The Seawall Subcommittee
SLR and Storm Surge in Watch Hill
4:00 - 5:00 PM, April 8, 2021 via Zoom
Minutes

Meeting convened at 4:03 PM

Subcommittee Members Present: Joan Beth Brown, Elizabeth Bean, Grant G. Simmons, Barbara Knowlton, Richard H. Sayre, Richard Holliday, Georgia Jones, Dennis Algiere, Deborah Lamm, Pete August, Janice Sassi, Jocelyn Lahey, and guest Duncan Kopp.

Deborah Lamm & Joan Beth Brown

- Deborah and Joan Beth thank everyone for attending.
- Goals of this meeting are to learn what other sites are doing to mitigate SLR impacts in built waterfront sites, from an engineer's perspective.
- No Grant Agreement yet from DEM. Other sites waiting as well.

Joan Beth Brown

- Will engage Robin Main to help with DEM grant. First job to review the Grant Agreement when it is sent to us.

Jocelyn Lahey

- Jocelyn reviewed SNEP (Southeast New England Program Network) and NWFW (National Fish and Wildlife Foundation) opportunities. Details of each are attached.
- Reviewed NFWF program and grants. Will hopefully be ready to prepare a proposal in the 2022 grant round. Purpose to evaluate and design means to mitigate SLR impacts to Watch Hill. Requires 1:1 match.
- Reviewed SNEP technical assistant opportunity. Will pursue this summer and hopefully get guidance on funding models.
- Gave quick Bio on Joanne Throwe, our next speaker for the subcommittee.

Duncan Kopp, P.E., Jacobs, Topic: *Examples of coastal adaptation to sea level rise impacts in built Waterfronts*

- PowerPoint presentation attached.
- Previous projects, New York City waterfront, Boston waterfront.
- Besides SLR flooding, need to consider utilities, septic, water, lighting, electric.
- Napatree to Yacht Club seawall, not much room for a berm. Can only go up.
- Sheet pile wall costs $5K-8K/linear foot. Relatively easy and fast to build (months).

- Rock revetment requires 2 feet of run for every 1 foot of rise. Would need to extend revetment into Harbor which would be a permitting challenge. Army Corps does not like to see an incursion more than 1.5-2 feet into the seaward side.
- Important to consider a cost-benefit assessment – does the benefit to the community justify the cost.
- Have a number of ways to “green” the seaward side of a sheet pile wall to enhance habitat.
- Any metal in the intertidal range that is exposed to air and saltwater during the daily tidal cycle is quickest to degrade. A capped metal pile wall should have a 50-75 years lifespan.
- Need to be sure landward side elevation of the seawall is higher than the groundwater elevation.

Group

- Open discussion.
- After session with Joanne Throwe, need to synthesize our findings and report to Sea Level Rise Working Group
- Dennis suggests partnering with the Town of Westerly.
- Would be smart to develop a shovel-ready project should federal infrastructure become available.

Deborah Lamm

- Next meeting May 13, 4:00 PM, Joanne Throw, Throwe Environmental, Financing
- Thanks everyone for participating.

Adjourned at 5:20 PM

SNEP and NFWF NCRF Project Strategies

March 11, 2021

The plan described here is based on a very informative call between Conservancy staff and Joanne Throwe and her SNEP team (Dan Nees, U Maryland; Kyle Gray, URI Marine Affairs; Taylor Throwe, Throwe Environmental). Joanne and team reviewed what was and was not competitive in SNEP and NFWF grant competitions. Based on the information received in the call and following discussions with the Resilient Watch Hill project team, we have concluded this would be our best plan to proceed. Our goal is to be able to prepare and submit compelling and competitive proposals.

SNEP = Southeast New England Program Network, an EPA program. LINK

When the SNEP Network Community Assistance Call for Participants comes out this summer, we will submit a request for help. If awarded, the Throwe Environmental Team would lead us through a financial analysis of costs and funding sources for mitigating 3-5 feet of Sea Level Rise (SLR) for our community. If we are successful, work would begin in October. No money will change hands and match is not required. https://snepnetwork.org/call-for-participants/

NFWF NCRF = National Fish and Wildlife Foundation National Coastal Resilience Fund
https://www.nfwf.org/programs/national-coastal-resilience-fund

The *Site Assessment and Preliminary Design* program in the NCRF would be most appropriate for us. Grants are typically $250,000 and require 1:1 match. The purpose of the grant is to determine where natural and nature-based solutions, coupled with gray infrastructure (hybrid model), may be implemented in the future to reduce flooding risk and exposure to communities.

For the 2021 season, the WH Resiliency team will continue reviewing the existing mitigating infrastructure in place in Watch Hill; characterize the dimensions of the problem, including how potential engineering and nature-based solutions might mitigate against impacts from nuisance tides, SLR, large storms, and stormwater runoff.

We will summarize our observations in a 2021 WH Resilience planning report. This will be the basis of a pre-proposal to NFWF in Spring 2022. The NFWF grant would allow us to characterize and prioritize our short list of candidate solutions in enough detail so a “go/no-go” decision can be made on the best way to proceed. If awarded the NFWF grant, it would (hopefully) be possible to use the DEM Resilience Grant as match as that project will still be underway.

Jacobs Challenging today. Reinventing tomorrow.

Watch Hill Sea Wall

April 8, 2021

About Me

- Bachelor's Degree in Civil Engineering from Tufts University
- Master's Degree in Civil Engineering from Massachusetts Institute of Technology
- Professional Engineer in RI, MA
- Work for Jacobs Engineering Group, Inc (NYSE: J)
  - #1-ranked Engineering Design Firm and #1-ranked Ports & Marine Firm (ENR, 2020)
  - Lead our Ports & Maritime team and business in Northeast, Midwest, Mid-Atlantic US and all of Canada
  - Focus is on developing and upgrading marine terminals around the world

Some of Our Ongoing Resiliency Projects

Resiliency-Related Services:

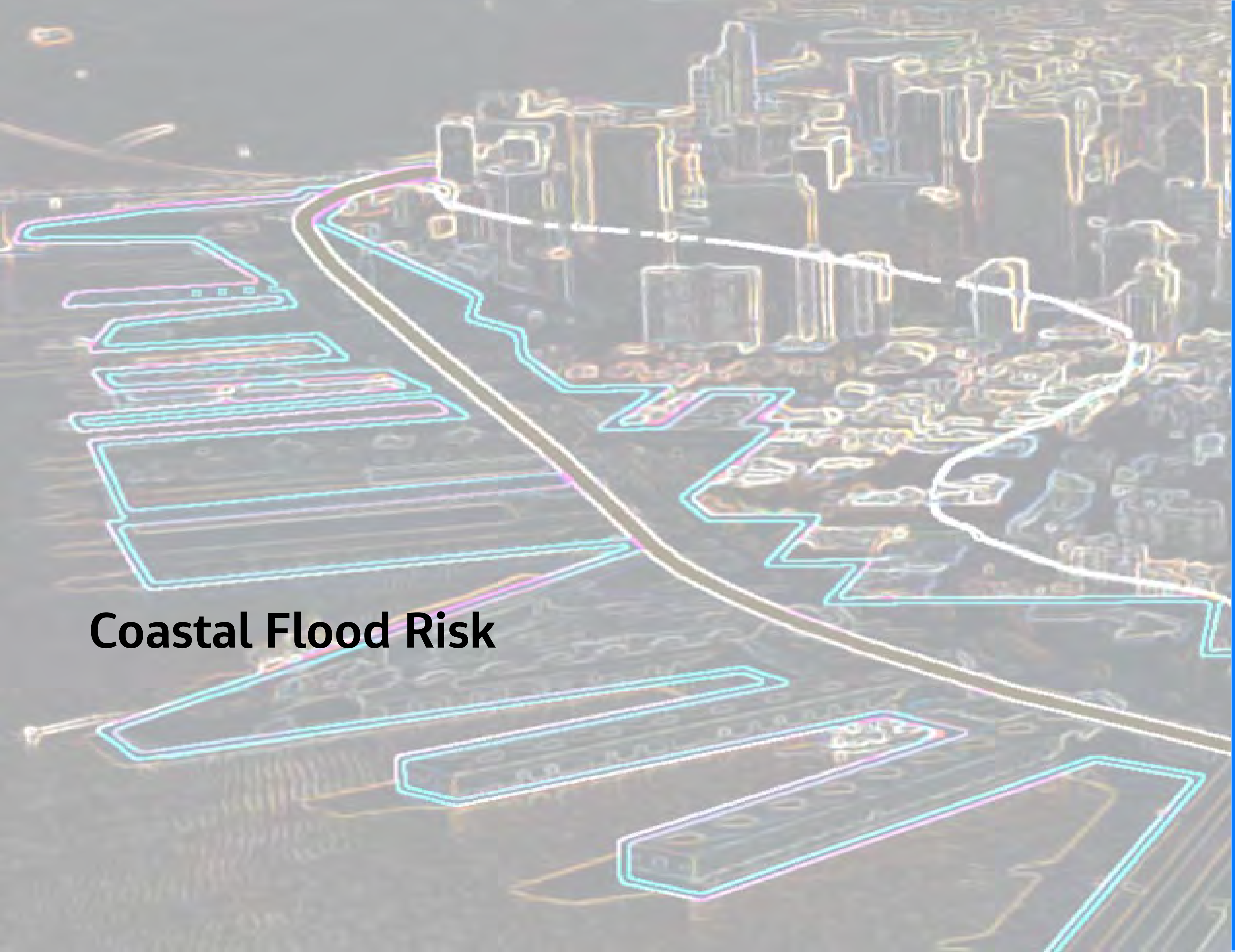
- Program management
- Flood protection engineering
- Sea level rise & storm modeling
- Asset management
- Operational planning
- Emergency response

East Side Coastal Resiliency

San Francisco Seawall Resiliency Program

NYC Harbor Barrier

USACE Galveston Flood Protection Program



Coastal Flood Risk

Coastal Flood Risk and Damage

- According to current FEMA flood maps, approx.800k residents in the NY Metro Area live within the 1% annual exceedance probability floodplain
- According to a 2018 study titled “Estimates of present and future flood risk in the conterminous United States” published in *Environmental Research Letters*, nearly 41 million people live within the floodplain nationally (https://iopscience.iop.org/article/10.1088/1748-9326/aaac65/pdf)
- In the same study, the damage estimates from a 100-yr flood is $1.2 trillion
- With sea-level rise, the impacts of flooding will continue to grow with more people getting affected and the damage estimates increasing

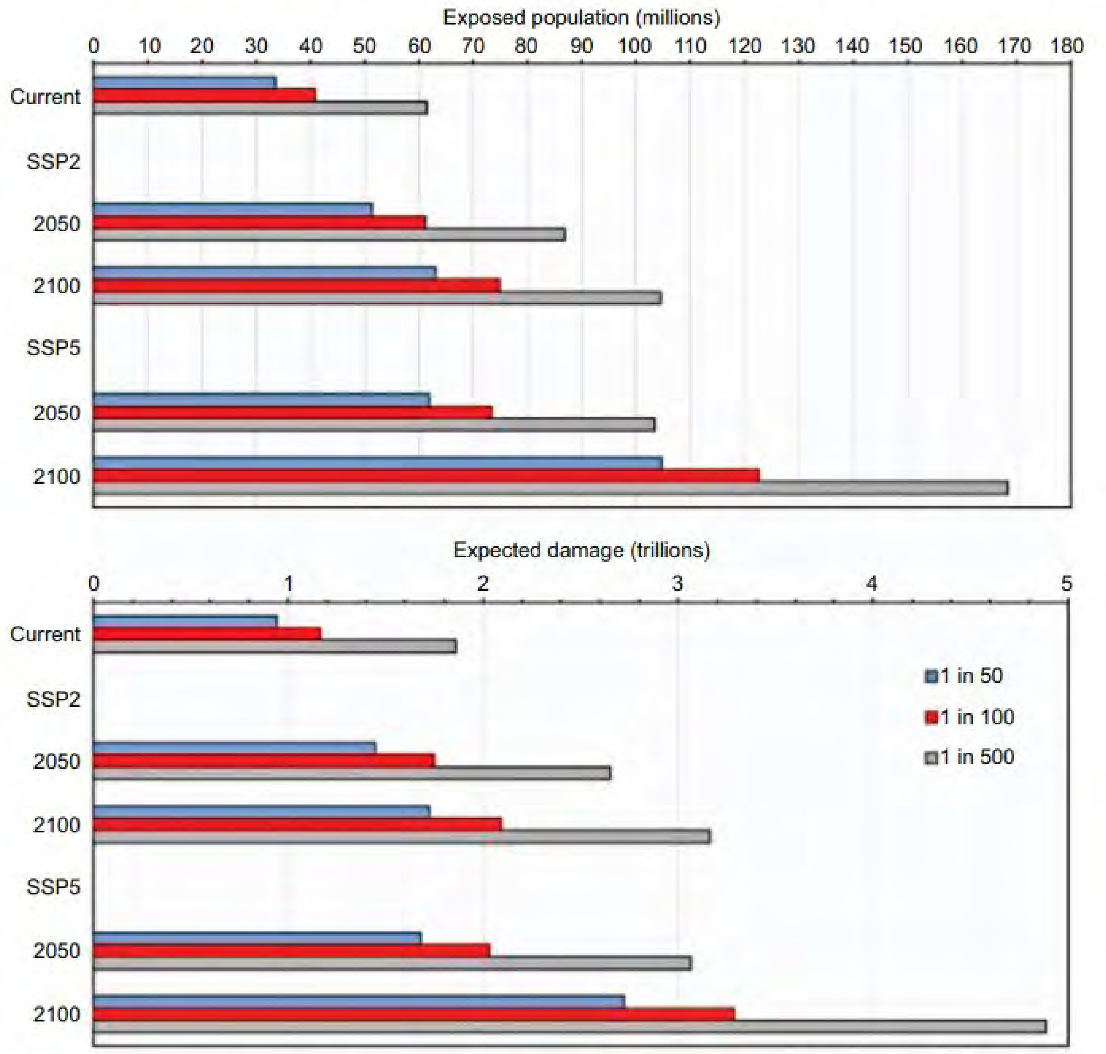


Figure 2. Selected exposure (population) and risk (damage) estimates for present and future 1 in 50-, 100- and 500 year floods. SSP2 represents a medium growth scenario, in terms of population and development, while SSP5 represents a higher one.

https://iopscience.iop.org/article/10.1088/1748-9326/aaac65/pdf

Sea-Level Rise Projections

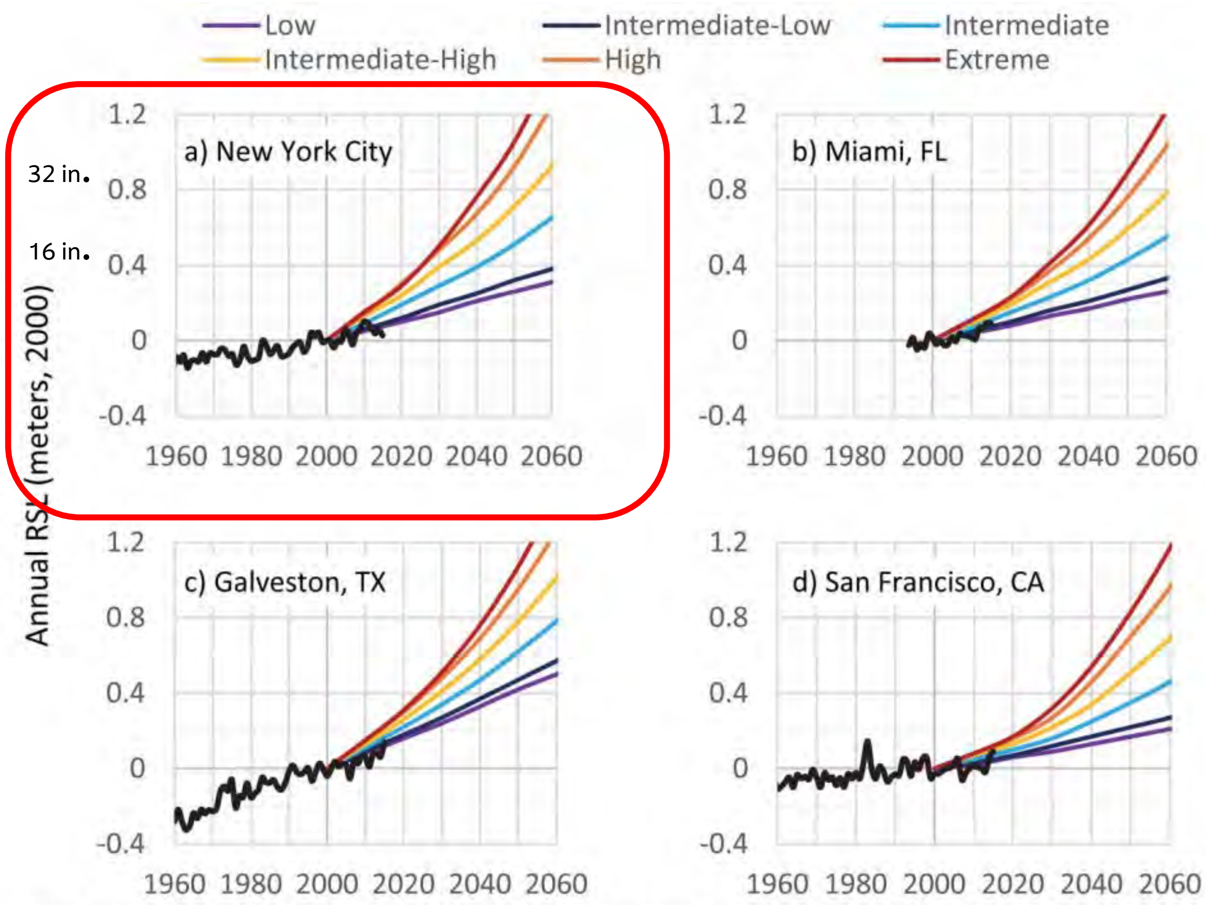


Figure 14. Average annual RSL for New York City (The Battery), Miami (Virginia Key), Fla., Galveston, Tex. and San Francisco, Calif. with their respective (median-value) RSL under the six scenarios. The NOAA RSL observations (tidesandcurrents.noaa.gov/sltrends) are shown relative to the midpoint (year 2000) of the 1991–2009 epoch (1994–2009 at Virginia Key), which is the reference level for the scenarios.

https://tidesandcurrents.noaa.gov/publications/techrpt83_Global_and_Regional_SLR_Scenarios_for_the_US_final.pdf

APPENDIX 2 - CLIMATE CHANGE PROJECTIONS

Climate change projections are provided by the New York City Panel on Climate Change (NPCC). The full NPCC report is available from the New York Academy of Sciences.[89] Tables 8-10 (below) were reproduced directly from the NPCC report, while Table 2 (see Section II.A) was developed using the data underlying the NPCC report to inform the design of HVAC systems under warmer conditions.

Table 8 – NYC sea level rise projections[90]

Baseline (2000-2004) 0 in	Low estimate (10th percentile)	Middle range (25th to 75th percentile)	High estimate (90th percentile)
2020s	2 in	4-8 in	10 in
2050s	8 in	11-21 in	30 in
2080s	13 in	18-39 in	58 in
2100	15 in	22-50 in	75 in

Note: Projections are based on six-component approach that incorporates both local and global factors. The model-based components are from 24 global climate models and two representative concentration pathways. Projections are relative to the 2000-2004 base period.

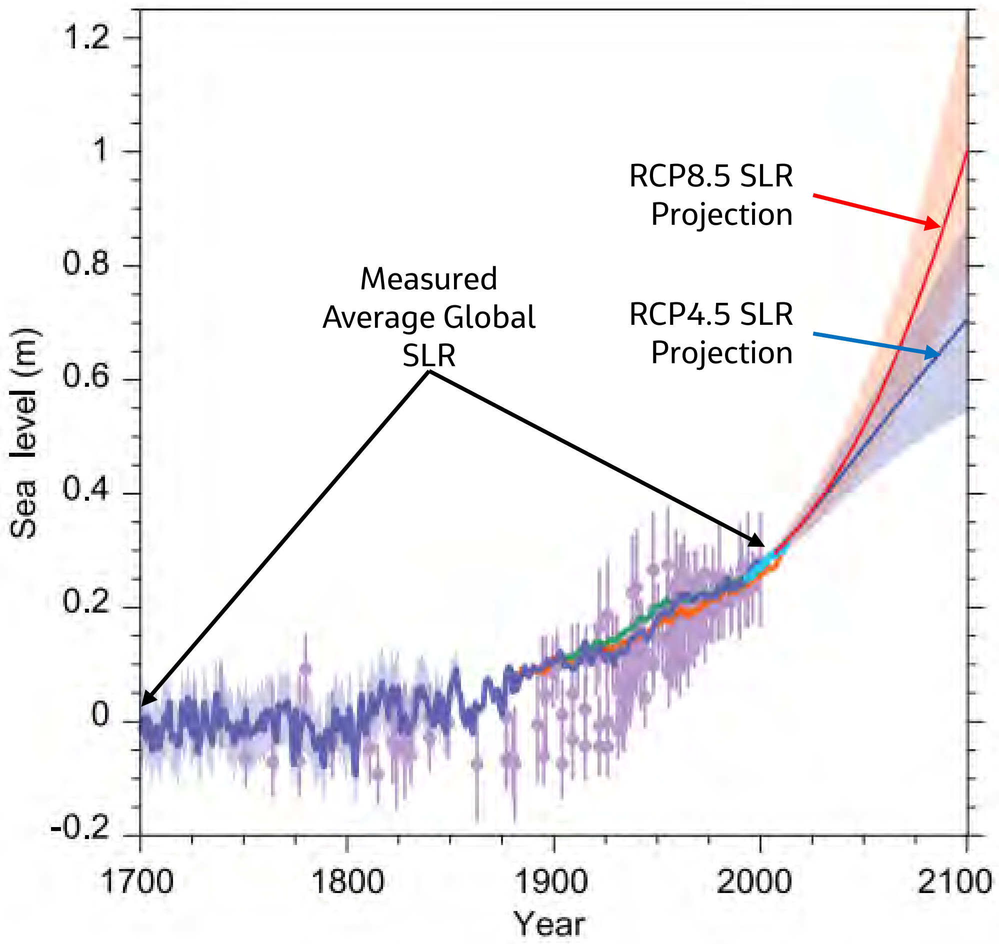
Climate Change in New England

- Temperature
- Precipitation
  - Has increased by up to 15%
  - Expected to increase further
- Sea Level Rise (SLR)
  - Expected to increase by up 3' by 2100

AR5 global warming increase (°C) projections[11]

Scenario	2046–2065 Mean and *likely* range	2081–2100 Mean and *likely* range
RCP2.6	1.0 (0.4 to 1.6)	1.0 (0.3 to 1.7)
RCP4.5	1.4 (0.9 to 2.0)	1.8 (1.1 to 2.6)
RCP6.0	1.3 (0.8 to 1.8)	2.2 (1.4 to 3.1)
RCP8.5	2.0 (1.4 to 2.6)	3.7 (2.6 to 4.8)

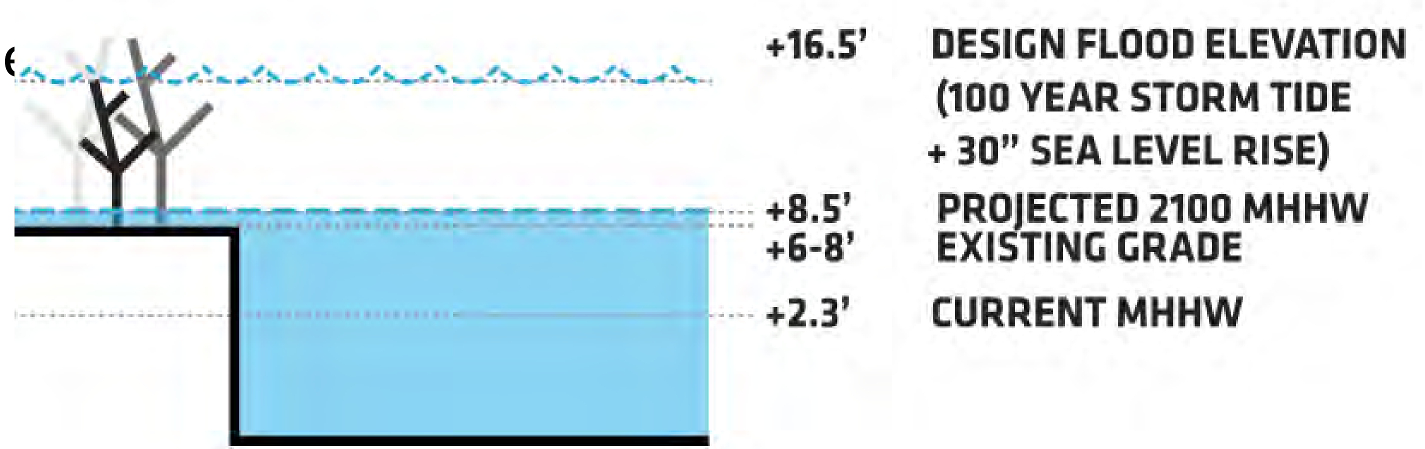
Representative Concentration Pathway (RCP) is a greenhouse gas concentration (not emissions) trajectory adopted by the IPCC for its fifth Assessment Report (AR5) in 2014

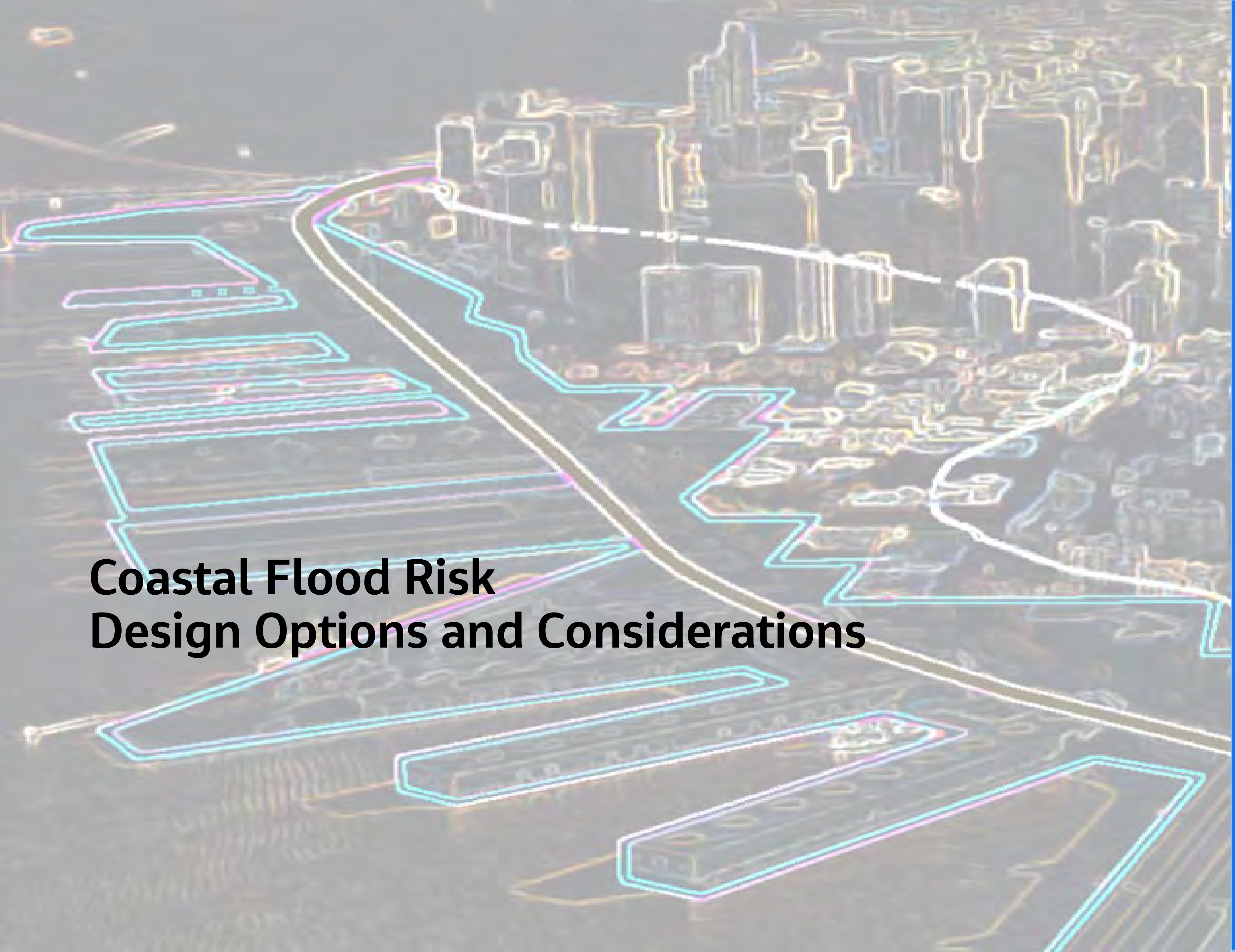


International Panel on Climate Change, Assessment Report (AR) 5, 2014

Effects of Climate Change

- Sea Level Rise
  - Daily tide fluctuations cause flooding
  - Floods go to higher elevations, further inlan
- Precipitation
  - Extreme events become common
  - Higher rainfall in extreme events
  - 500-year event becomes 100-year e
- Temperature
  - Higher & lower extremes





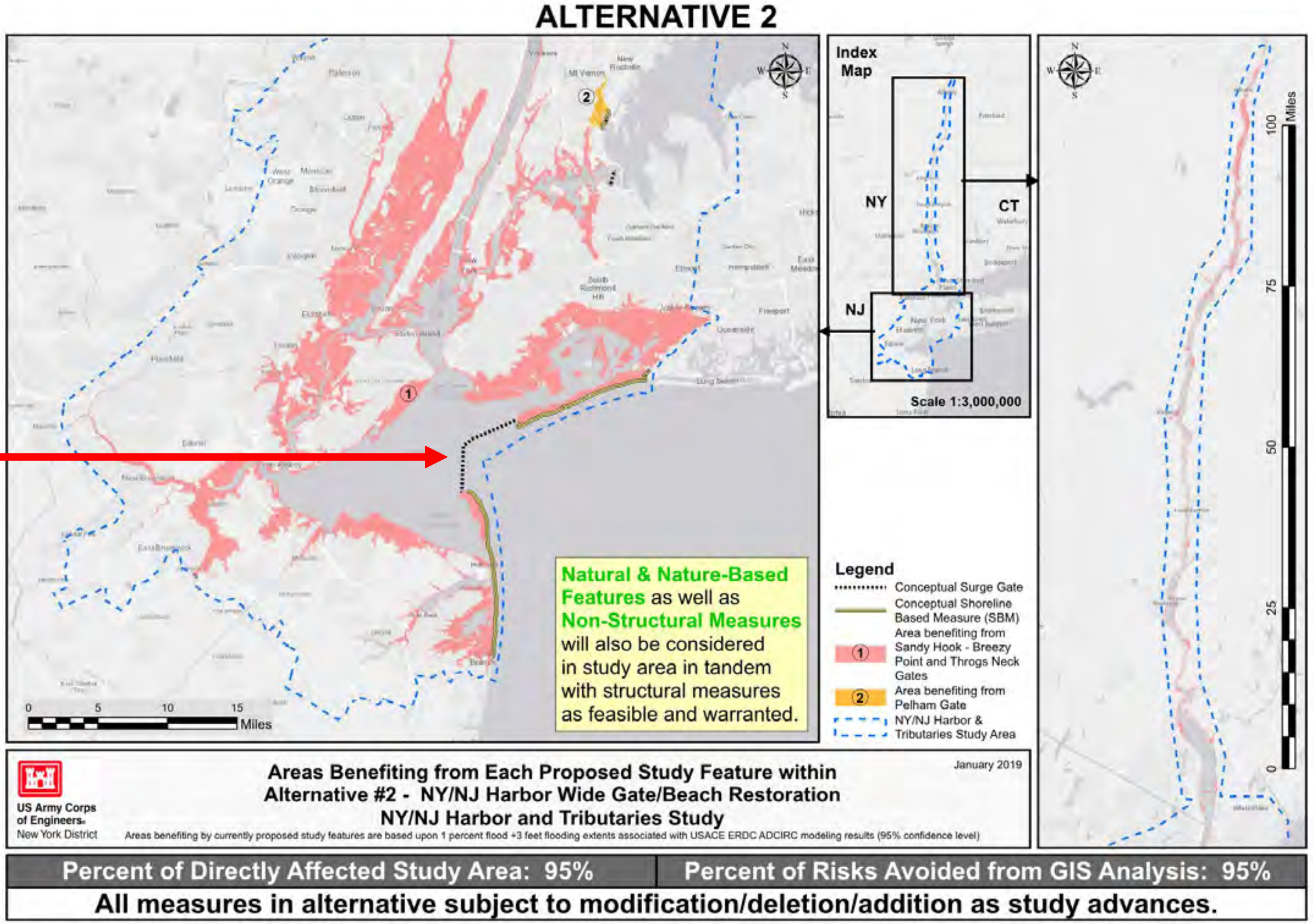
Coastal Flood Risk
Design Options and Considerations

Coastal flood risk design options and considerations

- Who do we protect?
  - Regional-based
  - Neighborhood/Community-based
  - Site-based
- What do we protect from?
  - Extreme flooding vs nuisance flooding
- How do we protect?
  - Passive vs Active measures
- When do we protect?
- How do we maintain our protection?

Who Do We Protect?

- Regional-based
- Neighborhood/Community-based
- Site-based



Who Do We Protect?

- An example of a regional scale protection system is the 25.4 km long flood protection barrier that is currently operating successfully in St. Petersburg in the Russian Federation.
- Barrier was put to the test in December 2012 and prevented a storm surge flood that, had the barrier not been in place, would have been the fourth highest flood in the recorded history of the city. The residents of St. Petersburg were largely unaware that a flood event had even occurred.

By Ssr (Thanks to N. Rublëva & A. Davydov for help & equipment) - Own work, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=35697377

Who Do We Protect?

- Regional-based
- Neighborhood/Community-based
- Site-based

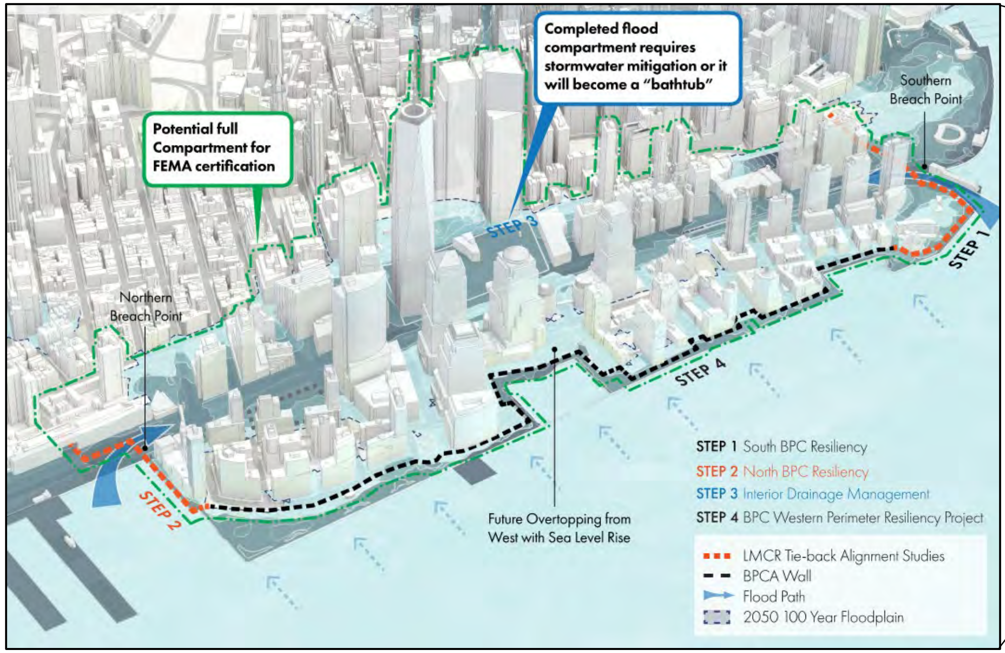
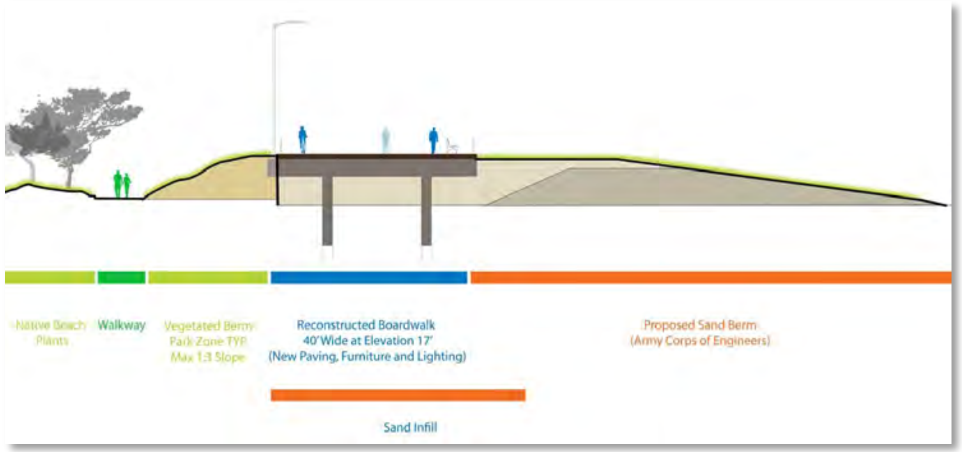
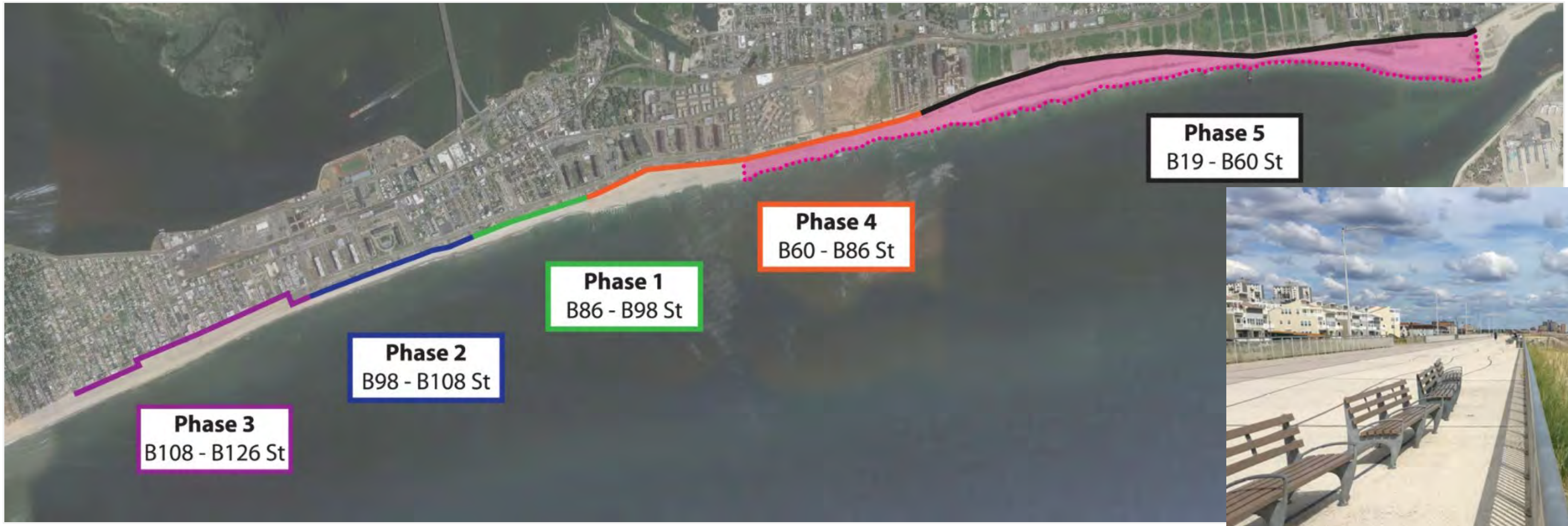


Figure taken from the Lower Manhattan Climate Resiliency Study

Who Do We Protect?

- The Rockaway Boardwalk Reconstruction project is an example of a neighborhood/community-based flood protection system.
- The project involves 4.7 miles of a reconstructed boardwalk that was heavily damaged after Hurricane Sandy. The boardwalk not only serves as a waterfront and recreational amenity, but also protects the neighborhood from a 100-yr storm event.

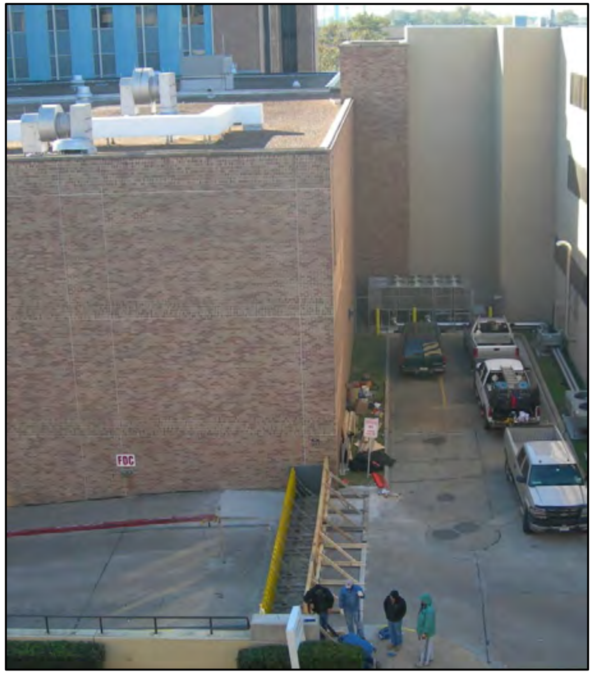




Rockaway Boardwalk Reconstruction

Who Do We Protect?

- Regional-based
- Neighborhood/Community-based
- Site-based



Who Do We Protect?

- The protection of the NYU Langone Hospital campus is an example of site-based flood protection system
- Perimeter floodwall was constructed to protected against a 500-yr return period flood elevation
- Combination of floodwalls and deployables
- Protection measures included raising of critical assets, installing backflow preventers on storm and sanitary connections, and developing a pumping plan and providing emergency power

https://www.health.ny.gov/facilities/public_health_and_health_planning_council/meetings/2013-06-27/docs/nyu_langone.pdf

NYU Langone Hospital

Hinged Flood Door at Ground Level

Sliding Flood Door at Cellar Level

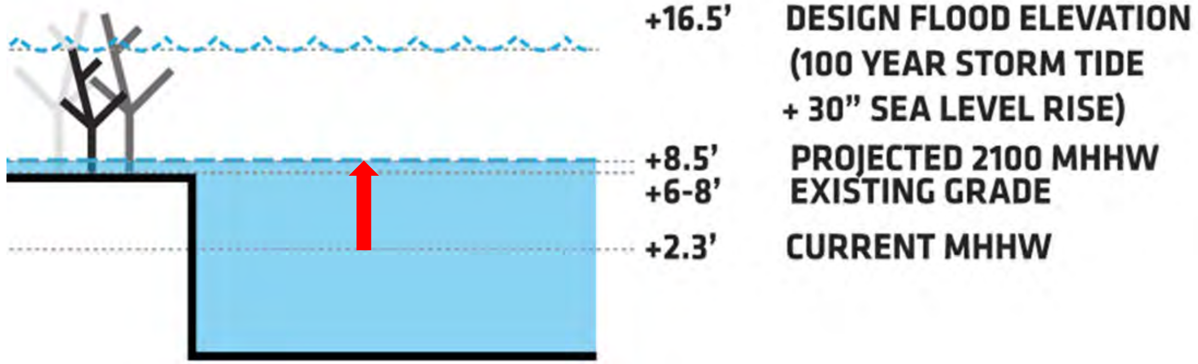
Normal Condition

Wall In Use

https://drii.org/downloadpresentation/c1a1716918

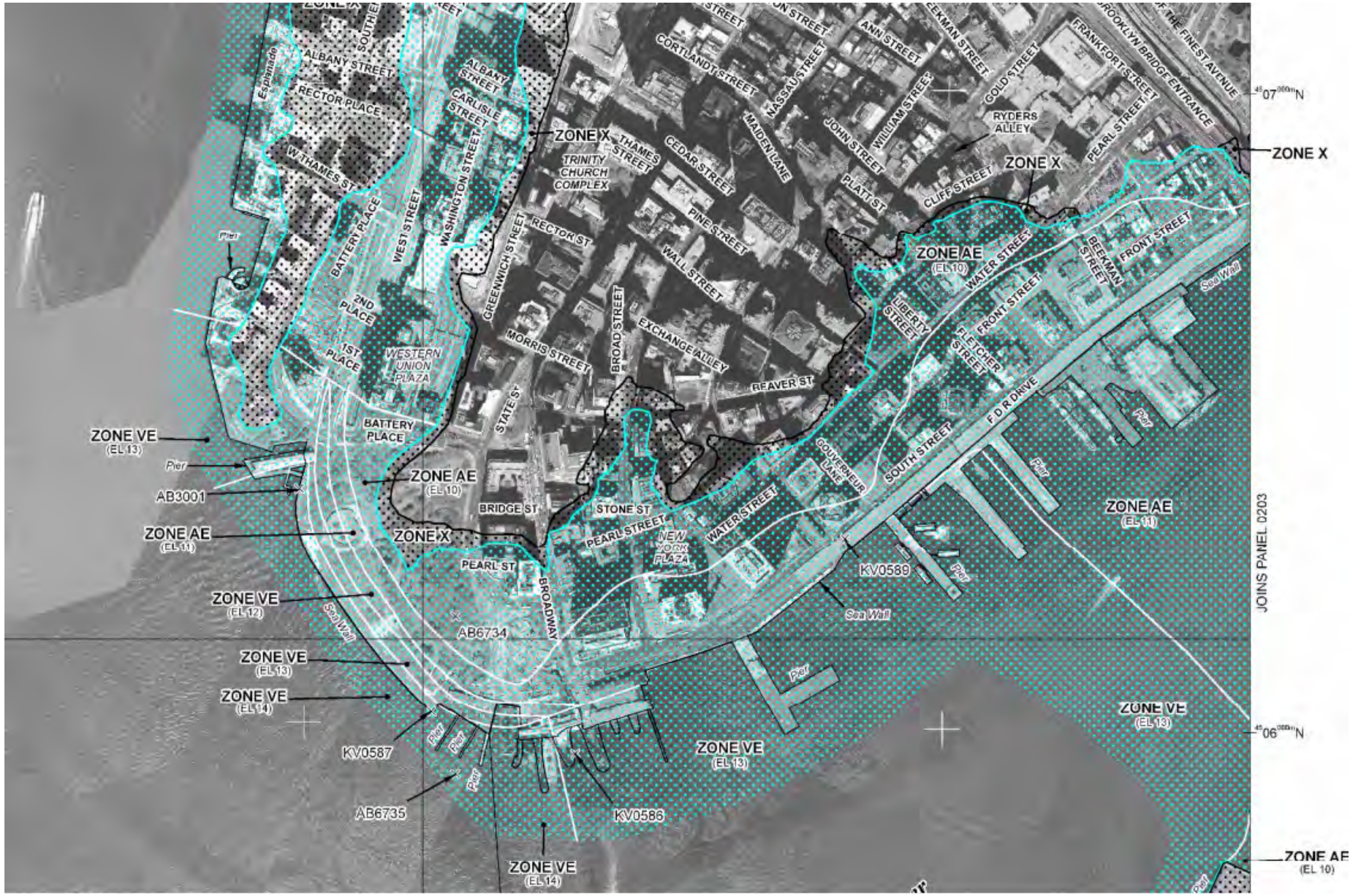
From What Do We Protect?

- Flooding from extreme events versus nuisance flooding
- An extreme flooding event could be from a 100-yr or 500-yr return period storm event, with or without sea-level rise (SLR)
  - The 100-yr return period flood means that there is a 1% chance of a flood event occurring in any given year.
  - The 500-yr return period flood means that there is a 0.2% chance of a flood event occurring in any given year
  - FEMA flood maps (FIRMs) show the floodplain for both of these events
- Nuisance flooding, or tidal flooding, is a condition that may occur during normal or exceptionally high tides in low-lying areas
- Future adaptability – for today, for 2050, for 2100?



By B137 - Own work, CC BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=52334453

Extreme Flooding - FEMA Flood Insurance Rate Map (FIRM)



LEGEND

SPECIAL FLOOD HAZARD AREAS SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A	No Base Flood Elevations determined.
ZONE AE	Base Flood Elevations determined.
ZONE AH	Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
ZONE AO	Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE AR	Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99	Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V	Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

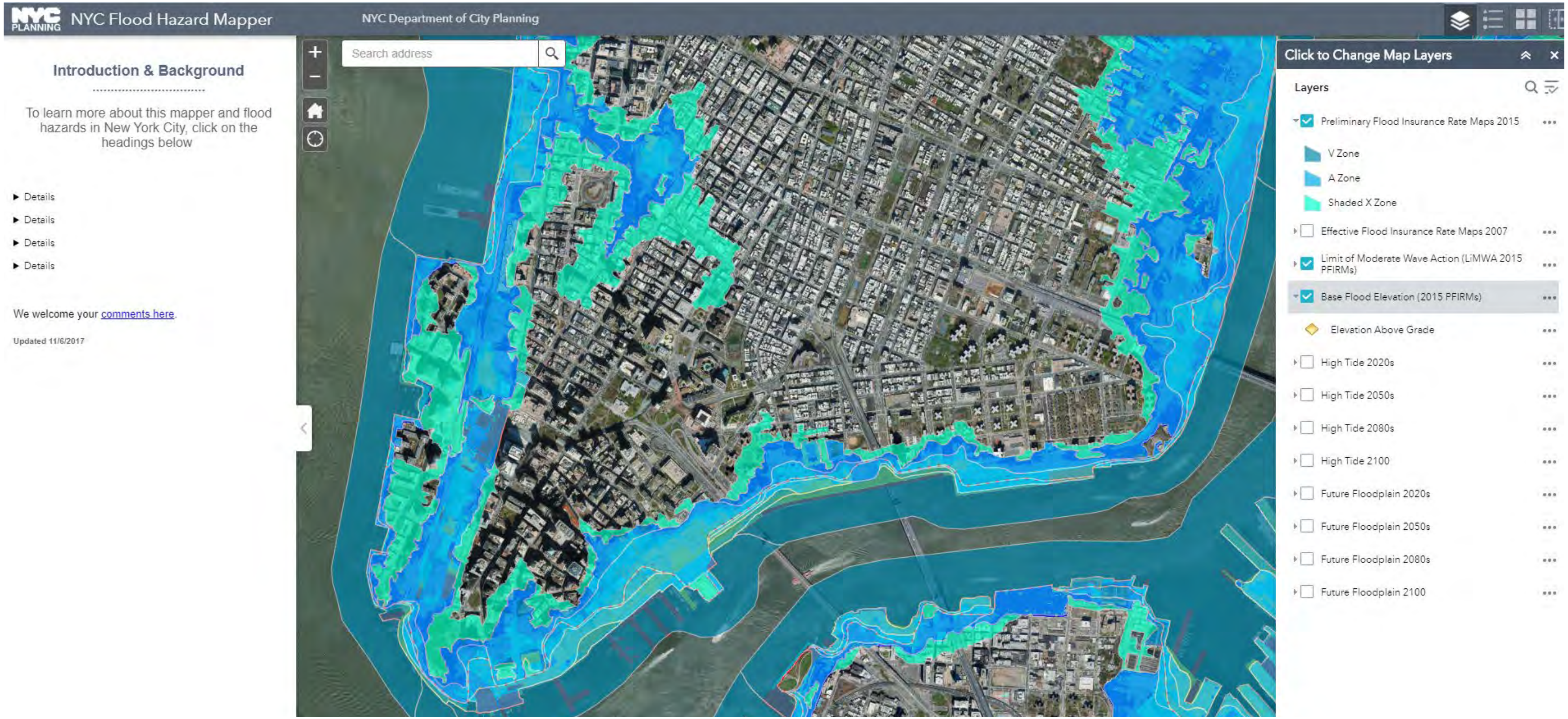
OTHER FLOOD AREAS

ZONE X	Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

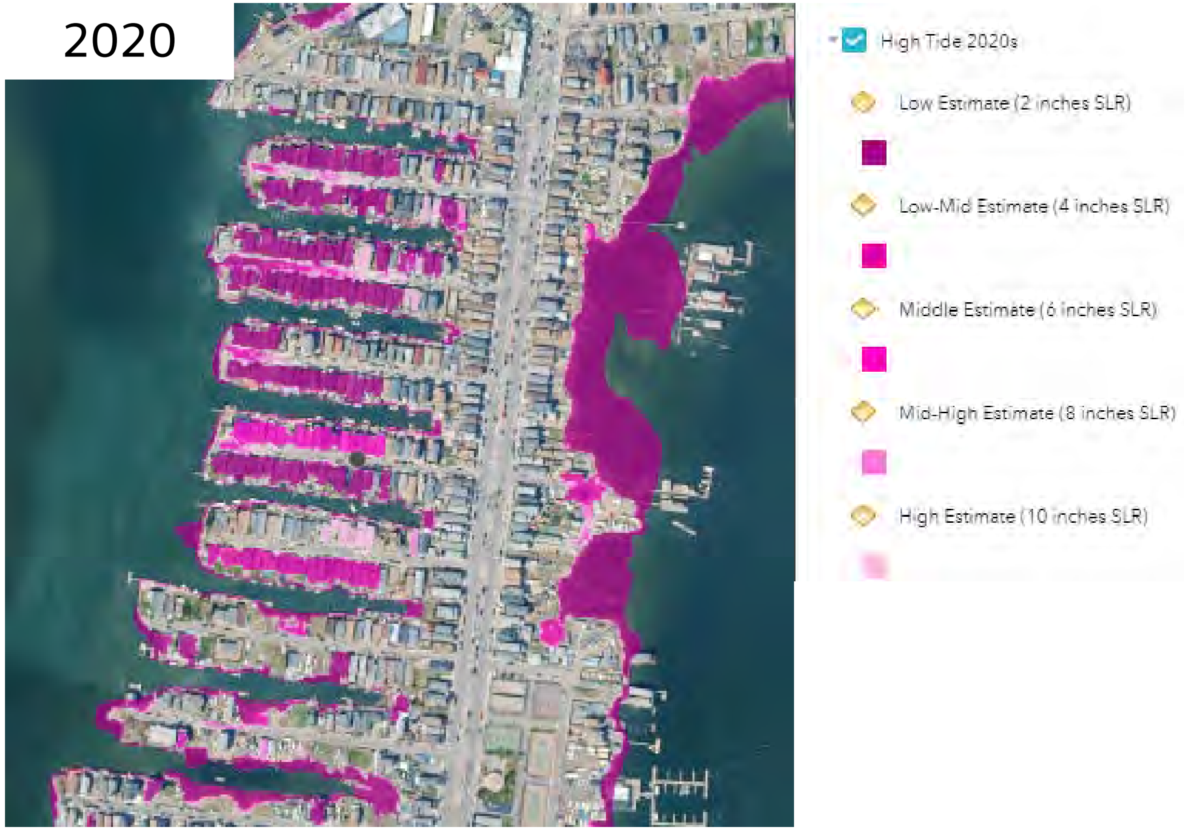
ZONE X	Areas determined to be outside the 0.2% annual chance floodplain.
ZONE D	Areas in which flood hazards are undetermined, but possible.

Extreme Flooding – NYC Flood Hazard Mapper Tool



NYC Flood Hazard Mapper (https://www1.nyc.gov/site/planning/data-maps/flood-hazard-mapper.page)

Nuisance/Tidal Flooding – Flood Hazard Mapper



Layers showing future **high tide in the 2020s, 2050s, 2080s, and 2100** are based on NPCC's projections for SLR in New York City. Mapping of the flood inundation extents anticipated for each projection was completed by DCP based on a 2010 Digital Elevation Model for New York City using a modified bathtub approach provided by NOAA. The layers do not accurately depict inundation on over-water structures, such as docks and piers, and are not reliable for areas outside of New York City. The layers illustrate the scale of potential flooding on land, not the exact location, and do not account for erosion, rapid subsidence, or future construction. They are not appropriate for site scale planning or design.

Cross-Bay Boulevard – 10th Road to 17th Road (Broad Channel, Queens)

NYC Flood Hazard Mapper (https://www1.nyc.gov/site/planning/data-maps/flood-hazard-mapper.page)

How Do We Protect?

- Permanent barriers (Passive system)
  - Levees/dikes, floodwalls
  - Pros: Reliable, does not need to be deployed
  - Cons: Blocks access and view corridors, can take up more real estate (ie. a levee)
- Deployable barriers (Active system)
  - Gates, stop logs, flexible barriers, etc.
    - Roller gates
    - Swing gates
    - Crest/Flip-Up gates
    - Vertical lift gates
    - Miter gates
  - Pros: Does not limit access or view corridors when not deployed
  - Cons: Less reliable, requires additional resources to operate and deploy before the storm

When Do We Protect?

- Deployable barriers need to be manually or mechanically deployed prior to the flood event
- Each type of barrier requires different manpower and equipment to deploy (and remove)
- Timing of the deployment must be coordinated with the rest of the region, neighborhood, or site to ensure that the flood protection system is functioning and will perform as intended
  - How many days before the storm?
  - Will the barrier block evacuation routes?
  - What resources are available to deploy the barrier?
- Maintenance and Operations Manual for the flood protection system must be prepared and strictly followed
- Who is going to operate the barrier?
- Self-deploying barriers are available but the reliability of the system is a concern

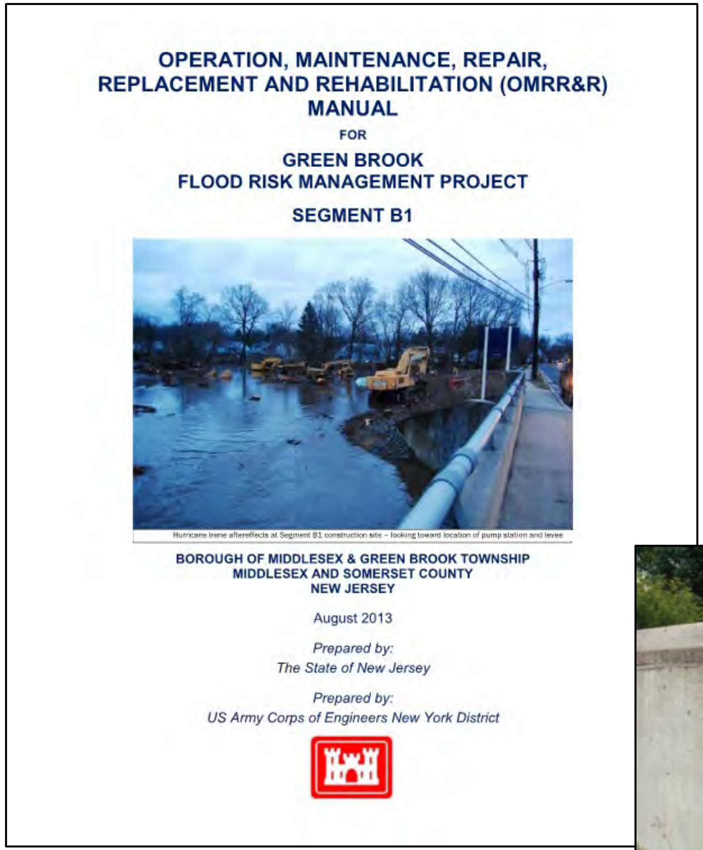
https://bismarcktribune.com/news/state-and-regional/red-river-in-fargo-now-expected-to-reach-feet-early/article_c18fcee0-6503-5fc4-921e-863e9ed4828f.html


https://wcfcourier.com/news/local/fletcher-ave-flood-gates-to-close-this-morning/article_70d14628-c2e4-11e2-b49b-0019bb2963f4.html


https://www.ny1.com/nyc/all-boroughs/news/2018/07/20/flood-barriers-completed-at-two-nyc-tunnels

How Do We Maintain Our Protection?

- Regular inspections of the flood protection system is required by FEMA as part of the certification process (quarterly and annually)
- Regular testing of the deployables is required to ensure that the system functions and can be properly deployed when needed (annually)
- Level of protection of system must be re-evaluated every 5 years to ensure that it still provides the level of protection it was designed to
  - Sea-level rise impacts
  - Land subsidence impacts
  - Impacts from changes to the topography
- Maintenance and Operations Manual for the flood protection system must be prepared and strictly followed
- Perform inspections and repairs (if necessary) after flood events



OPERATION, MAINTENANCE, REPAIR, REPLACEMENT AND REHABILITATION (OMRR&R) MANUAL

FOR

GREEN BROOK FLOOD RISK MANAGEMENT PROJECT

SEGMENT B1

Hurricane Irene aftereffects at Segment B1 construction site – looking toward location of pump station and levee

BOROUGH OF MIDDLESEX & GREEN BROOK TOWNSHIP
MIDDLESEX AND SOMERSET COUNTY
NEW JERSEY

August 2013

Prepared by:
The State of New Jersey

Prepared by:
US Army Corps of Engineers New York District

Coastal Resiliency Design Considerations

- Base Flood Elevation (BFE)
- Height:
  - Water depth
  - Retained height
  - + Sea Level Rise (SLR)
  - + Freeboard (consider Storm Surge, Wave Height, Precipitation, etc.)
  - + Curb
- Utilities
- Access and public
- Permitting and approvals

Design Flood Elevation Examples

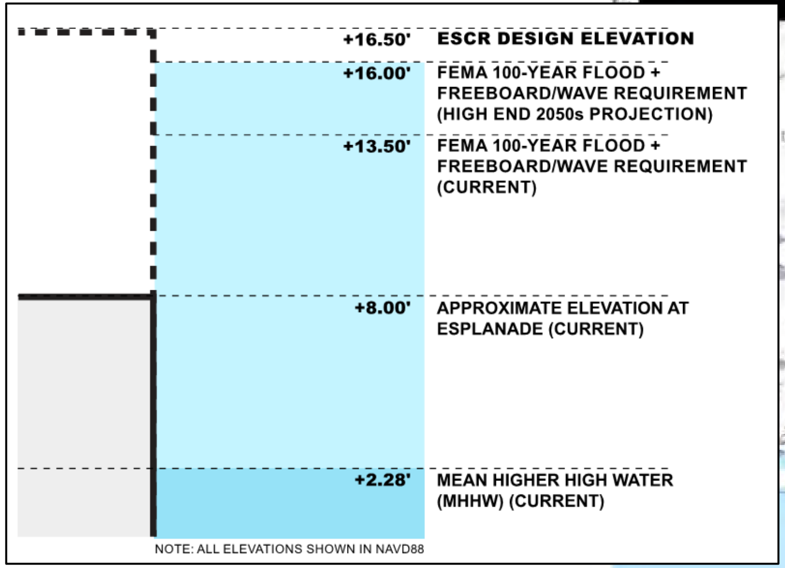
Boston, MA

CONFIDENTIAL

Agency	Flood Model	Design Flood	BFE	SLR (2070)	Freeboard	**Total DFE**
			FT NAVD88	FT	FT	**FT NAVD88**
	FEMA FIRM (2016)	100-year	12	3.7	1	**16.7**
	BH-FRM (2017)	100-year	9.7	3.3	1	**14.0**
	BH-FRM (2017)	100-year	9.7	3.3	1	**14.0**
	BH-FRM (2017)	100-year	9.6 (Confirm)	3.3	3	**15.9**
	BH-FRM (2017)	500-year	10.7	3.3	3	**17.0**

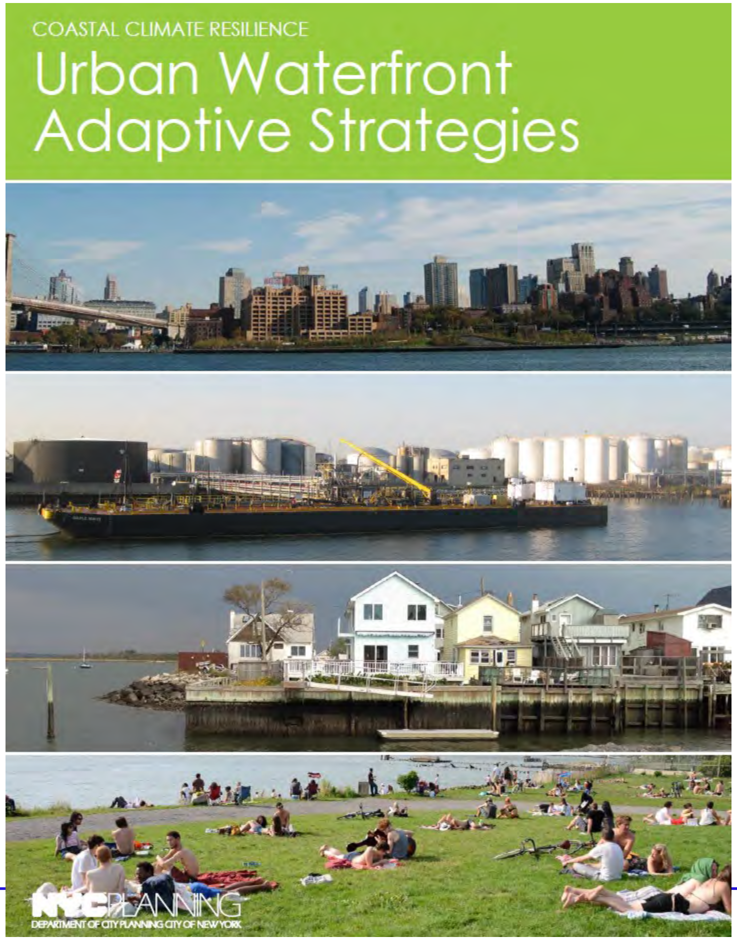
Design Flood Elevation Examples

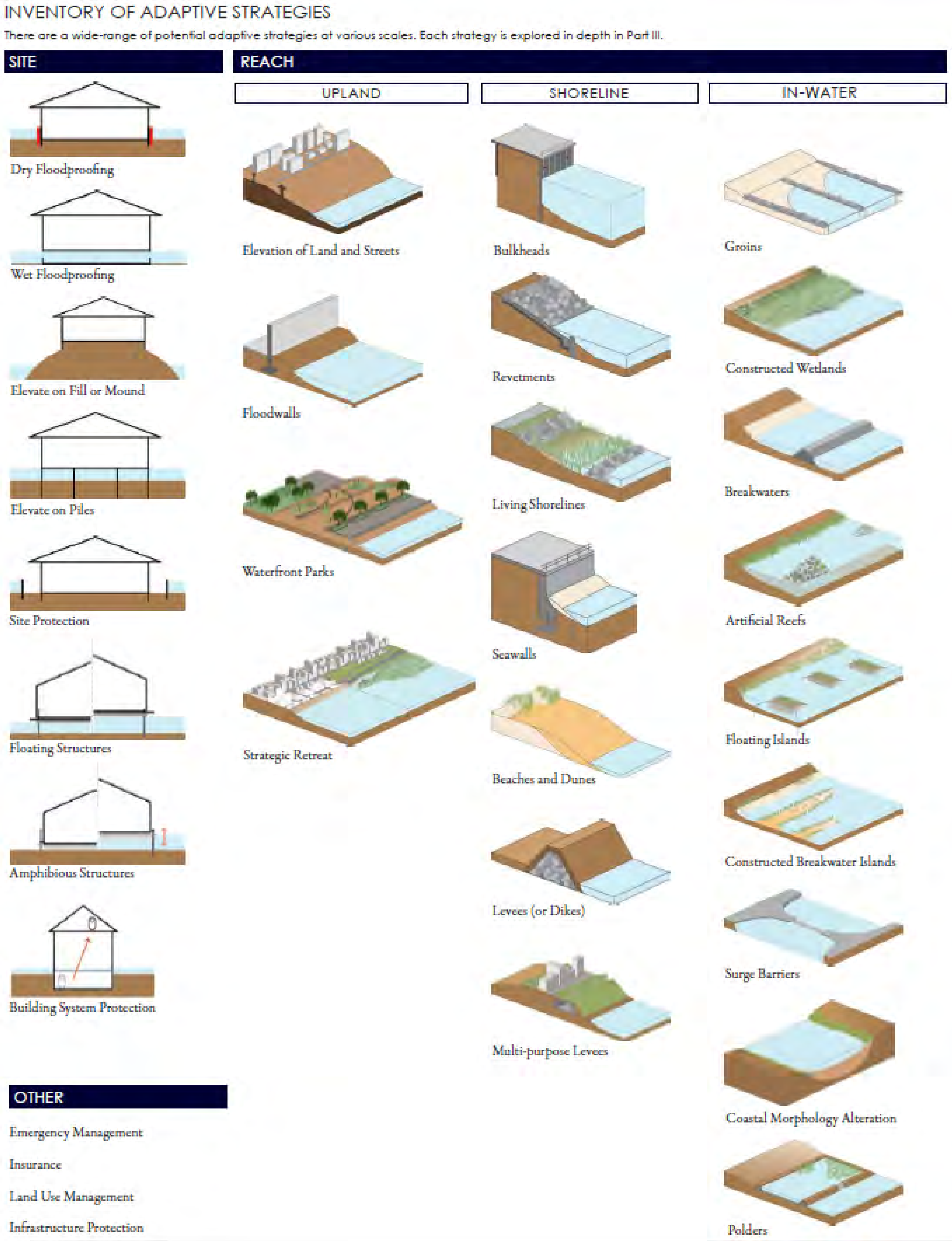
New York, NY



Potential Waterfront Options

- From *Urban Waterfront Adaptive Strategies* by NYC Dept of City Planning 2013.

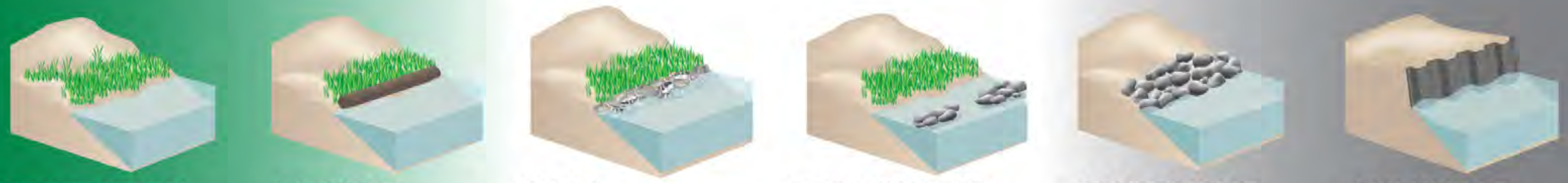




Potential Waterfront Options

GREEN - SOFTER TECHNIQUES ⟷ **GRAY - HARDER TECHNIQUES**

Living Shorelines — *Coastal Structures*



VEGETATION ONLY - Provides a buffer to upland areas and breaks small waves. Suitable for low wave energy environments.

EDGING - Added structure holds the toe of existing or vegetated slope in place. Suitable for most areas except high wave energy environments.

SILLS - Parallel to vegetated shoreline, reduces wave energy, and prevents erosion. Suitable for most areas except high wave energy environments.

BREAKWATER - (vegetation optional) - Offshore structures intended to break waves, reducing the force of wave action, and encourage sediment accretion. Suitable for most areas.

REVETMENT - Lays over the slope of the shoreline and protects it from erosion and waves. Suitable for sites with existing hardened shoreline structures.

BULKHEAD - Vertical wall parallel to the shoreline intended to hold soil in place. Suitable for high energy settings and sites with existing hard shoreline structures.

Flood Resilience: A Multi-layered Approach

Resiliency requires integrated solutions that address complex issues like social values, competing resource demands, climate change, extreme events, environmental improvements, aging infrastructure, and funding.

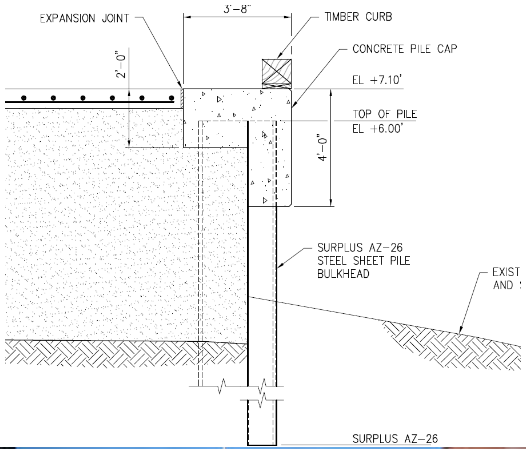
Watch Hill Harbor

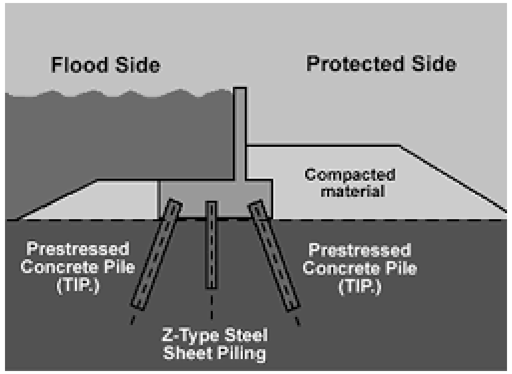
Watch Hill Harbor

- ~1900 lin-ft of shoreline (excl. second wall on “Cabana-side” of Fort Road)
- Federally authorized channel depth of -10ft
- Various size, type, age, and condition seawalls
- Inadequate height for met-ocean conditions

Potential Options

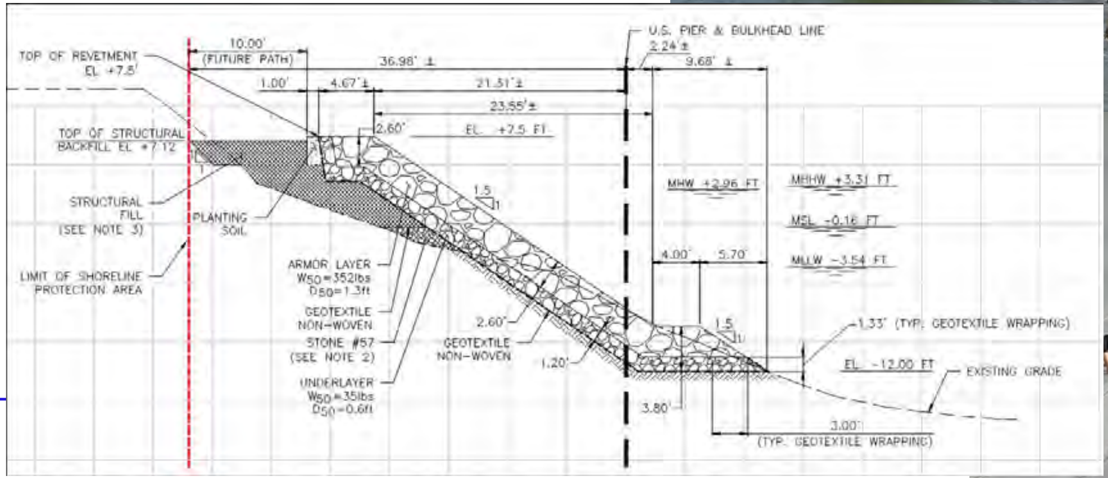
- Bulkhead/Seawall/Floodwall
  - Narrowest option (min1-2ft)
  - “Hard infrastructure





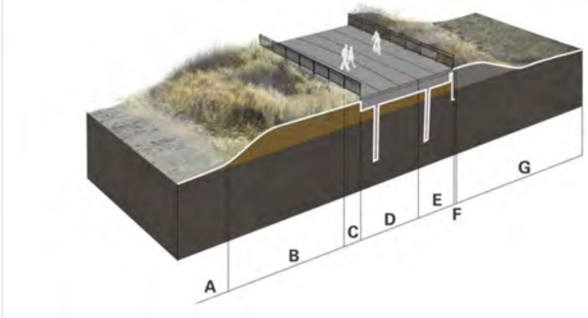
T-Wall supported on a pile foundation

- Revetment/Rock Slope/Living Shoreline
  - Wider: ~ 2H:1V
  - Allows for green & nature-based solutions

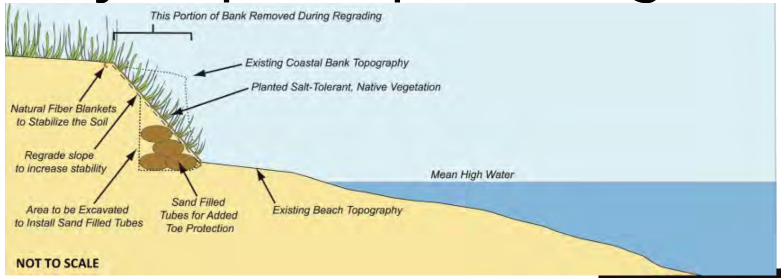


Potential Options in Watch Hill Harbor

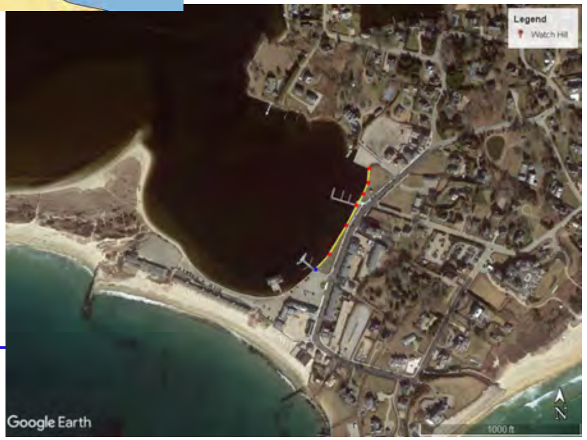
- Bulkheading/Seawall
  - 1200 lin-ft (Misq Club to Dock & Dock by Holdredges)
  - May need second wall along Cabana side



- Revetment/Rock Slope/Living Shoreline
  - 700 lin-ft with space for revetment
  - Takes up more width; approx 2H:1V
  - Likely would require cutting into land vs. pushing out into harbor
  - May help with permitting and approvals



"Living Shorelines in New England: State of the Practice, The Nature Conservancy, July 2017



Jacobs

Challenging today.
Reinventing tomorrow.