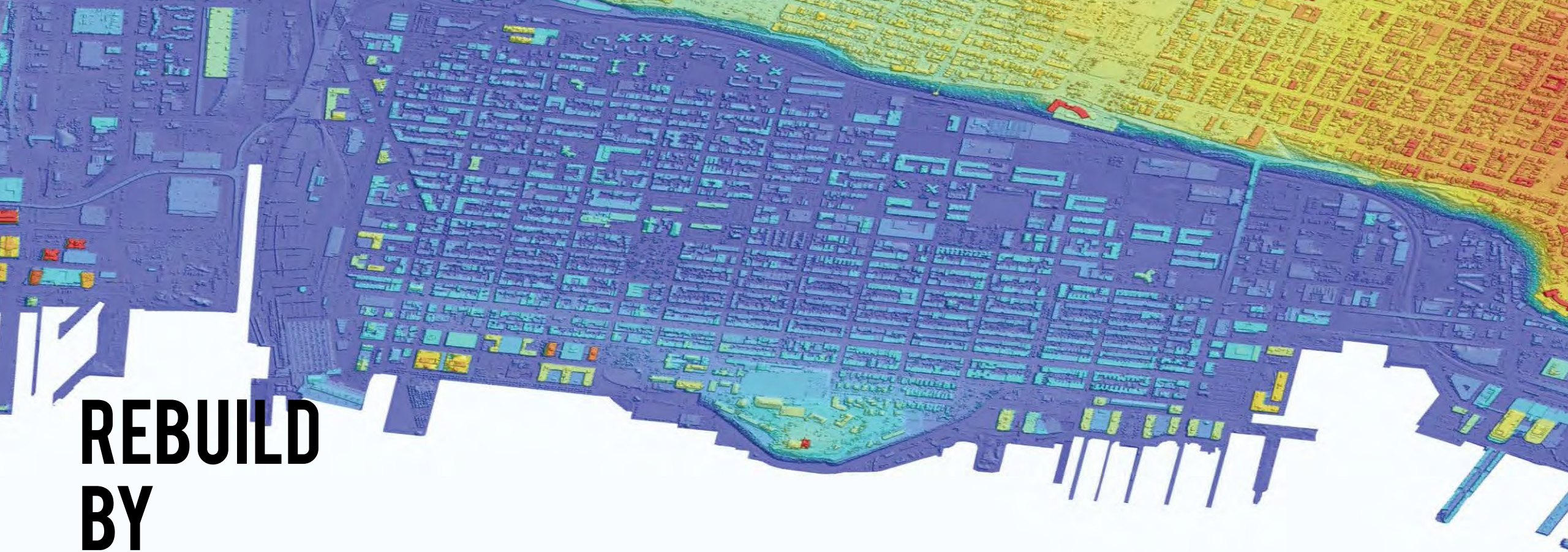


REBUILD BY DESIGN

▪ RESIST ▪ DELAY ▪ STORE ▪ DISCHARGE ▪

HUDSON RIVER

Hoboken Weehawken Jersey City | New Jersey

COASTAL STORM SURGE FLOOD MODELING RESULTS

Meeting Agenda

Introduction	NJDEP
Project Update	Dewberry
Introduction to Coastal Storm Surge Modeling	Stevens Inst.
Coastal Modeling Scenarios	Dewberry
Modeling Results	Dewberry

PROJECT STATUS

Upcoming Meetings

Community Meeting (CAG) Alternatives Analysis ..... **July 28**

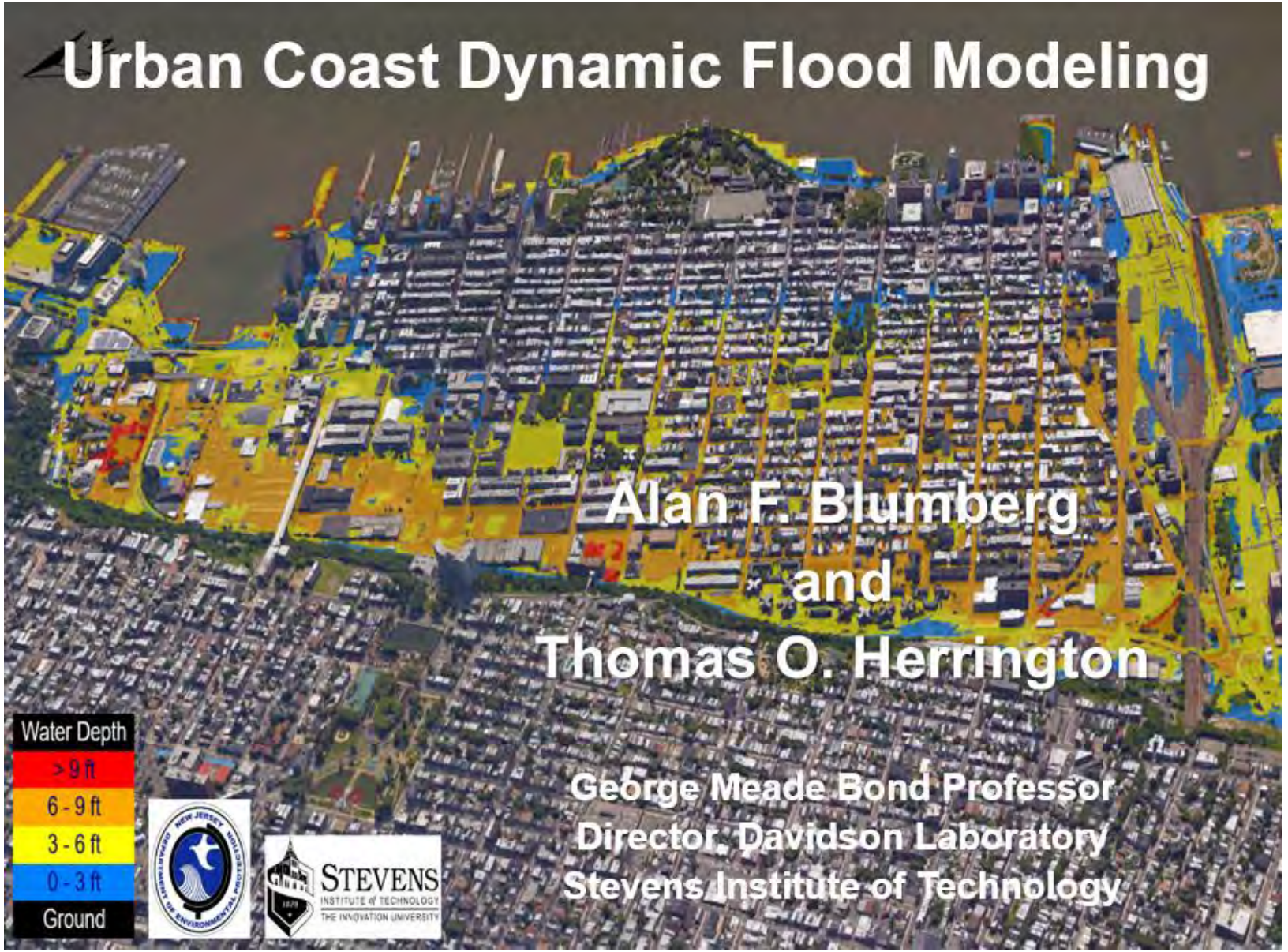
Public Meeting for Preferred Alternative ..... **Week of August 15th**

Draft Environmental Impact Statement (DEIS) Public Hearing ... **Dec. 2016**

www.rbd-hudsonriver.nj.gov

Coastal Storm Surge Modeling

Urban Coast Dynamic Flood Modeling



Alan F. Blumberg
and
Thomas O. Herrington

George Meade Bond Professor
Director, Davidson Laboratory
Stevens Institute of Technology

Stevens and NJDEP
RBD Hoboken "Resist"

- "Assist" Dewberry to perform coastal storm surge model validation
- Provide Dewberry with Hoboken data from Hurricane Sandy
- Review the final configuration of the Resist portion of the project
- Consider impacts to Jersey City and Weehawken

Project Drivers

What is **probability** of a flood event?

Where will the water be from a particular storm?

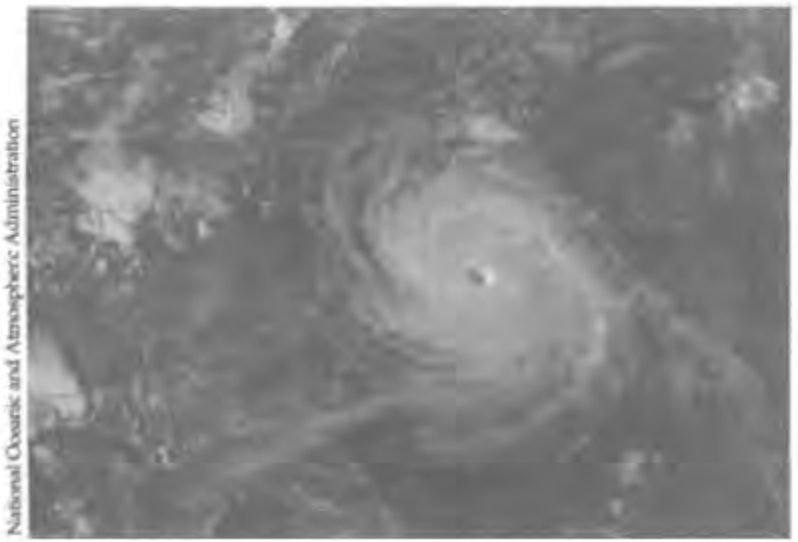
- **what streets**
- **how deep**

How would you **mitigate** against the event?

How best to **communicate risk and uncertainty**?

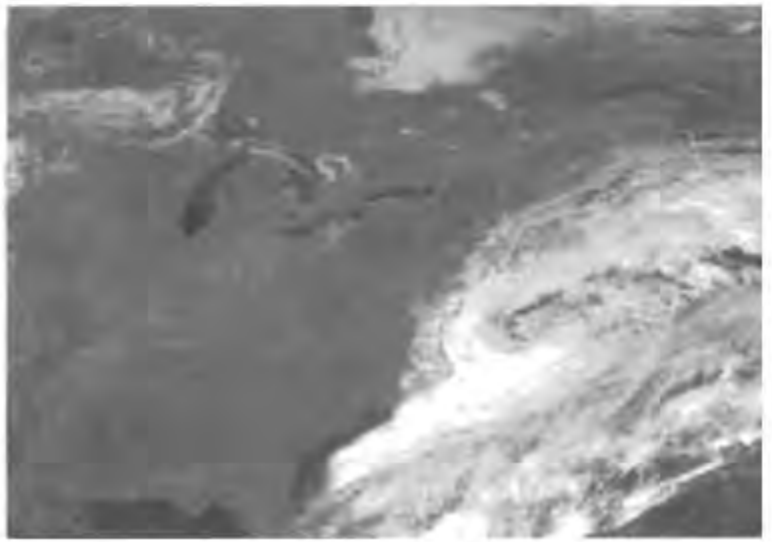
Severe Weather

Tropical Cyclones (Hurricanes)



National Oceanic and Atmospheric Administration

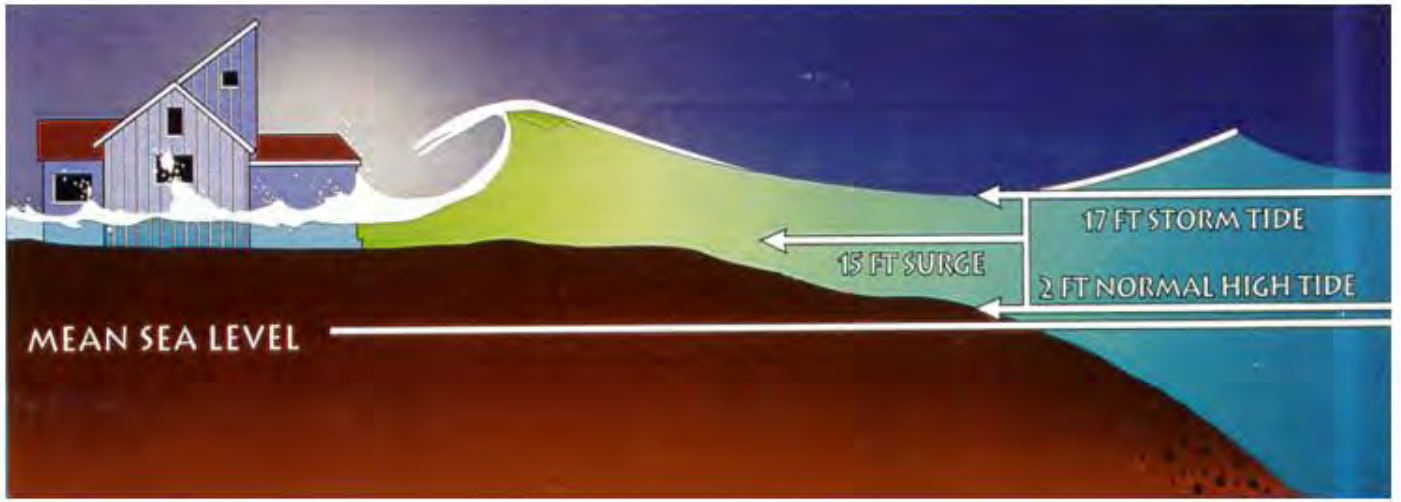
Extra-Tropical Storms (Nor'easters)



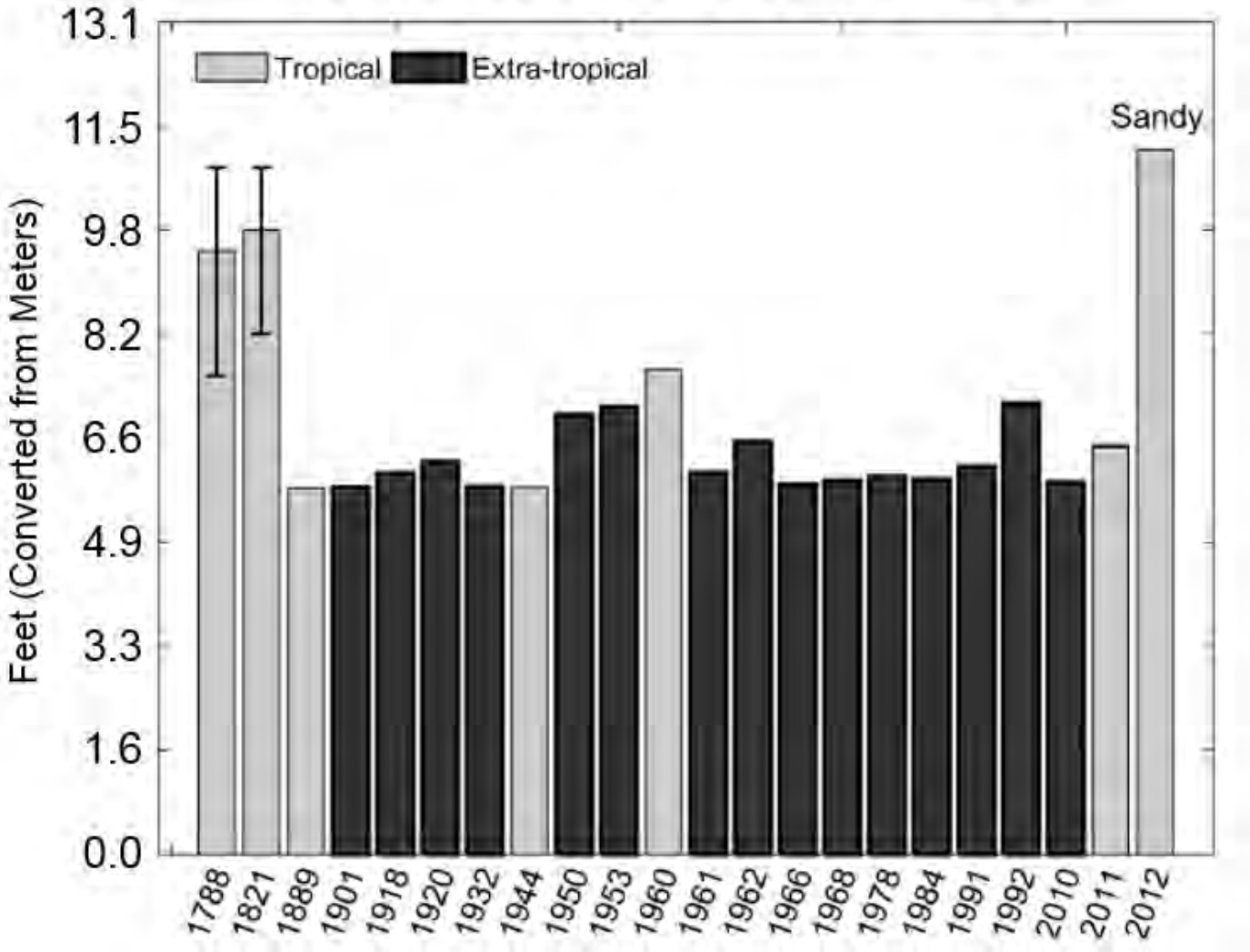
Water level = Tides + Meteorology

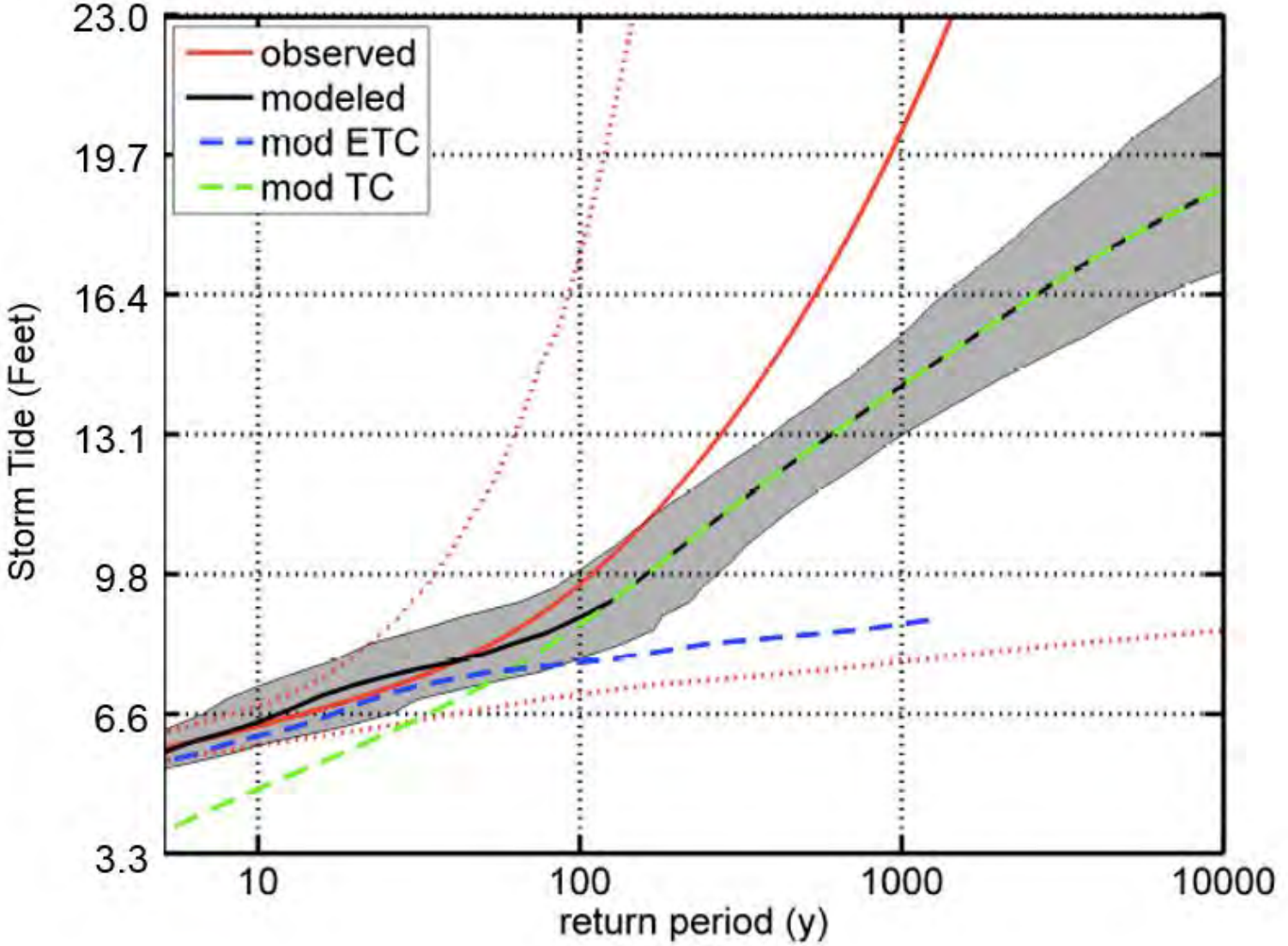
Tides are caused by the Sun and the Moon

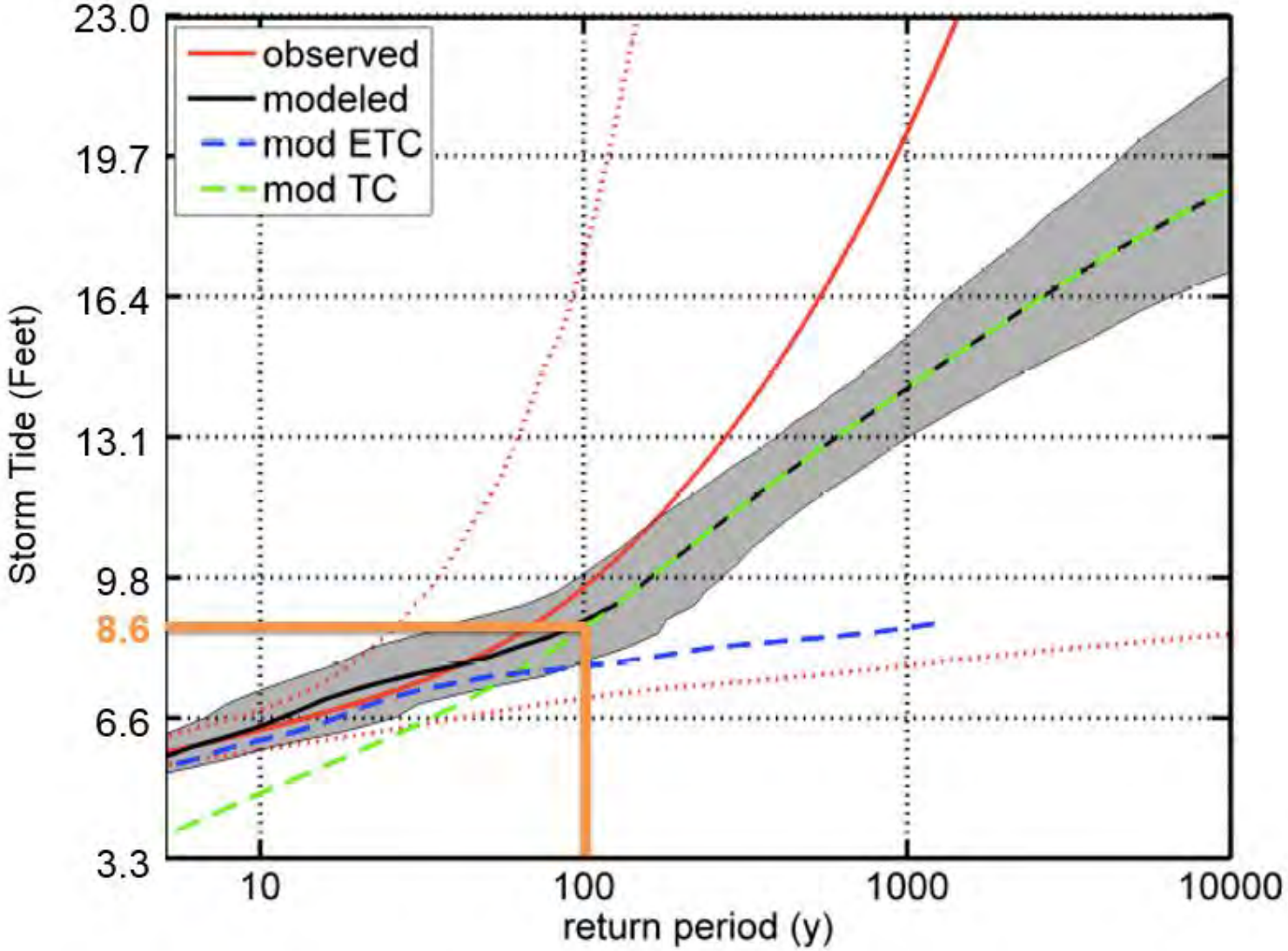
Meteorology represents the “Storm Tide”



Storms of The Past




observed
modeled
mod ETC
mod TC
23.0
19.7
16.4
13.1
9.8
6.6
3.3
Storm Tide (Feet)
10
100
1000
10000
return period (y)


observed
modeled
mod ETC
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Storm Tide (Feet)
23.0
19.7
16.4
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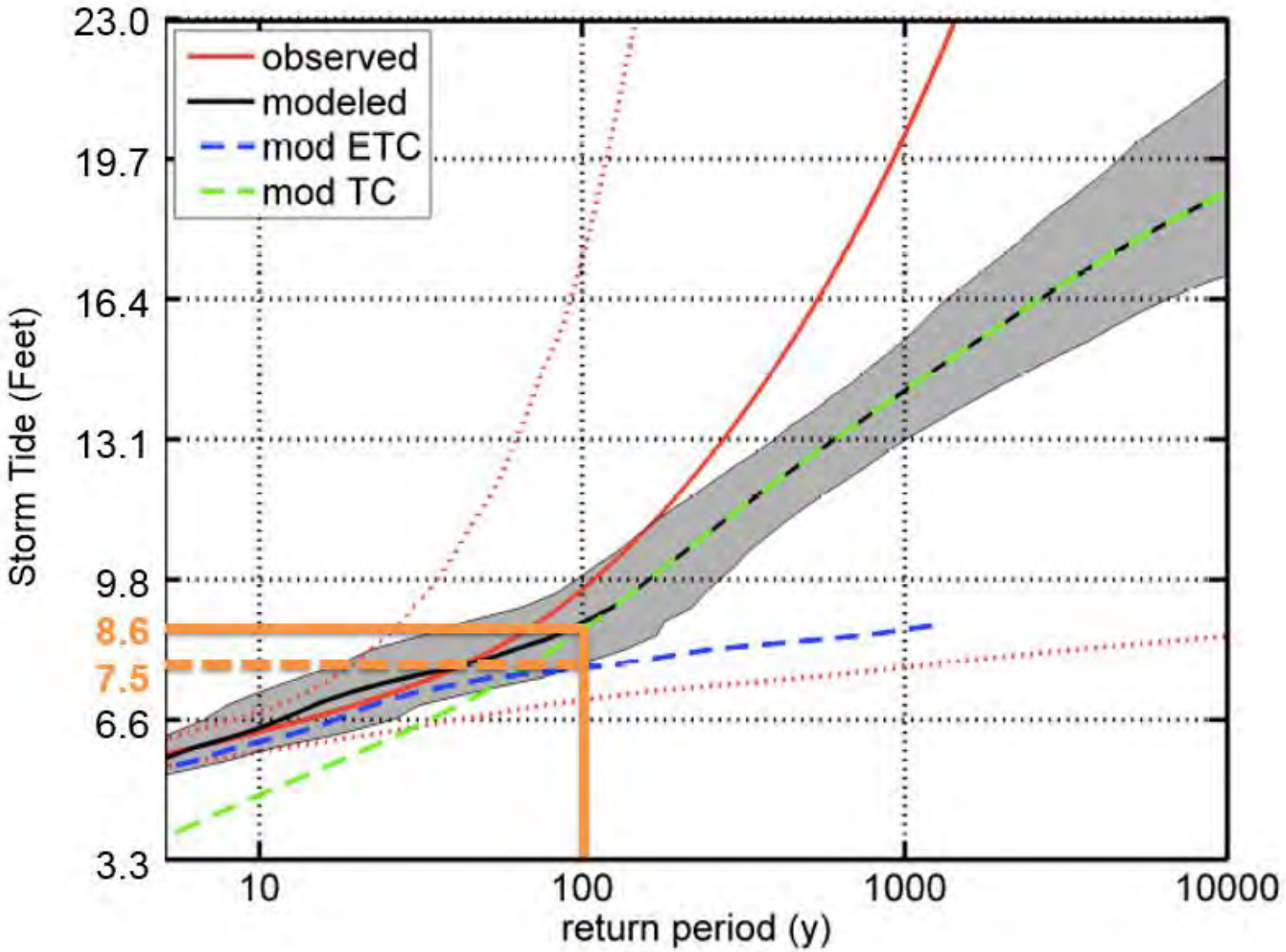
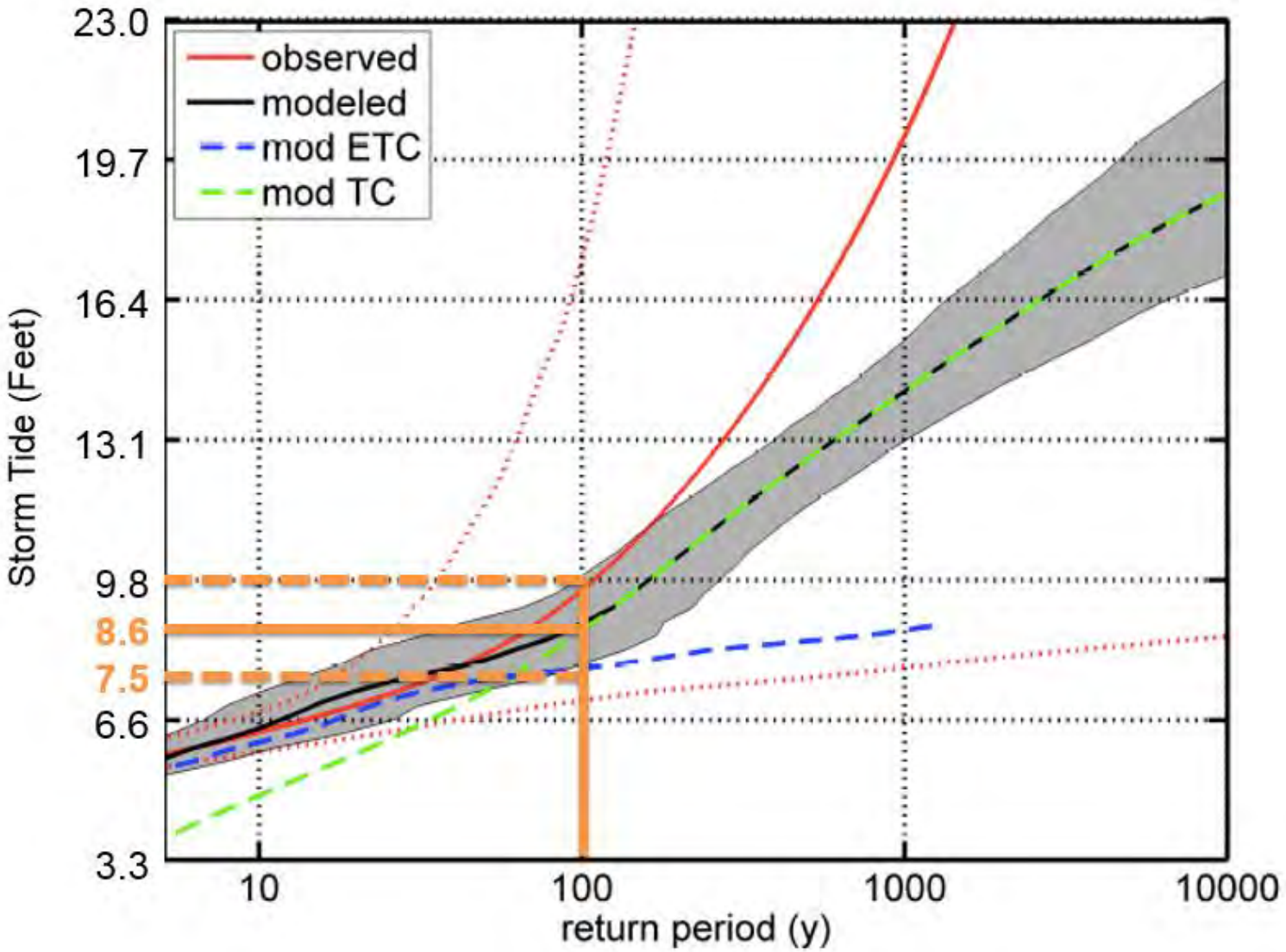
9.8
8.6
6.6
3.3
10
100
1000
10000
return period (y)


observed
modeled
mod ETC
mod TC
Storm Tide (Feet)
23.0
19.7
16.4
13.1
9.8
8.6
7.5
6.6
3.3
10
100
1000
10000
return period (y)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23.0
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16.4
13.1
9.8
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7.5
6.6
3.3
Storm Tide (Feet)
10
100
1000
10000
return period (y)

Probabilities

10 year event is 10% - 1 to 2 feet of water*
chance of being left handed

50 year event is 2% - 3 to 6 feet of water*
chance you will get Chickenpox after the vaccine
or chance of getting bitten by a dog

100 year event is 1% - 5 to 8 feet of water*
chance of earning more than $22,500/year

Hurricane Sandy's storm tide was a
260 year event or 0.4% - 6 to 9 feet of water*

Same probability as having identical twins.

*** On the ground in Hoboken**

The Basis of Urban Coast Dynamic Flood Models
Isaac Newton - 1687

Depth Integrated Equations of Motion

$$\bar{u} = \frac{1}{D}\int_{-h}^{\eta} u\,dz; \quad \bar{v} = \frac{1}{D}\int_{-h}^{\eta} v\,dz; \quad D = h + \eta$$

$$\frac{\partial \eta}{\partial t} + \frac{\partial}{\partial x}(\bar{u}D) + \frac{\partial}{\partial y}(\bar{v}D) = 0$$

$$\frac{\partial \bar{u}}{\partial t} + \bar{u}\frac{\partial \bar{u}}{\partial x} + \bar{v}\frac{\partial \bar{u}}{\partial y} - f\bar{v} = -g\frac{\partial \eta}{\partial x} + \frac{\tau_{sx} - \tau_{bx}}{\rho_o D}$$

$$\frac{\partial \bar{v}}{\partial t} + \bar{u}\frac{\partial \bar{v}}{\partial x} + \bar{v}\frac{\partial \bar{v}}{\partial y} + f\bar{u} = -g\frac{\partial \eta}{\partial y} + \frac{\tau_{sy} - \tau_{by}}{\rho_o D}$$

$$m\vec{a} = \sum \vec{F}$$

Data, Data, Data

Models contain our 'knowledge' of the physics.

Data contains information about the 'true' state

Data Requirements:

Wind & Atmospheric pressure over NY/NJ metro area

Tides in the adjoining offshore NY Bight

Water level data in Hoboken, JC, Weehawken & NYC


Weehawken
Hoboken
Jersey City
0 10 20 m


HOBOKEN

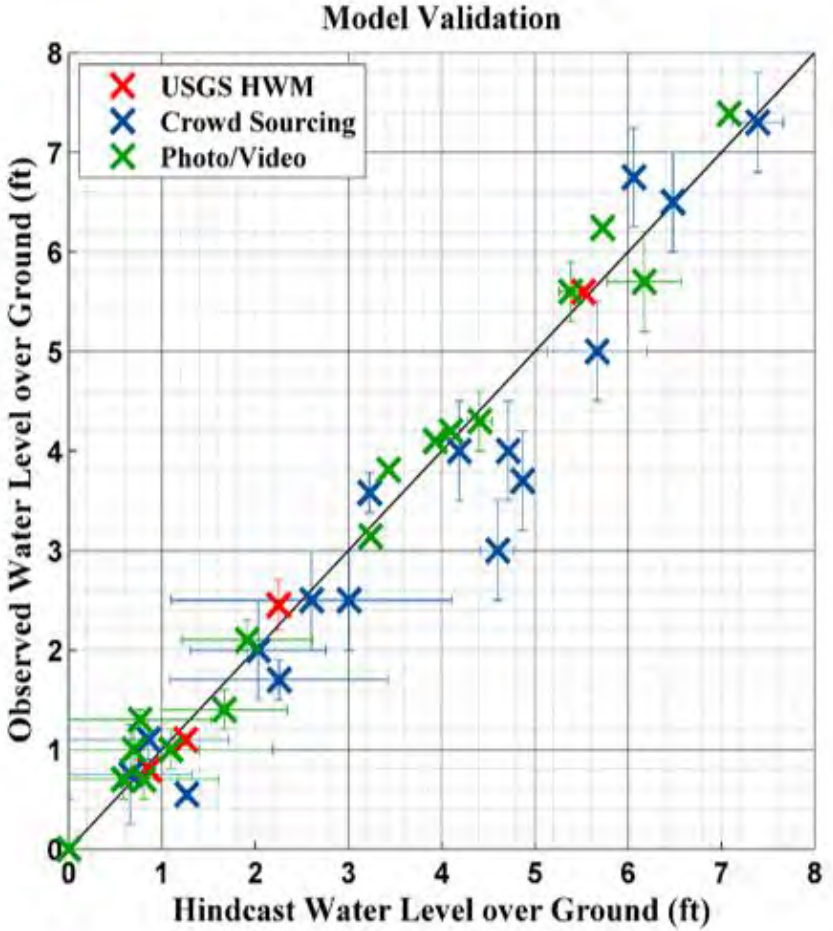
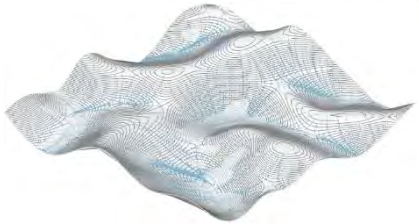

Model Validation
USGS HWM
Crowd Sourcing
Photo/Video
Observed Water Level over Ground (ft)
Hindcast Water Level over Ground (ft)
0
1
2
3
4
5
6
7
8

Photo courtesy of REUTERS/Eduardo Munoz

Coastal Modeling Input and Output Parameters

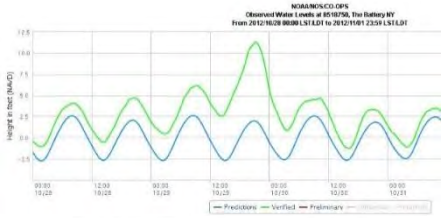
Used FEMA accepted Danish Hydraulic Institute (DHI) MIKE 21 Coastal Model

Major MIKE 21 Coastal Model Inputs



Topography

Land Use



Storm Surge Water Levels

MIKE 21 Coastal Model Simulation Engine

Major MIKE 21 Coastal Model Outputs

- Maximum Water Depth
- Animations
- Time Series Plots
- Difference Plots

Coastal Scenarios

- No Action Alternative (NAA)
- Alternative 1
- Alternative 2
- Alternative 3

RESIST ALTERNATIVES

Alternative 1 (Waterfront)

Alternative 2 (15th Street)

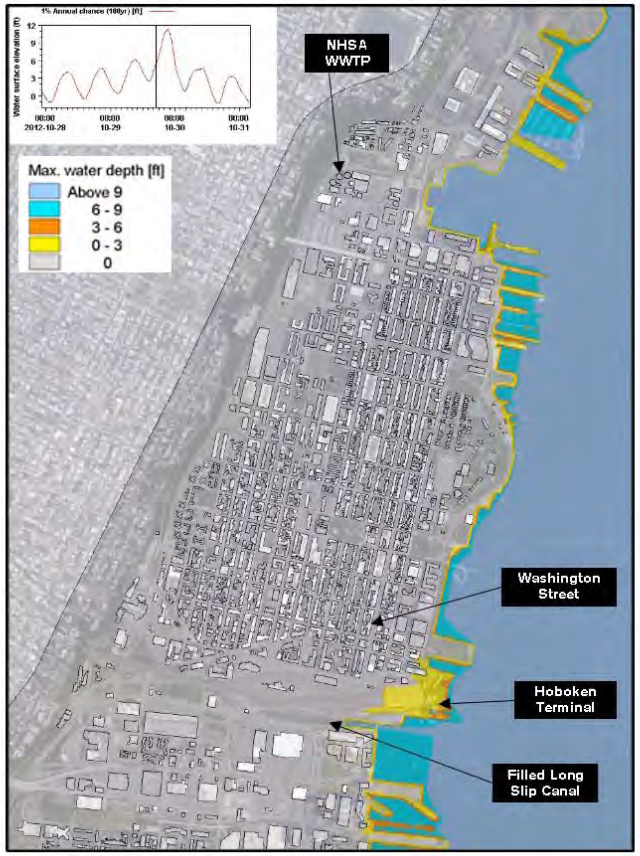
Alternative 3 (Alleyway)

Coastal Modeling Scenario

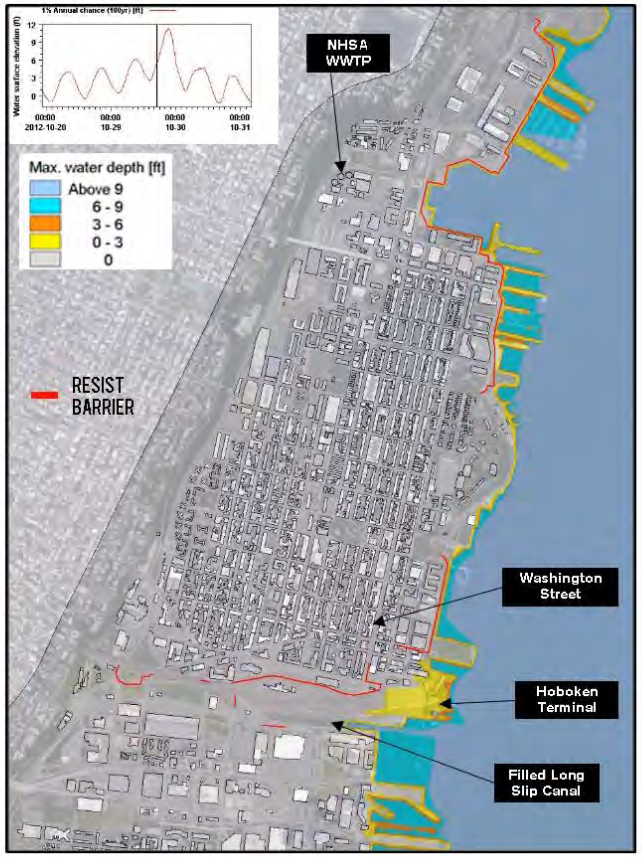
100 Year Coastal Storm (1%)

ANIMATION SHOWING 100-YEAR COASTAL STORM SURGE FOR NAA AND ALTERNATIVE 1

No Action Alternative

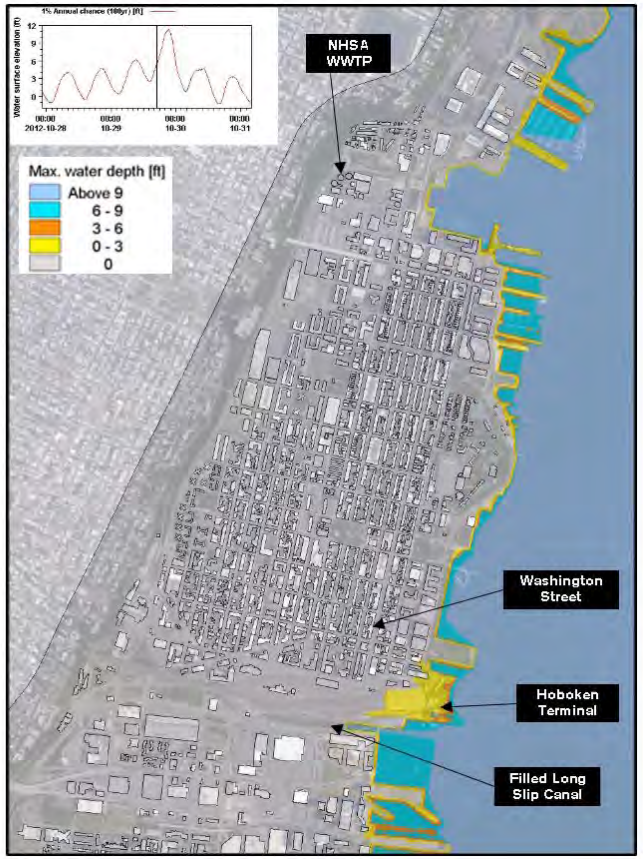


Alternative 1



ANIMATION SHOWING 100-YEAR COASTAL STORM SURGE FOR NAA AND ALTERNATIVE 2

No Action Alternative



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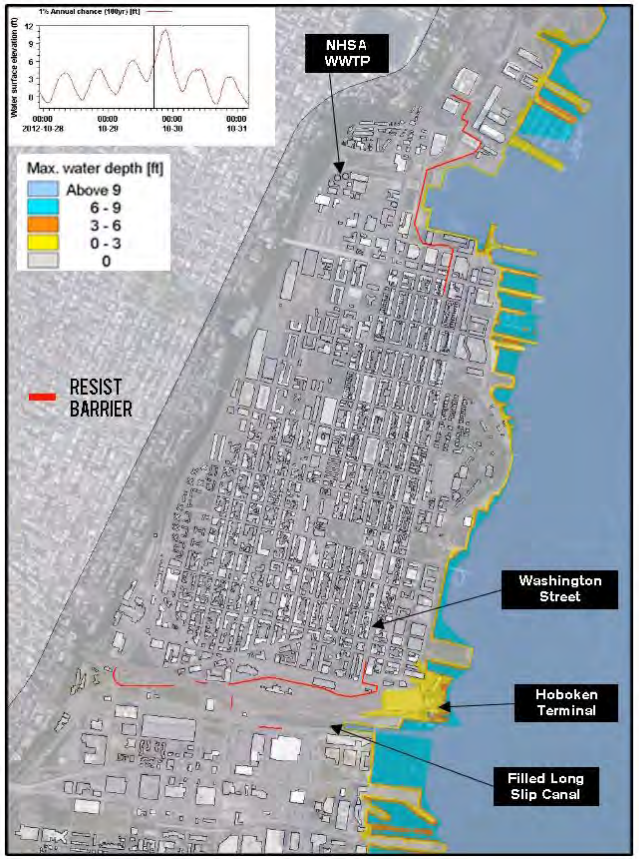
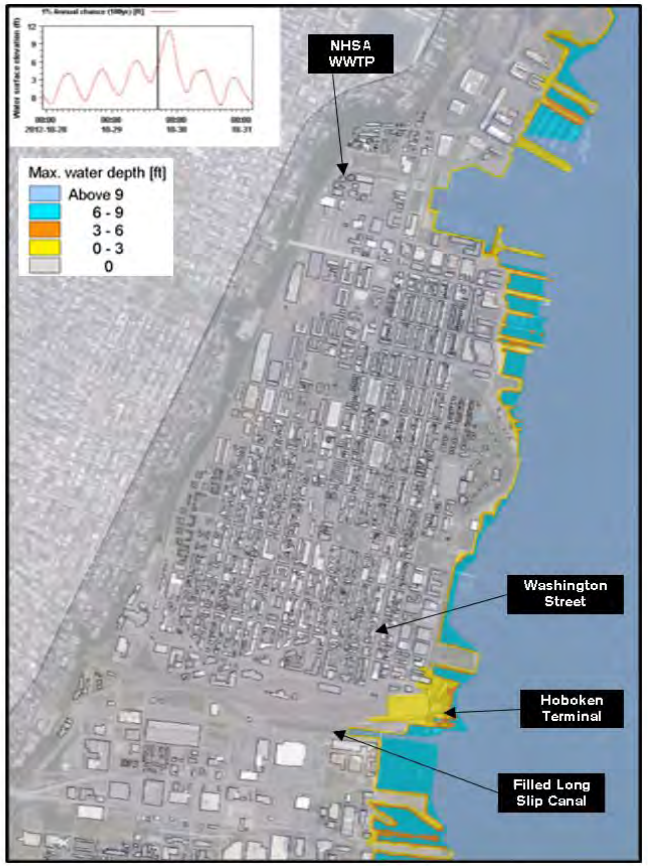
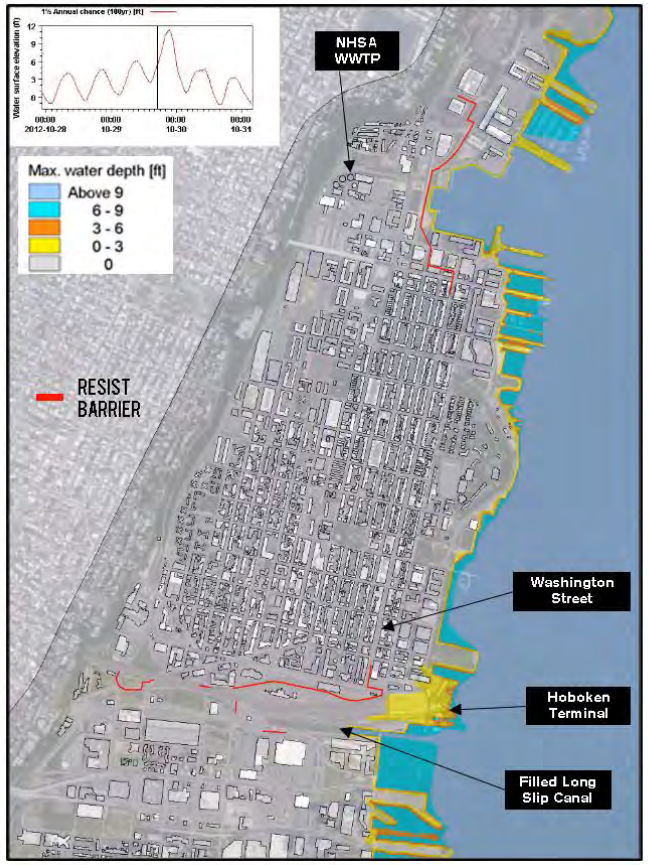


ANIMATION SHOWING 100-YEAR COASTAL STORM SURGE FOR NAA AND ALTERNATIVE 3

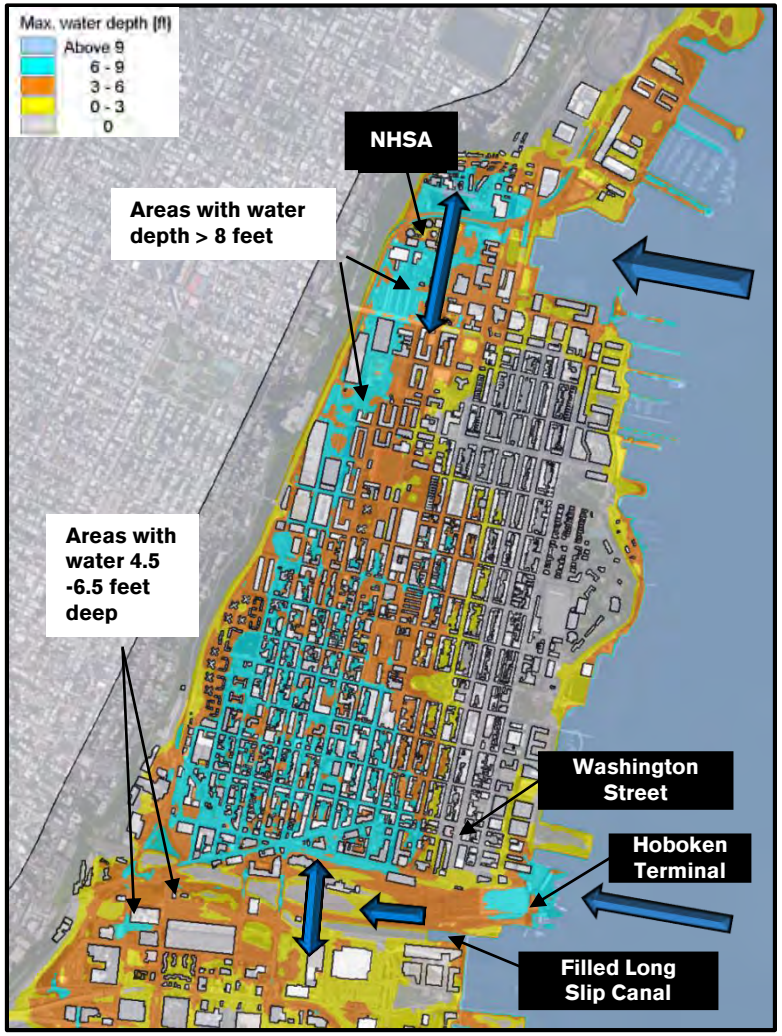
No Action Alternative



Alternative 3



NAA WITH 100-YEAR COASTAL STORM SURGE
MAX. WATER DEPTH IN FEET

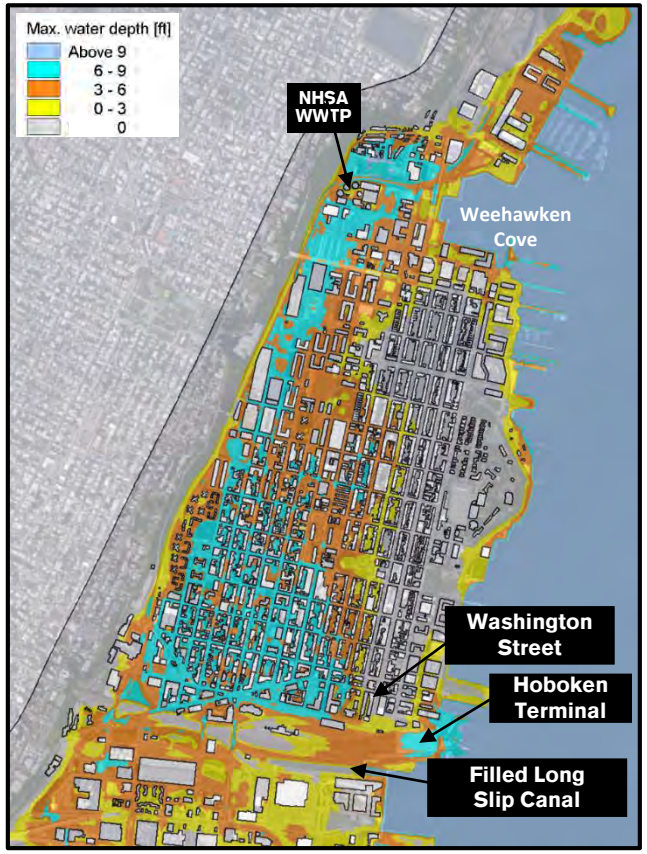


Flood waters enter the north via the Weehawken Cove area.

Flood waters enter Hoboken & Jersey City via the NJT Hoboken Terminal

NAA AND ALTERNATIVE 1 WITH 100-YEAR COASTAL STORM SURGE
MAX. WATER DEPTH IN FEET

No Action Alternative



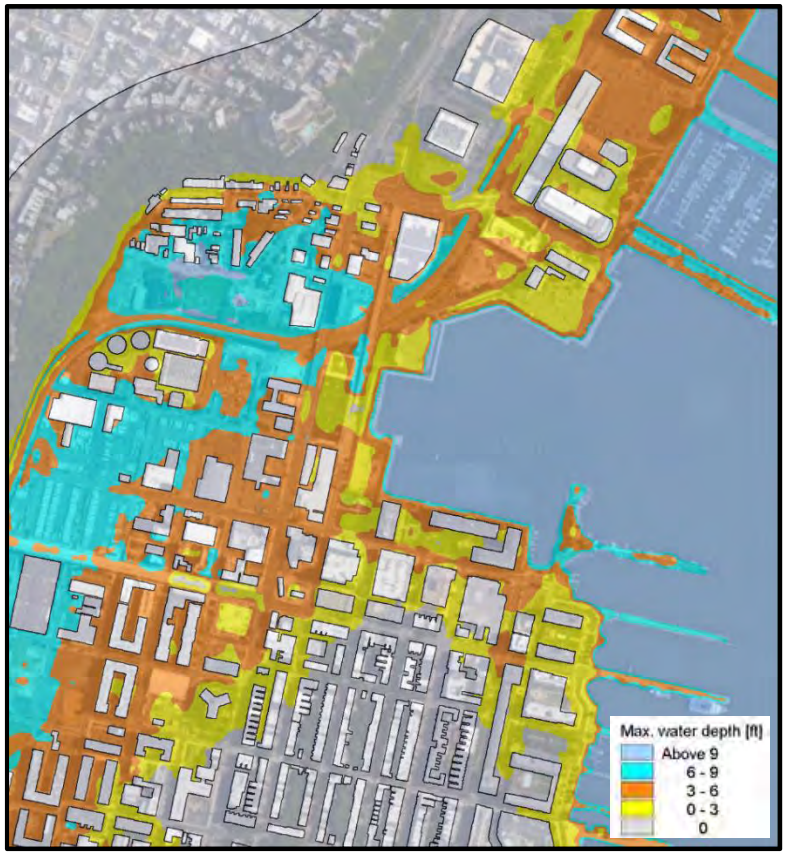
Alternative 1

— shows resist feature alignment

NORTH AREA CLOSE-UP COMPARISON OF NAA AND ALTERNATIVE 1 WITH 100-YEAR COASTAL STORM SURGE

MAX. WATER DEPTH IN FEET

No Action Alternative



Alternative 1

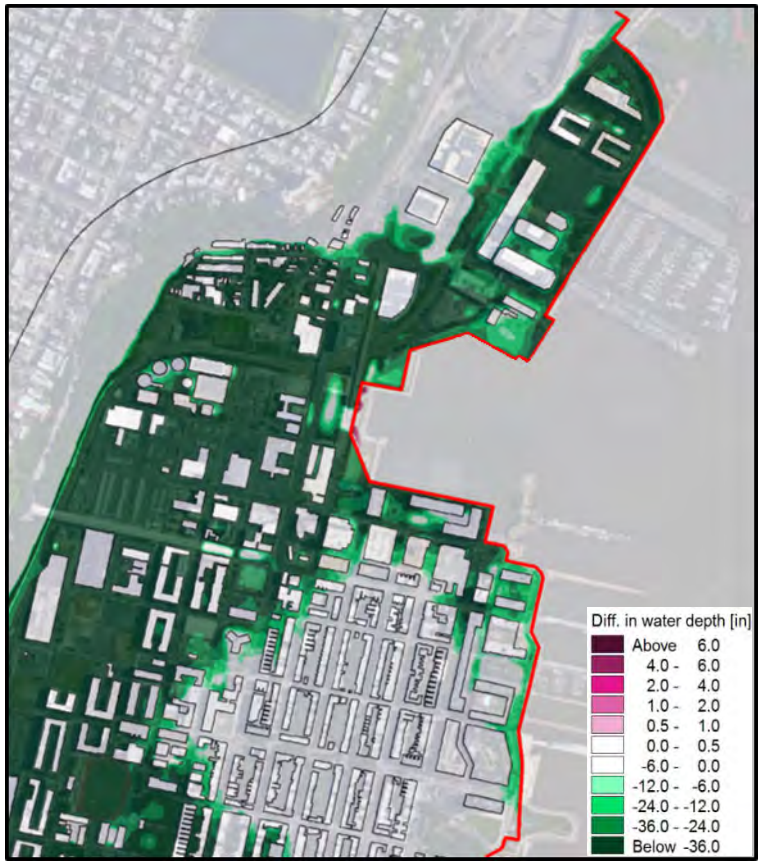
DIFFERENCE IN WATER DEPTH (IN INCHES) BETWEEN NAA AND ALTERNATIVE 1 IN THE NORTH STUDY AREA FOR THE 100-YEAR COASTAL STORM SURGE

GREEN shows decreases in flood depth in inches

PINK shows increases in flood depth in inches

—— shows resist feature alignment

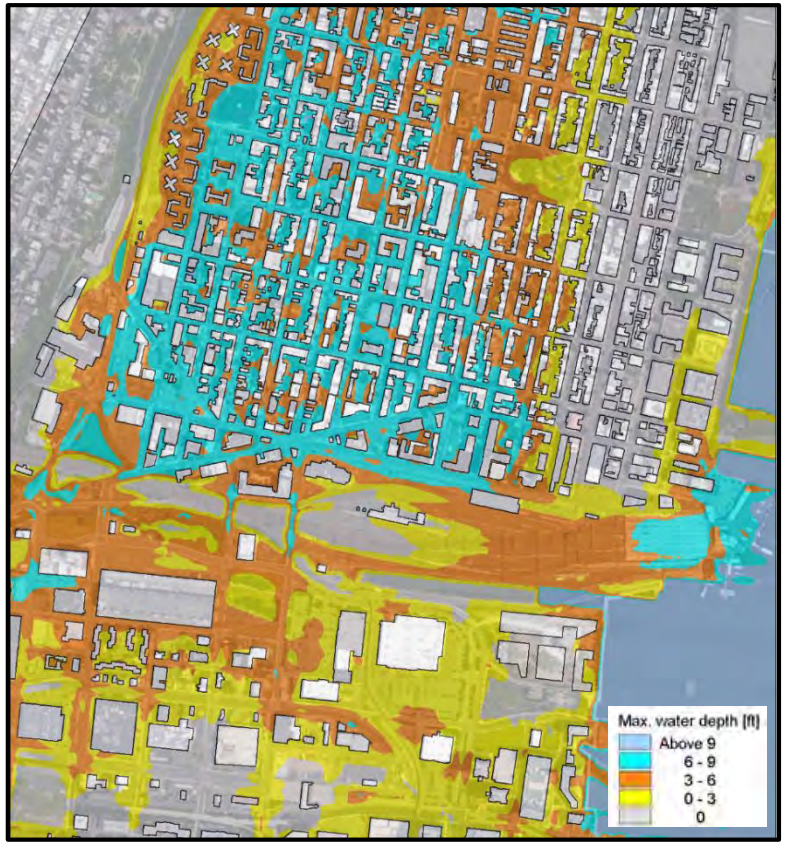
Alternative 1



SOUTHERN AREA CLOSE-UP COMPARISON OF NAA AND ALTERNATIVE 1 WITH 100-YEAR COASTAL STORM SURGE

MAX. WATER DEPTH IN FEET

No Action Alternative



Alternative 1

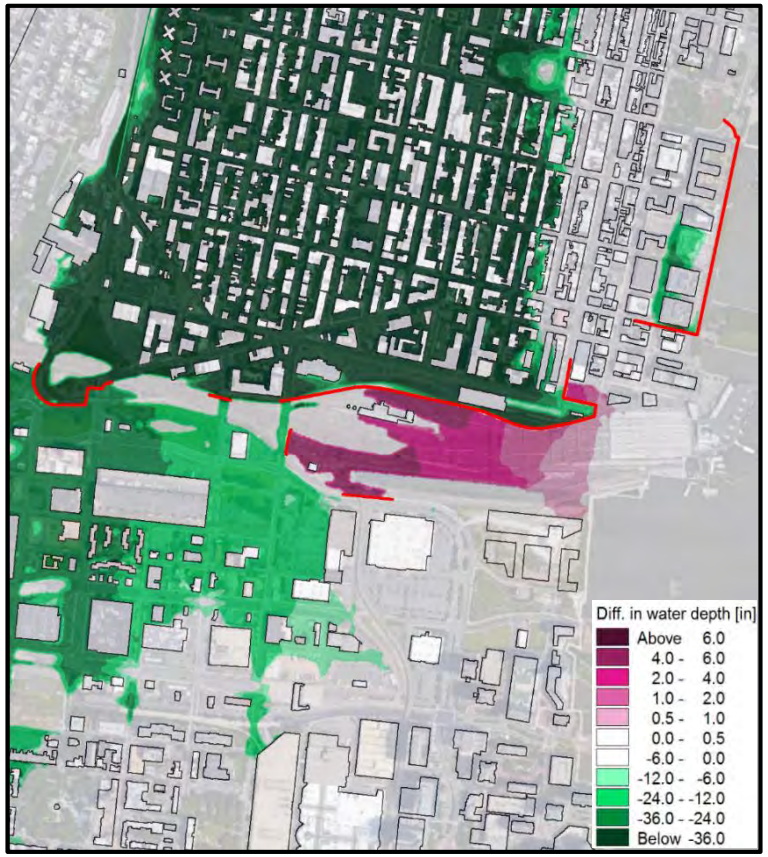
DIFFERENCE IN WATER DEPTH (IN INCHES) BETWEEN NAA AND ALTERNATIVE 1 IN THE SOUTH STUDY AREA FOR THE 100-YEAR COASTAL STORM SURGE

GREEN shows decreases in flood depth in inches

PINK shows increases in flood depth in inches

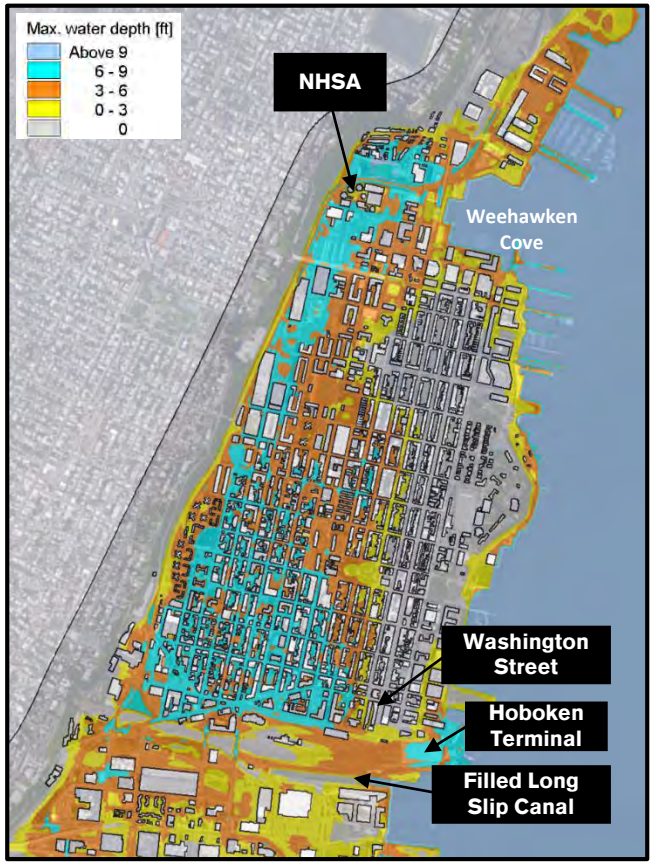
—— shows resist feature alignment

Alternative 1

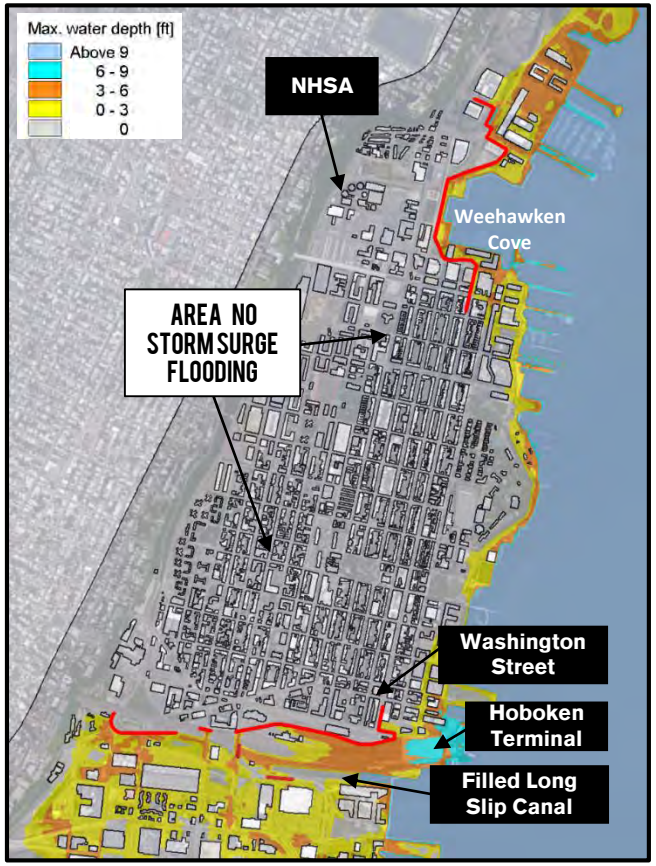


NAA AND ALTERNATIVE 2 WITH 100-YEAR COASTAL STORM SURGE
MAX. WATER DEPTH IN FEET

No Action Alternative



Alternative 2



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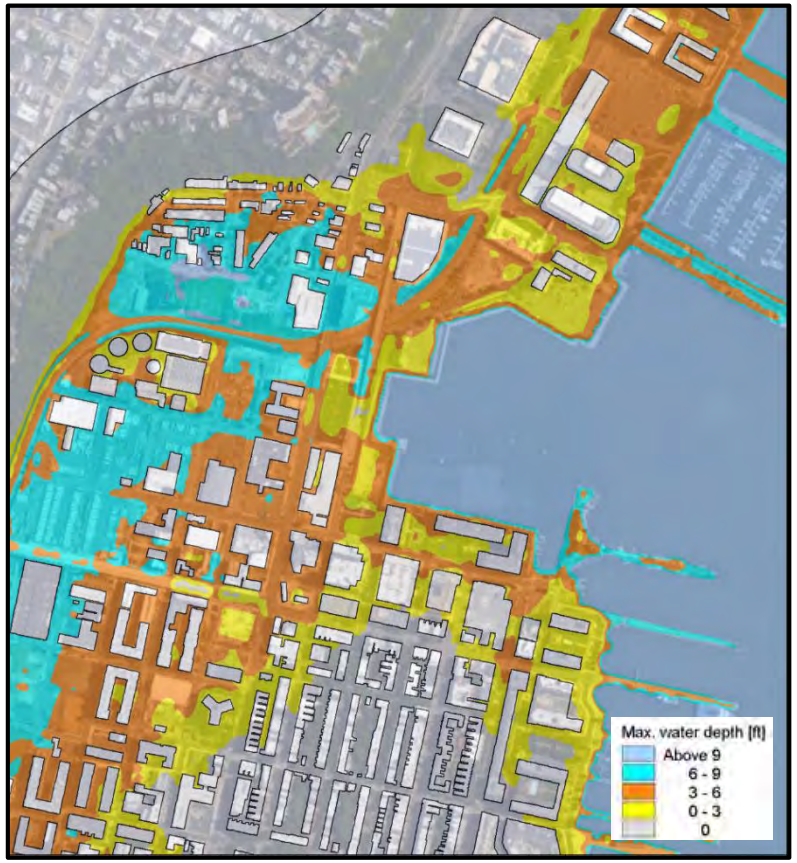
NORTHERN AREA CLOSE-UP COMPARISON OF NAA AND ALTERNATIVE 2 WITH 100-YEAR COASTAL STORM SURGE

MAX. WATER DEPTH IN FEET

No Action Alternative



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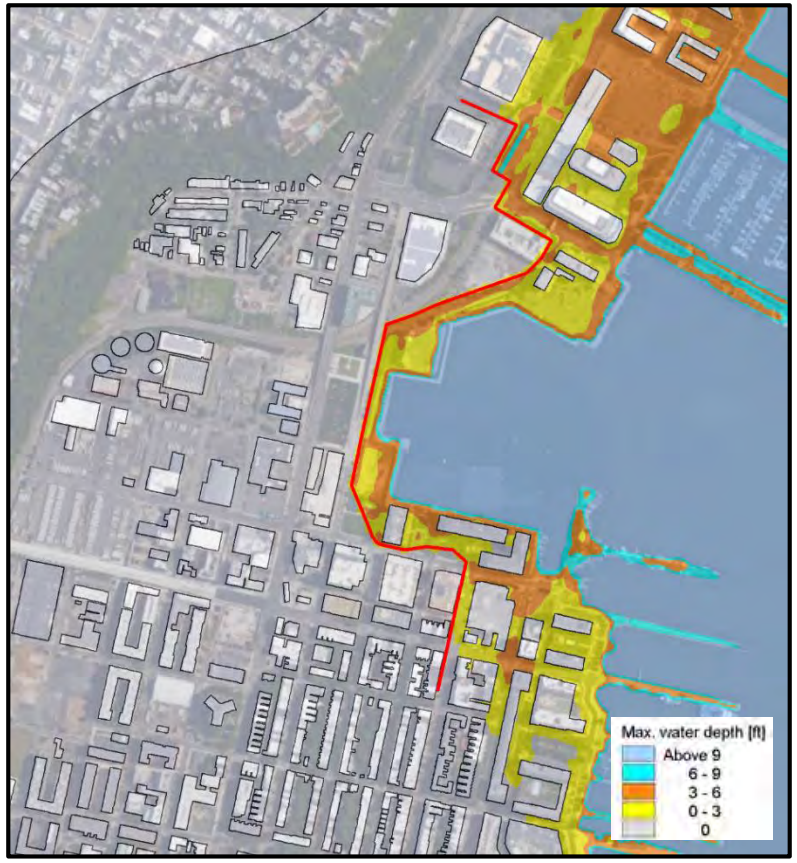


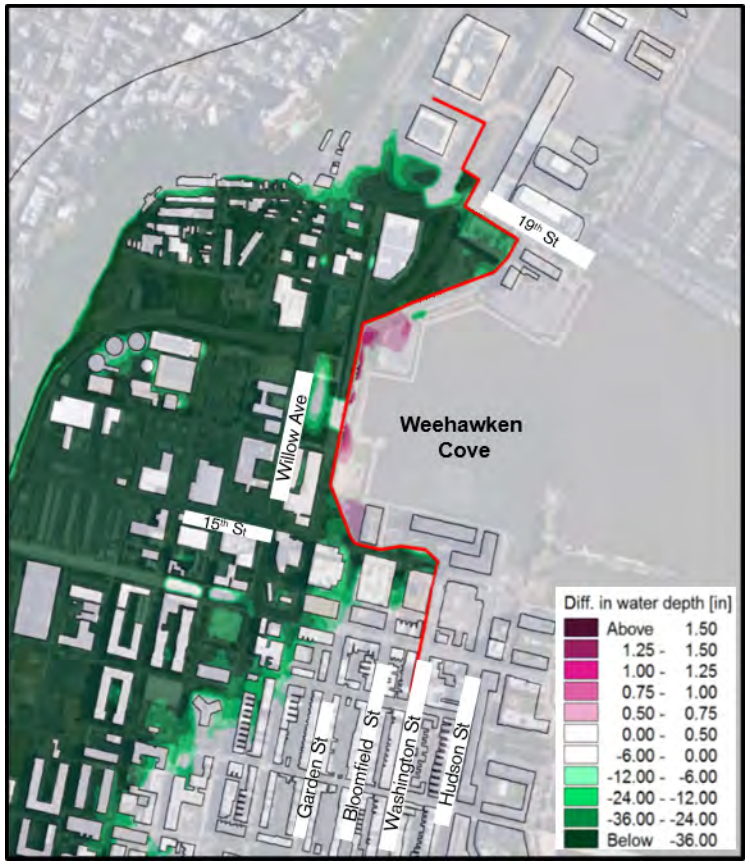
DIFFERENCE IN WATER DEPTH (IN INCHES) BETWEEN NAA AND ALTERNATIVE 2 IN THE NORTH STUDY AREA FOR THE 100-YEAR COASTAL STORM SURGE

GREEN shows decreases in flood depth in inches

PINK shows increases in flood depth in inches

—— shows resist feature alignment

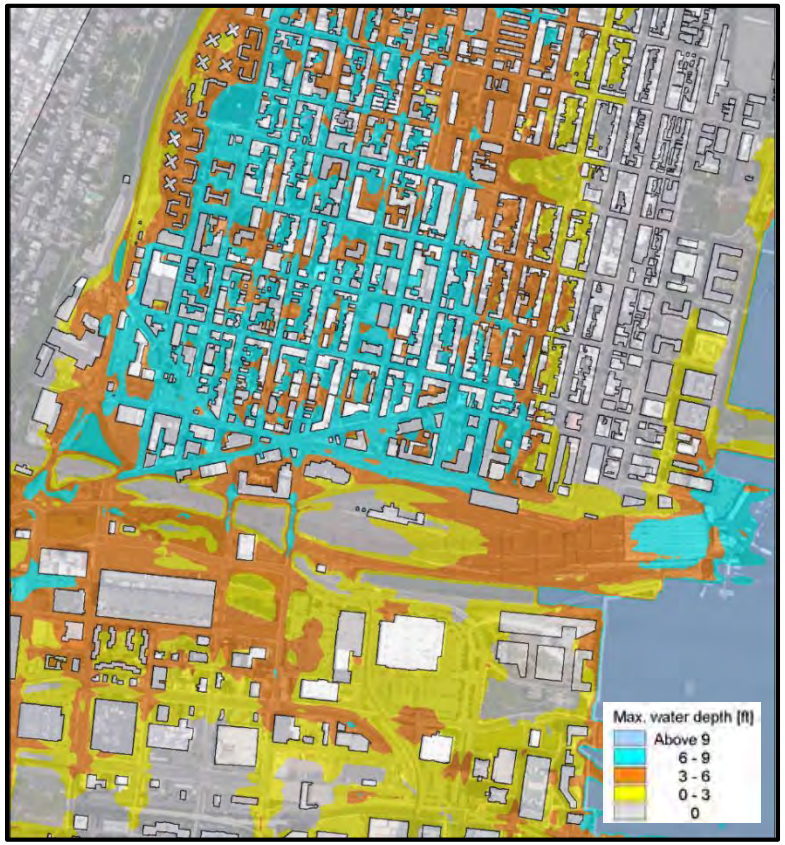
Alternative 2



SOUTHERN AREA CLOSE-UP COMPARISON OF NAA AND ALTERNATIVE 2 WITH 100-YEAR COASTAL STORM SURGE

MAX. WATER DEPTH IN FEET

No Action Alternative



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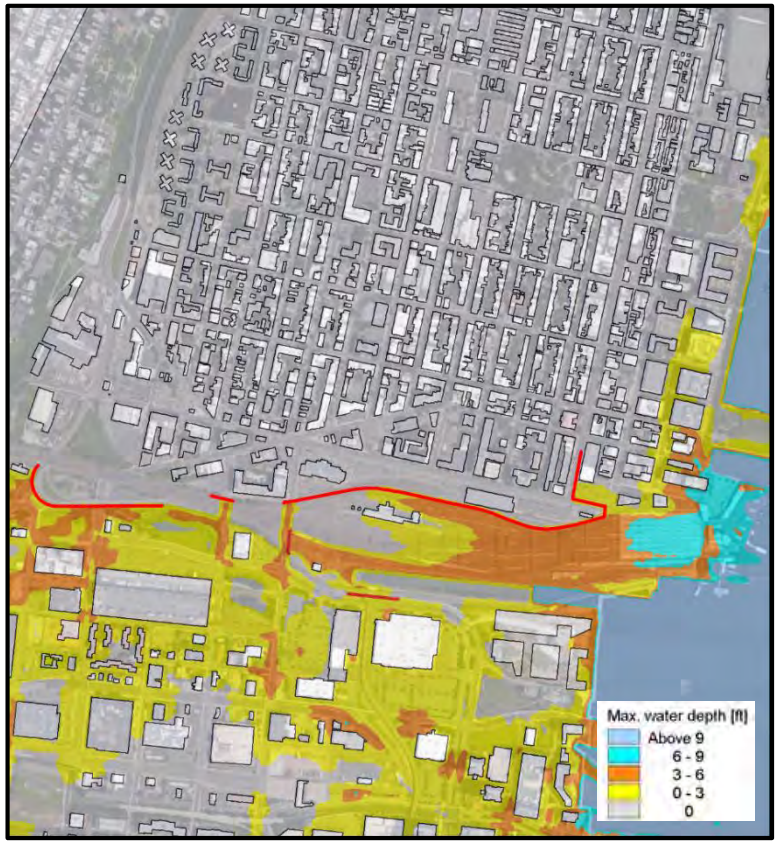


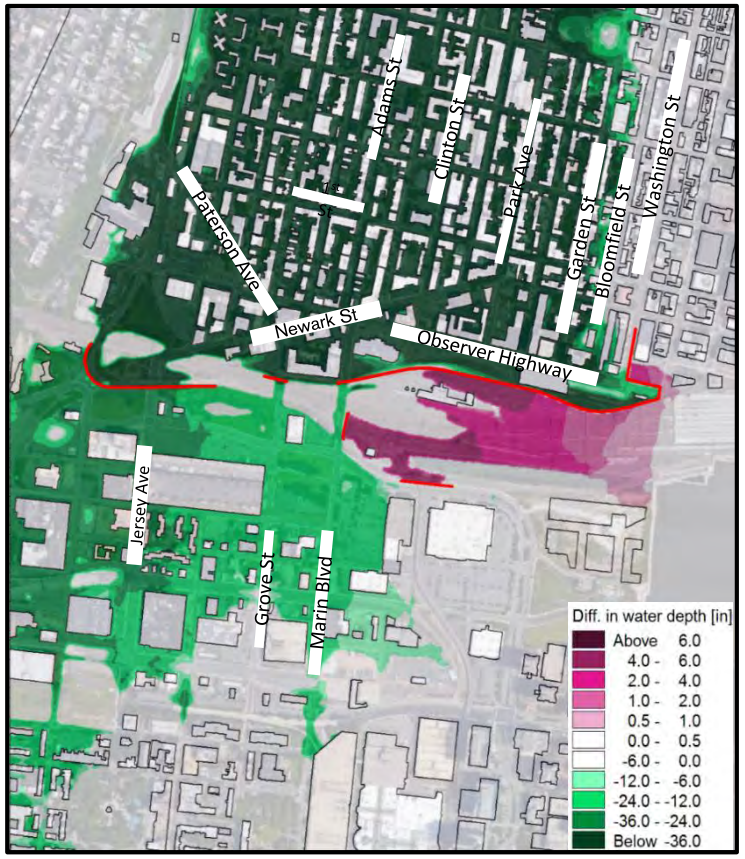
DIFFERENCE IN WATER DEPTH (IN INCHES) BETWEEN NAA AND ALTERNATIVE 2 IN THE SOUTH STUDY AREA FOR THE 100-YEAR COASTAL STORM SURGE

GREEN shows decreases in flood depth in inches

PINK shows increases in flood depth in inches

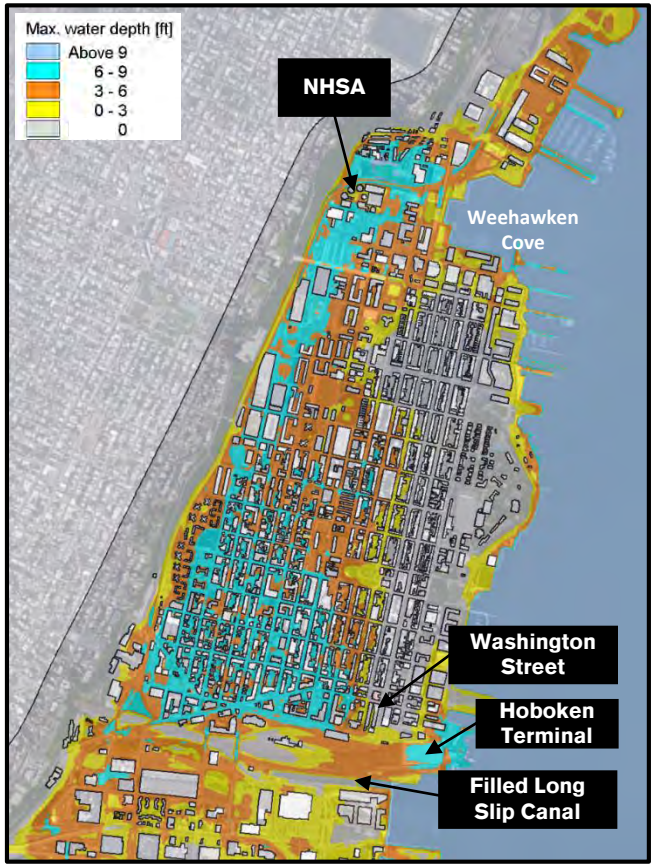
—— shows resist feature alignment

Alternative 2

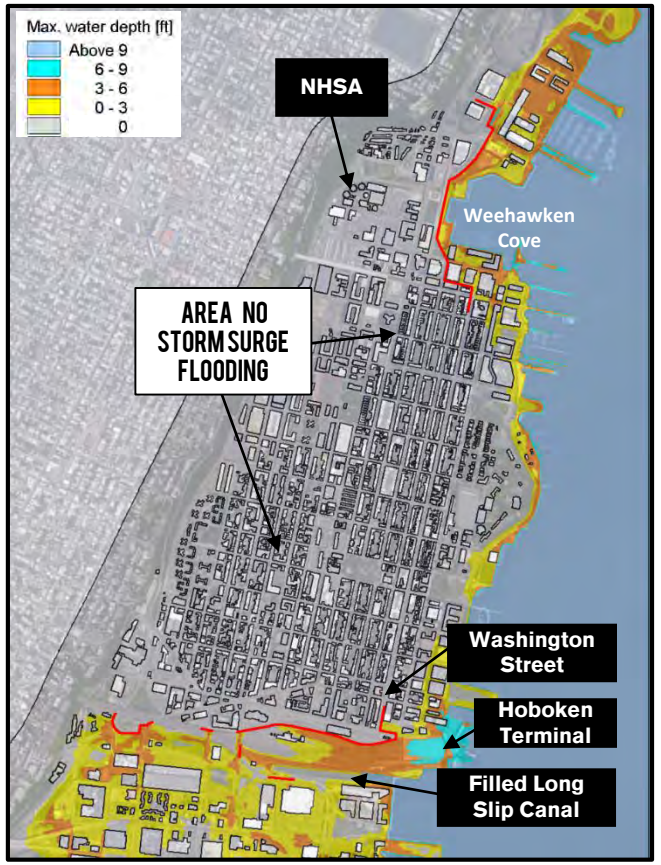


NAA AND ALTERNATIVE 3 WITH 100-YEAR COASTAL STORM SURGE
MAX. WATER DEPTH IN FEET

No Action Alternative



Alternative 3

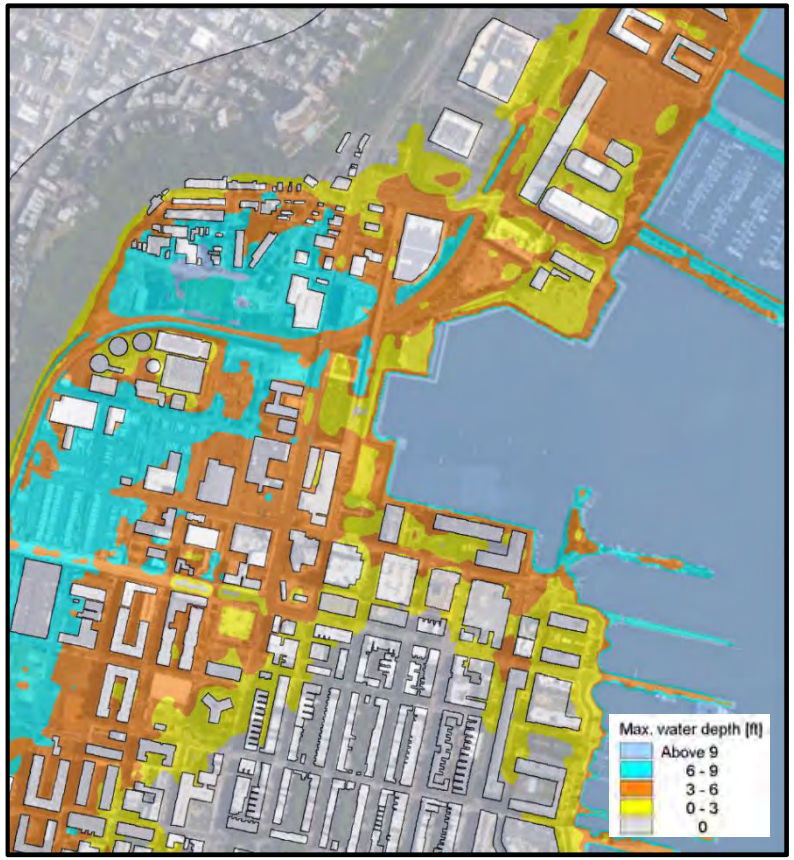


—— shows resist feature alignment

NORTHERN AREA CLOSE-UP COMPARISON OF NAA AND ALTERNATIVE 3 WITH 100-YEAR COASTAL STORM SURGE

MAX. WATER DEPTH IN FEET

No Action Alternative



Alternative 3

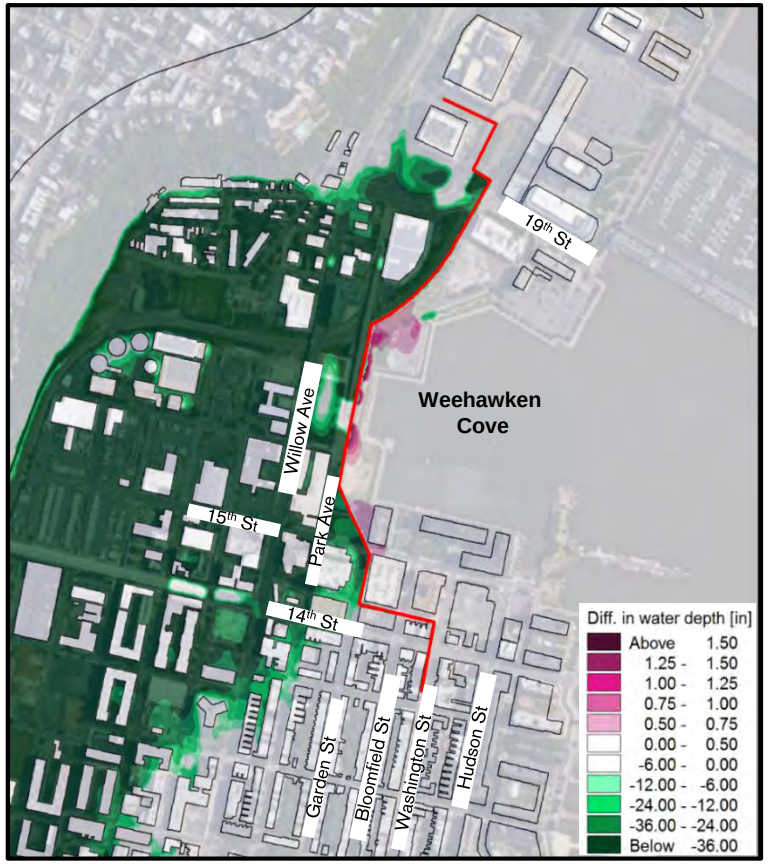
DIFFERENCE IN WATER DEPTH (IN INCHES) BETWEEN NAA AND ALTERNATIVE 3 IN THE NORTH STUDY AREA FOR THE 100-YEAR COASTAL STORM SURGE

GREEN shows decreases in flood depth in inches

PINK shows increases in flood depth in inches

—— shows resist feature alignment

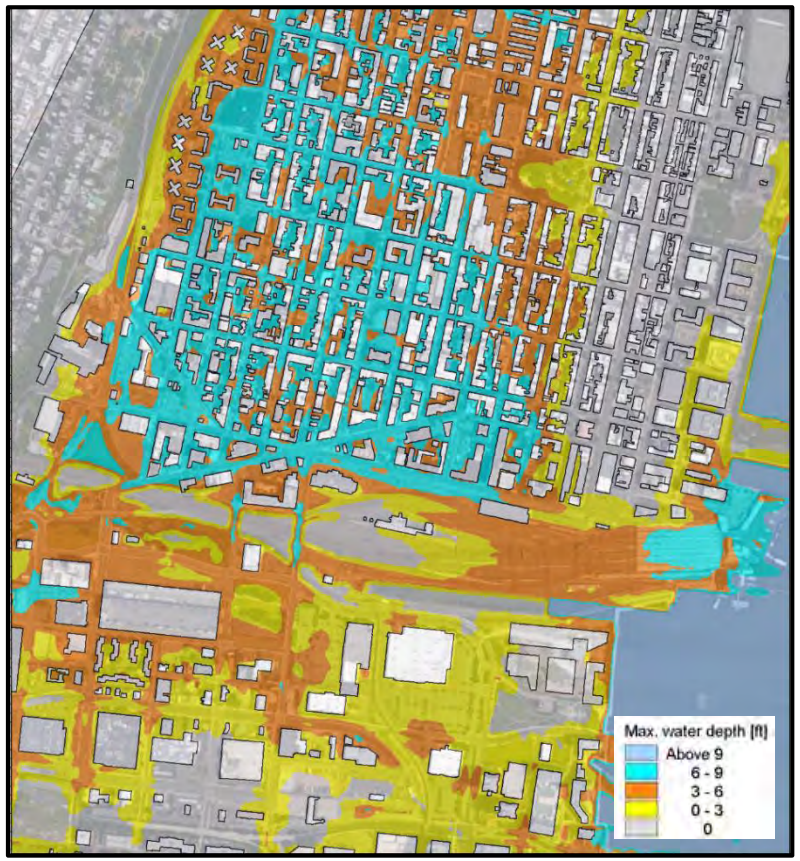
Alternative 3



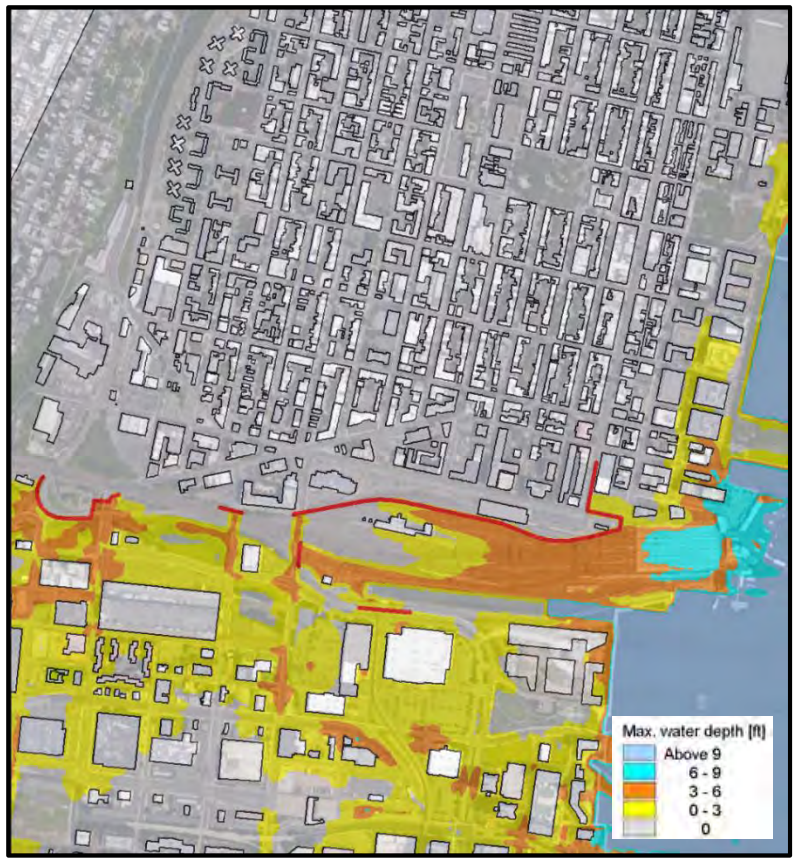
SOUTHERN AREA CLOSE-UP COMPARISON OF NAA AND ALTERNATIVE 3 WITH 100-YEAR COASTAL STORM SURGE

MAX. WATER DEPTH IN FEET

No Action Alternative



Alternative 3



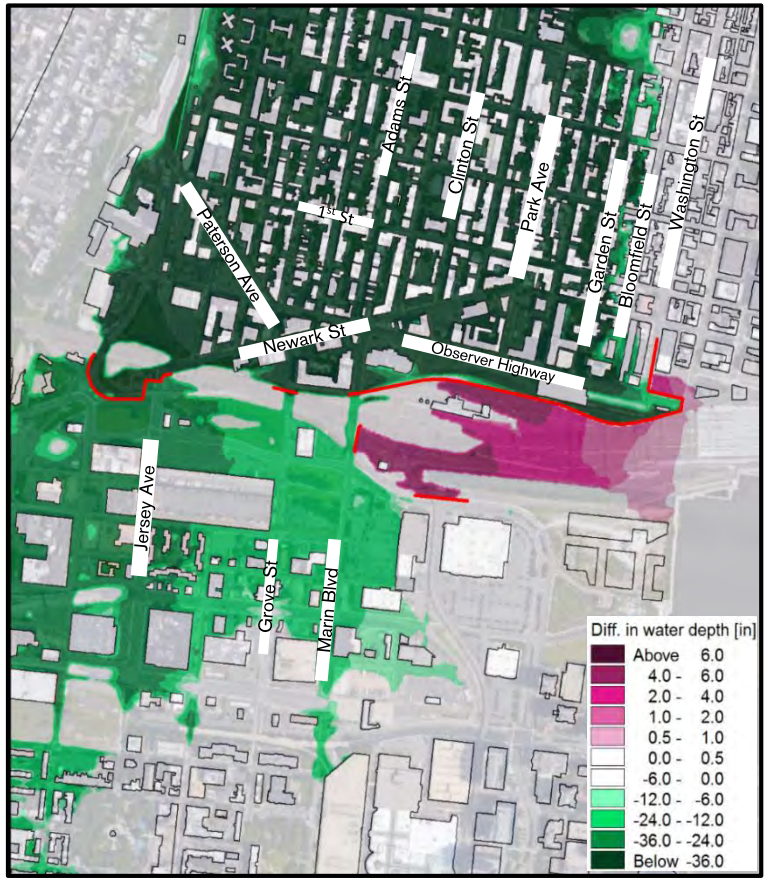
DIFFERENCE IN WATER DEPTH (IN INCHES) BETWEEN NAA AND ALTERNATIVE 3 IN THE SOUTH STUDY AREA FOR THE 100-YEAR COASTAL STORM SURGE

GREEN shows decreases in flood depth in inches

PINK shows increases in flood depth in inches

—— shows resist feature alignment

Alternative 3



Coastal Modeling Scenario

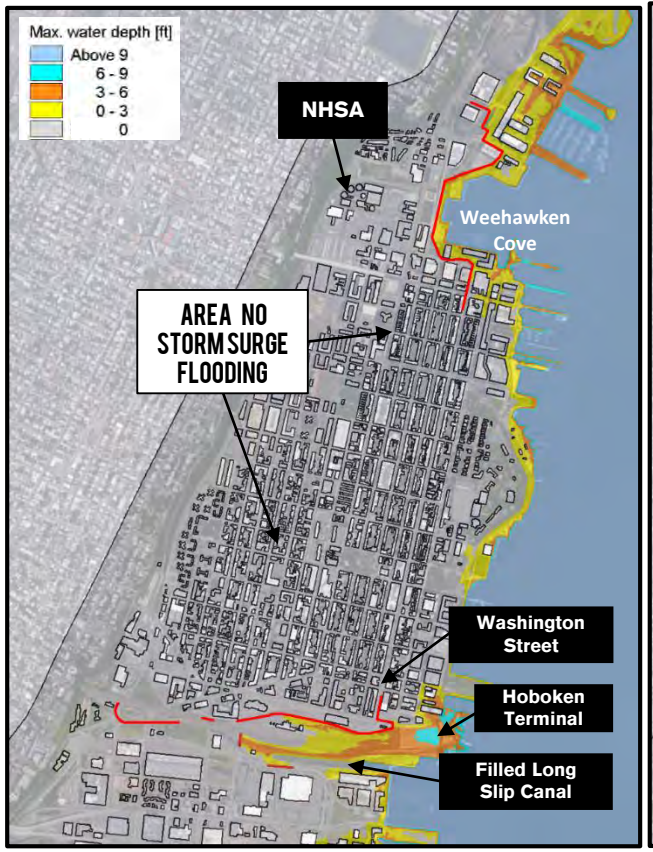
50 Year Coastal Storm (2%)

NAA, ALT. 1, ALT. 2, AND ALT. 3 WITH 50-YEAR COASTAL STORM SURGE
MAX. WATER DEPTH IN FEET

No Action Alternative

Alternative 1

Alternative 2

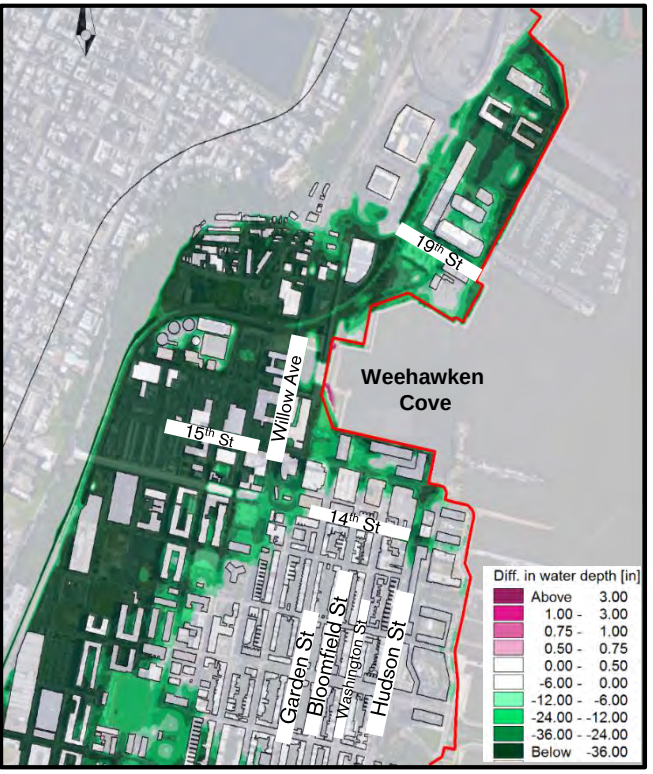


Alternative 3

shows resist feature alignment

COMPARISON OF DIFFERENCES IN WATER DEPTH (IN INCHES) BETWEEN NAA AND THREE ALTERNATIVES IN THE NORTH STUDY AREA FOR THE 50-YEAR COASTAL STORM SURGE

Alternative 1



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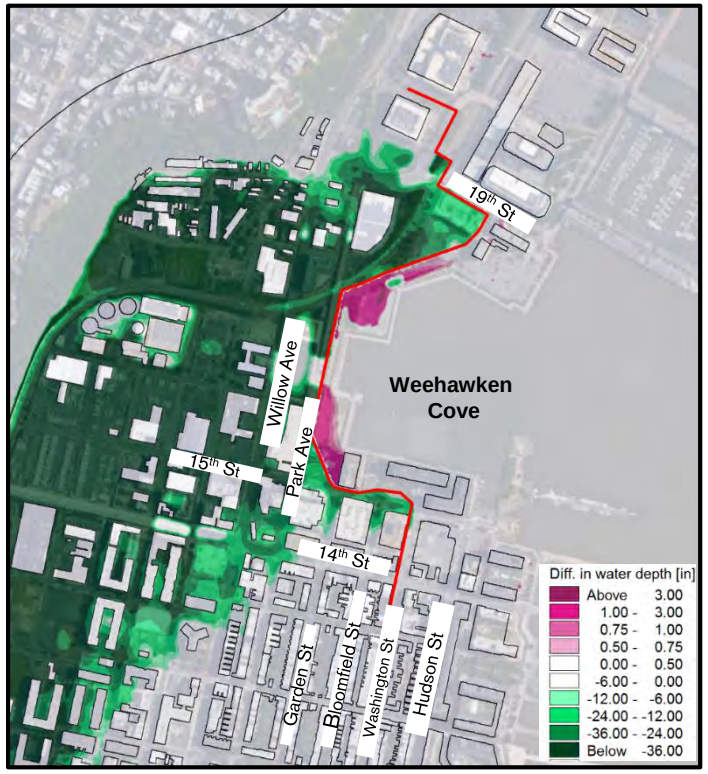
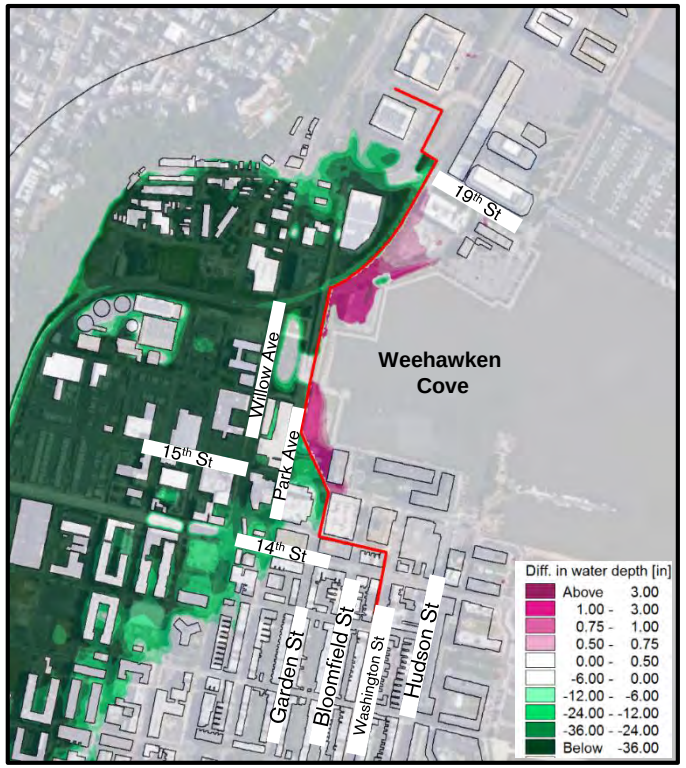


Alternative 3



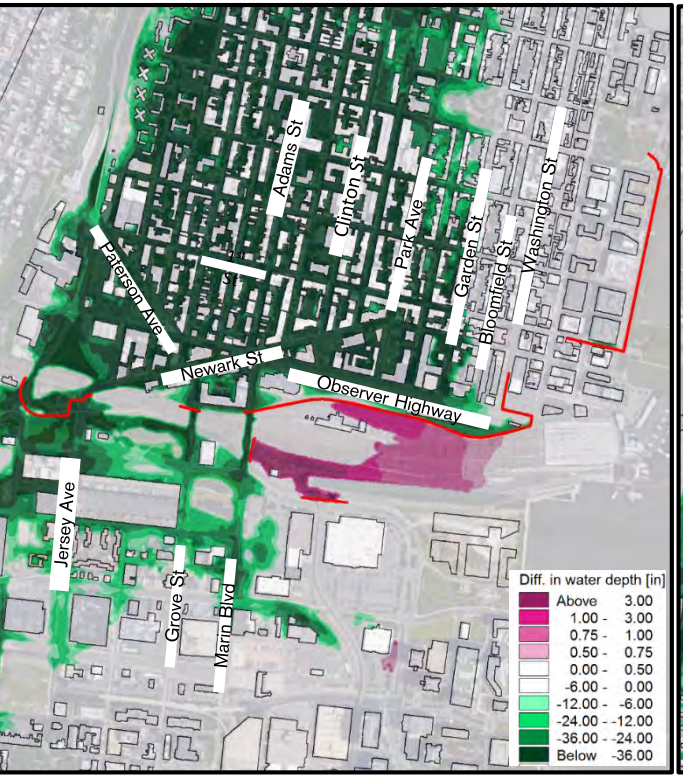
GREEN shows decreases in flood depth in inches

PINK shows increases in flood depth in inches

—— shows resist feature alignment

COMPARISON OF DIFFERENCES IN WATER DEPTH (IN INCHES) BETWEEN NAA AND THREE ALTERNATIVES IN THE SOUTH STUDY AREA FOR THE 50-YEAR COASTAL STORM SURGE

Alternative 1



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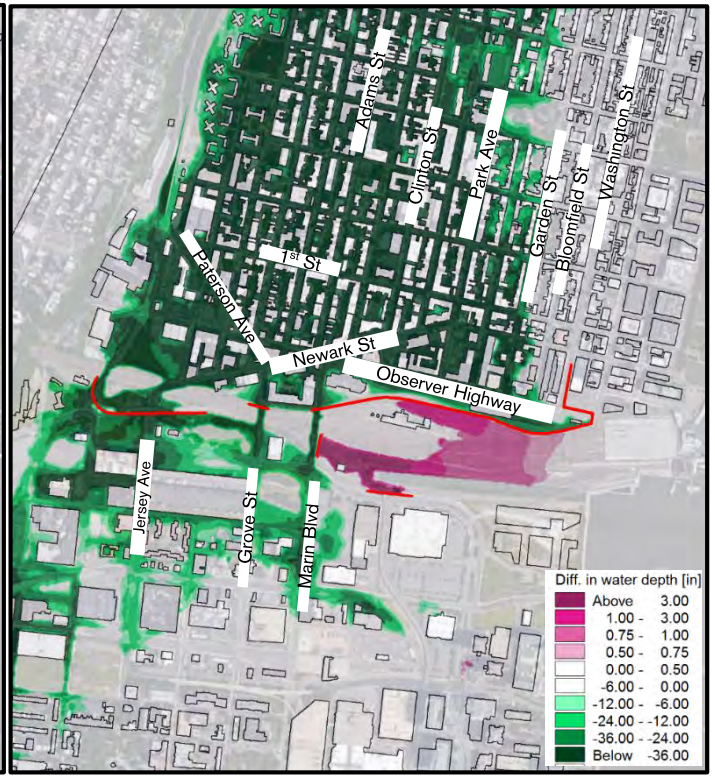

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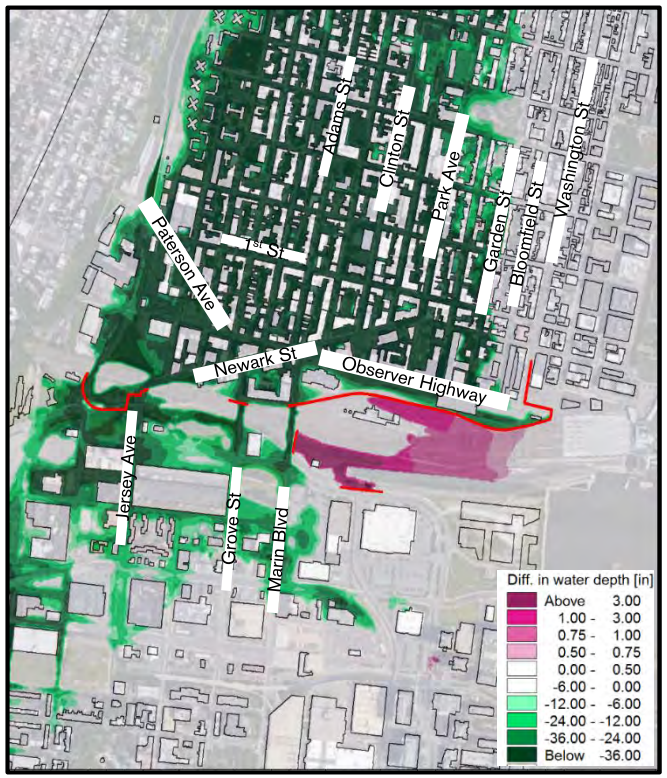


GREEN shows decreases in flood depth in inches

PINK shows increases in flood depth in inches

—— shows resist feature alignment

Coastal Modeling Scenario

10 Year Coastal Storm (10%)

NAA, ALT. 1, ALT. 2, AND ALT. 3 WITH 10-YEAR COASTAL STORM SURGE
MAX. WATER DEPTH IN FEET

No Action Alternative

Alternative 1

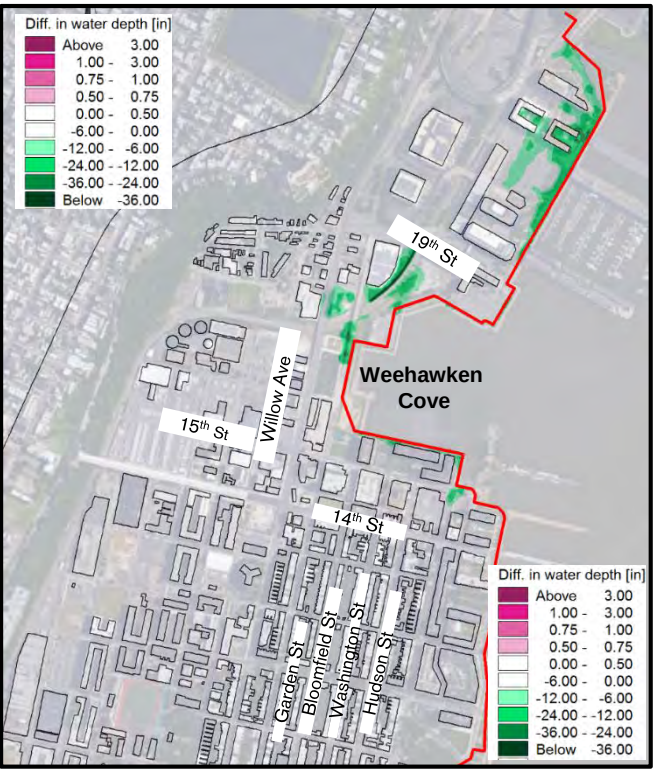
Alternative 2

Alternative 3

shows resist feature alignment

COMPARISON OF DIFFERENCES IN WATER DEPTH (IN INCHES) BETWEEN NAA AND THREE ALTERNATIVES IN THE NORTH STUDY AREA FOR THE 10-YEAR COASTAL STORM SURGE

Alternative 1



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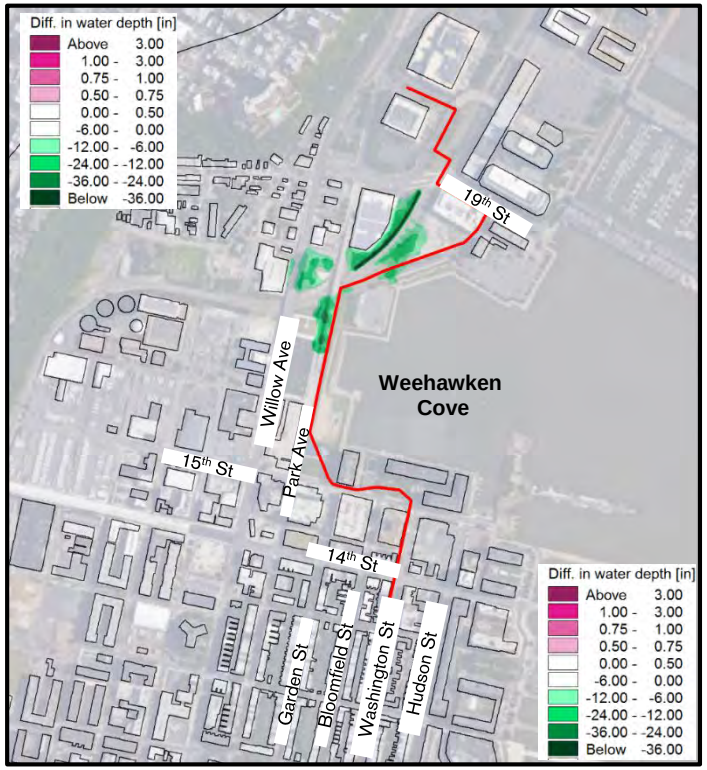
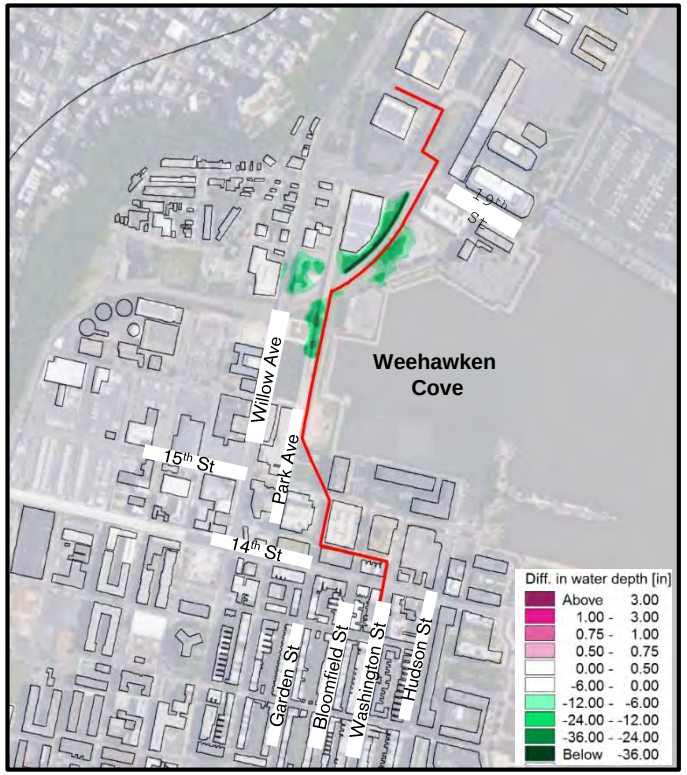


Alternative 3



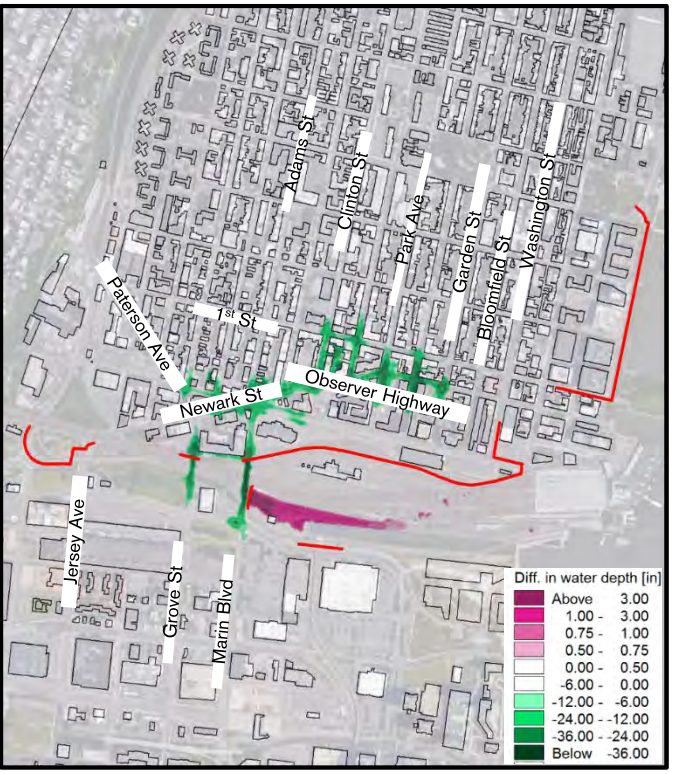
GREEN shows decreases in flood depth in inches

PINK shows increases in flood depth in inches

—— shows resist feature alignment

COMPARISON OF DIFFERENCES IN WATER DEPTH (IN INCHES) BETWEEN NAA AND THREE ALTERNATIVES IN THE SOUTH STUDY AREA FOR THE 10-YEAR COASTAL STORM SURGE

Alternative 1



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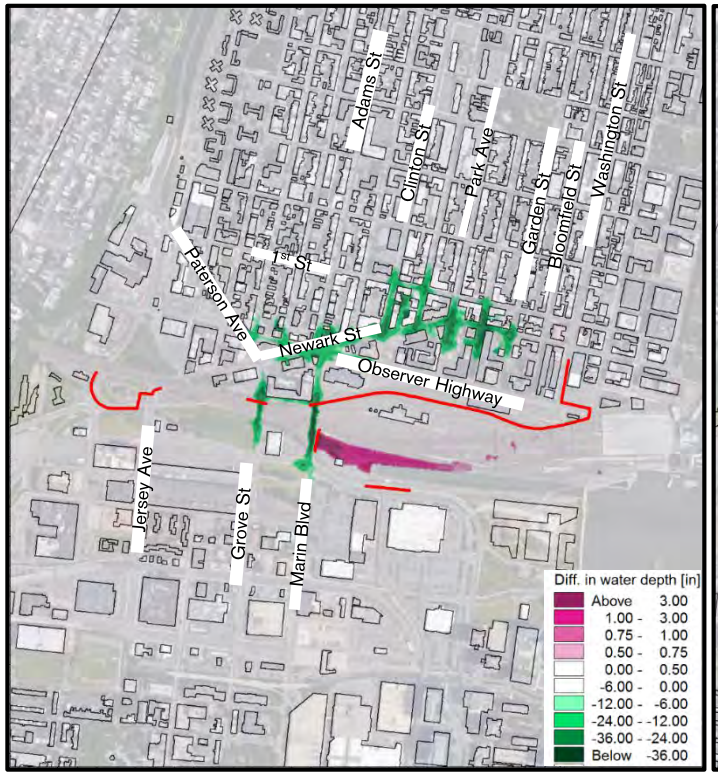
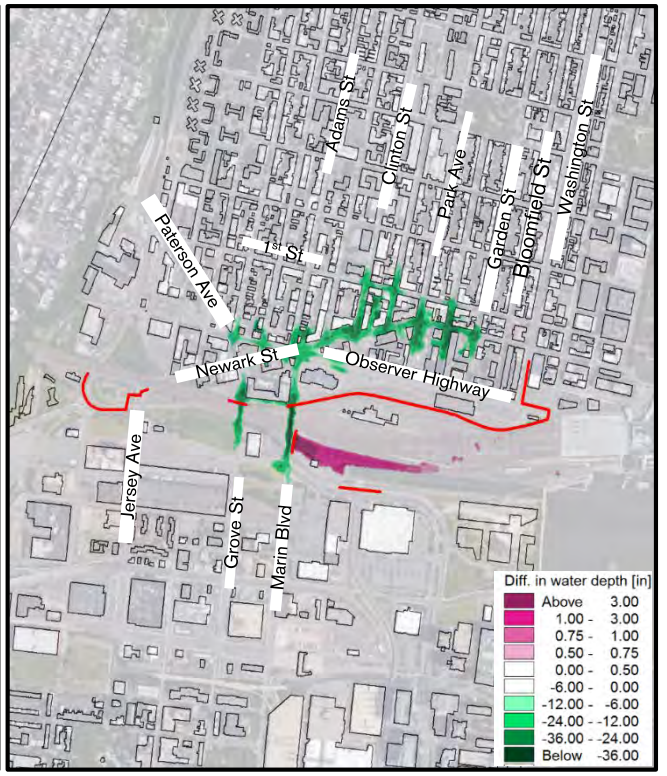


Alternative 3



GREEN shows decreases in flood depth in inches

PINK shows increases in flood depth in inches

—— shows resist feature alignment

Key Takeaways

We have 3 technically feasible alternatives that will provide flood risk reduction benefits for the project area in the 100-year, 50-year, and 10-year coastal storm events

Adjacent areas also recieve Flood Risk Reduction

Approximately 1-inch increase in spot locations in the Weehawken Cove - Harborside Park Area

Community Meeting (CAG) Alternatives Analysis ..... July 28

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The End

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