Harry Weed
Summary: Discussed Slow Streams and Eco-Edge strategies

Presentation: South Shore Estuary

Interboro Team:
Interboro / Alex / Beth / Stakeholders
/ Deltares / Hydrus / Rainhout /
IMC / Rebecca / Dutch Center for Urban
Resilience / Hydrology / Planning
Institute / Dutch Best
Management Practices, RFA

Reserve Council
Date: 3/11/14
Location: Seatuck Environmental Association, Islip
Attendance: South Shore Estuary Reserve Council
Summary: Presented *Living with the Bay*; received feedback

Meeting: Town of Hempstead Department of Conservation and Waterways
Date: 3/11/14
Attendance: James Browne
Summary: Discussed Slow Streams and Eco-Edge strategies

Meeting: Town of Hempstead Department of Engineering
Date: 3/11/14
Attendance: Jeffrey Tierney
Summary: Discussed Slow Streams and Eco-Edge strategies

Meeting: Village of Lynbrook Public Works Department
Date: 3/11/14
Attendance: Phil Healey
Summary: Discussed Slow Streams and Eco-Edge strategies

Meeting: Village of Freeport
Date: 3/21/14
Attendance: Mayor Robert Kennedy, Chris Squeri
Summary: Discussed Phase One project idea for the Eco-Edge strategy; debated whether bulkheading would be a better solution; debated appropriateness of housing in the downtown; meeting resulted in a willingness to work together going forward

Interboro Team: Interboro / Apex / Dutch Seabots / Deltares / N+S / Dalmont / IMC Robbins / Center for Urban Publics / David Rusk, Institute for Urban Projects, RFA / Delft Investment Planning

How did the team's participatory design process solicit direct input from community members in the project area?

We very clearly explained the shared problems of marsh erosion and storm surge and very clearly presented our proposed solutions in numerous project partner, stakeholder, and community meetings. The current design is the product of the extensive dialogue we had with community members.

Specifically, we conducted the following community meetings in which we discussed our proposed solutions for the Eco-Edge strategy

Meeting: Community Meeting I
Date: 2/22/14
Location: Baldwin Senior High School
Attendance: Approximately 60 people
Summary: Presented *Living with the Bay*; conducted an open discussion; led breakout tables on each of our four strategies

Meeting: Community Meeting II
Date: 3/8/14
Location: Operation SPLASH
Attendance: Approximately 75 people
Summary: Presented *Living with the Bay*; conducted an open discussion; led breakout tables on each of our four strategies

Event: High School Resiliency Workshop
Date: 3/18/14
Location: Lynbrook High School
Attendance: Students from Lynbrook Sustainability Club
Summary: Presented scaled-down version of *Living with the Bay*; discussed the threats of surge, sea level rise, and stormwater; discussed strategies for combating the threats

Event: Boat and Bus Tour of *Living with the Bay*

Date: 3/29/14
Location: Operation SPLASH
Attendance: TBD

Community Meeting I Highlights
Two local residents (Hugh and Angelo) discussed the Interboro Team's Ring Dike Road intervention for the near-bayfront communities as part of the bay sub-region. Both public representatives concurred with the approach of raising the first road in from the Bay plan to minimize back-bay flooding issues. They also agreed with individually raising homes on the bay side of the raised dike road. Their observations and recommendations, which have subsequently been incorporated into the Interboro RBD intervention plans for the bay, included the following:

—The homes on the inland side of the dike ring road would lose their visual sight lines to the bay. Additionally, the presence of the raised roads would make accessing their properties via car more difficult. Both representatives indicated that the third row of home in from the bay do not have sight lines/view sheds to the bay; therefore, the proposed intervention would not deleteriously impact view sheds for the majority of the homes protected by the raised roads.

—They both recommended that the land-side home properties be raised utilizing clean/compacted fill materials in a wedge-shaped geometry with the thickest part along the newly raised road and sloping away to the "back" property line. The advantages of this include the following: 1) the raised homes would be protected from future flooding events; 2) raising the land-side homes would maintain their visual sight lines to the bay and help maintain their property values; 3) it would allow better vehicular access to their properties; and 4) the properties could be re-graded in such a way to allow for the installation of stormwater best management practices such as grassy swales.

As a final note, both neighborhood representatives were supportive of constricting new marsh/wooded islands as an appropriate intervention measure. They indicated that their families would enjoy accessing the island via small boats and taking advantage of them for picnicking, fishing, clamming, and other recreation opportunities.

Community Meeting II Highlights
During the two aforementioned public meetings/presentations, two separate representatives brought up the issue of the need to drain the back bays as rapidly as possible subsequent to a major meteorological event. They concurred with the Interboro Team's proposed intervention of installing cross-barrier island drainage/flood-equilibration conduits. Both the Operation Splash and SSER Council representatives recognized that new inlets form from the back-bay side of barrier islands when the water levels are higher in the bay than in the adjacent ocean. Their observations and recommendations, which have subsequently been incorporated into the Interboro RBD intervention plans for the bay, included the following:

—Care/high-end hydraulic modeling will be required to ensure that the proposed conduits do no harm to the water chemistry of the bay
—During periods of "normal times" (e.g., not during periods of potential flooding), the conduits could be left open to allow for the bay and ocean waters to intermingle, which it is believed would improve the surface water quality of the bay

Interboro Team, Alex Ezeh, Sarah Stalberg
Interboro Partners / Rainbow/ Urban
/ Deltaplan / Concrete Planet
IMG Rebuild by Design / Interface Studio
Pennsylvania Department of Conservation and Natural Resources, RFA
Prosperity Partnership / Delft University of Technology

—The conduits could be equipped with tide electrical generators, thereby providing a source of alternative and renewable energy

How did the team's participatory design process result in the formation of a coalition of support?

All too many individuals in Nassau County are aware of the chief problem that the Eco-Edge strategy addresses, namely, protection from storm surge. Our conviction that this was a major issue that needed to be addressed resonated with people, especially those who experienced storm surge first hand. In our community meetings, we had overwhelming support for the Eco-Edge strategy:

The Eco-Edge strategy was relatively easy to get support for politically as well, since protecting their residents from storm surge is among the top priorities of most mayors and other elected officials. The county supervisor, Nassau DPW, the Town of Hempstead Waterways and Conservation Department, and the mayors of Freeport all expressed support for the project.

Please see Chapter 1 for a complete list of project supporters.

Interboro Team: Alex Hanson Slabbers / Deltares / Mark Lindhout / IMG Rebel / Michael Dorn / Urban Redevelopment Corporation / NJ Transit / Department of Transportation Project Planning Program / Project Partners, RFA Investments, TU Delft

Innovation

How does the project represent a higher-performing approach to reducing risk while providing multiple benefits and amenities (physical, social, economic, environmental)?

The flood risk within the bay is not just a story of high water levels but also one of low-lying areas and the lack of sediment. The strategy on the large scale shows that nourishing the ebb-tidal delta and the channels can supply the sediment demand within the bay. The wooded marsh ridges help to catch this sediment and allow the vulnerable marshes to grow. The constructed ridges provide a habitat that is almost not present within this area. On top of that, they also reduce the surge by 2 feet and the wave run up by another 2 feet.

The dike ring is not just a structure. It creates a new water drainage system with retention ponds and swales.

How does the solution employ new design approaches, construction methods, materials, or technology to significantly enhance resilience?

It designs with nature, constructing higher ridges and low-impact sediment catchment structures (simple wooden structures) and providing enough sediment on the ebb-tidal delta and in the channels. The tides and currents will disperse the sediment, and the “right” sediment particles will fall in the right places.

It combines water retention with water safety. Dike rings provide new rainwater storage possibilities alongside and beneath them. They can drain, retain, and store water. It creates high evacuation roads. It combines the individual heightening strategies with a “backbone’ structure (the dike ring) so that the investment is beneficial for a larger area.

Interboro Team: Design Slabbers / Interboro / Apex / Bosch Slabbers / Deltares / H+N+S / Ramboll / IMG Rebel with Center for Urban Pedagogy, David Rusk, NJIT Infrastructure Planning Program, Project Projects, RFA Investments, TU Delft

Design Quality/Excellence

How does the project incorporate multiple scales, interests, objectives, and phases?

The Eco-Edge is in essence a strategy that can be incorporated within the whole bay area. Marsh restoration is an aspect that is relevant for the whole Long Island sound and is studied within several small scale studies, also by the NY Rising project. Developing a marsh edge that provides a higher safety level and (re)introduces a habitat seems to be a new aspect with regards to the current studies. The implementation of the marsh edge will therefore be challenging and take some time. New studies and Phase One projects will have to be part of this, and morphology/coastal safety experts as well as ecologists and nature experts need to be consulted. The edges will also provide new sites for recreation, nature trails, and canoe quays.

The edge between water and land is one that has always attracted people, and this is the same in Freeport. The public water edge needs restoration after Sandy and can be redesigned to offer a better connection to the water, more recreational facilities, and a more natural gradient to boost biodiversity.

A levee can be seen as just a safety measure, but as we seek to increase the quality of daily life as well, this was not an option. The integration of the levee within the road structure creates a safer evacuation route, a new recreational route, water retention areas, and the possibility to create a new more effective drainage system. By redeveloping the parcels connected to the levee, the urban quality is increased.

Interboro Team: Bosch Slabbers / Deltares / HKS / Palmboom & Pedaso / Dr. Dana Cuomo / IMG Rebuild by Design / Urban Planning / TU Delft / MIT Innovation for Urban Program, Project Partners, RFA Investments, TU Delft

How does the project perform as more than just a defense mechanism and represent a development-oriented and future-driven approach?

The two major threats, storms and sea level rise, have their own mechanisms and uncertainties. Our proposal gives room to adapt to these uncertainties. The marsh ridges and the levees and parcels can be can be raised once more.

The proposed measures of marshes and levees at the heights of 12 and 10 feet will result in an immediate increase in water safety. Even if the marshes are partly developed, they will reduce the wave impact on the urban area behind them.

In the far future (2100), compartment dams can be put in place to provide water safety during more intense storms, while the marshes and dike rings provide safety in everyday situations and during spring tide.

This design allows the communities to keep contact with the water and enjoy the value of living in the bay but also allows them to adapt to changing circumstances.

How does the project represent a planning and design approach that is comprehensive and inclusive?

This approach consists of three levels:
—The larger system from which the design provides sediment
—The eco edge/marshes that reduce the surge by 2 feet and the wave impact by at least 50%
—The dike rings that keep the communities safe and allows them to restructure the urban fabric/individual parcels to bring them to a safe level.

We tried to create a design that would allow local inhabitants to be a part of bringing their community to safety and thus adjusted the design to the local needs. We also created a design that provides basic safety on a state/county

level so that it can be implemented with regard to the natural system. The marsh ridges will function as a link between these two levels, as they are part of both the sediment strategy and the more local strategy. They catch sediment for the marsh growth and thus create biodiversity in the bay but also provide safety for the community that lives right behind the marsh.

How does the project articulate the complexity of the problem and solution in a clear and understandable way?

Taking into account increased water safety, biodiversity, and everyday life demands a well-balanced design. The current "sharp" edge between nature and urban environment results in an unbalanced natural system, leaves no room to grow with the sea level in the marshes or the urban area, and shows a lack of water safety measures. The design specifically takes on the task of creating a more natural gradient between urban areas and nature, and thus between water and land. The room to grow with the sea level is found in the marsh edges that capture sediment and the levees that are set back one plot at the the first road.

Interboro Team: Nine / Bosch Slabbers / Deltares / Arthur Schaapman / IMG Rebel / Bureau Stedenbouw / Pedagogy, Delft University of Technology / NJIT Infrastructure Planning Program, Project Investments, TU Delft / RFA

In what ways does the project represent the highest quality of 21st century design while also catalyzing a process to raise awareness of resilience issues?

Wetland and salt marsh regeneration is a difficult task and is not always implemented successfully. Research is still ongoing and being developed. New sub-regional scale projects and test sites are welcome to the global research. The combination of water safety, high ridges, and marsh regeneration is innovative. It provides a new ideas about the possibilities of marsh regeneration, increasing biodiversity, and providing tourism and education possibilities.

The redevelopment of public spaces into a resilient edge that creates a new natural gradient and enhances water safety can show how "simple" measurements within the public space create a more pleasant living environment and have ecological benefits.

Resilience of the urban marsh areas is not just heightening your bulkheads and maintaining the current situation as long as possible. It is looking into the area carefully and finding the room to grow into a more resilient area that can maintain itself even if the sea level rises drastically. Integrating the road with a levee and thereby creating a better water drainage system and retention areas is a new way of thinking. It allows the waterfront properties to stay connected to the high and dry road and experiment with raised or floating houses or raising their own parcels.

Impact

How does the project respond to the greatest/highest risks, vulnerabilities and/or impacts identified?

The design responds to a sea level rise of 3 feet by creating marsh ridges and levees that can be heightened when the surrounding is adapted to the current situation. There is room for a long-term perspective.

The design is developed specifically to relieve the most vulnerable zones and at least upgrade their safety to a Sandy level.

The design rebuilds the marshes as well as the communities. It gives room to develop both the natural and the urban areas.

How does the project reduce vulnerabilities, minimize consequences/losses, and increase the ability to withstand and rapidly recover from future disaster impacts/disruptions?
The marsh ridges greatly reduce the vulnerability to storm damage by wave run up, as the waves will be "absorbed" by the marshes. In the next "line," the levees will protect the areas from flooding during a Sandy-like storm. With higher water levels, the marshes will still reduce the wave impact and the new drainage system will reduce the water inundation time.

The new marshes will function as a buffer and allow the natural system to recover quickly.
The levee will function as an evacuation route and a starting point for recovery after a high-category storm.

How does the project present the potential for broader applicability/replicability, either in approach or solution?

The multilayered approach is a new way of thinking. It integrates water safety and spatial quality. This way of thinking can be applied to other marsh developments along Long Island or even along other similar coasts.

Marsh regeneration initiatives can review the marsh ridges' effect on water safety and take it into account so that the entire bay is transformed into an eco edge.

The levees can be integrated within other communities or in the public areas. The measures can be implemented with a step-by-step approach in phases and adapted to changing circumstances and community demands.

The levees are the most intrusive. A possible development course would be marshes, dams, and then the construction of the dike rings or barriers. Marshes will lower the wave height, which means that the crest of the levees can be lowered, which results in a lower construction cost and less horizontal space needed (as the slope will be smaller as well). The marshes work for the the levees when the wind and thus the wave blows in the direction from the marshes toward the levees. To protect the levees completely, we need to carefully construct marshes all around the edges. More research and modeling is needed to create a complete design for the marsh edge.

How does the project contribute to the overall recovery and rebuilding of the area/community?
It is focused on the local challenges. The site-specific interventions enhance nature, water safety, and cultural conditions.

Interboro Team
Interboro / Area / Design Studio
/ Deltares / Arup / Transport /
IMG Rebuild by Design / Urban
Research / Dutch Ministry of Infrastructure and Water Management / Dutch
Program Management Office / RFA
Investment Fund

What potential does the project have to catalyze transformative change?

It is the start of a new way of *living with the bay*. It creates new transitions between land and water, public and private, and hybrid forms of water safety.

How does the project address one or more of the following key areas of focus: a) vulnerable populations, b) critical infrastructure (particularly energy and communications), c) potential for leveraging other federal investments?

The project provides potential for leveraging other federal investments and allows vulnerable populations to take on their own water safety while they are also "backed" by investments of the state/county.

How does the project incorporate principles of sustainability, including water quality and energy efficiency?

The design improves the water quality, as water is retained longer and purified within the retention point. Also, less sewage or drainage overflow is the result of the redesign drainage and water system. The natural marshes will increase water quality by taking in the nutrients and will reduce CO2 as trees grow on the higher ridges.

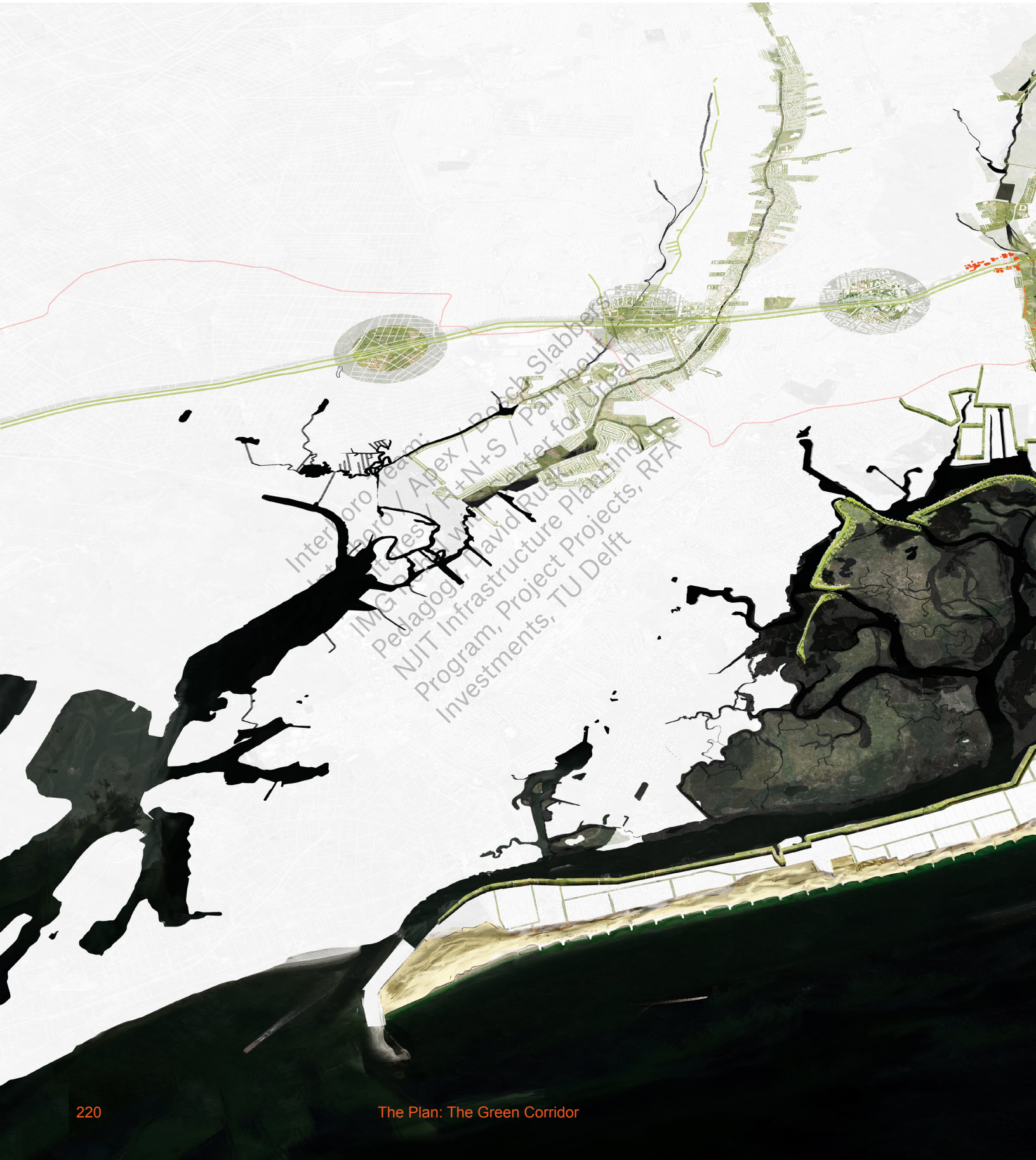
As we want to build with nature, our goal is to use the natural system to develop our design and therefore decrease development costs and efforts and disturbance of the system.

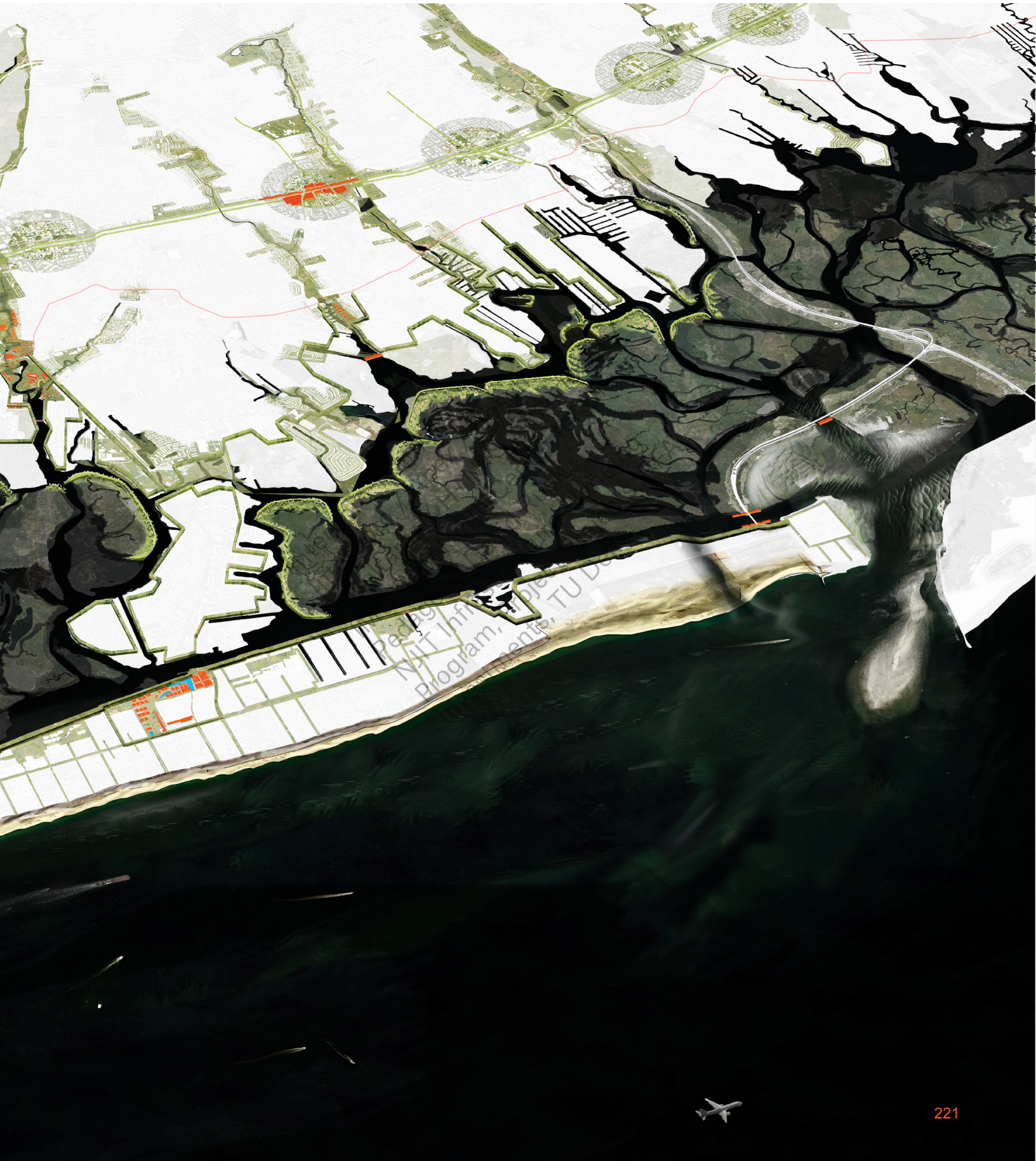
The levee development allows us to develop the road, levee, water system, and heightening of houses at the same time, which is cost and energy efficient.

Interboro Team:
Interboro / Apex / Bosch Slabbers / Deltares / H+N+S / Palmbout IMG Rebel with Center for Urban Pedagogy, David Rusk, NJIT Infrastructure Planning Program, Project Projects, RFA Investments, TU Delft

Interboro Team:
Interboro / Apex / Bosch Slabbers
/ Deltares / H+N+S / Palmbout /
IMG Rebel with Center for Urban
Pedagogy, David Rusk,
NJIT Infrastructure Planning
Program, Project Projects, RFA
Investments, TU Delft

Strategies for the Uplands: Green Corridor





Pedagogical Framework
NJIT Infrastructure Studio
Program, Principles, Elements, TU Delft

Strategies for the Uplands: Green Corridor

Our proposed "green corridor" is a reimagining of the Sunrise Highway-LIRR corridor that would seek to do four things: 1) target "high and dry" areas along the corridor for rental housing within walking distance of select LIRR stations; 2) improve the capacity of the corridor to capture stormwater runoff; 3) bundle proposed green infrastructure improvements with pedestrian safety improvements that would facilitate pedestrian connectivity; and 4) relieve "choke points" (points when the north/south rivers and streams are channeled into a pipe that goes under Sunrise Highway) by selective daylighting.

The Sunrise Highway is a six-lane, east/west, state-owned road that runs through southern Nassau County. Flanked by low-density retail to the south and the LIRR tracks on the north, the corridor does a good job of funneling commuters east and west (both by road and rail), but we think the Sunrise Highway corridor can do a lot more and can make a significant contribution to the region's resiliency.

How?

First, we think one of the best things we can do to create more resiliency in the region is to create affordable opportunities for people to live out of harm's way, and we think the Sunrise Highway corridor—which is presently underdeveloped—is a great place to do this. Many advocacy groups have pointed out that with its public transportation options, its relative density, and its mixture of uses, parts of the corridor have the potential to be the dense, walkable, mixed-use environment that so many of today's Long Islanders are looking for (for example, the aging boomers and their urban lifestyle–seeking children). But the corridor is also high and dry: it is just beyond the reach of a category 2 surge, a 6-foot sea level rise, and the FEMA flood zone; the corridor is as close as you can get to the more vulnerable communities of the South Shore while still being safely out of harm's way. Shouldn't we be encouraging housing there? We think there is an enormous opportunity to develop the thousands of acres of high and dry surface parking lots in and around Long Island's downtowns, which could house tens of thousands of present and future Long Islanders in safe, walkable, affordable neighborhoods with a variety of owner-occupied and rental housing. (Due to a lack of rentals, Long Island's rental vacancy rate was just over 4% when Sandy hit, a problem that was brought into sharp focus when displaced residents were unable to find suitable temporary housing.)

Second, the Sunrise Highway corridor is highly impermeable: the roads and the commercial and municipal parking lots along it are a major source of both flooding and polluted stormwater runoff (runoff that is channeled into Nassau's rivers and streams and ultimately the bay). We think there is an opportunity to green the corridor, reduce stormwater runoff, and, at the same time, make the corridor more attractive.
Third, the Sunrise Highway corridor is very dangerous. One study showed that more than 80% of Sunrise Highway motorists drove faster than the speed limit; another showed that Sunrise Highway was the second most dangerous road for pedestrians in Nassau County between 2009 and 2011. In part because of this, pedestrians are afraid to walk along or across it, a fact that disconnects communities from each other. We think there is an opportunity to bundle our proposed green infrastructure

Interboro Team: Interboro / Apex / Bosch Scabi / Deltec / HH+S / Palmbout / IMG Rob Wright Center for Urban Research / Dutton Studio / Pedestrian Planning Partnership / Urban Planners / Design Consultants / Delinea, RFA

investments with pedestrian safety improvements that would facilitate pedestrian and bike connectivity.

Finally, the Sunrise Highway corridor is the source of many "choke points" for Nassau County's many north/south rivers and streams. At the Sunrise Highway, many of these rivers and streams are channeled into narrow pipes that go under the highway. We think there is an opportunity to improve the flow of these rivers and streams by selectively daylighting them, restoring the flow, and returning them to their natural state.

Phase One Project
As a Phase One project, we propose to implement a "show piece" of the reimagined Sunrise Highway corridor around the Freeport LIRR station. Specifically, we propose to make two good initiatives (Freeport Plaza West and the Sunrise Streetscape Improvement Plan) great by adding green amenities that will reduce stormwater runoff and make the downtown more resilient in the face of future storms. It consists of two elements: green housing and green infrastructure.

Freeport Plaza West project is a redevelopment project sponsored by the Village of Freeport and the Freeport Community Redevelopment Agency. The site is adjacent to the Freeport LIRR station. In 2013, the Village issued an RFP and in 2014 selected Jaral Properties as the winning bidder. Jaral Properties is currently in negotiation with the Village. The developer is well respected in the community and is experienced in developing mixed-income housing. Jaral's project is in the schematic phase, and includes retail, hotel, mixed income housing, and parking. Because of the financial constraints of developing mixed income housing in Nassau County, the current scheme does not include any design elements to mitigate risks related to stormwater inundation or to provide resiliency functions that would be valuable in future emergencies. It should. Our proposal is to use CDBG-DR funds to add a 20% bonus to the development costs of the building to integrate green infrastructure (to manage water, generate off-grid power, etc.) and resiliency programs to the project.

The Sunrise Streetscape Improvement Plan
Freeport is the recipient of a 1.65 million dollar grant to improve its streetscaping along Sunrise Highway. The current plan is to install brick pavers and ornamental lighting. For the Phase One project, we propose to build on and considerably expand the current plan by introducing structural streetscaping improvements that include bioswales, permeable paving in station parking lots, and creatively reusing the abandoned water main as an alternative stormwater retention cistern.

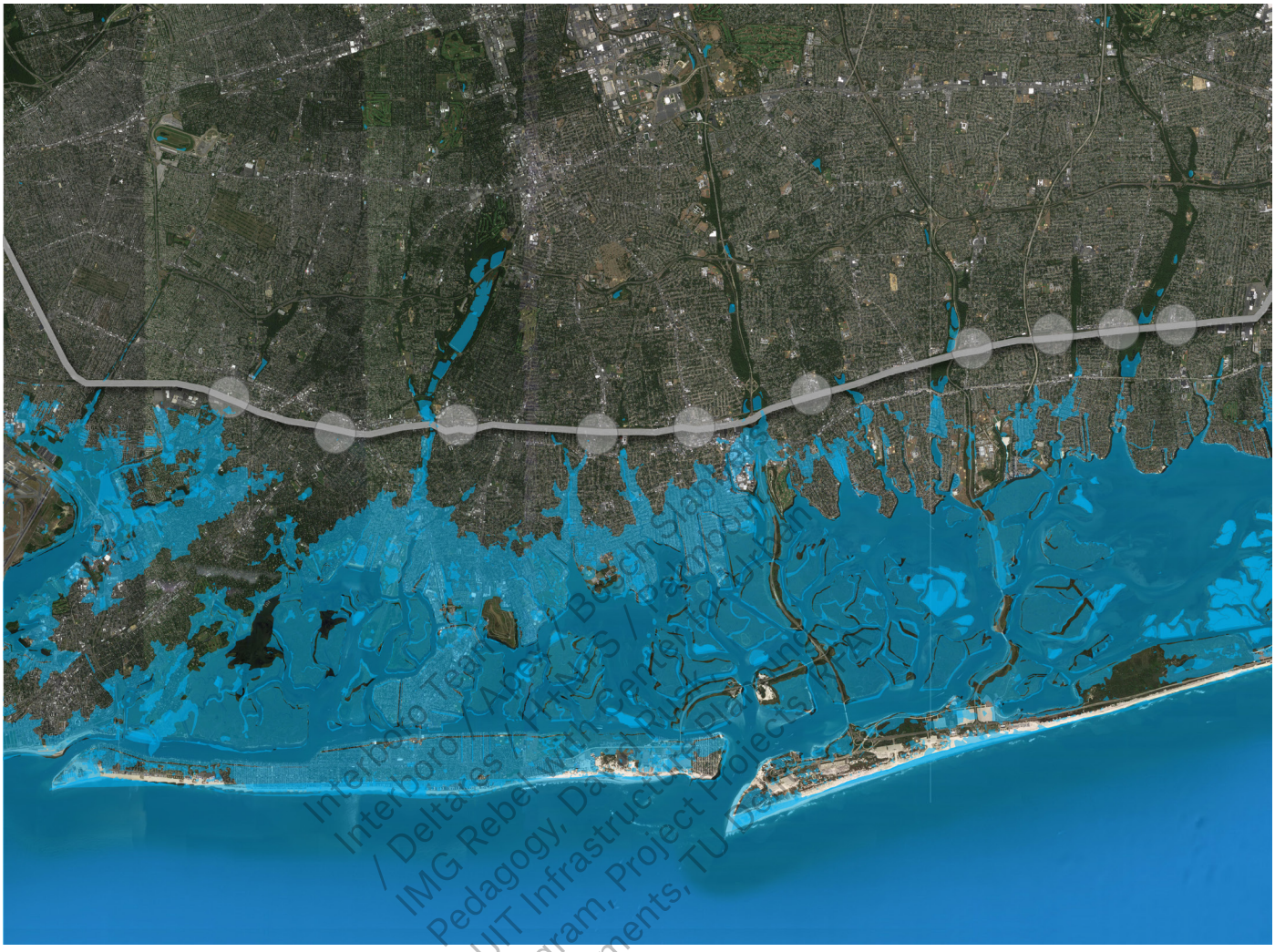
Interboro Team / Interboro / Arup / Boom Slabs / Deltares / Fitzus / Parsons / IMG Group / Rebecca Lewis / Partnership / Rebuild with Cones for Sirens / DPZ / David Rush / Long Island Infrastructure Planning Investments / Project Projects, RFA / TU Delft

Bird's-Eye View Of The Freeport Region

Interboro Team:
Interboro / Apex / Bosch Slabbers
/ Delaires / H+N+S / Palmbout/
McBebe with Center for Urban
Pedagogy, David Rusk,
MIT Infrastructure Planning
Program, Project Projects, RFA
Investments, TU Delft

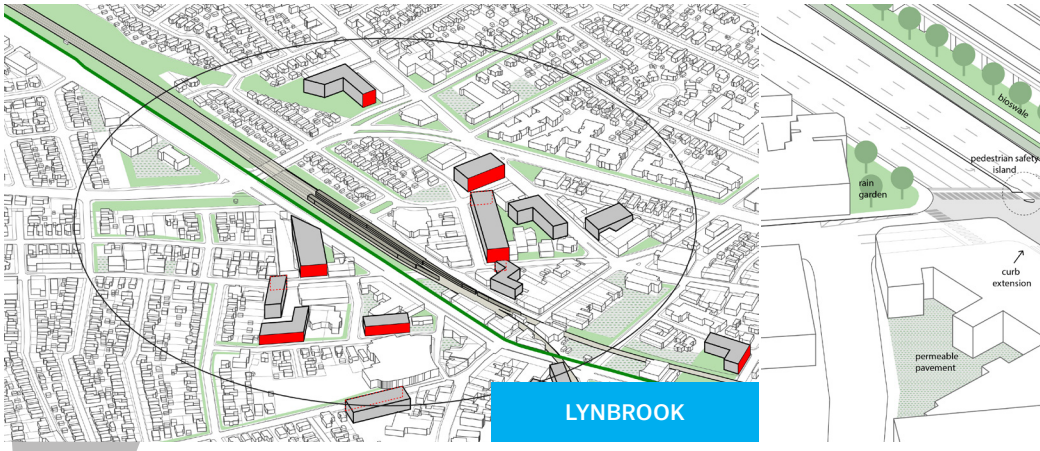
Impermeable surfaces

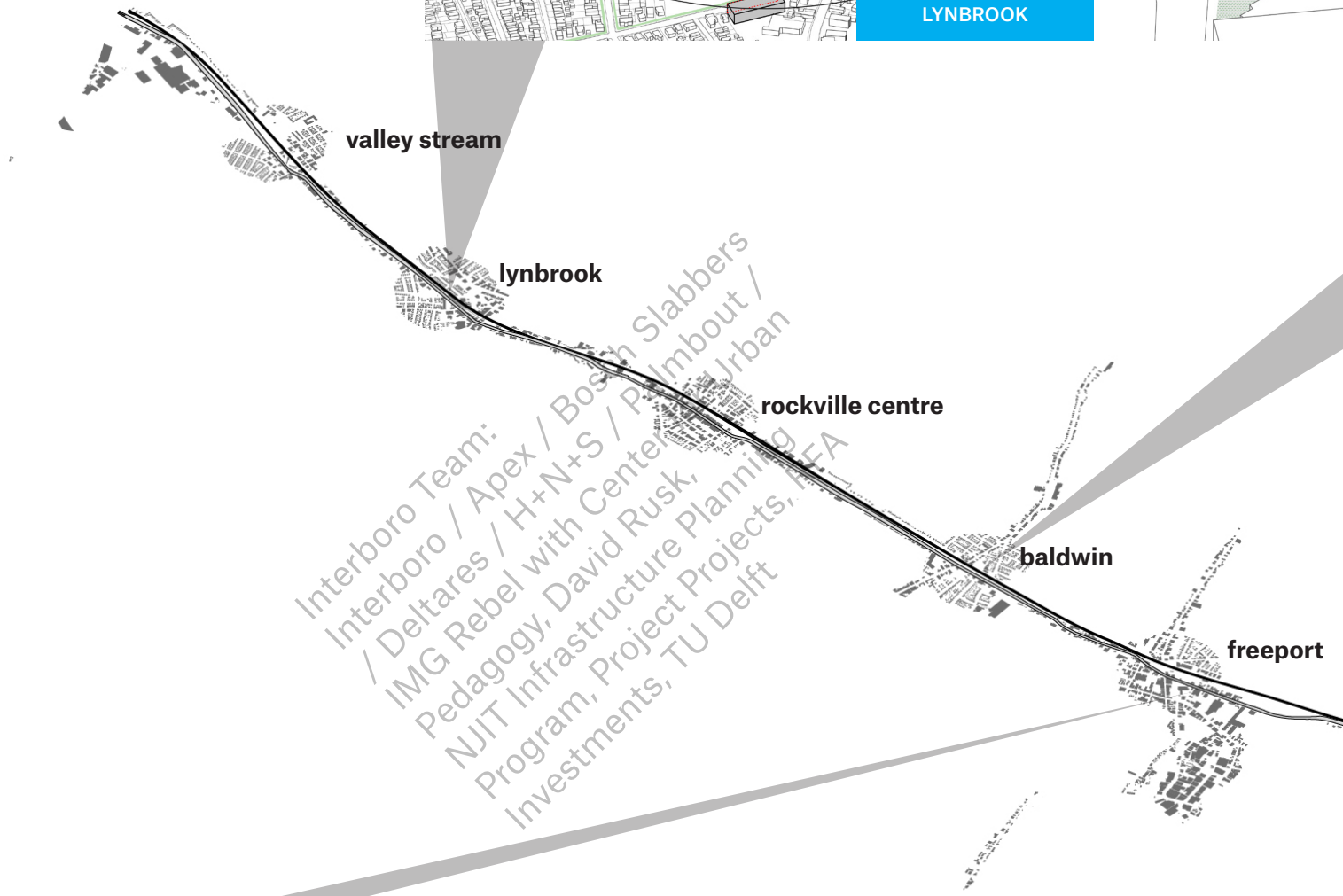
Sunrise Highway corridor is a major source of polluted stormwater runoff that drains into the bay.



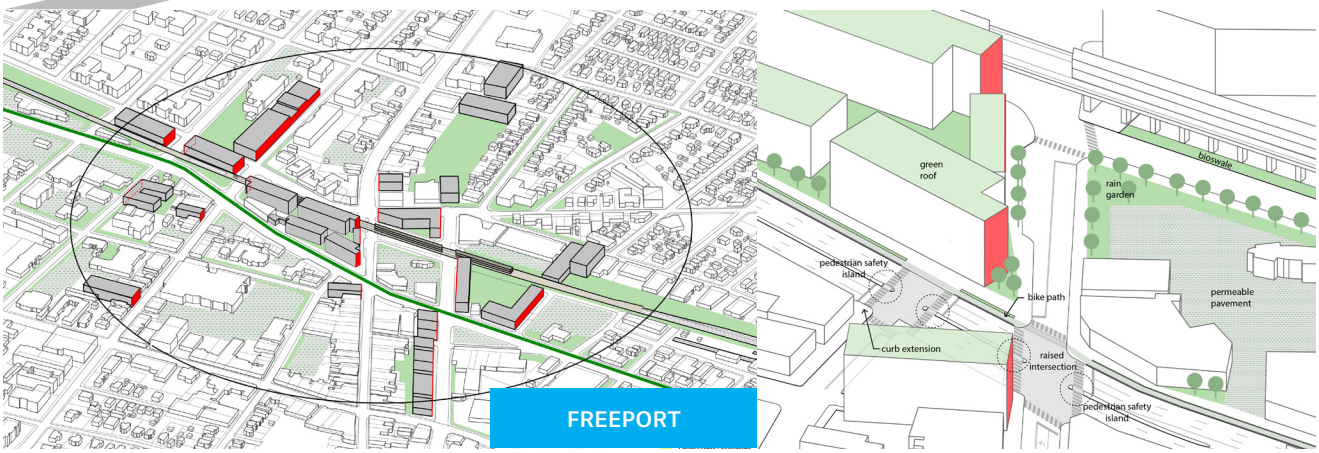
The Sunrise Highway corridor is as close as you can be to the bay but still be safe from surge and projected sea level rise. Shown here: the corridor and Sandy damage.

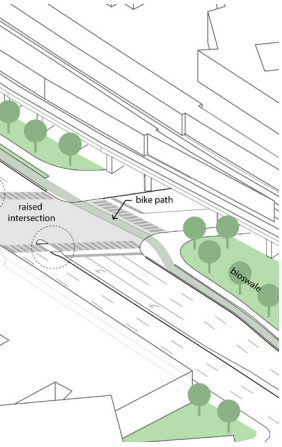
Green Infrastructure Elements

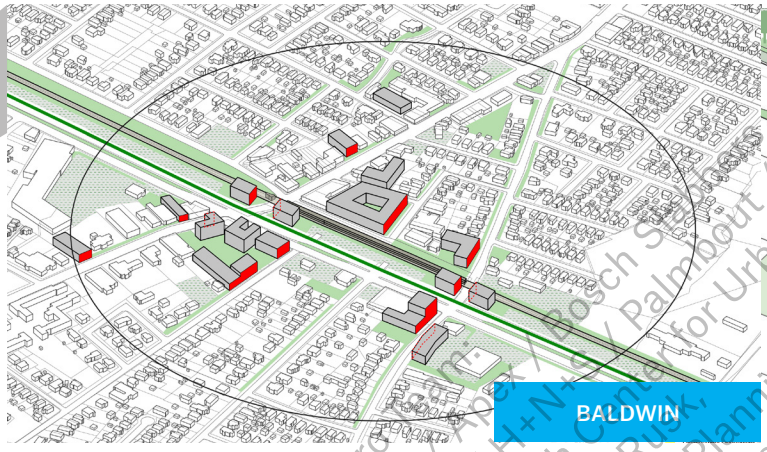


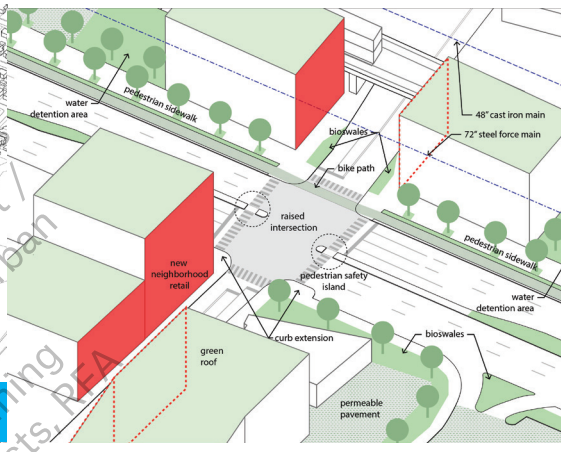


Interboro Team:
Interboro / Apex / Bosch Slabbers
/ Deltares / H+N+S / Palmbout /
IMG Rebel with Centre for Urban
Pedagogy, David Rusk,
NJIT Infrastructure Planning
Program, Project Projects, HFA
Investments, TU Delft



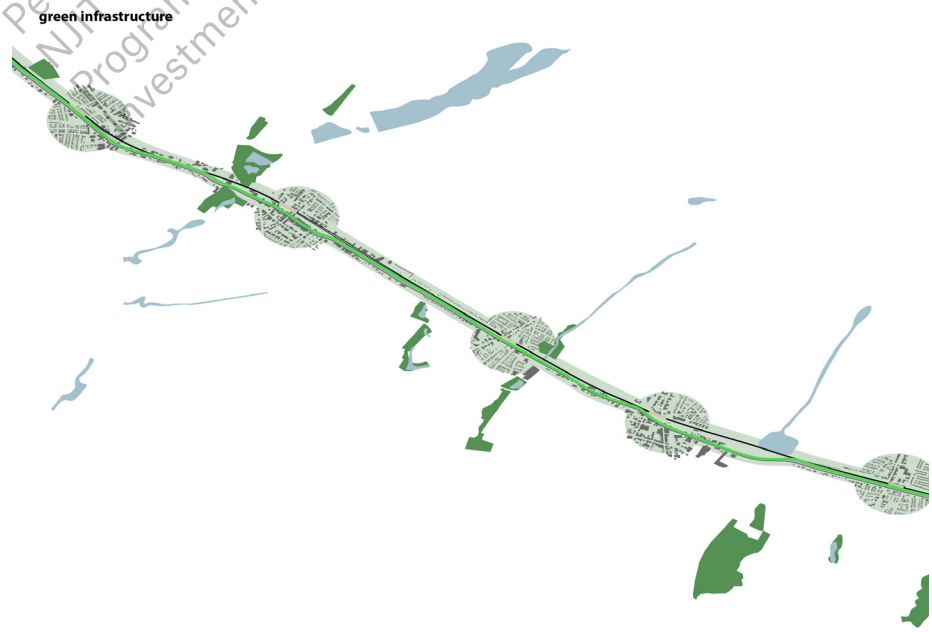






Baldwin is transformed by green infrastructure, pedestrian safety improvements, and new development that strengthens north south streets.

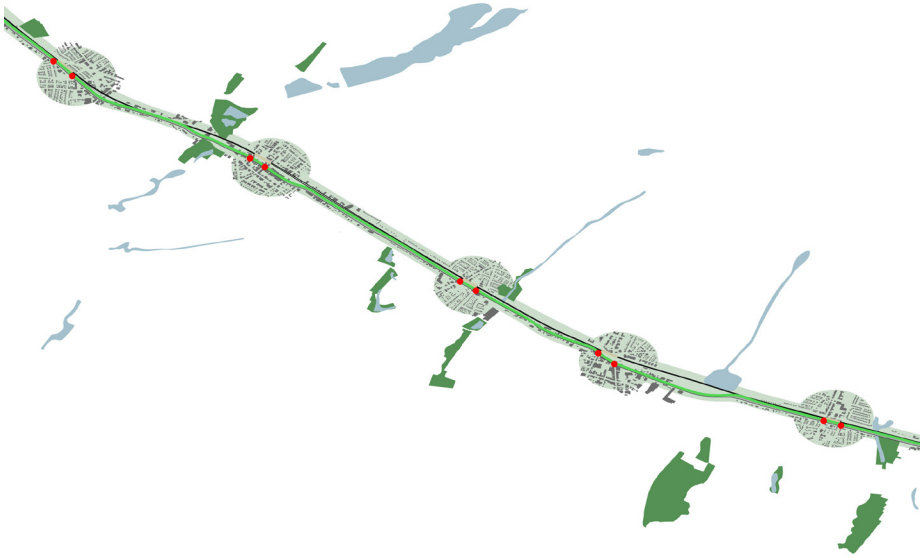
Interborough Express / Interboro / Alpex / Bosch Studio / / Deltares / H+N+S / Palmbout / IMG Rebel with Center for Urban Pedagogy, David Rusk, NJIT Infrastructure Planning Program, Project Projects, REA Investments, TU Delft



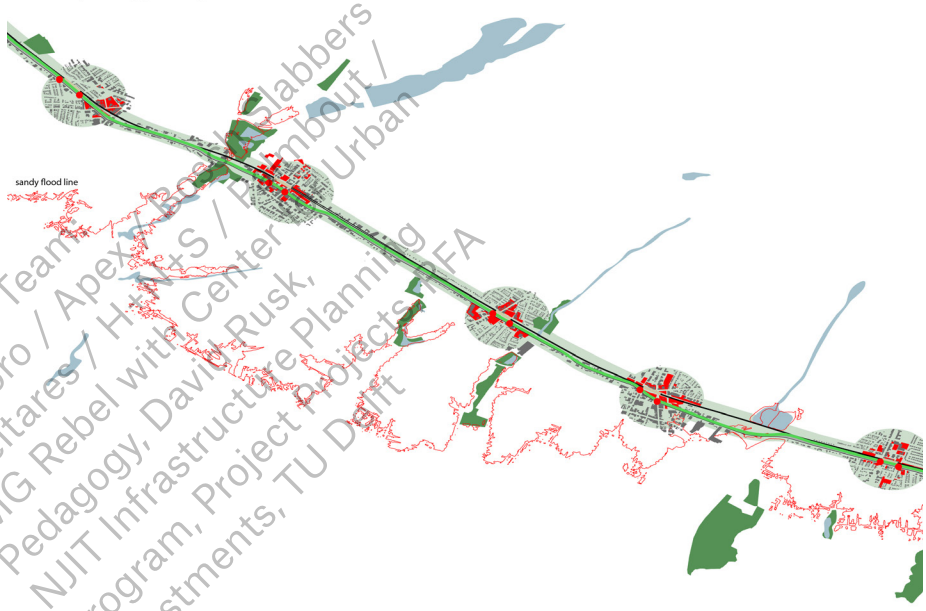
Interboro Team:
Interboro / Apex / Bosch Slabbers
/ Deltares / H+N+S / Palmbout /
IMG Rebel with Center for Urban
Pedagogy, David Rusk,
NJT Infrastructure Planning
Program, Project Projects, RFK
Investments, TU Delft

The Green Corridor consists of five elements: green infrastructure, a bike path, pedestrian safety improvements, new rental apartments, and strengthened north / west downtown streets.

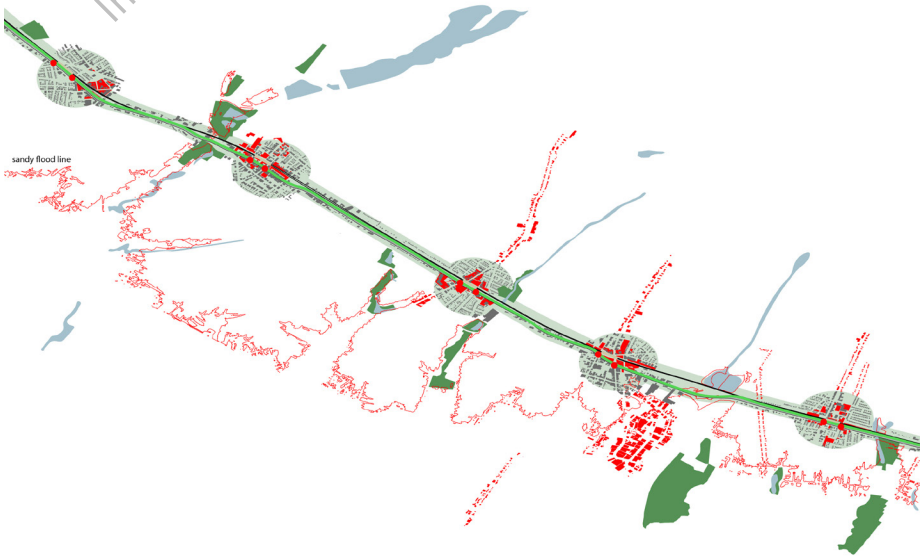
pedestrian safety



development opportunity



north-south retail corridors



Interboro Team: Apex / BOOM / Slabbers
Interboro / Apex / BOOM / Palmbout /
/ Deltares / H+N+S / Palmbout / Urban
IMG Rebel with Center
Pedagogy, David Rusk,
NJIT Infrastructure Planning
Program, Project Projects / FA
Investments, TU Delft

Building On Baldwin

Along the Sunrise Highway, there are a number of things to take advantage of. First, it is high and dry, and is therefore a good place to build rental housing. Second, it has a mixture of uses and density, which many Long Islanders are looking for. Third, it has a lot of unused water infrastructure that is leftover from when Long Island fed Brooklyn its drinking water that we think we can use for storage and flow augmentation.

Interboro Team:
Interboro / Apex / Bosco Sodders
/ Deltares / H+N+S / Pathport /
IMG Rebel with Center for Urban
Pedagogy, David Rusk,
NJ Infrastructure Planning
Program, Project Projects, RFA
Investments, TU Delft

Freeport Plaza West Greened

Interboro Team:
Interboro / Apex / Bosch Slabbers / Deltares / H+N+S / Palmbout / IMG Rebel with Center for Urban Pedagogy, David Rusk, NJIT Infrastructure Planning Program, Project Projects, RFA Investments, TU Delft

How did the research frame a deeper understanding of the problem?

This strategy addresses two major problems: 1) a chronic shortage of affordable apartments that are out of harm's way and 2) excess stormwater runoff that is the product of too much impermeable surface area and the threats this stormwater runoff poses for flooding and water quality.

How does the research inform the proposed solution?

An analysis of category 1 and category 2 storm surge and damage from Sandy revealed that the Sunrise Highway corridor is as close as one can be to the bay without being in harm's way. This led us to consider the corridor as a potential site for future development. Many advocacy groups have pointed out that with its public transportation options, its relative density, and its mixture of uses, parts of the corridor have the potential to be the dense, walkable, mixed-use environment that so many of today's Long Islanders are looking for (for example the aging boomers and their urban lifestyle–seeking children). But few of these advocacy groups have noticed that the corridor is also high and dry: it is just beyond the reach of a category 2 surge, a 6-foot sea-level-rise, and the FEMA flood zone; the corridor is as close as you can get to the more vulnerable communities of the South Shore while still being safely out of harm's way.

An analysis of the housing market revealed that there is a dearth of rental units and apartment units. In 2012, the Regional Plan Association reported that 21% of Long Island's households live in rentals. This percentage is substantially lower than neighboring suburban areas such as western Connecticut (34%) or northern New Jersey (37%). When Sandy struck, Long Island's rental vacancy rate was just over 4%: neither displaced residents nor relief workers were able to find suitable temporary housing, a point that was very recently made in a *Newsday* headline: "Displaced by Sandy, LI Renters Long for Home." As the Regional Plan Association has pointed out, between 2000 and 2011, about 17 new rental units were built on Long Island for every 1,000 residents, compared to an average of more than 26 for the rest of the region (excluding New York City). The same study showed that Long Island has an average of 1 rental unit available for every 107 households (similar New York–area suburbs have an average of 1 available rental unit for every 42 households).

A related analysis revealed considerable capacity for development along the corridor. If we tally all of the vacant lots, surface parking lots, and "development opportunities" (as identified by Nassau County in their 2013 Infill Housing Feasibility Report) and apply existing zoning, we see that there is capacity for close to 3,700 new units of housing in Nassau's "high and dry" downtowns along Sunrise corridor.

Interboro Team, Nine / Eleven Studio / Deltaspace / Matt Hitt / Stephen Ramsey / Public Works Center / Urban Image Partners / Bob Yaro / Regional Plan Association / Hofstra University / Planning Consultants, RFA / Nassau County Department of Planning / Nassau Infill Left

Village/Hamlet	Valley Stream	Lynbrook	Rockville Center	Baldwin	Freeport	Merrick
Developable area (sq ft)	561,754	762,925	1,081,587	1,065,981	762,925	1,072,645
Developable area (acres)	13	18	25	25	22	25
Dwelling Units/Acre	25 Units/Acre	26 Units/Acre	27 Units/Acre	28 Units/Acre	29 Units/Acre	30 Units/Acre
# of Dwelling Units	322	437	620	622	550	625
Village/Hamlet	Bellmore	Wantagh	Seaford	Massapequa	Massapequa Park	East Massapequa
Developable area (sq ft)	862,925	1,409,900	838,331	903,937	457,806	1,836,926
Developable area (acres)	20	32	19	21	11	42
Dwelling Units/Acre	25 Units/Acre	25 Units/Acre	25 Units/Acre	25 Units/Acre	25 Units/Acre	25 Units/Acre
# of Dwelling Units	495	809 Units	481 Units	518 Units	262 Units	1,055 Units
TOTALS:						
Developable area (sq ft)	6,170,742					
Developable area (acres)	147					
# of Dwelling Units	3,671					

An analysis of the impervious surfaces in Nassau County revealed that it is a hotspot of impervious surfaces and is a major contributor to stormwater runoff that ends up in the bay.

An analysis of the conditions along the Sunrise Highway corridor revealed excess parking lots, medians, and other areas that were conducive to green infrastructure improvements.

A historical analysis and discussions with Nassau County DPW revealed the potential for reusing the abandoned 72-inch water main under Sunrise Highway (formerly used to pipe drinking water to Brooklyn) for stormwater storage and flow augmentation.

Interboro Team:
Interboro / Apex / Bosch Quayle /
/ Deltares / H+N+S / Palmbout /
IMG Rebel with Center for Urban
Pedagogy, David Rusk,
NJIT Infrastructure Planning
Program, Project Projects, RFA
Investments, TU Delft

Demonstration of Participatory Design Process/Stakeholder Coalition

How did the team's participatory design process engage local stakeholder groups across sectors and interests?

For *Living with the Bay*, the Interboro Team engaged over 100 organizations, including academic institutions, NGOs, nonprofits, community groups, governmental agencies, and private companies.

Please see Chapter 2 for a complete list of organizations that we presented this strategy to.

Over the short time span of a few months, a fast-paced series of community meetings, workshops, and stakeholder meetings has brought together a remarkable coalition of project supporters, ranging from regional institutions such as the Long Island Regional Development Council to grass-roots advocacy groups such as Operation SPLASH. We are especially proud of the larger coalition of supporters we were able to assemble through our participatory design process in a region that is notoriously fragmented.

How did the team's participatory design process facilitate collaboration among jurisdictions to understand shared problems and explore shared solutions?

We conducted the following key meetings with governmental officials about our Green Corridor strategy:

Meeting: Nassau County Stage 3 Kickoff
Date: 11/21/13
Attendance: Ken Arnold, Resi Cooper, Michael Martino, Laura Munafo, Shila Shah, Rob Walker
Summary: Presented of Stage 2 plan; outlined hopes for Stage 3; learned about the county's priorities

Meeting: Nassau County DPW
Date: 11/27/13
Attendance: Ken Arnold, Sean Sallie, Brian Schneider
Summary: Received targeted feedback on Stage 2 plan and Stage 3 ideas; learned about current stormwater management practice; discussed feasibility of green infrastructure; discussed whether the area could really be protected against surge and sea level rise

Presentation: Long Island Regional Planning Council
Date: 12/10/13
Location: Molloy College, East Farmingdale
Attendance: John Cameron, Cara Longworth
Summary: Presented Stage 2 plan; discussed the need for affordable housing and rental housing; discussed the need for evacuation routes; discussed the importance of working with the villages and county

Meeting: NY Rising CR
Date: 1/2/14
Attendance: Laura Munafo, Zachary Richner, Jaime Rubin, Lead Nassau-based NY CR planners
Summary: Presented Stage 2 plan; heard presentation from each of the Nassau-based NY CR planners; discussed potential overlaps and opportunities to work together

Meeting: NY Rising CR
Date: 1/15/14
Attendance: Laura Munafo, Zachary Richner, Lead Nassau-based NY CR planners
Summary: Discussed the selection of priority projects from the process

Presentation: Long Island Regional Economic Development Council
Date: 1/23/14
Location: LI Regional Office of Empire State Development, Hauppauge
Attendance: Bob Brinkman, Marianne Garvin, Gilbert Hanson, Jim Morgo, Christopher Niedt, Rich Rotanz, Brian Scripture
Summary: Presented Stage 2 plan and Stage 3 progress; received feedback, especially on what is presently our Green Corridor strategy; invited to return in March when the project is further along to get official support

Interboro Team / Dyer / Blain Stakeholder / Deltares / Arup / Rutgers / Rebuild by Design / IMG / Pentagram / Rebuild with Center for Urban Ecology / David Rush / JUIT Infrastructure Planning Program / Project Projects, RFA / Investments / Rod Dorft

Meeting: Nassau County DPW
Date: 2/12/14
Attendance: Sean Sallie
Summary: Discussed the feasibility of doing green infrastructure, traffic calming, and TOD development along the Sunrise Highway corridor

Meeting: NY Rising CR
Date: 2/21/14
Attendance: Laura Munafo, Zachary Richner, Jaime Rubin
Summary: Updated State on Stage 3 plan

Presentation: South Shore Estuary Reserve Council
Date: 3/11/14
Location: Seatuck Environmental Association, Islip
Attendance: South Shore Estuary Reserve Council
Summary: Presented *Living with the Bay*; received feedback

Presentation: Long Island Regional Economic Development Council
Date: 3/19/14
Location: LI Regional Office of Empire State Development, Hauppauge
Attendance: Long Island Regional Economic Development Council, members of the public
Summary: Presented *Living with the Bay*; answered questions; council voted affirmatively to support the plan

How did the team's participatory design process solicit direct input from community members in the project area?

The Interboro Team presented the Green Corridor strategy at a number of community meetings.

Specifically, we conducted the following meetings with community groups about shared problems and solutions for Sunrise Highway and the LIRR stations areas along it.

Meeting: Community Meeting I
Date: 2/22/14
Location: Baldwin Senior High School
Attendance: Approximately 60 people
Summary: Presented *Living with the Bay*; conducted an open discussion; led breakout tables on each of our four strategies

Meeting: Community Meeting II
Date: 3/8/14
Location: Operation SPLASH
Attendance: Approximately 75 people
Summary: Presented *Living with the Bay*; conducted an open discussion; led breakout tables on each of our four strategies

Event: High School Resiliency Workshop
Date: 3/18/14
Location: Lynbrook High School
Attendance: Students from Lynbrook Sustainability Club
Summary: Presented scaled-down version of *Living with the Bay*; discussed the threats of surge, sea level rise, and stormwater; discussed strategies for combating the threats

Event: Boat and Bus Tour of *Living with the Bay*
Date: 3/29/14
Location: Operation SPLASH
Attendance: TBD

In Community Meeting I and II, we led breakout tables on the Green Corridor strategy. In these breakout sessions, residents expressed considerable concern about the lack of safety on Sunrise Highway. At Community Meeting I, a group form the Baldwin Civic Council pointed out numerous danger areas and expressed concern that both north/south and east/west pedestrian travel was difficult because of long crossing times and insufficient pedestrian infrastructure. The same group expressed support for the idea of a bike lane, one member of the group even going so far as to say that a bike lane would connect communities that were segregated from each other. One thing that came out of the discussion was the idea of an east/east greenway that would plug into future north/south greenways, creating a greenway network that would allow travel between a point along Sunrise Corridor and the bay.

Interboro Team / ARUP / Epoch Strategies / Dewberry / HNTB / Sambudd / McKinsey / Pratt Center for Urban Planning / NJIT Infrastructure Program / Paul Rusk, Planning Investments, LI Delegation, RFA

The same group was supportive of building rental housing along the corridor and suggested many sites that were good candidates for development.

At Community Meeting II, some residents expressed concern about removing a car lane or in any way impeding the flow of traffic. In the end, our proposal for the corridor did not include a lane closure.

How did the team's participatory design process result in the formation of a coalition of support? For decades, many advocacy groups in Long Island have been demanding more affordable rental housing. We built our coalition of support in part by reaching out to them. Specifically, we had the following meetings with advocacy groups about the rental housing component of our Green Corridor strategy:

Meeting: Health and Welfare Council of Long Island
Date: 12/10/13
Attendance: Gwen O'Shea
Summary: Discussed demographics, discrimination, the lack of affordable housing and rentals; discussed health care and the idea of community-based comprehensive service delivery models

Meeting: Long Island Housing Partnership
Date: 12/12/13
Attendance: Peter Elkowitz
Summary: Underlined the need for more affordable housing; discussed land trusts as a solution to the problem of rebuilding haphazardly (and not high enough)

Presentation: LIVOAD Long Island Long Term Recovery Group
Date: 12/20/14
Location: NYIT, Central Islip
Attendance: Approximately 30 people
Summary: Presented Stage 2 plan; answered questions about the process; received feedback

Meeting: Empire Justice
Date: 1/15/14
Attendance: Maria Degennaro
Summary: Learned about Empire's work around foreclosures; discussed incorporating foreclosed homes into our plan, for example by ensuring that foreclosed homes in less vulnerable areas get targeted for assistance

Meeting: Baldwin Civic Association
Date: 2/12/14
Attendance: David Viana
Summary: Discussed TOD development opportunities in Baldwin and the need for a gentler Sunrise Highway corridor

Meeting: ERASE Racism
Date: 2/14/14
Attendance: Elaine Gross, Jennifer Simcovitch
Summary: Discussed failure of most communities to do an analysis of impediments to fair housing; discussed misuse of Sandy funds; discussed school segregation; Elaine suggested Lynbrook as a good site for TOD

Meeting: Jaral Properties
Date: 3/21/14
Attendance: Rob Salvatico
Summary: Discussed our Green Corridor strategy; discussed Freeport Plaza West development and how it could fit into our strategy; received support for working with developers to make the development more sustainable

Interboro Team / Alex Bosch Stabner / Deltaspace / Lisa Palmbout / IMC Rebecca Lewis / Centro Urbano / Redacción Daniel Rast / NYIT Infrastructure Planning Program, Project Manager, Investments, HUD Dept, RFA

Innovation

How does the project employ new design approaches, construction methods, materials, or technology to significantly enhance resilience?

In addition to incorporating BMPs into both the housing and green infrastructure components of the Green Corridor, the project proposes to reuse abandoned water infrastructure under Sunrise Highway for water storage and flow augmentation. This abandoned system, which includes a 72-inch steel force main, a 48-inch cast iron main, a 36-inch cast iron main, and a network of pumping stations, once provided Brooklyn with its drinking water.

How does the project Incorporate funding/financing mechanisms to leverage resources?

For our Phase One project, we propose to implement a “show piece” of the reimagined Sunrise Highway corridor around the Freeport LIRR station. Specifically, we propose to make two good initiatives (Freeport Plaza West and the Sunrise Streetscape Improvement Plan) great by adding green amenities that will reduce stormwater runoff. In this sense, we are leveraging other finance vehicles (both public and private) toward our resiliency goals.

Interboro Team:
Interboro / Apex / Bosch Slabbers / Deltares / H+N+S / Palmbout / IMG Rebel with Center for Urban Pedagogy, David Rusk, NJIT Infrastructure Planning Program, Project Projects, RFA Investments, TU Delft

Design Quality/Excellence

How does the project performs as more than just a defense mechanism and represent a development-oriented and future-driven approach?

Just about every national housing trend points to an increased demand for rental living. In Long Island, things like an aging population, delayed marriage, and smaller family sizes all point to the need for smaller, less-expensive housing and more rental housing. But Long Island has been slow to accommodate this demand. In a recent study, The Regional Plan Association found that there was an average of 1 rental unit available for every 107 households. (By comparison, northern New Jersey, the Hudson Valley, and southwestern Connecticut have an average of 1 rental available for every 42 households.) The same study revealed that 17 new rental units were built on Long Island for every 1,000 residents between 2000 and 2011, compared to an average of more than 26 for the rest of the region (excluding New York City).

If we tally all the vacant lots, surface parking lots, and "development opportunities" (as identified by Nassau County in their 2013 Infill Housing Feasibility Report) and apply existing zoning, we see that there is capacity for close to 3,700 new units of housing in Nassau's "high and dry" downtowns along Sunrise corridor.

How does the project represent a planning and design approach that is comprehensive and inclusive?

Inclusion is at the very heart of this proposal, as it is ultimately about increasing the affordability and accessibility of Nassau County. While the Phase One project is focused on one site, Sunrise Highway is a major thoroughfare that connects many different communities.

The proposed masterplan for the corridor examines this artery comprehensively, considering the potential and currently underexploited interrelationships among different transportation infrastructures (rail, road, bike, and pedestrian), stormwater management, housing, and retail.

Interboro Team: Interboro / AKF / Design Guild / Delaney / Partners / Dunnhoff / IMC Rebuild with Centerprise / Rebuild by Design / Kristin Lucas / David Rush / Urban Investment Project / Future Planning Projects, RFA / Delft

Impact

How does the project respond to the greatest/highest risks, vulnerabilities and/or impacts identified?

First and foremost, if Long Island doesn't create affordable opportunities for people to live out of harm's way, tens of thousands of people in more vulnerable, low-lying areas would have to remain vulnerable and pay increased insurance premiums, spend money raising their homes, or move outside the area. The Long Island Community Foundation put it very well in a recent report about Long Island's Rental Housing Crisis when they noted that without an increased number of rental homes, the following is likely to happen:

—Long Island's economy is likely to stagnate

—Homeowners will find it more difficult to sell their homes

—Villages, towns, and counties could be vulnerable to Fair Housing lawsuits

—Parents, children, and grandparents will live farther apart

—We will miss an opportunity to improve communities across Long Island

Additionally, stormwater runoff and flooding from rain events will increase and traffic fatalities will increase.

How does the project reduce vulnerabilities, minimize consequences/losses, and increase the ability to withstand and rapidly recover from future disaster impacts/disruptions?

If we tally all the vacant lots, surface parking lots, and "development opportunities" (as identified by Nassau County in their 2013 Infill Housing Feasibility Report) and apply existing zoning, we see that there is capacity for close to 3,700 new units of housing in Nassau's "high and dry" downtowns along Sunrise corridor. That means a lot of present and future Long Islanders living out of harm's way.
As mentioned, the addition of new units will create more housing options for those residents who might need temporary shelter after the next big storm. There is currently insufficient supply.

How does the project present the potential for broader applicability/replicability, either in approach or solution?

Our Phase One project is catalytic. We think that if we can get affordable apartment building on the Sunrise corridor off on the right foot, we can really make a difference by paving the way for others. While this project seems obvious and simple, it is remarkably difficult in Nassau County to develop medium density rental housing. This project will serve as an important prototype.

How does the project contribute to the overall recovery and rebuilding of the area/community?

When Sandy struck, Long Island's rental vacancy rate was just over 4%; as a result, neither displaced residents nor relief workers were able to find suitable temporary housing, a point that was very recently made in a *Newsday* headline: "Displaced by Sandy, LI Renters Long for Home." First and foremost, building rental apartments in high and dry areas will ensure that there are more places for persons displaced from future extreme weather events.

What potential does the project have to catalyze transformative change?

If done correctly, the development of new mixed-use, mixed-income rental housing in Long Island's downtowns has the potential to really transform Long Island. As the Long Island Index put it, "with over 100 downtowns and nearly as many rail stations, Long Island has a wide range of places that could

Interboro Team / Area / Boston Slabbers / Deltais / H+N+S / Parmout / IMG / Rebel with a Cause / Center for Urban Pedagogy, David Rusk, MIT Urban Studies Program, Project Planning Investments, and Delft

support a pattern of development, one that builds on what is already here and helps improve quality of life throughout Nassau and Suffolk."

How does the project address one or more of the following key areas of focus: a) vulnerable populations, b) critical infrastructure (particularly energy and communications), c) potential for leveraging other federal investments?

The Green Corridor strategy is about helping vulnerable populations. On the one hand, this refers to populations that are vulnerable to water-based threats like surge and sea level rise. On the other hand, this refers to those who can't afford to live in Nassau County. As the RPA put it, "The average auto mechanic or school bus driver makes less than two-thirds of what is needed to afford what is considered to be a fair market rent for a typical two-bedroom apartment. Other occupations in which people struggle to pay average rents include carpenters, electricians, machinists, graphic designers, computer support specialists, real estate agents, mail carriers, landscaping workers, nurses, secretaries and social workers." Part of the problem has to do with supply and demand: thanks to exclusionary zoning practices, there is a short supply of apartments and rentals. Because of changing demographics, there is an increased demand for them. The result, as the RPA put it, is that trying to rent a home on Long Island is much more difficult than it is in other places, even other suburban regions. "There are few apartments or houses to rent to start with. Of these, very few are vacant and on the market. And those that are available are expensive for the average person looking to rent."

How does the project incorporate principles of sustainability, including water quality and energy efficiency?

Development around dense, walkable downtowns with public transportation is sustainable because it cuts down on carbon emissions associated with driving.

The green infrastructure component of the Green Corridor strategy uses swales, permeable paving, and other green infrastructure BMPs to capture stormwater and therefore recharge the groundwater and reduce inundations into Nassau's creeks, rivers, and bays.

Interboro Team / Alex Bell Studio / Deltec / Urban Land Institute / Regional Plan Association / IMG Rebuild / Nassau County / Hofstra University / Stantec / Urban Investment Strategies / Dewberry / RFA

How does the strategy demonstrate the feasibility of the design proposal?

Our Phase One project is feasible, as the Freeport Plaza West development can be greened using innovative best practices that can help the development attain LEED certification.

What are the project's risks and uncertainties?

Exclusionary zoning and anti-urbanism is evident in Nassau County, which partially explains the lack of development along the Sunrise Highway corridor. As one elected official told us, "I don't believe housing and retail should mix." The same official speculated that the only people who would want to live in an apartment and not drive a car are "poor people."

The threat to the green infrastructure and pedestrian safety component is the likely opposition of drivers to make any changes to Sunrise Highway that would slow it down in any way at all.

What does the cost-benefit analysis show? What does it not take into account?

Again, the larger vision for the Green Corridor strategy would result in tens of thousands of present and future Long Islanders living out of harm's way. It could also open the door to Nassau County's bay culture to those who presently can't afford it.

Interboro Team: Alex / Joseph Stabile
Interboro / Alex / Peter / Jonathan
/ Deltares / Peter / Jonathan / Urban
IMG Rebel with Centerbrook
Pedagogy: David Ries
IHE Infrastructure Planning
Project Projects RFA
Investments, TU Delft

Chapter 6: Implementation

Interboro Team:
Interboro / Apex / Bosch Slabbers
/ Deltares / H+N+S / Palmbout /
IMG Rebel with Center for Urban
Pedagogy, David Rusk,
NJIT Infrastructure Planning
Program, Project Projects, RFA
Investments, TU Delft

Interboro Team:
Interboro / Apex / Bosch Slabbers
/ Deltares / H+N+S / Palmbout /
IMG Rebel with Center for Urban
Pedagogy, David Rusk,
NJIT Infrastructure Planning
Program, Project Projects, RFA
Investments, TU Delft

Living With The Bay Strategy

Working locally within a regional strategy

Living with the Bay is a long-range planning, design, and realization effort spearheaded by New York State, Nassau County, and local communities. Its mission is to enhance the resiliency of Southern Nassau County. This will be achieved through an integrated, tri-scalar approach: further enhancing the long-term regional perspective (level 1), developing master plans at a sub-regional scale within this regional perspective (level 2), and preparing and implementing Phase One projects in each of the sub-regions (level 3).

This report is the first draft of this long-term perspective for Nassau County, the master plans for some key areas in the region, and specific projects that are moving toward realization. All three levels together will lead to a safer and more resilient region and at the same time add economic, ecological, social, and spatial qualities to the region.

Living with the Bay Alliance

This implementation plan is a continuation and strengthening of the joint planning efforts of the RBD process. We understand that the RBD organization will no longer "own" the process after completion of Stage 3. This would mean that Living with the Bay needs new owners to ensure the RBD legacy. Who could be better new owners than the project partners who have been successfully collaborating in the past three RBD phases and who are explicitly supporting the Living with the Bay strategy? Therefore, we propose to establish the Bay Alliance, a coalition composed of the public and private partners, communities, residents, and key members of the RBD leadership who will continue working together to

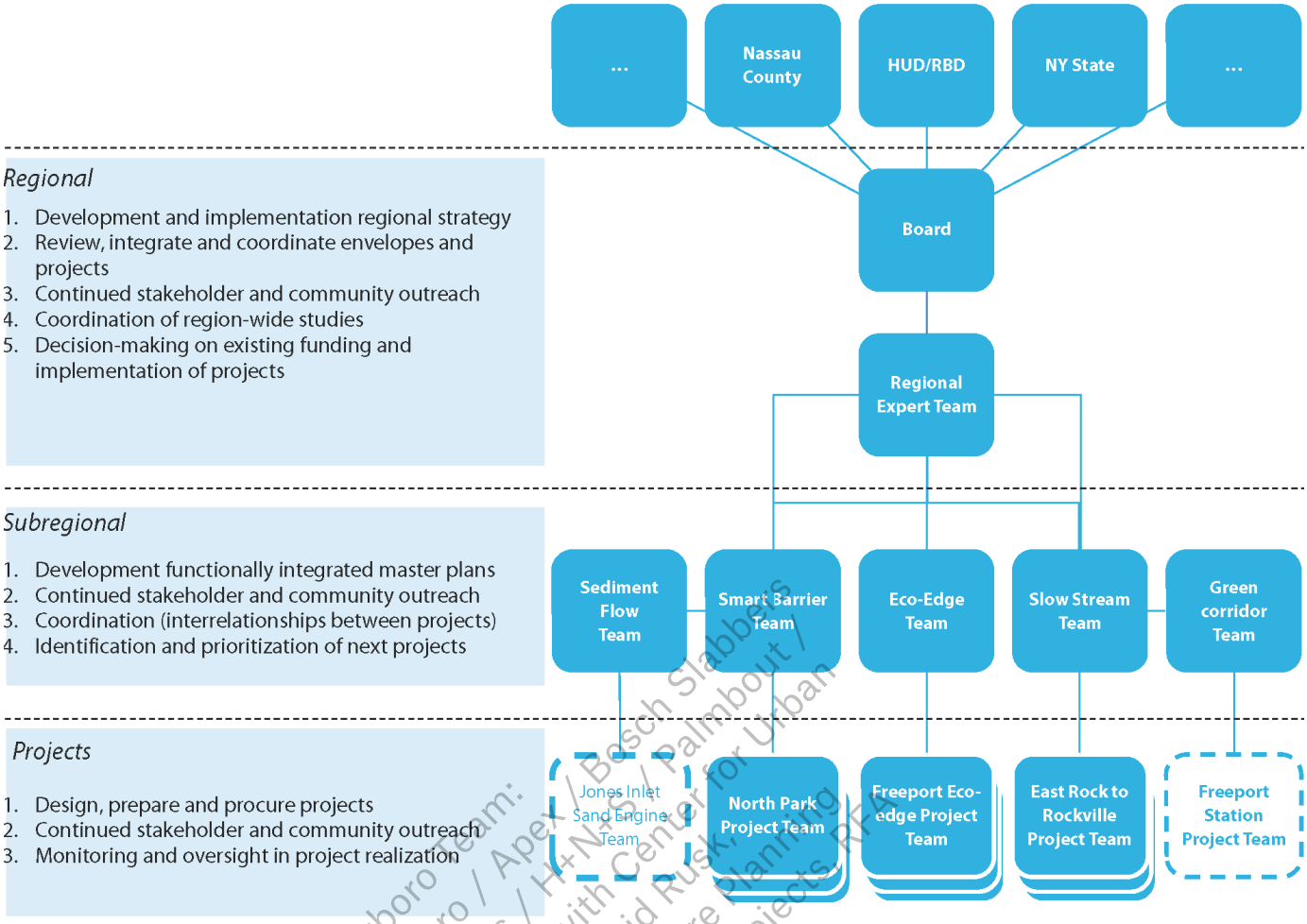
—steer and enable the development and implementation process
—ensure linkages between the regional scale, the sub-regions, and the projects
—monitor the budgets and apply for funding
—stimulate information and experience sharing between projects
—deliver results

Joint development on three levels

n the Bay Alliance, strategy development, planning, and design are joint responsibilities of the stakeholders involved. The Interboro Team recommends effectuating this by having the partners make staff available for participating in the Bay Alliance and contributing office space and amenities. Formal representation and government contribution will be channeled through the State of New York. In 2014, the Bay Alliance partners will sign a Memorandum of Understanding, in which all objectives, principles, conditions, governance, activities, and timeline of this partnership will be laid out.

The Alliance will continue working on the region, sub-region, and project levels. The regional perspective is relevant in order to understand the water system "as-is" and the effect of project interventions in this water system, thereby informing decision making and project optimization on the sub-region and project levels. The sub-regional perspective serves to functionally integrate the water system with other functions (including housing, recreation, and environment) and zoom in on a scale that is workable and meaningful for direct stakeholders. The project level is ultimately where the specific interventions in resiliency of southern Nassau County are prepared and realized.

Interboro Team / Rem / Dutch Studio / Deltares / Fugro / Arup / IMC Belgium / Rebel with a Cause / Rutgers / David Rust / Joost Vrijling / Infrastructure Planning / Project Projects, RFA / Westerdijk / TU Delft



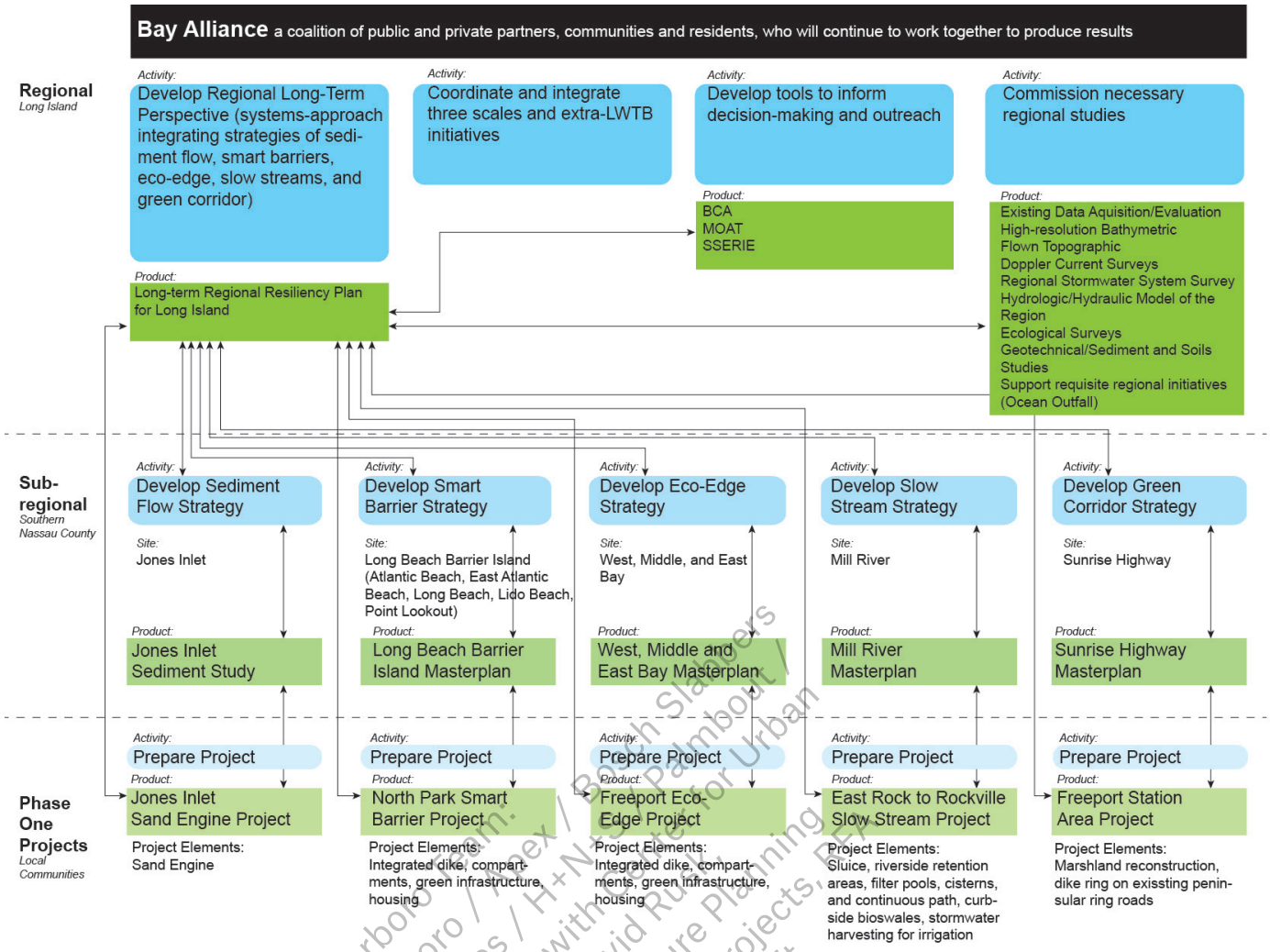
Alliance Organization

Interboro Team: Interboro / Apex / Bosch Slabbers / Deltares / H+N+S / Palmbout / IMG Rebel with Center for Urban Regeneration, David Rusk, Planning Innovations, Infrastructure Planning Investments, Project Projects, RFA, TU Delft

After project approval, the further preparation, procurement, and realization are no longer a joint responsibility, yet a (delegated) principal of the project will be appointed. The principal will be responsible for commissioning the project and contracting consultants and contractors to carry out the work. These activities do not require joint ownership but clarity in terms of responsibilities and risk allocation. Naturally, the principal coordinates with the relevant project partners throughout the preparation and implementation phases. The principal will often be an agency experienced in project preparation, commissioning, and oversight and have a "natural" responsibility for and knowledge of the project.

One mission, one location

The Alliance will have a base in Nassau County, which will become the "meeting point" for the Bay Alliance participants and the "control tower" from which all the information will be brought together and effective coordination will take place. Regular meetings and working sessions will ensure the different feedback loops between the different scale levels. Locating the epicenter of all planning and realization activities in Nassau County ensures that each project gets embedded in the different scale levels and organizational structure. Furthermore, the actual creation of a studio where all team partners will be permanently present will facilitate a fluent communication



Living with the Bay Project Organization

between the parties from different countries and backgrounds. By creating a studio that takes an independent lead on "neutral grounds" with strong partners that know how to tackle the issues and are spirited to make change happen, we believe that a broadly accepted long-term perspective will be created, sub-regions will be developed in a truly integrated way, and projects will be efficiently advanced to shovel-readiness.

Continued Dutch and American investment and partnership

The Interboro Team—which combines the best of Dutch and American expertise—is excited about moving forward together to further develop and successfully realize coastal resilience in Nassau County. Having worked together in the RBD "pressure cooker" has contributed to creating an even stronger team. There will be three refinements in our approach:

—Work from one location. What we learned from the RBD process is that being in one location is crucial for further streamlining our processes and communication. Therefore, the key Dutch team members have already committed to a more frequent or even permanent presence in the region.

—Shift in skill sets for implementation. The creative process of conceptualization and design requires different skills than the effective and smooth preparation and realization of a project. Moving toward implementation, we will continue to provide design and planning leadership but will also increasingly use our team's expertise in project

management, finance, and contracting to facilitate implementation.

—Studies and monitoring for better informed decision making. The Long-Term Perspective for Long Island cannot and will not be an empty shell but needs to be scientifically proven and tested. We will scientifically prove our concepts by more research on specific topics and test them by implementing sub-regional scale projects and phasing our projects. The monitoring of these projects—which some of our team members are experienced in—will result in new important data for the long-term perspective.

Here are the studies that are required to enhance decision-making information:

Existing Data Acquisition/ Evaluation:
Several entities, such as the Town of Hempstead, City of Long Beach, Nassau County, Hofstra University, and SUNY Stonybrook, have various types of data sets ranging from surface-water quality studies to side-scan sonar surveys to stormwater abatement systems to ecological resources. As part of this task, we will meet and collect available data and then collate them to identify data gaps that need to be addressed.

High-resolution Bathymetric/ Flown Topographic/Doppler Current Surveys:
There is very little available, high-quality, electronically manipulatable data with respect to the bottom topography (i.e., bathymetry) and existing current patterns of the bay, marsh islands, creeks, inlets, etc. These data will be critical in completing the detailed flood potential models that will be used to evaluate and design our intervention measures, including marsh islands, dike rings, and bay compartmentalization. A National Fish and Wildlife Foundation (NFWF) grant has been developed and submitted to partially offset costs associated with these surveys.

Regional Stormwater System Survey:
Detailed knowledge of the existing municipal and significant private stormwater abatement system is critical for two main reasons: 1) back-bay flooding during Sandy backed up through stormwater outfalls and resulted in greater-than-anticipated flooding in upland areas; 2) upland flooding and bay inundation associated with high-precipitation events.

Hydrologic/Hydraulic Model of the Region:
A computer model is only as good as the data put into it. The team has developed a preliminary hydrologic/ hydraulic model of the region to evaluate "test" proposed intervention measures. The data acquired from the above tasks/surveys will be incorporated into the model to allow for the construct of a better/more thorough model. The use of a hydrologic/ hydraulic model to assess any intervention measures will be a critical component during the review of projects by regulatory agencies. A NFWF grant has been developed and submitted to partially offset the costs and support this modeling.

Ecological Surveys:
Some of our intervention measures will require the filling of existing underwater lands. An understanding of the existing ecological resources will be require as part of regulatory review.

Geotechnical/Sediment and Soils Studies:
Many of the interventions require knowledge of the strength/bearing capacity of the underlying soils. Additionally, the chemical quality of bay sediments and adjacent soils may need to be confirmed in the event that they are utilized as part of intervention measures.

Interface Tech. / Arup / Dr. Stanley Suchman
Interface / Deltares / Hydro Logic / Dr. Ivan
IMG / Rowan Williams Davies & Irwin / Dr. Ivan
Peacock / Dr. David Kaplan / Planning
Alternatives / Infrastructure Planning
Investments / Project Projects, RFP
Plan Partners / TU Delft

Support requisite regional initiatives

The completion of the Bay Park STP Ocean Outfall and Long Beach Conversion projects are critical to the implementation of many of our projects as the resultant improvement in the Bay's surface water quality will allow for marsh island vegetation propagation and survival. Along with our proposed stormwater interventions which will also result in improved surface water quality conditions, the ecological conditions of the Bay will improve and provide Nassau County residents with multiple recreational opportunities ranging from picnicking on islands, kayaking, clamming, fishing, etc.

The long-term viability of the interventions proposed herein are intertwined with the overall health of the Bay from an ecological and water resources perspective. One of the keys to the long term success of the Bay and Bay front elements of the interventions for Nassau County is the health and water quality of the Bay. At present, the Bay suffers from degraded water quality from both industrial and non-point (run-off) source pollutant inputs, as well as from a long history of filling of the Bay and Marshlands. The resultant degradation of water quality in the Bay has been well documented by a variety of State, Federal, and Local groups. A byproduct of the degraded water quality is loss of robustness of the aquatic and intertidal plant species living in the Bay. These aquatic and subaquatic plant species are critical components of the resilience infrastructure for the Bay as they act to anchor sediment and beach soils, countering the effects of wave and current action erosion on the landscape. The physical presence of marsh islands, marshes, and coastal beaches, bluffs, and dunes act to dissipate energy from waves and currents, and help reduce storm surge. Degradation of the anchoring plant species adds to the fragility of the marsh and coastal edge lands, making them more susceptible to erosion, which in turn lowers the landscape and reduces the protection from storm energy and storm surge. Of particular concern is the buildup of nutrients in the Bay from fertilizer-rich stormwater runoff and sewer and septage inputs. In response to the presence of the excess nutrients in the Bay, the flora has adapted a shallower root system, making it more susceptible to being uprooted by storm flow, currents, waves, and surge. This translates to a more eroded coast and marsh, as the anchor plant systems that help protect the coastline become degraded.

In recognition of the erosion susceptibility condition that is contributing to coastal vulnerability, a comprehensive plan to improve the health and quality of the Bay system is needed. This task element has been incorporated into our Team's overall regional planning element for the project. Additionally, within the Phase 1 Barrier Island (Long Beach) Project, the Team has incorporated elements of a project to improve the water quality in the Bay by extending the Bay Park Sewage Treatment Plant outfall pipe, moving its effluent outfall location from its current position within the Bay and extending it well out into the open ocean to the south of Long Beach. This project, considered by State and County officials to be a critical project aimed at improving Bay water quality and thus coastal resiliency, has not yet been conceptualized nor designed. The Interboro Team is including elements of the Bay Pipe STP Sewer Pipe Outfall Project in our RBD project. In order to jump start the process of installing the BPSTP Ocean Outfall Pipe, the Team has included the costs for completing the design of the Ocean Outfall Pipe in the Phase 1 section of the Long Beach Smart Barrier Project. By including the design elements in the RBD project, the Team is providing the opportunity for incorporating resilient design into the Sewer

Interboro Team: AECOM / Cornell Scherer / Interboro / Arup / Dewberry / Deltares / Mott MacDonald / Parsons Brinckerhoff / IMG Rebuild / Rockefeller Center for Urban Sustainability Research / Urban Planning Collaborative / Mitigation Strategies / Infrastructure Finance / Investment Advisory / Dept. of Insurance, RFA

Outfall Project. It is the intent of the Team to work with the County to ensure that best environmental practices, resilient design, and green concepts are incorporated into the Outfall Pipe Project. In order to assist the County in providing implementation of the resilient components of the Sewer Outfall Project, the Team is including approximately 12% of the construction costs of the Outfall in its budget for Long Beach Phase 1 Project.

A wide range of stakeholders, ranging from governmental entities, advocacy groups and communities organizations have identified the Bay Park STP Ocean Outfall as a priority.

Open and transparent approach

Throughout the RBD process, the nature of our approach has been open and transparent. We have been transparent in sharing our ideas and progress and open to receiving feedback and stimulating the creation of even better ideas. This approach has proven to be successful and has led to tremendous support by the wide range of stakeholders we are working with. We intend to continue this approach in the following ways:

Community participation. We will continue to share our ideas with and solicit feedback from a wide range of communities. We are mindful that in order to make meaningful change, we must ensure that the people who would be most impacted are informed of and help shape the planning and design process.

Knowledge and inspiration from "outside." We will be seeking expert opinions and creative interventions from outside the Alliance and the Interboro Team, thereby preventing blind spots or self-referencing. Having a close link with different (design) universities and their research and education programs allows us to organize that efficiently.

Regular (informal) coordination with authorities. This coordination is relevant not only for 1) the proactive solution of upcoming issues but also for 2) sharing knowledge and experience, 3) coordinating plans and decisions, and 4) smoothing regulatory procedures and permitting.

On the basis of experiences in similar projects, we will work with "administrative support groups" within the most important partner authorities. Practically, this means that appointed groups of experts will dedicate all or part of their time to help coordinating from within these authorities.

Tools to enhance decision making and outreach

The implementation of the Living with the Bay strategy and the RBD program is challenging. This is not just because of the technical complexities and interrelationships between the interventions but also because these complexities and interrelationships, in combination with a wide variety of stakeholders, make decision making and outreach even more challenging. This awareness is embedded in our implementation strategy, but in addition to that we want to further develop the following specific tools that enhance decision making and outreach—not just for Living with the Bay, but for the RBD program as a whole.

BCA Tool: In Stage 3, Interboro Team members Deltares and IMG Rebel developed a framework to stimulate and support all teams to further think about the beneficial aspects of their project, project evaluation, and project implementation. This framework has helped all teams to promote and optimize the proposed projects by explicating its benefits and costs to society. The framework that was used is loosely based on the methodology of benefit-cost analysis. The current framework is relatively simple and does not go much into monetization, but moving toward implementation, the tool needs further sophistication because it is going to inform decision making on projects and funding. We will

Interboro Team / Arup / Ross Stabbors / Deltares / Public Art Project / IMG Rebel / Mott MacDonald / Urban Publics / Rutgers University / Program Planning Consultants, LLC / Dewberry, RFA

further develop and apply the framework for our team and all other teams.

MOAT: Over the past few months, we have been conceptualizing MOAT (Mother of all Tools), which now is in its early design stage. MOAT provides a digitally accessible map that locates all potential interventions with key information available for each intervention. Besides outreach, the tool can be used to support decision making. The tool uses a uniform format for all interventions to facilitate decision making on the basis of objective information. The tool visually highlights interrelationships between interventions to facilitate the development of comprehensive strategies. We have been working closely with the Nature Conservancy and jointly concluded that MOAT would be an interesting addition to its existing CR tools. MOAT could run on their existing platform. The Nature Conservancy would like to "work more closely together on this" in the next phase.

SSERIE: Of all the sentiments expressed in our meetings with stakeholders, community members, and residents, perhaps none is more common than the sentiment that resiliency is not possible without increased education about Long Island's natural systems. There is consensus that a better, broader understanding of the extent to which conventional development patterns negatively impact these natural functions is necessary for more informed decision making about the region's future. Increased, accessible, and comprehensive education about the region's natural systems is therefore a major part of our team's work. We are tentatively calling this the South Shore Estuary Reserve Education Initiative (SSERIE). We are proposing to work with project partners Operation SPLASH to add a Living with the Bay component to the accredited grade-school curriculum they are presently developing. Specifically, we would use the implementation of our project as an educational opportunity, inviting students to take tours of our projects as they are constructed.

STUDIO: The team will erect a studio to facilitate the Bay Alliance taking an independent lead on 'neutral grounds' with strong partners who know how to tackle the issues and are committed to make change happen. This physical address on site will be the place where all stakeholders as well as the residents are welcome and where the different projects are further developed by the Bay Alliance teams. To further enhance community involvement, we envision using different techniques, such as: serious gaming, interactive models, design sessions, debates, exhibitions, Bay photography competitions and activities in the field (excursions, cleaning the bay, etc.).

Current status of our projects

We put together an ambitious strategy and an ambitious implementation plan. Our goal is to effectively work toward creating a more resilient southern Nassau County. All of the activities in this implementation plan contribute to reaching that goal and lead to the realization of projects. The projects we present in this plan are meaningful by themselves and are at the same time successfully integrated with other functions (within the sub-regions) and are interrelated in terms of the overall water system (at the regional level).

Some projects have a more independent and no-regret character than others: Slow Streams Phase One and The Smart Barrier Phase One are directly meaningful and create opportunities for future interventions building on these first phases. These projects require further preparation but are closer to implementation readiness. For the Eco-Edge sub-region, the situation is different:

Interboro Team / Interboro / Deltares / IMG Rebel / Delft University of Technology / Landscape Architecture / Delft University of Technology / Stakeholders / Community / Urban Planning / Research Projects, RFA

location and dimensions of marshlands and cross barriers affect the wave run up, which should affect the dimensions of dikes. Investing in flood protection without an understanding of these interrelationships will most likely lead to a waste of taxpayer money and the realization of suboptimal interventions. For the Eco-Edge sub-region, this means that we propose first doing some more homework and creating better information to allow for better informed decisions at the scale of individual interventions and optimal packages of interventions. Only recently we started developing the The Green Corridor Phase One project, after gaining stakeholders' support for our ideas about this area. We are expecting that this project can be further developed shortly and optimized on the basis of the regional stormwater system survey.

Understanding regulatory needs

As nearly all of the proposed intervention/resiliency measures are going to be installed within and/or adjacent to regulated freshwater, tidal, and/or saltwater wetlands, there will be multiple regulatory agencies with jurisdiction and permitting authorizations. Additionally, many local municipalities have building code regulations that may require approvals such as demolition permits, building permits, and roadwork permits.

The following provides a summary of various regulatory agencies/ municipalities and associated programs that we will be required to comport.

Interboro Team:
Interboro / AKF / Bosch Slabyns
/ Deltares / HR&A / Palmhouse /
IMG Rebel / Urban Center for Urban
Research and Planning
Resilient Delaware
UTI Urban Project Projects, RFA
Investment Plan - Draft

Organization	Permit/department
New York State Department of Environmental Conservation (NYSDEC)	· Stream Disturbance · Excavation and Fill in Navigable Waters · Docks, Moorings, or Platforms · Dams and Impoundment Structures · Freshwater Wetlands · Tidal Wetlands · 401 Water Quality Certification · Coastal Erosion · Aquatic Vegetation Control · Aquatic Insect Control · Fish Control · Incidental Take of Endangered/ Threatened Species · State Pollutant Discharge Elimination System (SPDES) Small municipal stormwater sewer systems (MS4s)
New York State Office of General Services (NYSDOS)	· State-Owned Lands Under Water · Utility Easement (pipelines, conduits, cables, etc.) · Docks, Moorings, or Platforms
New York State Department of State (NYSDOS)	· Coastal Consistency Concurrence
United States Army Corps of Engineers (USACE)	· Section 404 Clean Water Act · Section 10 Rivers and Harbors
United States Environmental Agency (USEPA)	
Town of Hempstead	· Department of Conservation and Waterways · Stormwater Management · Structures in Waterways · Landmarks Preservation Board
City of Long Beach	· Public Works · Water/Sewer Administration
Village of Island Park	· Building Department · Public Works
City of Long Beach	
Environmental Advisory Board	· Architectural Review Board · Long Beach Housing Authority · Planning Advisory Board
Village of Atlantic Beach	· Building Department
Village East Rockaway	· Building Department · Department of Public Works
Village of Freeport	· Emergency Management · Public Relations · Public Works
Village Hewlett Bay Park	
Village Hewlett Harbor	
Village of Hewlett Neck	
Village of Lawrence	· Building Department · Public Works
Village of Lynbrook	· Building Department · Architectural Review Board · Public Works · Emergency Management
Village of Malverne	· Building Department · Public Works · Emergency Management
Village of Rockville Centre	· Building Department · Community Development

Interboro Team / Interboro / Apex / Bosch Slabbers / Deltares / H+N+S / Palmbout / IMG Rebel / Mich Center for Urban Redacosy, David Rusk, NJIT Infrastructure Planning Program, Project Projects, RFA Investments, TU Delft

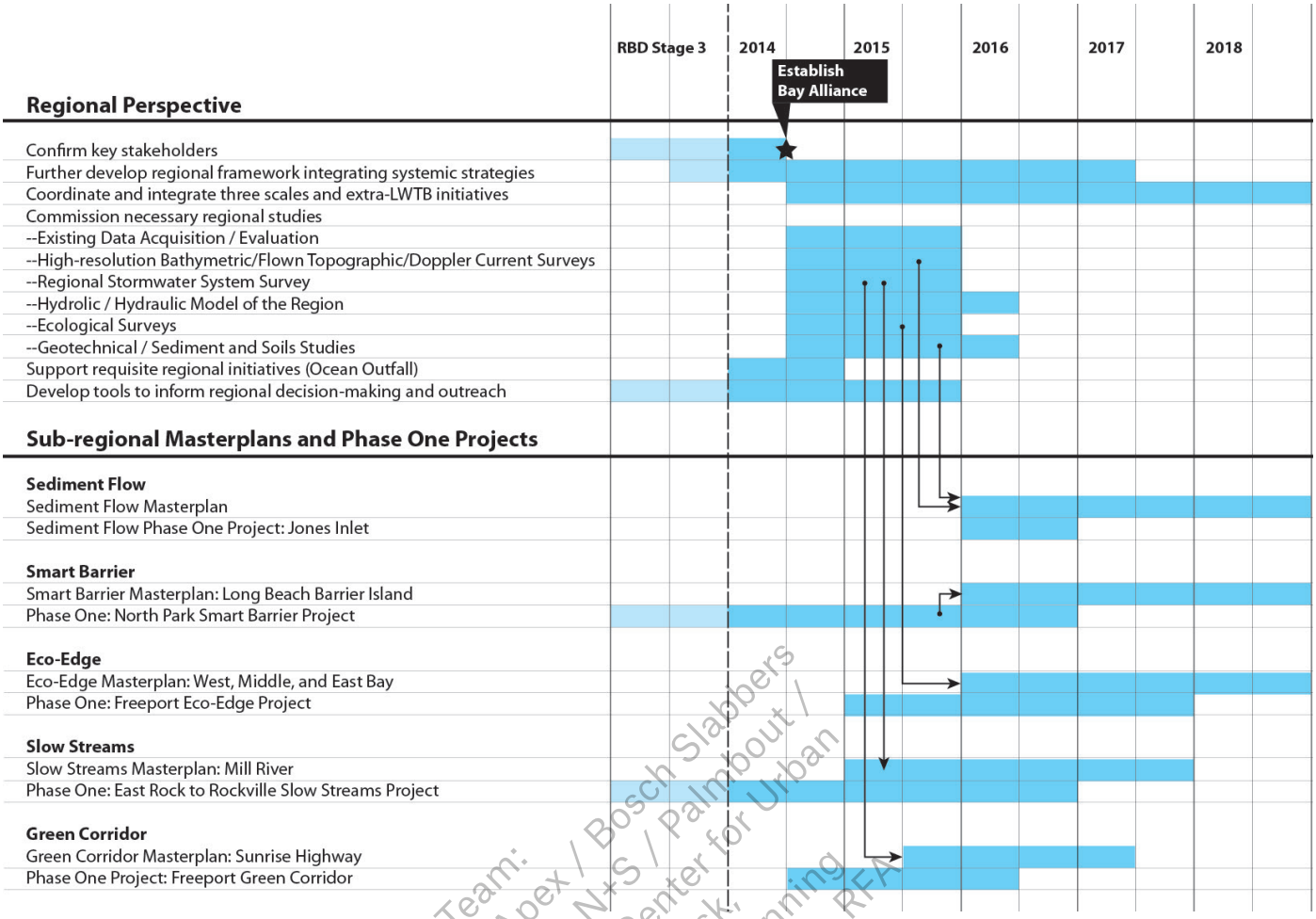
Many of the Interboro Team's intervention/resiliency measures are innovative and have not been attempted within the United States, New York State, and/or Nassau County in the past. This will make permitting procedures complicated and challenging. Our approach mitigates the regulatory risks and uncertainties as much as possible:

—Our team is well versed in the regulatory requirements. Our projects are carefully designed to be as implementable/permitable as feasible. We will continue using that approach. Several of our partners—for example the Town of Hempstead DC&W—will not only be a regulatory agency with respect to our projects but will also be strong technical team members who will work closely with us to understand existing conditions and to assist in developing strong, long-term resiliency measures.

—Our team is very familiar and experienced with the permitting requirements and permitting agencies in the Nassau County region and is often on a "first-name basis" with many of the regulatory personnel. We will continue to involve the permitting regulatory authorities via the pre-application meeting process. Our regional projects are of sufficient scale that it is appropriate to maintain a dialogue with the permitting agencies throughout the data-acquisition and design phases of the projects. This will minimize the potential for "surprises" to arise.

—We have observed that there is a new paradigm in the regulatory agency stance in that new and innovative resiliency measures will be more-reasonably considered, assuming that the permit application data supports such measures. As part of our "Do No Harm—Have No Regrets" strategy, we are well aware that a few region-wide, comprehensive sets of critical data (bay-bottom bathymetry, current flow patterns, surface-water quality, ecologic population studies) will be critical in supporting the final permitting and designs of our projects, which is why one our first tasks will be to conduct an assessment of existing relevant data sets and conduct a data-gap analysis. Both the NYSDEC and Town of Hempstead DC&W support our approach and have volunteered to assist us in conducting the data-gap analysis. We have already prepared and submitted a grant application to the National Fish and Wildlife Foundation (NFWF) to conduct a regional bathymetric/Doppler current study and to further refine a high-end hydrologic model of the waters in the region.

Interboro Team:
Interboro / AECOM / Bayer Stamm / Deltares / Dutch Institute for Urban Resilience / Parsons / IMG Rebel / Hitachi Center for Urban Resilience / Dutch Ministry of Infrastructure and Water Management / Delft University of Technology, RFA
Permeability Study
Not for Distribution
Preliminary Draft



Implementation Timeline

Interboro Team: Interboro / Apex / Bosch Slabbers / Delaware / H+N+S / Palmbout / IMC Panel with Center for Urban Pedagogy, David Busk, Infrastructure Planning Institute, Project Projects, RFA

An ambitious implementation timeline

Our project timeline is organized according to the three scales—the region, the sub-region, and local sites—and builds on the work conducted in RBD Stages 2 and 3. While each scale has its own timeline, the activities of the different scales have certain interdependencies.

At the regional scale, there will be four primary tasks: to further develop the regional framework (which includes the five strategies of Sediment Flow, The Smart Barrier, The Eco-Edge, Slow Streams, and The Green Corridor), to coordinate and integrate the design and planning efforts at the three scales and with initiatives outside of LWTB, to develop tools to inform regional decision making and outreach, and to commission necessary regional studies.

At the sub-regional scale, we propose to develop masterplans for key, catalytic, and prototypical areas. The development of these masterplans will begin after having established a conceptual plan and confirmed key stakeholder support (the future "owners")—tasks that we have already completed for most of the projects. The development of these masterplans will be rooted in a highly participatory process, engaging a wide range of community stakeholders. The masterplan process will conclude with an approved plan.

At the local scale, after having established a conceptual plan, a preliminary budget, a draft BCA, and confirmed key stakeholder support (the future "owners"), we will prepare the selected Phase One projects. The preparation will include (but is not limited to) further design development,

outreach, completing the design, and bidding the project, after which, the project can be constructed. All Phase One projects will include the monitoring and measuring of impacts, which in most cases will begin before construction starts.

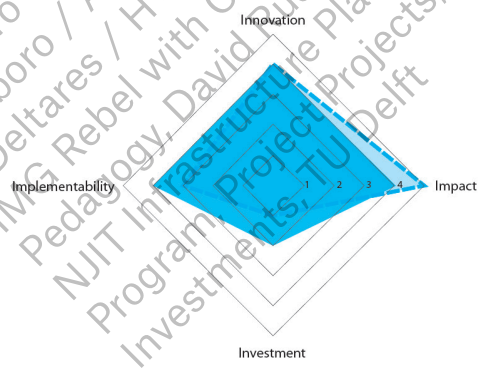
Innovation, impact, investment and implementability of our projects

To further illustrate that our projects are not all the same in terms of implementability, but also in terms of innovation, impact, and investment, we scored the projects against these criteria. The innovation score is about the extent to which similar interventions have been implemented in the US or elsewhere in the world. The impact score is informed by the BCA and in the first place addresses the benefits of the project in terms of flood prevention, but also covers environmental, social and economic values. The investment score is about the financial costs of implementing and maintaining the project (please note that high financial costs lead to a low score and vice versa). Implementability encapsulates all aspects that are critical in taking the project to implementation, including most importantly technical feasibility, current status of the design, political feasibility, community support, and regulatory complexities. The following graphs illustrate our current scoring of our projects. In the following sections of this implementation plan that cover the specific projects, we will further clarify our scores.

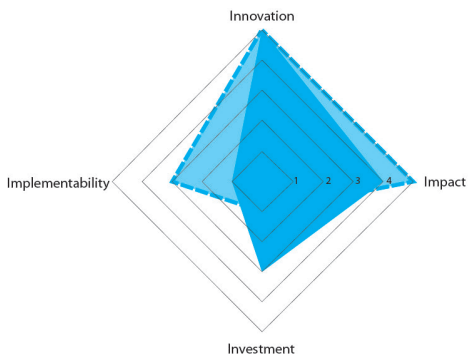
The colored surface that is based upon the scores for the first phases of our projects determines the our short term priority of the project. The dotted line indicate the scores from a longer term perspective.

Interboro Team:
Interboro / Apex / Bright Sands / Deltares / H+N+S / Rainmaker / IMG Rebel with Center for Urban Pedagogy, David Dusk, NJIT Infrastructure Planning Program, Project Projects, RFA Investments, TU Delft

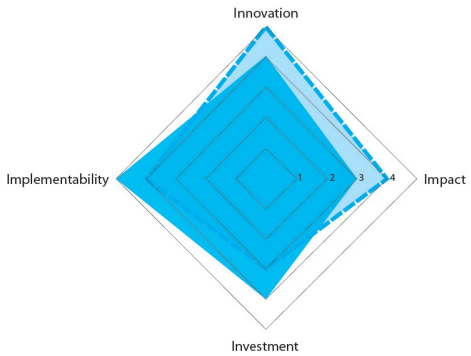
Smart Barrier



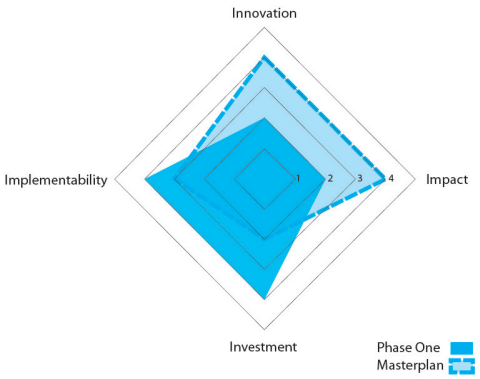
Eco-Edge



Slow Streams

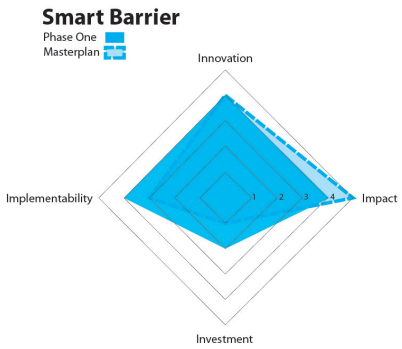


Green Corridor



The Smart Barrier

1. Current Status



Feasibility of the design

This project is feasible. From a technical standpoint, the integrated dike, compartments, and green infrastructure are all achievable and have been implemented elsewhere in the world. However, because this type of infrastructure, for the most part, has not been developed in the United States, it could be characterized as *innovative*.

The project is politically feasible. Because Long Beach is a city, one of only two in Nassau County, coordination and implementation would be simpler and more streamlined compared to other jurisdictions in the region. The city's leadership is strong, dynamic, committed to innovation, and fully supportive of the project. The city of Long Beach would be an exceptional partner moving forward. While the majority of the properties in the project area are controlled by the city, there are several properties that are not currently owned by the city. The time and cost of acquiring these properties are assumed to be feasible; however, until the acquisitions are completed, they present a risk. All in all, the project is highly *implementable*.

The capital costs for this project are high, approximately $250 million, which makes the score on investment low. As indicated in the summary of the BCA, the project has significant positive flood protection and social, environmental, and economic effects. Therefore, this project scores high on *impact*.

Cost-benefit analysis

The Phase One project of The Smart Barrier has the primary goal to make living around the bay safer and also to strengthen what makes living and recreating in the North Park area great. Currently, there is no alternative comprehensive plan for protection. Individual homeowners do raise their homes, and there are plans to protect some of the existing infrastructure individually on a case-by-case basis. Given the attractiveness and density of Long Beach, a retreat from the barrier island or even from the most vulnerable areas of Long Beach is highly unlikely.

The first phase will provide a "protective compartment" (formed by the new dike landscape, a small levee in the median of Magnolia Boulevard, and the natural elevation of Long Beach Boulevard and Park Avenue). This compartment will provide protection from 12-foot storm surges. The project directly protects 1,000 to 2,000 homes from storm surges. In addition, it will result in significant reduction of street flooding and property damage from stormwater in approximately the center third of Long Beach (10,000 to 15,000 residents). Moreover, the Phase One project protects critical infrastructure, such as the water purification plant and the sewerage plant—protected by the new dike prior to being decommissioned—and LIPA substations. This will have a direct impact not only on the facilities proper but also on the power, water, and sanitary sewage needs of large portion of residents on the Long Beach Barrier Island (30,000 to 40,000 people). The relocation of the gas supply vent to a more protected location will increase the safety of the gas supply for all of Long Island.

Interboro Team / ARUP / Bosch Slabbers / Deltares / HNTB / Dutch Dept. for Urban Development / Rebuild by Design / IMG / Public Risk Management / Dutch Ministry of Infrastructure and Water Management / Port Authority of New York and New Jersey / Port Authority Investments / Projects / RFA

The re-creation of a natural coastline on the bay shore and the water retention landscape will replace pervious pavement to re-create natural habitat. The ocean outfall for Bay Park and the consolidation of the sewage treatment plants (which we support by proposing the construction of a return pipe and pumping station) will radically improve the water quality in the entire western bay.

The creation of a new "gateway" to Long Beach will increase positive identification with the area. The creation of a new public space (park) for the city helps to bring inhabitants together. Making the traditionally most disadvantaged community of color the first neighborhood to be protected from flooding will contribute to social justice. The project will also have a positive effect on regional tourism. The first impression of the city will be more inviting, and visitors will be able to experience the beach, the commercial area of Long Beach, and the recreated bay shore (including a new marina) within a 10-minute walk. The new development site will contribute to economic development in this area of Long Beach.

This first compartment functions both as protection for the most vulnerable neighborhoods and as a sub-regional scale for a long-term strategy of compartmentalization that can be constructed, evaluated, and adjusted incrementally over time. With each new compartment, time will have passed and new knowledge will have become available. By the time the last compartments comes up, people might have decided to actually retreat from these parts of the barrier island and move to a more densely developed central compartment instead. Aside from the risk presented by major surges, the project addresses the "everyday" problem of stormwater flooding by providing stormwater retention areas.

Interboro Team: Adey / Bosch / Shaoqi Interboro / ARUP / Palmbout / Deltares / IMG / Rutgers / Center for Urban Pedagogy / Public Rising NJIT Infrastructure Planning Program, Princeton Polytechnic, RFA Investments, Inc. Dirt

Cost estimates

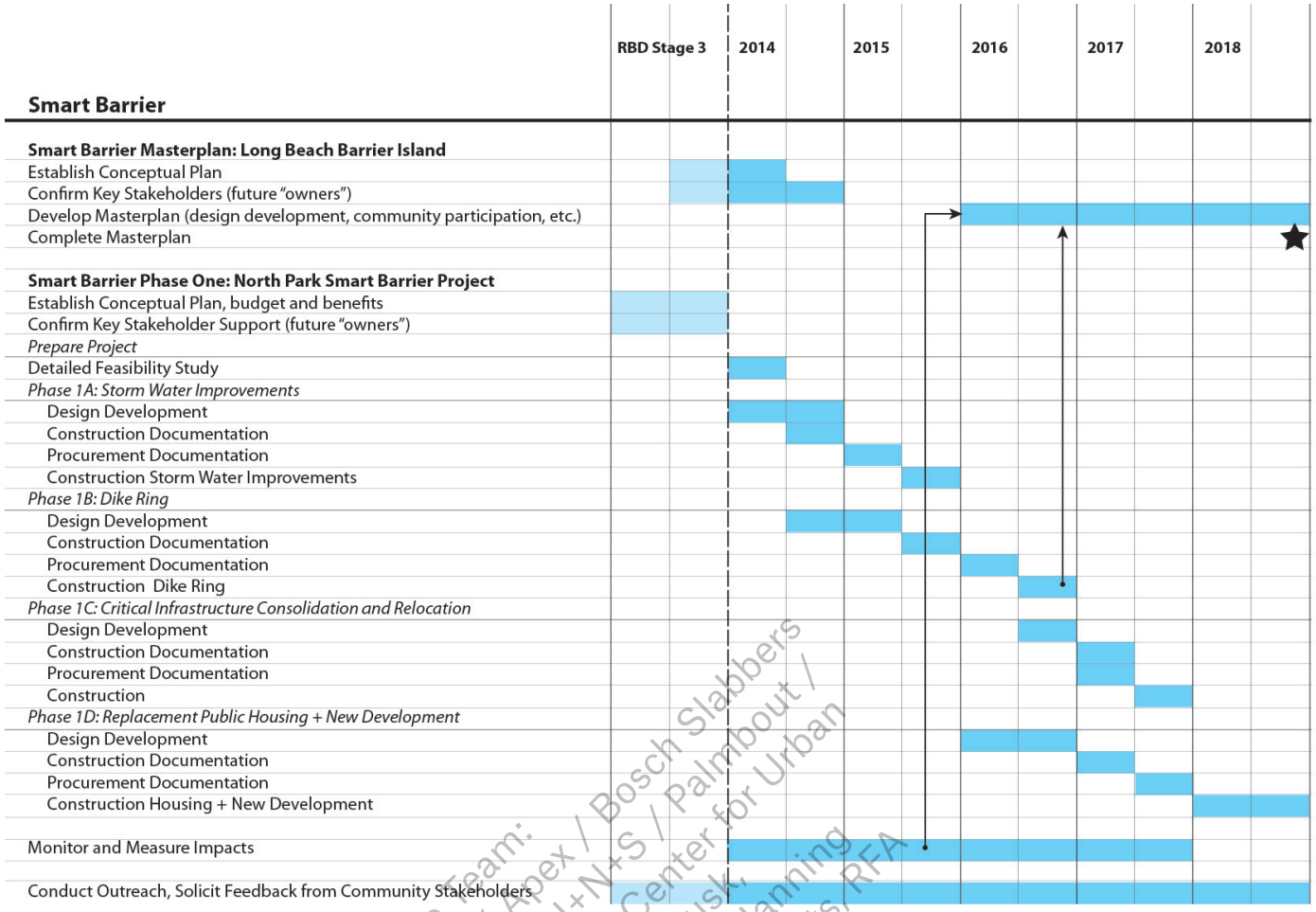
The preliminary cost estimate incorporates costs for all Phase One project elements and is based on the current status of the design. The cost estimate also includes the appropriate soft costs and contingencies.

Summary of The Smart Barrier Phase One USD (x 1,000,000)	**CAPEX**	**OPEX**	**LIFE CYCLE**	**LIFE CYCLE DURATION**
Primary Project Elements: Road Dike Surrounding Phase One Area, Bulkhead on North, Smart Barrier with Boardwalk, Demo and Recreate 100 Units Housing, Stormwater Collection, Conversion of Sewer Treatment Plant to Pump Station	**209.7**	2.1	21.0	30-YEAR
Resilient Upgrade to Sewer Line—Long Beach STP to Bay Park STP	**8.9**	0.09	0.18	30-YEAR
Sewer Pump House/Resiliency Center	**14.1**	0.1	1.4	30-YEAR
6 Acres of New Water Garden Park Greenspace	**14.6**	0.1	0.7	30-YEAR
Design and Permitting of Ocean Outfall for Bay Park STP Ocean Outfall Pipe Project	**37.2**	0	0	
15% Cost Share for Construction of Bay Park STP Ocean Outfall Sewer Line	**90.1**	0	0	
TOTAL	**374.6**	**2.4**	**23.3**	

Interboro Team: Interboro / Apex / Bosch Slabbers / Deltares / H+N+S / Palmbout / IMG Rebel with Center for Urban Pedagogy, David Ruskin / NJIT Infrastructure Planning Program, Project Projects, RFA Investments, TU Delft

2. Next steps

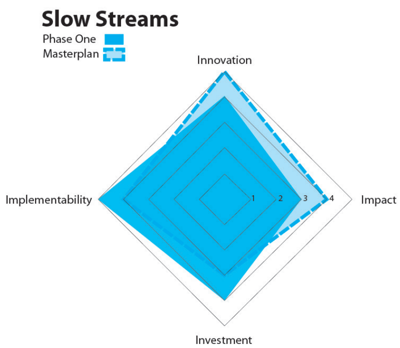
As shown in the timeline below, we have already established a conceptual plan that is supported by the key stakeholders, the Village of East Rockaway and the Village of Rockville Centre. The next step is to conduct a feasibility analysis. The Village of Rockville Centre has already provided a survey of their existing stormwater system, which will streamline the process. As part of the feasibility analysis, some modeling is required to study the performance and impacts of the sluice during different weather events. After the feasibility analysis is performed, the design development, construction documentation, and procurement can proceed. Outreach to the community should be continued and with a sharpened focused on the design elements as they are developed. The planning, design and capital costs of this project are CDBG-DR eligible.



Smart Barrier
Implementation Timeline

Interboro Team:
Interboro / Apex / Bosch Slabbers
/ Deltares / H+N+S / Palmbout /
IMG Rebel with Center for Urban
Pedagogy, David Rusk,
NJIT Infrastructure Planning
Program, Project Projects, RFA
Investments, TU Delft

1. Current Status



Feasibility of the design

The Slow Streams Phase One project is highly feasible. The Phase 1A project is located in East Rockaway and Rockville Centre. Rockville Centre controls two sides of the Mill River, an atypical condition in Nassau County, since most rivers serve as the political boundary between villages. This jurisdictional condition will facilitate implementation. The mayors of the two villages and their Department of Public Works superintendents strongly support the project because of the focus on flood and storm water reduction; both villages are vulnerable to flooding from tidal surge and storm water inundation. Additionally, both villages seek to improve the recreational resources for their residents, which this project will do by increasing park space and better connecting the existing open spaces resources through a continuous path. New York State and community leaders from the CRZ process have prioritized stormwater management improvements and have also expressed support for this project. In our multiple outreach efforts, community members consistently expressed positive support for the Slow Streams strategy, the Mill River Masterplan and the Phase One project. From a political and stakeholder perspective, this project is highly *implementable*.

The improvements of Phase 1A--a sluice, a water retention and filtration park, and curbside bioswales--are all technically feasible. While such elements have been implemented elsewhere in the world, they have not been implemented together or systemically in Nassau County. They are therefore *innovative*.

Phase 1A will reduce tidal flooding for a significant number of homes along the Mill River and reduce the frequency of flash floods resulting from stormwater inundations. It therefore will have high *impact*. Furthermore, because these improvements will be highly visible to and physically experienced by the residents (in the form of public space), their impact in the eyes of the public will be increased. The capital costs of Phase 1A are low in comparison to the other Phase One projects, approximately 40 million, which makes the score on *investment* high.

Cost-benefit analysis

The Slow Streams Phase One project has the primary goal to reduce stormwater damage. In order to avoid isolated, second-best solutions that are insufficient in the long run and probably vulnerable to spatial quality, our approach minimizes negative effects of the intervention and tries to optimize benefits. The current approach in this area (the reference situation) is close to a "do little" scenario. No major investments or development plans exist with regard to water adaptive housing in this vulnerable area. The community and individuals will most likely keep up the status quo and will adapt by isolated patching-up activities. With regard to stormwater, there is a current need for redoing the stormwater system. New and bigger stormwater pipes (to improve the undersized grey infrastructure) and some extra stormwater ponds/gravel well will probably be installed. In case of storms, stormwater will be redirected to less-vulnerable areas, eventually by pumping. Catch basins and plugged-up grey infrastructure will be cleaned out, which is one of the current best management practices. Oil/water separators might be used for decreasing

pollution. All in all, there will be small, isolated investments with no comprehensive plan while at the same time sea level rise and flooding will continue (and depending on the climate scenario, intensify) and probably aggravate the current situation.

In contrast to regular stormwater interventions that only generate benefits of prevented damage when heavy storms occur, our approach is carefully designed to generate benefits even when there is no storm. This improves the cost-benefit ratio of the investment and spreads the benefits over time and over a bigger group of beneficiaries. The elements of the Phase One project work stand alone (no regret) but have added value when put together, as they cover the cycle of gathering, infiltrating, cleaning, and storing water while at the same time improving spatial quality and ecological conditions. The measures form an important first step in the realization of the long-term goal to make the Mill River area a safe and attractive place to live.

The exact benefits of additional flood protection have to be thoroughly assessed in a stormwater study. So far, we can estimate the effect area of the different interventions.

The Mill River Avenue swale will be 260 yards in size. A large direct effect on approximately 45 houses is likely. In addition, a medium indirect effect can be expected on subwatersheds affecting 2,113 houses and a small indirect effect on the entire watershed with more than 100,000 houses. For the Mill River sluice gate with a width of 80 yards, which closes at low tide during storm events for maximum storage capacity, the expected amount of extra storage is 233,000 cubic yards. This storage volume can be enlarged by lowering adjacent lots and adding upstream segments to the storage basin. As a rough estimate, a direct or indirect effect is expected on more than 9,500 buildings within the watershed. The room for the river intervention includes lowering lots, which adds extra storage capacity of 25,100 cubic yards. As an outlook, in Phase Two of the plan, the sluice will be connected from the wastewater treatment plant to high ground, which is dry during category 2 storms. This will protect an estimated 10,400 buildings within the region.

Next to (pluvial and fluvial) flood protection, the Phase One project generates benefits especially with regard to environmental and social effects. There will be more room for ecological gradients, with no barriers for fish species because the sluice is open under non-storm conditions. At all times, water quality is improved through prefiltering and more riparian zones that help to clean and detoxicate the water. Currently, the potential of the river as a strong component of spatial quality is not fully exploited. Giving back the banks to the river improves spatial quality and connects the neighborhood to the river. The attractiveness of living at the water and the recreational value of the area are enhanced, which will most likely have a positive effect on property prices. The bicycle and pedestrian route and boardwalk add recreational value to the area as slow-traffic routes are improved. Better water quality will lead to better fishing conditions, which again enhances the recreational value of the area.

Not only does our Phase One project aim to outweigh the costs by realizing benefits early and constantly, it is also well suited to be adapted in the future.

Interboro Team / Atelier / POSTDOCS / Stichting Interbores / Deltares / IMC / Rapenburg / Pedaliers / Delft University of Technology / Urban Planning / NUTI / Research Center for Urban Program, Project Projects, RFA Investments, Finance

The project is a milestone in the realization of our approach of a slow stream and can be extended by adding more and more interventions. With regard to the main aim, flood protection, the project can ultimately even be extended so as to protect the area not only from fluvial and pluvial flooding but also from swells from the bayside.

Cost estimates

The preliminary cost estimate incorporates costs for all Phase One project elements and is based on the current status of the design. The cost estimate also includes the appropriate soft costs and contingencies.

Cost estimates

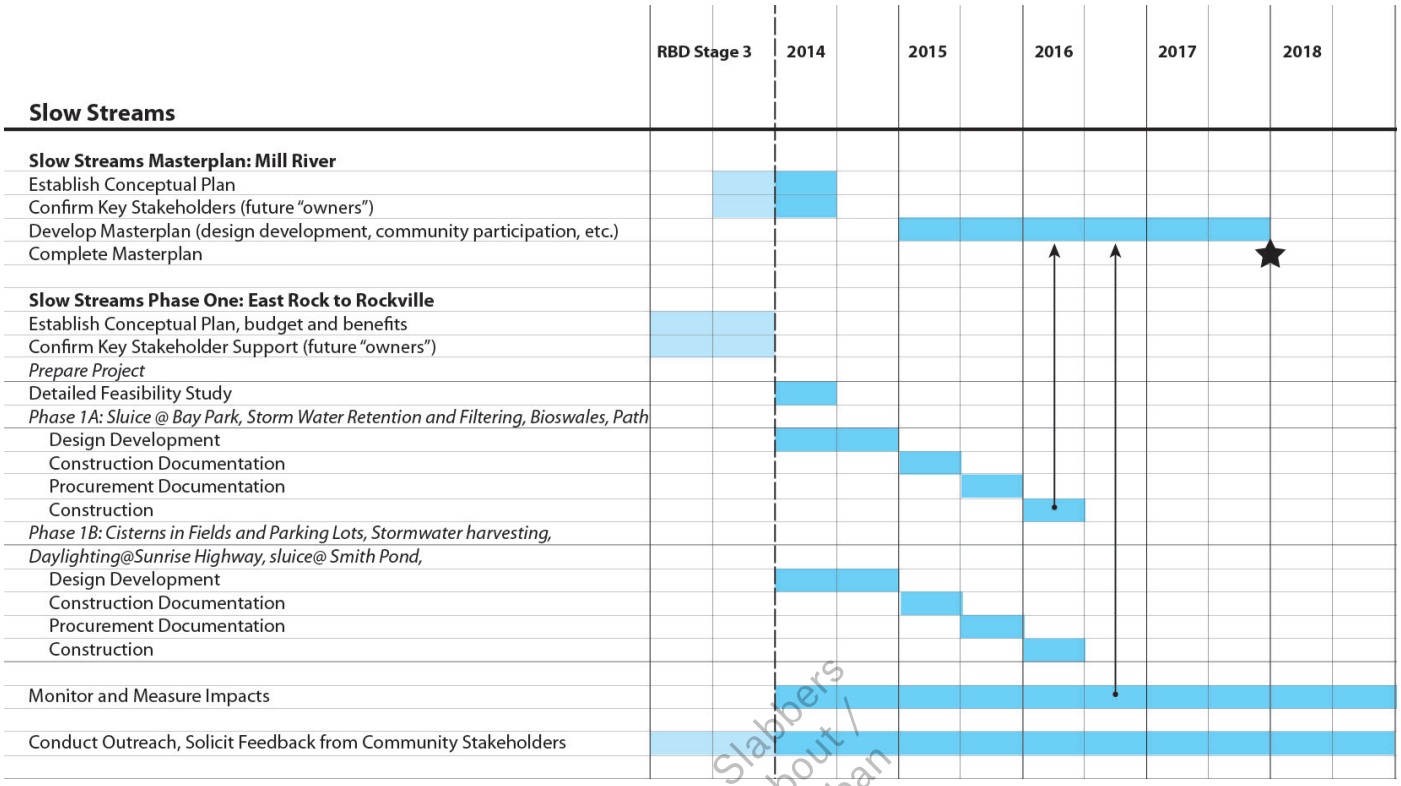
The preliminary cost estimate incorporates costs for all Phase One project elements and is based on the current status of the design. The cost estimate also includes the appropriate soft costs and contingencies.

Summary of Slow Streams Phase One USD (x 1,000,000)	**CAPEX**	**OPEX**	**LIFE CYCLE**	**LIFE CYCLE DURATION**
1a: Primary Project Elements: Sluice Lock, Sluice Dam, Widen Creek at Select Location and install Water Park, Pilot Bioswale, Bicycle Route, Pedestrian Boardwalk	**38.1**	0.2	3.8	30-YEAR
1b: Primary Project Elements: Village of RC-underground SW storgae, sluice lock, day light Sunrise / Mill River Node, Bike Path (S Smith Pond to ER HS and RC). ER-bridge from temp Storage Site to ER HS, Underground SW storage, retention bioswales, retention cisterns next to LIRR Station.	**139.2**	0.7	13.9	30-YEAR
TOTAL	**177.3**	0.9	17.7	30-Year

Architecture Team: Bosch Slabbers / Landscape Architecture: Apex / Bosch Slabbers / Civil Engineer: H+N+S / Palm bout / MC Model with Center for Urban Pedagogy, David Rusk, NYC Infrastructure Planning Program, Project Projects, RFA Investments, TU Delft

2. Next steps

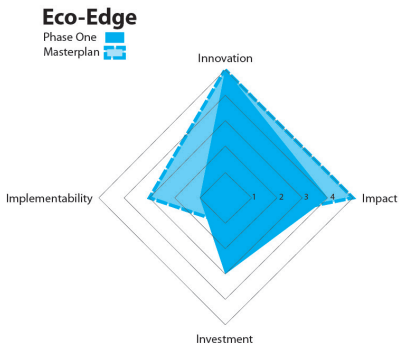
design development, construction documentation, and procurement can proceed. Outreach to the community should be continued and with a sharpened focused on the design elements as they are developed. The planning, design and capital costs of this project are CDBG-DR eligible.



Slow Streams
Implementation Timeline

Interboro Team:
Interboro / Apex / Bosch Slabbers
/ Deltares / H+N+S / Palmbout /
IMG Rebel with Center for Urban
Pedagogy, David Rusk,
NJIT Infrastructure Planning
Program, Project Projects, RFA
Investments, TU Delft

1. Current Status



Feasibility of the design

Marshland restoration and building dikes have been done before. They are both technically possible but have their own challenges and risks. Marshland restoration is relatively new and not always successful, as it depends on factors such as water quality, water flow, and sediment availability. This makes the project very innovative. Constructing higher grounds that provide a new habitat and calmer water in which sediment will settle and marsh will grow is feasible but needs to be researched and tested further before it can be implemented. Whereas the dikes are less technically complicated, this part of the project is a big intervention in an urbanized area, which will lead to challenges with respect to permitting and community support. This makes the project score low on implementability. The capital costs for this project are high as well, over $200 million, which makes the score low on investment. As indicated in the summary of the BCA below, the project has significant positive flood protection and environmental effects. Therefore, this project scores high on impact.

Cost-benefit analysis

Despite the fact that our project area has historically been marshland, currently most marshes are residential areas and no investments in preservation of marshlands are made. This results in continuous loss of marshland by erosion and bad water quality, which leads to a decrease of nature and surroundings of living area. Without an intervention, bad water quality and decrease of nature and wildlife at the bay will cause the area to lose its attraction—there will be fewer recreational activities and the typical bay culture. With regard to housing, no comprehensive plans exist to make the bayside properties safer. This means that the existing (housing) use continues but that there will be a lack of new investments in the area because of unsafe flood conditions. Only some individual house owners are able to afford to elevate and adapt their homes. Because of the deteriorating conditions, fewer households will have flood insurance. Some residents might have to move away and abandon their houses. This will influence the quality of the area negatively.

Our project aims to reduce the risk of flood damage in the first place and to achieve this in an environmentally empowering way. The combination of marshlands, which reduce wave swell, and a dike ring will lead to higher evacuation routes and protect 7,245 houses in total, 2,112 within the first phase. A new drainage system collects stormwater from inside the dike ring and has a single controlled outlet (with a tidal valve or even a pump in the future), and there is water storage

Interboro Team / Adrian Blackwell / Bo-Yin Yandle
Interboro / ARUP / Parsons Brinckerhoff
/ Delft University of Technology / Center for Urban
IMG / Rotterdam Climate Initiative / Rotterdam Rijnmond
Delta Development Corporation / Rotterdam Port Authority
Port Infrastructure Planning
Municipality of Rotterdam / Public Works, RFA
Investments, Spatial Development

along the streets in the dike ring. Outside the dike rings, 5,184 houses will be raised, 750 within the first phase.
The marsh ridges for this stage of the project are designed at 12 feet but can be raised in the future to 18 feet if more extreme climate conditions demand for it. Even further in the future, a connection of the ridges by locks can be realized. The project design is thus flexible and adaptive.

The dike ring intervention serves two purposes in times of flooding: it protects about 7,250 buildings and at the same time serves as an elevated evacuation route. The construction will also take into account a new drainage system that collects stormwater from inside the dike ring and has a single controlled outlet and water storage capacity along the streets. Thus, damages from both pluvial and bayside flooding are prevented. In light of the fact that climate scenarios predict sea level rise as well as more frequent and heavy rainfalls, the investment will amortize at a quicker pace.

The marshland is one of the most valuable types of nature in the world, not only for the local environment. The marshes will improve the water quality due to the catchment of sediment that leads to clearer water, the use of nutrients that leads to plant growth and clearer water, and a restored balance that leads to an increase in fauna. The marshes work as an eco-nursery for the ocean, especially fish, and a station for migrating birds. Furthermore, they are home to many valuable and endangered species, like the crab, turtle, and osprey.

Despite the positive environmental effects of the marshes, we are aware of the fact that the construction of marsh islands will change the view of the properties at the waterfront. The current open bay view will change to a view of marshlands. It is not clear if this has a negative effect on property value. It is also possible that the enhanced recreational activity "at the back door" (canoeing to marsh lands, better fishing and clamming opportunities, improved marina facilities) will result in a net positive effect on property value.

In addition to the major positive environmental effect, the intervention will also serve a social purpose. The project area is mono-functional, residential. There is a big difference in quality of living between the inhabitants living along the water and those living inside the urban grid. The latter lacks contact with the water. By adding public space and special facilities along the water edges in the residential areas of this project, the large number of houses that used to lack contact with the water will benefit from an increase in property value and living experience. Thus, while the public space serves water storage purpose in times of flooding through swells from the bay and stormwater from the land, it also generates benefits on an everyday basis, which improves its benefit-cost ratio.

Interboro Team / ABX / Boosinger / Interboro / ARUP / Parsons / Deltares / IMG Rebuild / Architecture / Urban Redesign / Parsons / Parking / DUT Infrastructure / Landscape / Program, Project Spaces / Investments / Public Spaces RFA

Cost estimates

The preliminary cost estimate incorporates costs for all Phase One project elements and is based on the current status of the design. The cost estimate also includes the appropriate soft costs and contingencies.

Summary of The Eco-Edge Phase One (Freeport) USD (x 1,000,000)	**CAPEX**	**OPEX**	**LIFE CYCLE**	**LIFE CYCLE DURATION**
Marsh Island Construction	**77.4**	0.8	1.5	10-YEAR
Ring Road Dike Construction	**156.0**	0.8	1.6	30-YEAR
TOTAL	**233.4**	**1.6**	**3.1**	

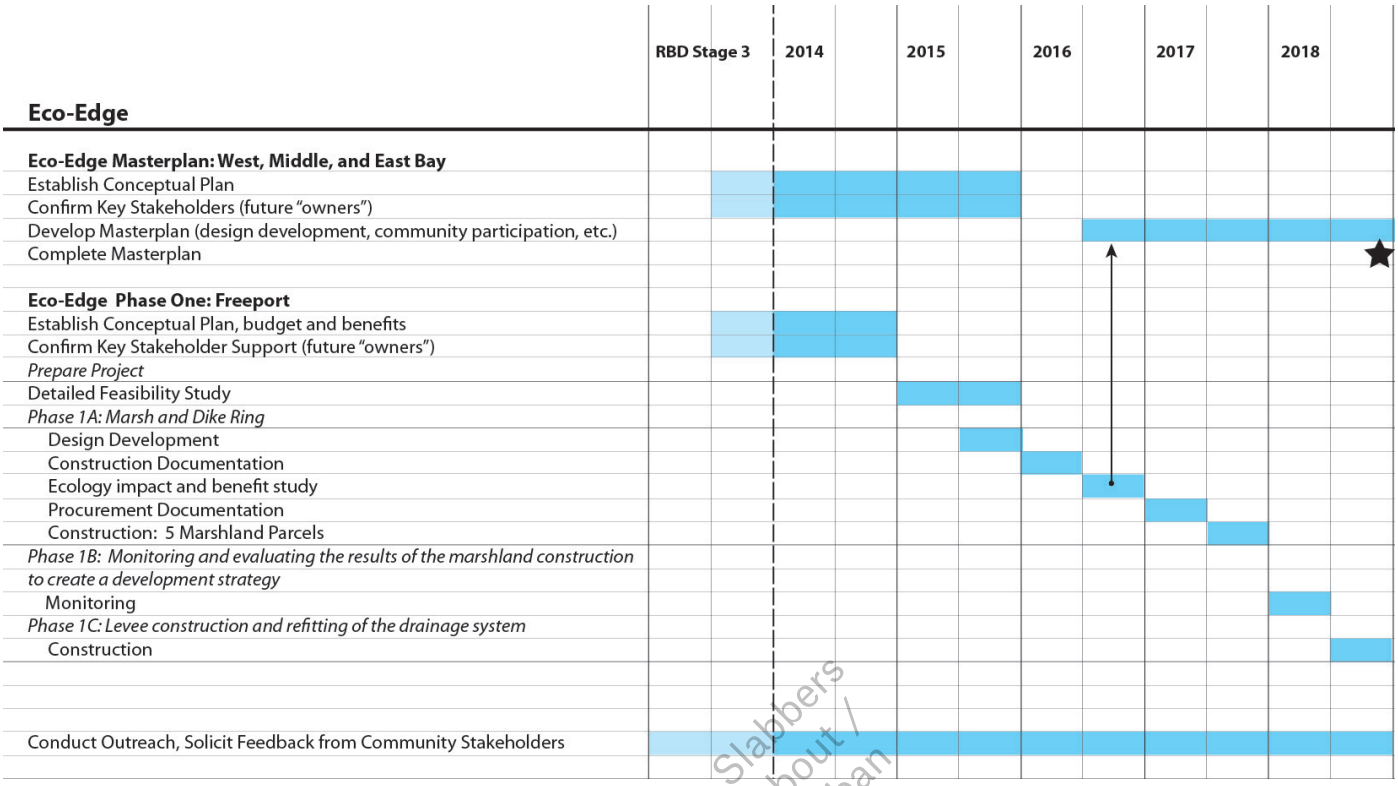
For the overall sub-region, the cost estimate (exclusive of deployable storm barriers) is as follows:

Summary of The Eco-Edge Phase Two (envelope Baldwin and Freeport) USD (x 1,000,000)	**CAPEX**	**OPEX**	**LIFE CYCLE**	**LIFE CYCLE DURATION**
Marsh Island Construction	**419.6**	4.2	8.4	10-YEAR
Ring Road Dike Construction	**493.7**	2.5	4.9	30-YEAR
TOTAL	**913.3**	**6.7**	**13.3**	

Interboro Team:
Interboro / Apex / Bosch Slabbers
/ Deltares / H+N+S / Pambout /
IMG Rebel with Center for Urban
Pedagogy, David Rusk,
NJIT Infrastructure Planning
Program, Project Projects, RFA
Investments, TU Delft

2. Next steps

As shown in the timeline below, we have already established a conceptual plan that is supported by the key stakeholders including the Town of Hempstead and Village of Freeport. The next step is to conduct final hydraulic modeling (which will incorporate all acquired data) to confirm the geometry of the initial marsh islands and develop an initial project plan wherein we will design and permit a Phase One marsh island, raised ring road neighborhood and, potentially, a few deployable flood barriers. Once the final Phase One design has been finalized, its efficacy will be confirmed via data acquisition and modeling and permit application package will be prepared and submitted. Once all permits are received and sufficient blended funding is in place, the design / bid package will be developed, bid and the contract let. Upon contract award, construction will be conducted. Outreach to the community should be continued and with a sharpened focused on the design elements as they are developed. The planning, design and capital costs of this project are CDBG-DR eligible.

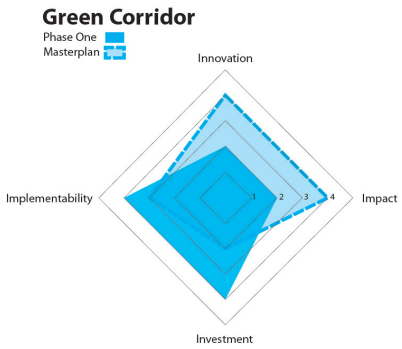


Eco-Edge
Implementation Timeline

Interboro Team:
Interboro / Apex / Bosch Slabbers
/ Deltares / H+N+S / Palmbout /
IMG Rebel with Center for Urban
Pedagogy, David Rusk,
NJIT Infrastructure Planning
Program, Project Projects, RFA
Investments, TU Delft

The Green Corridor

1. Current Status



Feasibility of the design

This project is highly feasible. It consists of two elements: green housing and green infrastructure. For the housing component, we propose to work the Jaral Properties, a well respected, progressive developer who has already been selected as the winning bidder of an RFP solicited by the Village of Freeport to build a hotel on a village-owned property adjacent to the Freeport LIRR train station. The developer is currently in negotiations with the Village. The design is at the schematic level and includes retail, hotel, mixed income housing, and parking. We propose to use CDBG-DR funding to add an additional 20% to the budget to finance the additional costs to make a "green" building. The community strongly supports this project. The project is highly implementable. As demonstrated, very few affordable rental units are developed in Nassau County, and as far as we know, no affordable rental units that utilize green technologies are developed. The project is therefore innovative. The project as proposed includes 120 hotel rooms and 180 residential units, so overall, its impact will be moderate. Its greatest impact will be in providing a prototypical demonstration project, which if replicated across the corridor would be quite significant.
The CDBG-DR investment in the project is relatively low, as it is only 20% of the overall project. Therefore, this project scores high on investment.
The green infrastructure improvements--the bike path, the bioswales, and the permeable parking surface conversions are highly implementable and over the long term, if applied across the corridor, would cumulatively have a sizable impact on managing storm water. The potential reuse of the abandoned water main will be harder to implement but would be extremely innovative.

Cost-benefit analysis

If Long Island does not create affordable opportunities for people to live out of harm's way, tens of thousands of people in more vulnerable, low-lying areas would have to remain vulnerable and pay increased insurance premiums, spend money raising their homes, or move outside the area. The Long Island Community Foundation put it very well in a recent report about Long Island's Rental Housing Crisis when they noted that without an increased number of rental homes, the following is likely to happen:

—Long Island's economy is likely to stagnate.
—Homeowners will find it more difficult to sell their homes.
—Villages, towns, and counties could be vulnerable to Fair Housing lawsuits.
—Parents, children, and grandparents will live farther apart.
—We will miss an opportunity to improve communities across Long Island.
—Additionally, stormwater runoff and flooding from rain events will increase and traffic fatalities will increase.

We think one of the best things we can do to create more resiliency in the region is to create affordable opportunities for people to live out of harm's way, and the Sunrise Highway corridor—which is presently underdeveloped—is a great place to do this. Many advocacy groups have pointed out that with its public transportation options, its relative density, and

Interboro Team / Dessi Stapler / Interboro / AKRF / Stantec / Deltec / IMG Rebar / Center for Urban Design and Architecture / Planning Partnership / Public Projects, RFA

its mixture of uses, parts of the corridor have the potential to be the dense, walkable, mixed-use environment that so many of today's Long Islanders are looking for (for example, the aging boomers and their urban lifestyle–seeking siblings)

Our proposed Green Corridor is a reimagining of the Sunrise Highway–LIRR corridor that would seek to do four things:

—Target "high and dry" areas along the corridor for mixed-use, mixed-income housing within walking distance of select LIRR stations
—Improve the capacity of the corridor to capture stormwater runoff
—Bundle these green infrastructure improvements with pedestrian safety improvements that would facilitate pedestrian connectivity
—Relieve "choke points" (points when the north/south rivers and streams are channeled into a pipe that goes under Sunrise Highway) by selective daylighting

The largest benefit of this project in terms of flood protection is that as many as 300,168 dwelling units can be built beyond the reach of a category 2 surge, a 6-foot sea level rise, and the FEMA flood zone. In addition, hundreds of acres of high and dry surface parking lots in and around Long Island's downtowns will be developed into safe, walkable, attractive, and green affordable neighborhoods. A six-lane highway will turn into an attractive complete street. Green infrastructure will prevent flooding and will also make the corridor more attractive. The pedestrian improvements that will be bundled with the green infrastructure will make the corridor safer and more attractive and will "pave the way" for developers, who we think will be more inclined to develop housing along a corridor that is more attractive and safe.

Interboro Team / Andy / Bob / Slade / Interboro / AKS / Pathfinder / Deltaspace / HNS / Partnership for Urban Pedestrians / IMG / Dave Reed / UIT / Transportation Planning Program, Project Prospects, RFA Investments / Tom Dunne

Cost estimates

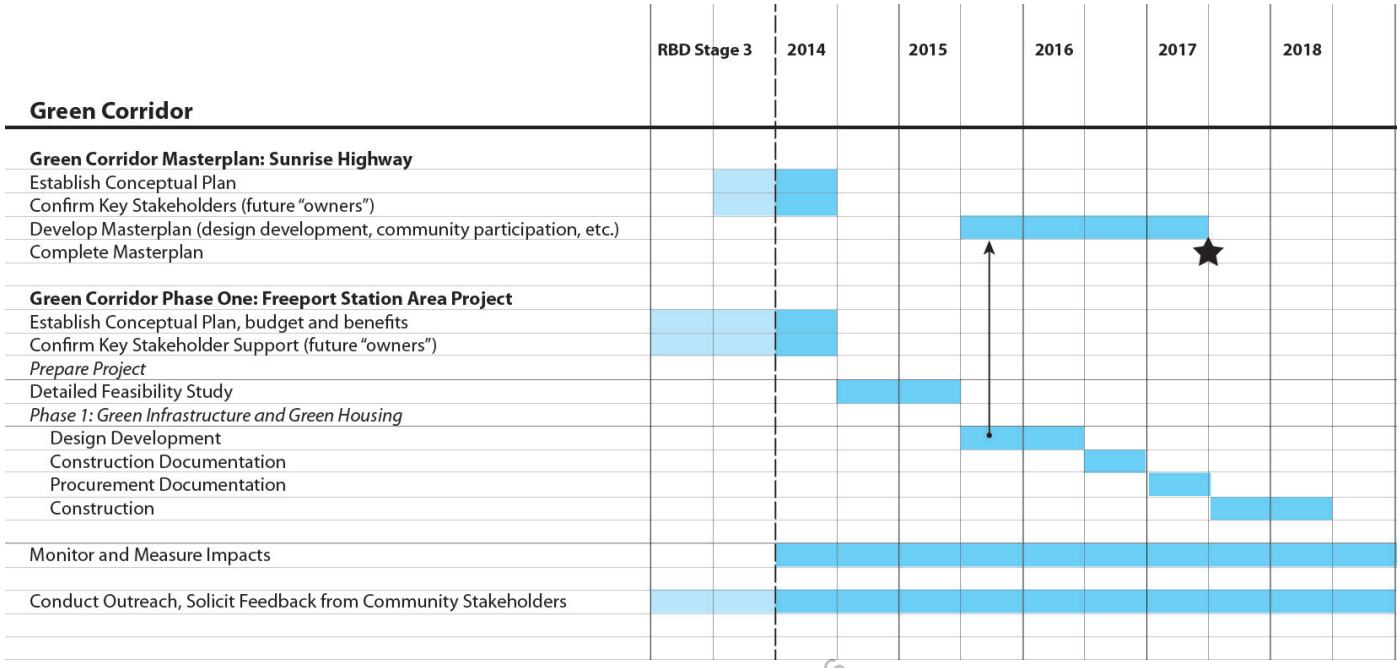
The preliminary cost estimate incorporates costs for all Phase One project elements and is based on the current status of the design. The cost estimate also includes the appropriate soft costs and contingencies.

Summary of The Green Corridor Phase One USD (x 1,000,000)	**CAPEX**	**OPEX**	**LIFE CYCLE**	**LIFE CYCLE DURATION**
Bike Path between Freeport and VS LIRR Stations, seven miles of bioswales from VS to Freeport, permeable paving conversion from parking lots, convert roadway intersections, developer POD upgrade.	**175.4**	0.9	17.5	30-YEAR

2. Next steps

In terms of the housing component of the project, the next steps would be to sign an MOU with the developer. In terms of the green infrastructure component of the project, the next steps would be to sign an MOU with the Village of Freeport to provide planning and design services to develop green infrastructure. Both are CDBG-DR eligible.

Interboro Team / ARUP / Bosch Slabbers / Interboro / Kalmbout / / Deltares / Fitness / Kalmbout / IMC / Pennsylvania Station Urban Pedagogy / Fitness / CEMEX / Pedagogy / NJ Transit / Rutgers / NJIT Infrastructure Planning Program, Project Priorities, RFA Investments, TOD Data



Green Corridor
Implementation Timeline

Interboro Team:
Interboro / Apex / Bosch Slabbers
/ Deltares / H+N+S / Palmbout /
IMG Rebel with Center for Urban
Pedagogy, David Rusk,
NJIT Infrastructure Planning
Program, Project Projects, RFA
Investments, TU Delft

Interboro Team:
Interboro / Apex / Bosch Slabbers
/ Deltares / H+N+S / Palmbout /
IMG Rebel with Center for Urban
Pedagogy, David Rusk,
NJIT Infrastructure Planning
Program, Project Projects, RFA
Investments, TU Delft

Funding

1. Funding needs

1.1 Capital costs

The largest part of the funding need for the implementation of the Living with the Bay regional strategy will consist of the investment costs related to all of the resiliency projects that will be implemented. The first phases of our projects are well advanced toward implementation, which is why we are suggesting HUD to earmark the indicative RBD share of these projects in the budget planning. By the end of 2014 and in 2015, the first Living with the Bay projects will be ready for decision making, resulting in formal investment cost funding requests.

USD (x 1,000,000)	**Investment cost estimate**
The Smart Barrier—Phase One	374.6
Slow Streams—Phase One	177.3
The Eco-Edge—Phase One	233.4
The Green Corridor—Phase One	175.4

Interboro Team: Interboro / Apex / Bosch Slabbers / Deltares / H+N+S / Palmbout / IMG Rebel with Center for Urban Pedagogy, David Rusk, NJIT Infrastructure Planning Program, Project Projects, RFA Investments, TU Delft

Costs estimated for this project were generated using standard engineering conceptual cost estimating practices. Concept-level project drawings and renderings were utilized to estimate quantities, lengths, areas, and thicknesses from publicly available mapping and information sources, as well as from visual field observations and site visits. Unit costs were estimated from RS Means Sourcebook 2014 information and from bid information from recent publicly bid projects in the New England and New York regional area. Quantity estimates were generated for the various project elements using measuring tools associated with publicly available digital images such as Google Maps, Google Earth, and State, Town, and Village maps, plans, and charts. The accuracy of measured information varies depending on the resolution and detail of the maps, plans, and charts used. An engineer's review of the projects was utilized to parse the project into reasonable component elements. Assumptions were made concerning quantities and values of sub-elements for each identified project element. Estimated costs were developed by multiplying estimated quantities by the estimated unit cost to develop a cost element, and then cost elements were summed to an engineer's estimate of the project component cost. Costs for engineering permitting oversight contingency and contractors' fees, taxes, and other incremental costs (the so-called "soft costs") were applied to the composite project element cost subtotals. In general, for this project estimated soft costs were calculated using: 10-percent of the estimated subtotal cost for engineering, 10-percent for construction oversight and administration, 20-percent for contingency (to account for uncertainties), and 25-percent for contractor fees and other direct costs. No land nor marine field surveys were conducted as part of this estimating process. The accuracy of the cost estimates are dependent on the accuracy of the measurements made and the viability of the unit costs estimated. This engineer's estimate is produced from information developed at the conceptual level only, and as such, it should viewed as a conceptual engineer's estimate of potential costs of the project. No guarantee or warrantee as to the accuracy of the costing or measurement information is given or implied. The cost estimate information included herein should be used for planning purposes only and should be considered conceptual in nature. See specific comments and the cost elements spreadsheet details below for additional information.

Interboro Team / Alex / Beach Shapes / Interboro / Alex / Report / Deltares / Hydraulics / Cost / IMCA Cable Burial Protection / Cost Estimation / Dell'Aquila / Planning / Pedro / Ocean / Cost / Investment / Dell'Aquila / Projects, RFA

1.2 Execution implementation plan

The largest part of the funding need for the implementation of the Living with the Bay regional strategy will consist of the investment costs related to all of the resiliency projects that will be implemented. The first phases of our projects are well advanced toward implementation, which is why we are suggesting HUD to earmark the indicative RBD share of these projects in the budget planning. By the end of 2014 and in 2015, the first Living with the Bay projects will be ready for decision making, resulting in formal investment cost funding requests.

USD (x 1,000,000)	**2014**	**2015**	**2016**	**2017**
Level 1 Development Regional Strategy (including establishing Bay Alliance)	0.5	2.0	2.0	1.5
Level 2 Development Master Plans (for all 4 Sub-regions)	1.5	2.0	1.8	0.8
Level 3 Project preparation (up to investment decision)	1.7	2.5	2.0	1.5
TOTAL	**3.7**	**6.5**	**5.8**	**3.8**

1.3 Studies and tools

In addition, we will have to conduct the studies and strongly suggest developing the tools as described in this implementation plan.

USD (x 1,000,000)	**2014**	**2015**	**2016**	**2017**
Studies				
Existing Data Acquisition/Evaluation	1.0	1.0		
High-resolution Bathymetric/Flown Topographic/Doppler Current Surveys	1.0	0.5		
Regional Stormwater System Survey	1.5	1.5		
Hydrologic/Hydraulic Model of the Region	0.1	0.2	0.1	
Ecological Surveys	1.0	1.5		
Geotechnical/Sediment and Soils Studies	0.5	1.0	0.5	
Tools				
BCA	0.1	0.1		
MOAT	0.1	0.1		
SSERIE	0.1	0.1		
STUDIO	0.3	0.3	0.3	0.3
TOTAL	**5.7**	**6.3**	**0.9**	**0.3**

Interboro Team: Interboro / Arcadis / Bosch Slabbers / Delta / Deltares / IEN+S / Palmbout / IMG Rebel / Earth Center for Urban Pedagogy, Dan Rosiek, NJIT Infrastructure Planning Program, Project Phoenix, RFA Investments, TU Delft

2 Funding sources

The Interboro Team has been aggressively evaluating and / or applying for grants (if available) and other potential funding sources / opportunities in addition to the the HUD RBD competition. The following provides a summary of the Team's efforts to date. Further, our project sponsors, including Nassau County, the Town of Hempstead and City of Long Beach, have been applying for various Sandy-related grants, as discussed below.

Grants Already Applied For

The following two grant applications had submission deadlines before the early April 2014 RBD completion deadline. At RBDs recommendation, the following grants were applied for in the name of, and with the approval, of Nassau County:

—National Fish and Wildlife Foundation (NFWF) grants, one to conduct high-resolution bathymetric, doppler current and shallow marsh island surveys – all data which will be required to support many of our intervention / resiliency measures. The second NFWF grant was to support the updating of a hydrologic / hydraulic computer model of the bay and creek tributary system which will be utilized evaluate the effectiveness and impacts of various intervention / resiliency measures prior to their post-permit-acquisition implementation.

—There is a Department of Transportation (DOT) / Federal Transit Administration (FTA) Public Transportation Emergency Relief Program grant, the stated purpose of which is "This resilience funding is intended to protect public transportation infrastructure that has been repaired or rebuilt after Hurricane Sandy or that is at risk of being damaged or destroyed by a future natural disaster. These investments reduce the likelihood that U.S. taxpayers are asked to repair the same infrastructure after a future major storm or natural disaster. Furthermore, the activities funded under this notice will help strengthen and build more resilient communities to better withstand future disasters."

Grants to be Applied for

There are a multitude of grants / funding sources associated with post-Sandy reconstruction which, if appropriate, will be applied for as our projects evolve:

—US Consolidated Fund Act Disaster Relief Fund.

—US DOT Transportation Investment Generating Economic Recovery (TIGER) Discretionary Grants) program. TIGER grants are awarded to build and repair critical pieces of the US freight and passenger transportation networks. Applicants must detail the benefits their project would deliver for five long-term outcomes: safety, economic competitiveness, state of good repair, livability and environmental sustainability.

—US Economic Development Administration (EDA) Public Works and Economic Adjustment Assistance Program is soliciting applications to support the implementation of economic development strategies that advance new ideas and creative approaches to advance economic prosperity in distressed communities.

—US Department of the Interior (DOI), U.S. Fish and Wildlife Service (USFW), Endangered Species Program provides funding to States and Territories for species and habitat conservation actions on non-Federal lands.

—National Oceanic and Atmospheric Administration (NOAA) National Coastal Wetlands Conservation Grant Program is soliciting applications to acquire, restore, and enhance

Interboro Team / Long Beach Shaper / Deltares / HDR / Cambridge / IMG Rebuild / Parsons Brinckerhoff / Pete Salkowitz / Regional Plan Association / Urban Investment Strategies / Planning Collaborative / Dan Plaza / Urban Partners / Dutchess County / NYU Intracorp / Projects, RFA

wetlands in coastal States through competitive matching grants to State agencies.

—NOAA Broad Agency Announcement (BAA) is a mechanism to encourage research, education and outreach, innovative projects or sponsorships associated with projected future climate-related changes include increased global temperatures, melting sea ice and glaciers, rising sea levels, increased frequency of extreme precipitation events, acidification of the oceans, modifications of growing seasons, changes in storm frequency and intensity, air quality, alterations in species' ranges and migration patterns, earlier snowmelt, increased drought, and altered river flow volumes.

—NOAA's Office of Ocean and Coastal Resource Management (OCRM) has a variety of grant program / funding opportunities including: Administrative Grants, Coastal Resource Improvement Program, Coastal Zone Enhancement Grants and Coastal Nonpoint Pollution Control Program (Technical Assistance).

—US Environmental Protection Agency (EPA) Safe Drinking Water Act established the Drinking Water State Revolving Fund (DWSRF) to make funds available to drinking water systems to finance infrastructure improvements. The program also emphasizes providing funds to small and disadvantaged communities and to programs that encourage pollution prevention as a tool for ensuring safe drinking water.

—The USFW Coastal Program is a voluntary, incentive-based program that provides direct technical assistance and financial assistance in the form of cooperative agreements to coastal communities and landowners to restore and protect fish and wildlife habitat on public and private lands.

—The USFW National Coastal Wetlands Conservation Grant Program has been designed to conserve and restore coastal wetlands and their fish and wildlife habitat.

—Federal Emergency Management Agency (FEMA) Hazard Mitigation Grant Program (HMGP) provides grants to states and local governments to implement long-term hazard mitigation measures after a major disaster declaration. The purpose of the HMGP is to reduce the loss of life and property due to natural disasters and to enable mitigation measures to be implemented during the immediate recovery from a disaster.

—New England Interstate Water Pollution Control Commission (NEIWPCC) is a not-for-profit interstate agency that utilizes a variety of strategies to meet the water-related needs of in a number of states, including New York by coordinating activities and forums that encourage cooperation among the states, developing resources that foster progress on water and wastewater issues, representing the region in matters of federal policy, training environmental professionals, initiating and overseeing scientific research projects, educating the public, and providing overall leadership in water management and protection.

—The USFW Cooperative Endangered Species Conservation Fund provides funding to States and Territories for species and habitat conservation actions on non-Federal lands. States and Territories must contribute a minimum non-Federal match of 25% for the estimated program costs of approved projects. A State or Territory must currently have, or enter into a cooperative agreement with the F&WS to receive grant funds. Four grant programs are available through

Interboro Team / Rosser / Slabbers / Deltares / ARUP / Parsons Brinckerhoff / IMG Rebuild by Design / Pentagram / Pentagram / Rockefeller Foundation / Urban Infrastructure Planning / Rockefeller Foundation / Projects / Projects RFA / Projects TU Draft

the Cooperative Endangered Species Conservation Fund, they include the "Traditional" Conservation Grants and the "Nontraditional" Grants: Habitat Conservation Plan Land Acquisition, Habitat Conservation Planning Assistance, and Recovery Land Acquisition Grants.

—The New York State Historic Preservation Office (SHPO) and the Natural Heritage Trust (NHT) offers grant assistance from these funds for the preservation of properties listed or eligible for listing in the National Register of Historic Places which were damaged by Hurricane Sandy. In New York the eligible counties are Suffolk, Nassau, Kings, Queens, Bronx, New York, Richmond, Westchester, Putnam, Rockland, Orange, Sullivan and Ulster.

Sponsor / Partner Grants

Interboro's primary sponsors / partners include Nassau County, the Town of Hempstead and the City of Long Beach.

Nassau County has reportedly applied, or is intending to apply, for the following grants associated with post-Sandy assessments / re-building projects, as indicated below:

The Town of Hempstead Department of Conservation & Waterways (DC&W) has a very active staff and program which conducts a wide-range of studies ranging from sedimentation accumulation rates studies, surface water quality studies, evaluating impacts from human versus other animals wastes, etc. Of late, the DC&W has been part of teams which have applied for three NFWF grants primarily associated with conducting pre- and post-Sanding sedimentation studies and evaluating to source types (e.g., human versus animal wastes). Project partners include Suffolk County, Hofstra University SUNY Stony Brook, Adelphi University, the USGS, NOAA, City University of New York (CUNY), the NYSDEC and NEIWPCC. They have also applied for various NFWS grants for green infrastructure interventions such as oyster reefs and soft eco-edge intervention measures.

The City of Long Beach has applied for a multitude of grants, including but not necessarily limited to the following: Smart Growth Parking Audit, Global Green Sustainable Neighborhood Assessment, NEA-Our Town, Gro1000, CFA - NYSERDA-CGC-Expedited Solar Permitting, CFA - Cleaner Greener, TIGER, CFA - NYS DOS, HMGP, NYS Empire State Development and NYS CDBG.

Interboro Team:
Interboro / AECOM / Bosch Studios
/ Deltares / Arcadis / Palmbout /
IMG Rebel / Rutgers Center for Urban
Research / David Kriesel /
NJ Transit / Future Planning
Program / Client Project / RFA
Investments / Dept

Program Phase	Program Component	Confirmed Funding Source
Repair	$432M for Repair of Hurricane Damage	FEMA 406 + NYS CBDG Match
Mitigation	$379M for Mitigation of Bay Park STP	FEMA 406 + NYS CBDG Match
	$20M for Mitigation of Bay Park STP	NYS CBDG
Wastewater Treatment	$130M - Bay Park STP Upgrades to Remove Nitrogen	TBD
	$ 20M – Sewering of Point Lookout	TBD
Ocean Outfall	$550M – Ocean Outfall	TBD
	$50M – Conversion of Small Plants to Pump Stations	TBD

Leverage Existing Funding Commitments / Existing Data Sets

Many grantors require some level of applicant matching funding. For instance, NFWS requires a 25% non-Federal match. NFWF also requires some level of matching funds. As indicated above, our three primary sponsors / partners all have applied for and / or have received grants from a wide variety of sources, all of which can / will be leveraged into our proposed RBD projects. In many cases, we will be able to access and utilize the data acquired through these grants and / or will be able to utilize these grants for some portion of the matching funds required by HUD

Additionally, we have partnered with many local universities and the Town of Hempstead DC&W, all of which acquired significant data with respect to ocean, bay bottom, marsh island, surface water and creek bottom conditions. All of these data were acquired through non-RBD funding sources. A preliminary project task will be to acquire, collate and evaluate such pre-existing data sets and incorporating the same into our projects. As such, we will be effectively leveraging existing data and will not have to re-collect data and "re-invent the wheel."

We have also been working closely with the NYS Rising Program to ensure that all proposed projects by both NYS and HUD RBD are complementary, not duplicative and not counter protective. Our proposed MOAT project component will be an important tool to ensure that Sandy-related projects proposed in the region are similarly complementary.

Developing Revenue Streams for Continued Operations and Maintenance

Many of our intervention / resiliency measures such as stormwater abatement best management practices (BMPs), deployable flow barriers, constructed islands, etc. will require routine operation and maintenance (O&M) activities to ensure their reliable continued operations. Funding for ongoing O&M is a major concern for out three municipal sponsors / partners. As specific projects become more refined, permitted and closer to implementation, we will develop O&M Plans for each intervention / resiliency measure and we will assess / apply for applicable funding. It will be appropriate to apply for such funding through various funding sources including clean water grants (maintaining stormwater abatement BMPs will ensure clean water discharges to the creeks and bays).

Interboro Transit / Nassau / Bay Stabilization / Deltaic / Marsh / Dune / Barrier / Beach / Shoreline / Marsh Island / Surface Water / Creek Bottom / Pre-Existing Data Sets / Leverage / Partnerships / Partnerships / Leverage / Pre-Existing Data Sets / Bottom / Creek / Surface Water / Marsh Island / Shoreline / Beach / Barrier / Dune / Marsh / Deltaic / Nassau / Interboro Transit
NJ Transit / Rail + S / Partnership / Partnerships / Leverage / Pre-Existing Data Sets / Bottom / Creek / Surface Water / Marsh Island / Shoreline / Beach / Barrier / Dune / Marsh / Deltaic / Nassau / Interboro Transit
Program / Partnerships / Leverage / Pre-Existing Data Sets / Bottom / Creek / Surface Water / Marsh Island / Shoreline / Beach / Barrier / Dune / Marsh / Deltaic / Nassau / Interboro Transit
Investment / Projects / Leverage / Pre-Existing Data Sets / Bottom / Creek / Surface Water / Marsh Island / Shoreline / Beach / Barrier / Dune / Marsh / Deltaic / Nassau / Interboro Transit
HUD / Projects, RFA

Innovative Funding and Financing Mechanisms

The Interboro Team has explored numerous innovative funding and financing mechanisms. The most relevant and promising mechanisms are described below.

Tax Increment Financing
The Interboro Team believes Tax Increment Financing can be an important financing mechanism for the Living with the Bay projects and will work with the cities and county on further structuring these financing mechanisms in the next phase.

Investments in flood prevention and stormwater retention make the protected land and properties more valuable. This will lead to a long-term cash flow of higher property tax revenues, also known as the "tax increment." Through Tax Increment Financing (TIF), these future cash flows can be made available for current investments. In other infrastructure sectors, TIF is a well-known method to use future gains in taxes to subsidize current improvements.

Insurance Premiums and Storm Water Tax
Specific taxes, fees, and installation of business improvement districts are ways to capture the value that is created by investing in resiliency and flood risk reduction. The Interboro Team will work with the public agencies on further structuring these financing mechanisms in the next phase.

Protecting the land and properties will reduce the flood risk for these properties. As a result, insurance premiums—reflecting the risk profile—are expected to go down. This can help pay for the same investments, either by letting property owners contribute on the basis of the insurance premium savings or by letting the property owners pay the same premium, in return for which the insurance companies will contribute to the investments. The Interboro team encountered a lot of complexities—mainly related to potential free riding—in further structuring this option but is committed to working further on this in the next phase. The Interboro team believes the potential link with a specific tax or fee will experience less complexity. The government could levy an additional property tax, a stormwater tax, or temporary fee or establish a business improvement district because it realizes some major improvements that the property owners benefit from, such as lower insurance premiums.

Availability Payment P3s
Availability Payment P3s can spread out the budgetary burden and create better and more efficient projects. The Interboro Team is working on structuring Availability Payment solutions for the dikes (and roads) in North Park and Freeport, the marshlands, and the stormwater systems and will continue to do so in the next phase.

Public-Private Partnerships (P3s) are contractual agreements between a public agency and a private entity that allow for greater private participation in the delivery of investment projects. Typically, this participation involves the private sector taking on additional project risks, such as design, construction, finance, and long-term operation. In addition to changing risk allocations, P3s also feature different ways to repay private investors. One of these repayment methods is availability payment, in which the contractor receives a long-term payment based on the availability of a facility at the specified performance level. Therefore, this innovative financing and contracting model not only spreads out the budgetary burden but also incentivizes creative design solutions and an optimal performance of the system over time.

Interboro Team: Interboro / ARUP / Bon Bouber / Deltares / Hydrologic / Pennings / IMG Rotterdam / Dutch Water Sector / Delft University of Urban Planning / Dutch Infrastructure Investment Fund / Program Projects, RFA / Applicants: Q Delft

The applicability this is how we would qualify the applicability of the innovative funding and financing mechanisms:

	Smart Barrier	Slow Streams	Eco-Edge	Green Corridor
Tax Increment Financing	+++	+	+++	++
Insurance Premiums and Storm Water Tax	++	++	+	+++
Availability Payment P3s	+++	+	++	+++

3 Next steps funding

In the next phase, we will collect and analyze additional data and develop detailed project plans based upon site hydraulic modeling and sponsor / partner requirements. This will allow us to also develop detailed life cycle costs estimates, which we will use as a basis for the continued evaluation of, application for and acquisition of blended funding sources. We will also develop a detailed business case, including quantitative risk analysis and financing structure. With this business case, we will continue to further financially optimize our projects and develop innovative funding, financing and contracting mechanisms to enhance the financial feasibility. The ultimate goal is to come to fully optimized and feasible business cases for our projects, on the basis of which robust decisions can be made.

Interboro Team / ABEC / Dr. Stephen Stanbury / Deltares / Arup US / Arup NL / IMG Rebel with Roberto Olivar Pedagogy, David Ridgway NJIT Infrastructure Planning Program, Project Projects, RFA Investments, TU Delft