

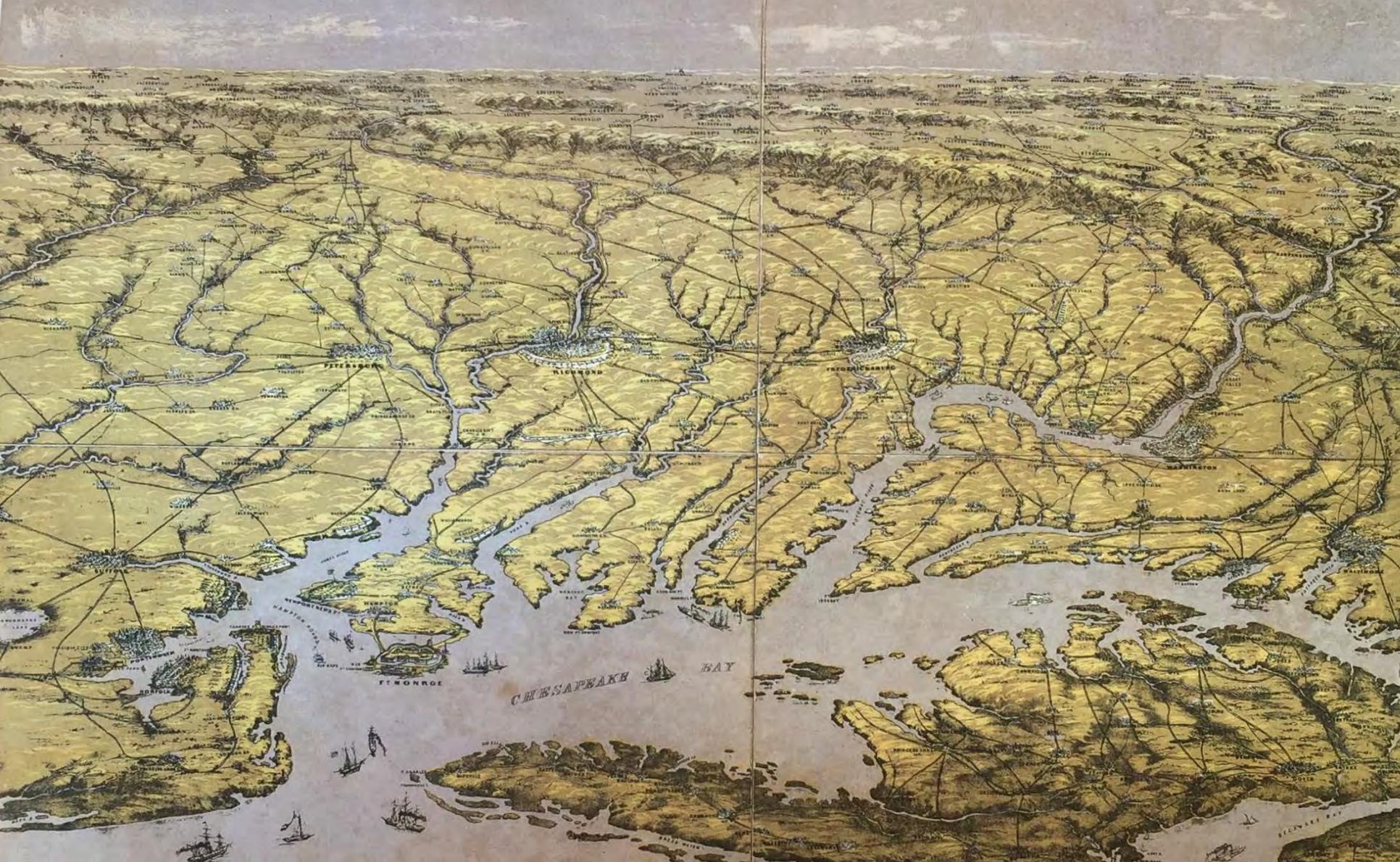


*Climate change "poses immediate risks to US national security...
Politics or ideology must not get in the way of sound planning."*

US Sec of Defense Chuck Hagel, Oct 2014



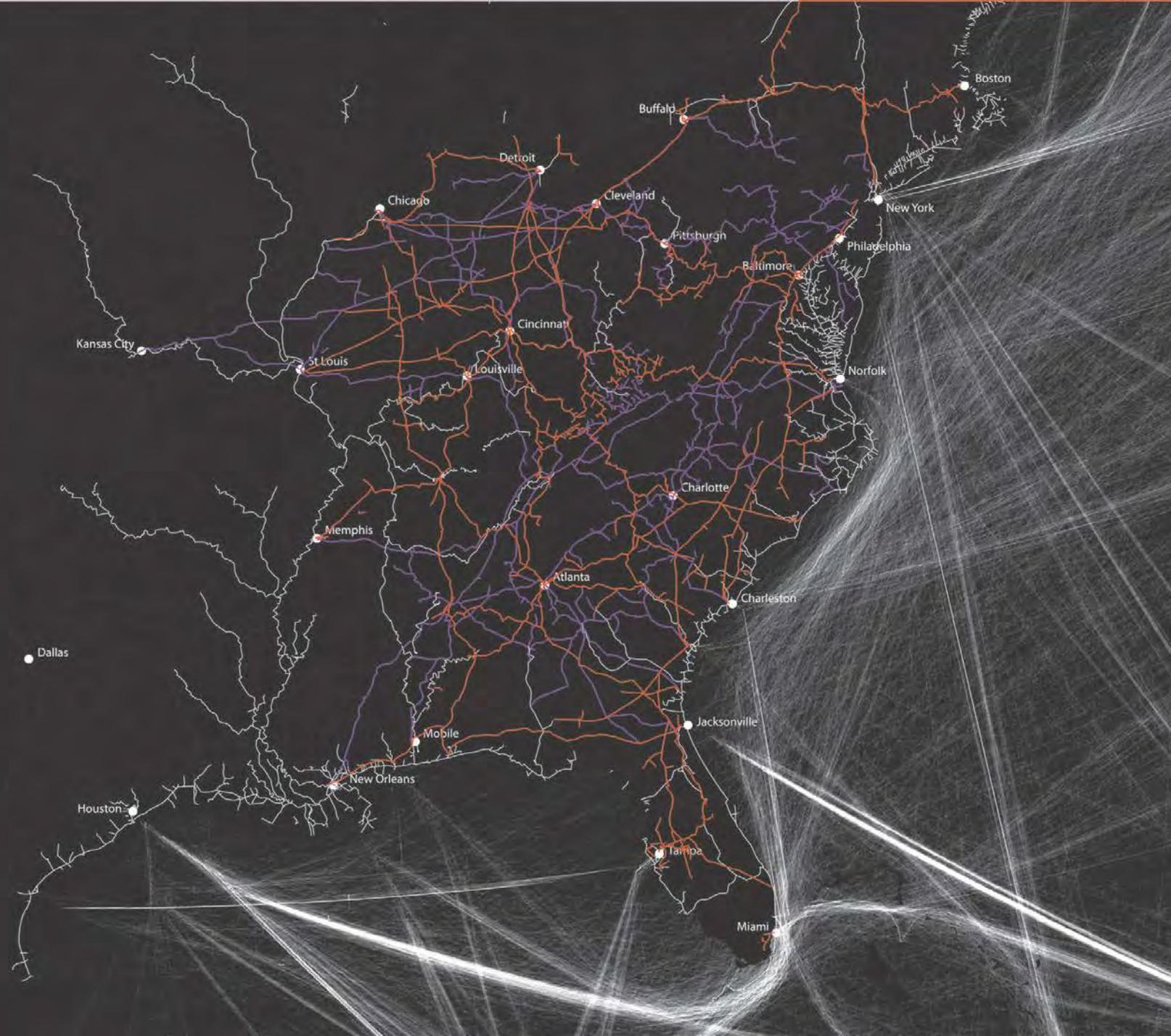
HAMPTON ROADS: A REGION RISING INTO RESILIENCY

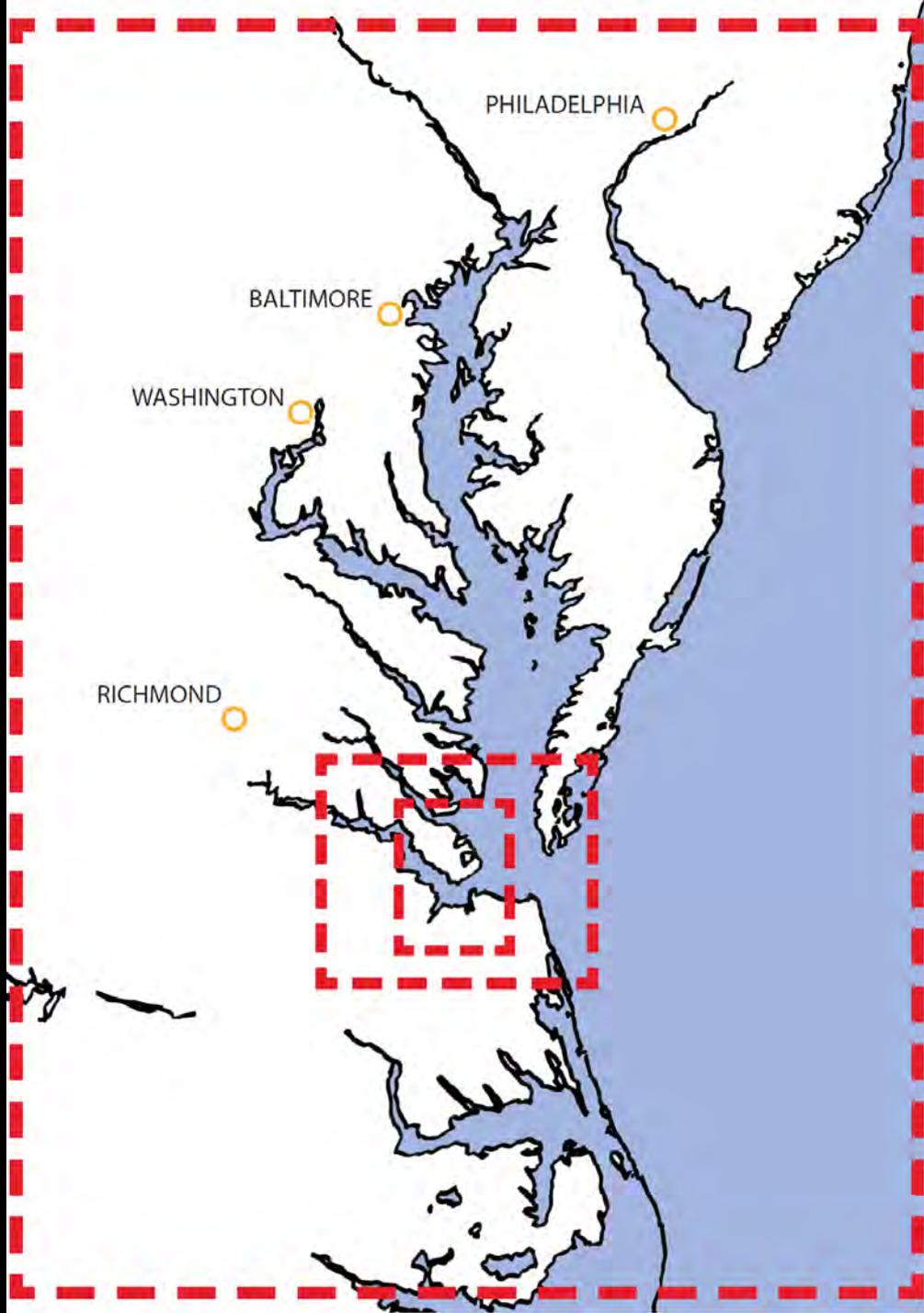


DUTCH DIALOGUES

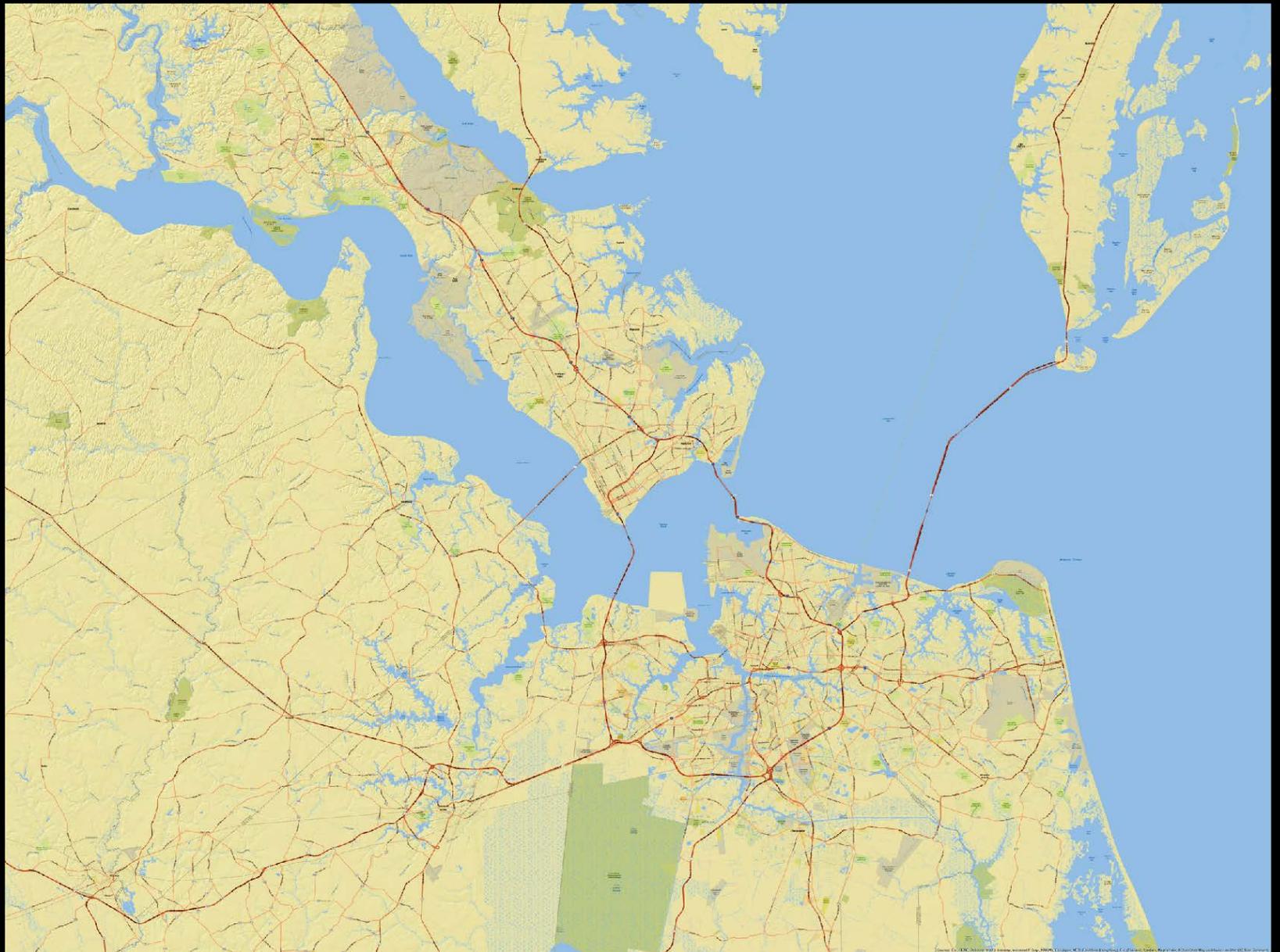
Virginia: Life at Sea Level

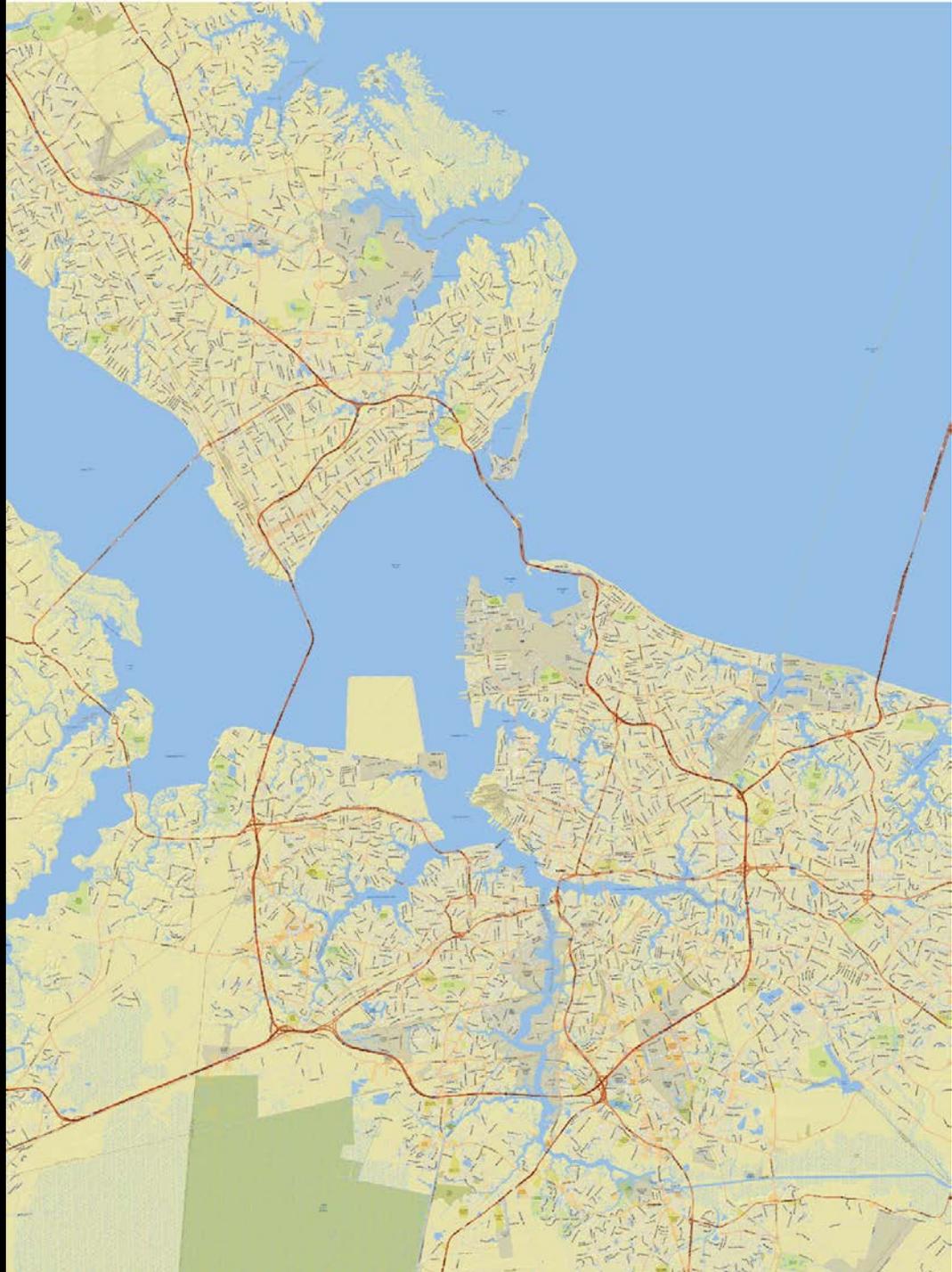
- Navigable Waterways
- Railroads
- CSX Railroads
- Norfolk Southern Railroads



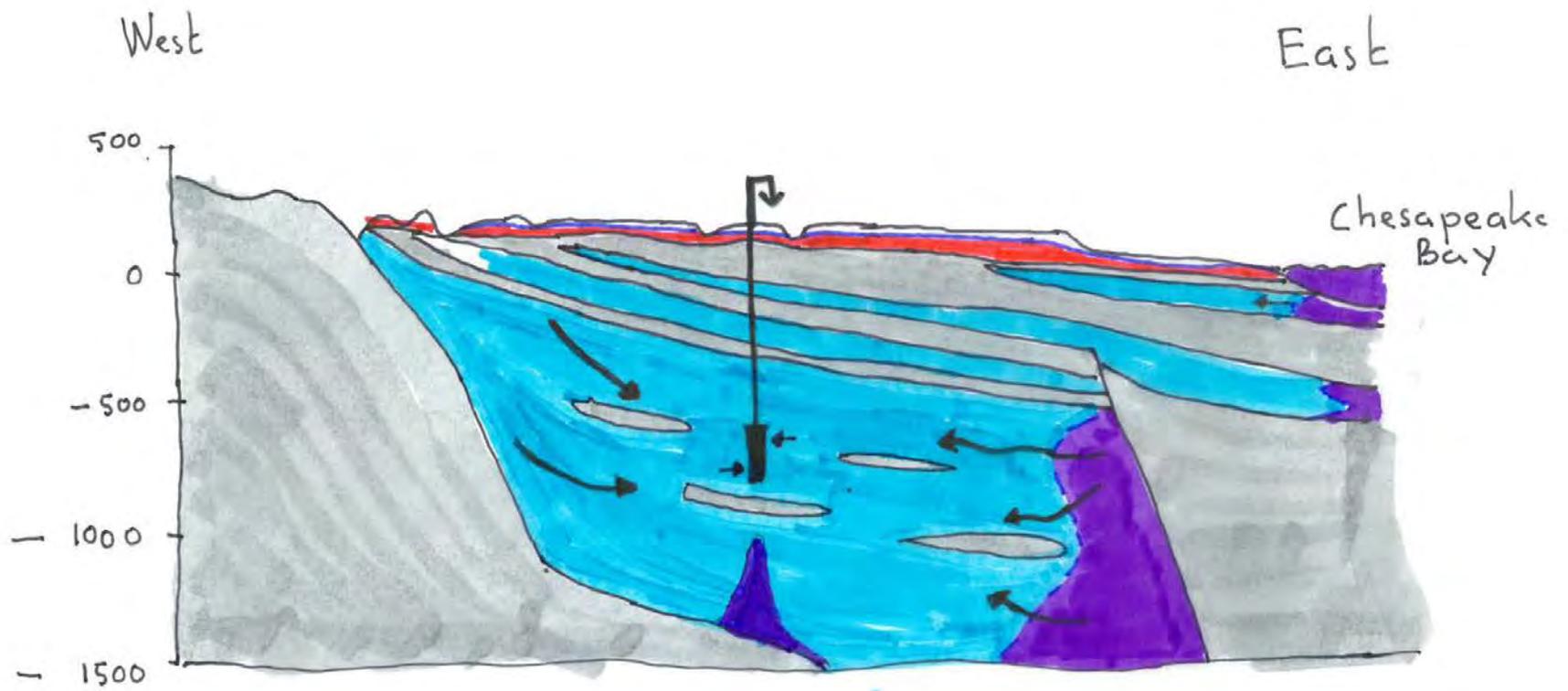












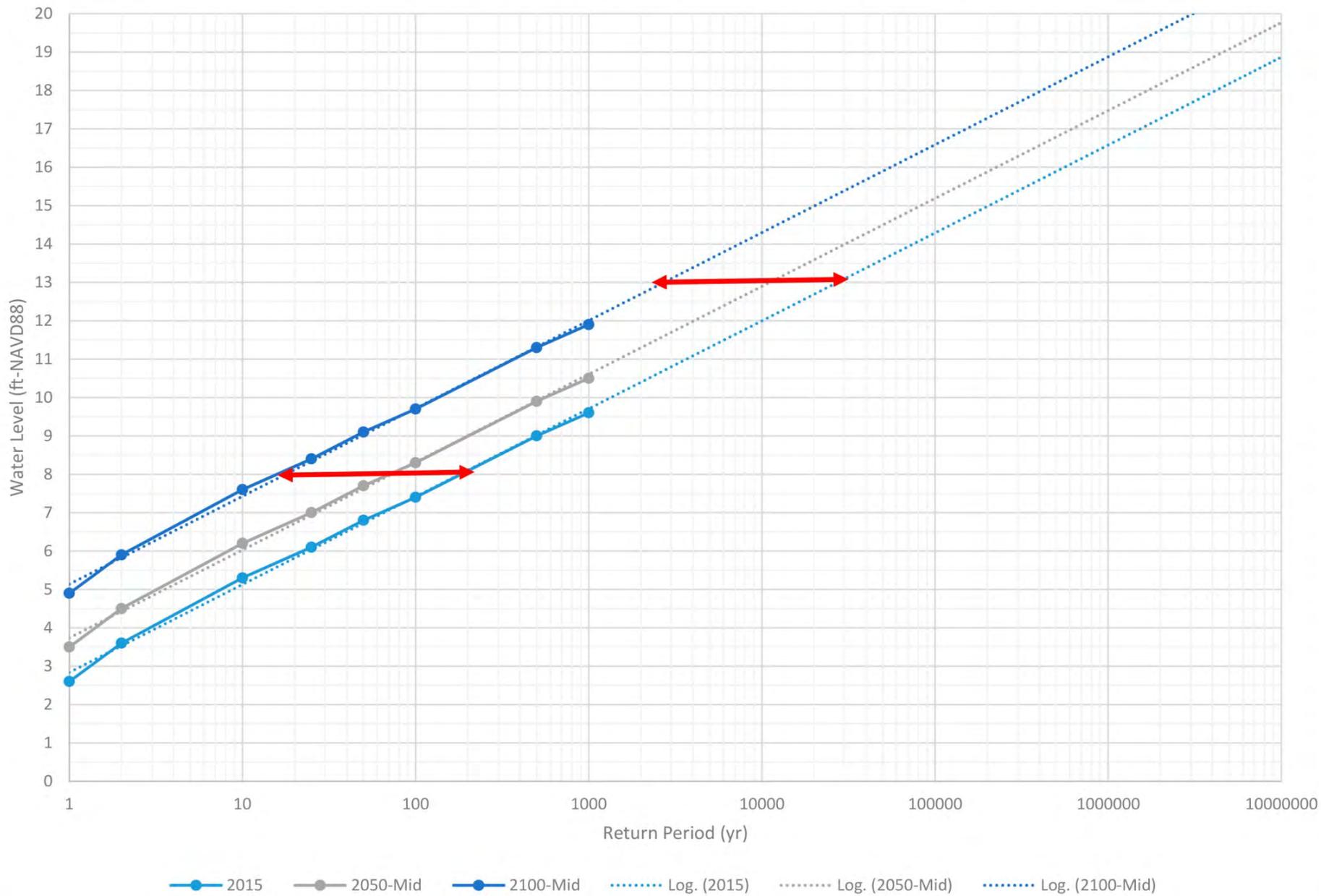
-  Polluted
-  Pristine (very old water!)
-  Salt



DUTCH DIALOGUES

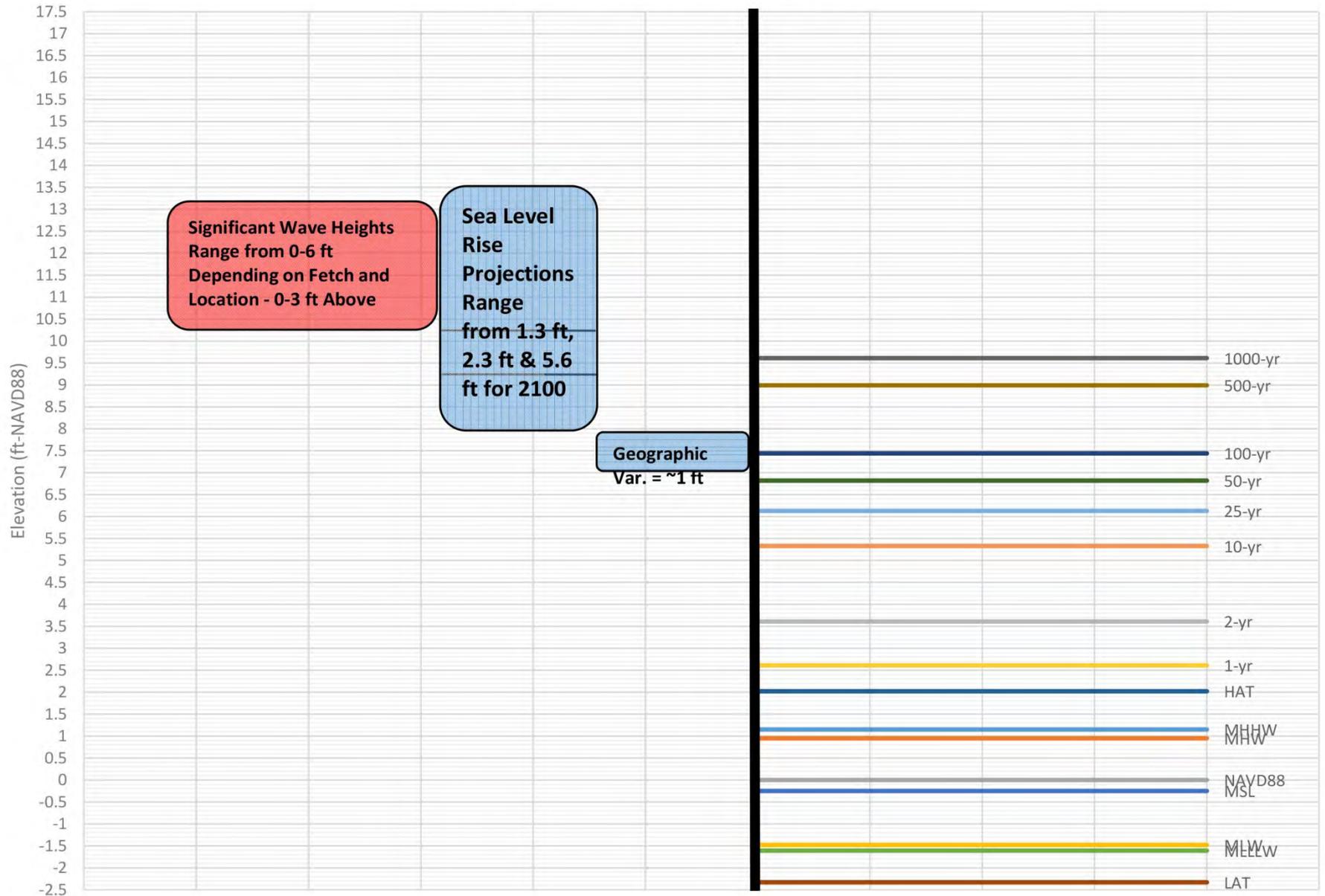
Virginia: Life at Sea Level

SEWELLS POINT WATER LEVELS VS. RETURN PERIOD

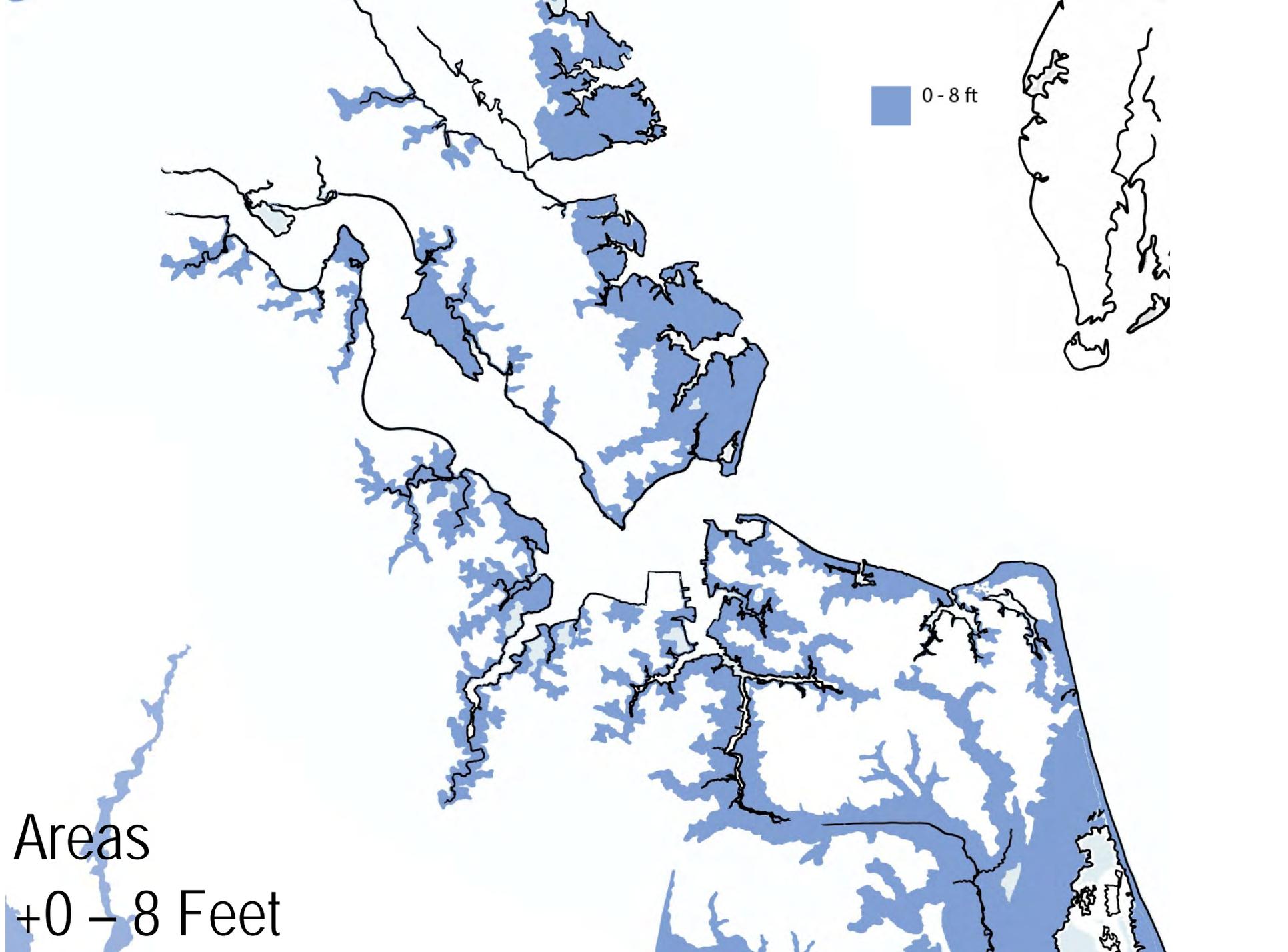


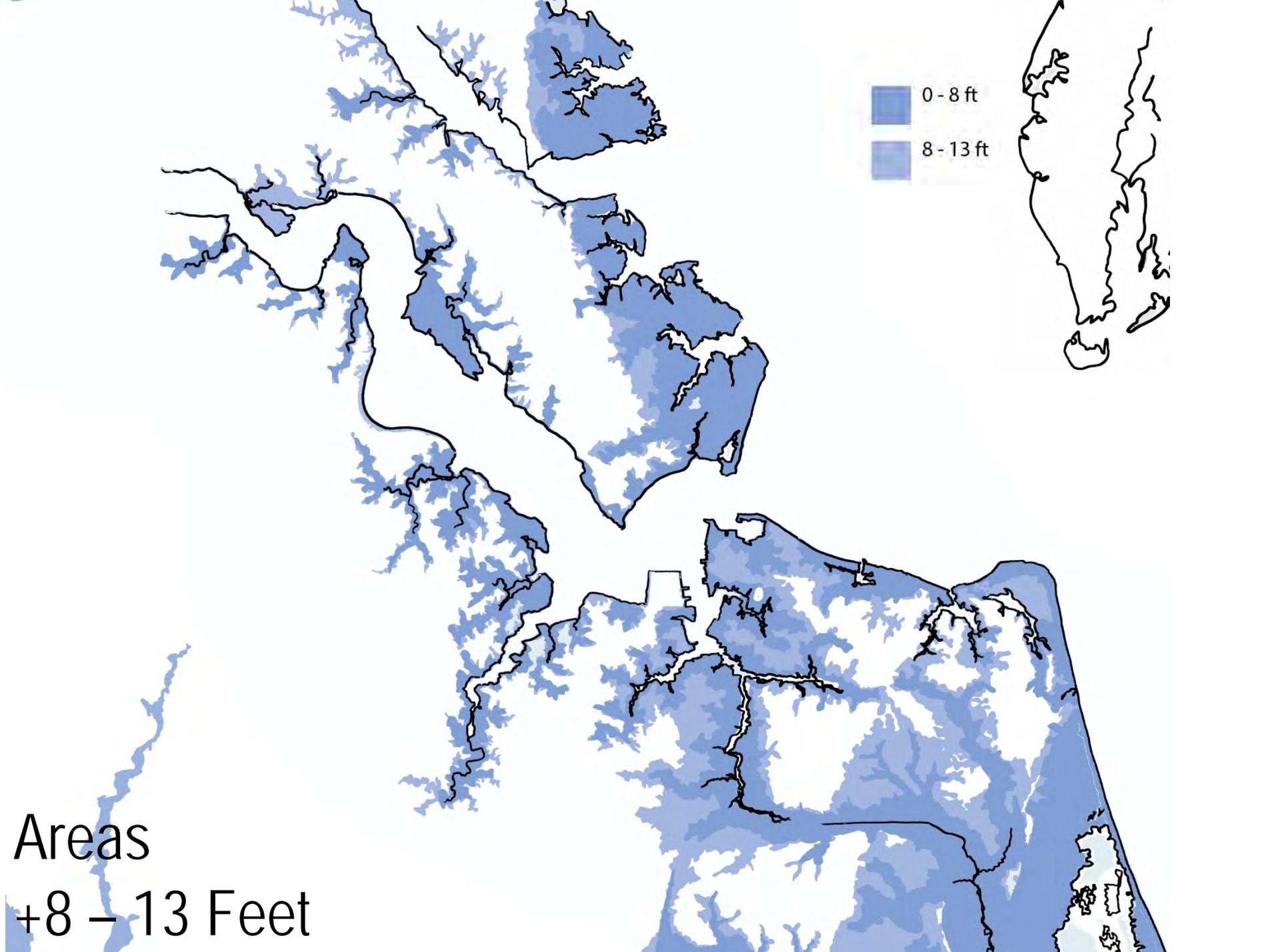
8ft: 1/100yr -> 1/20yr, 13ft: 1/1000yr in 2100

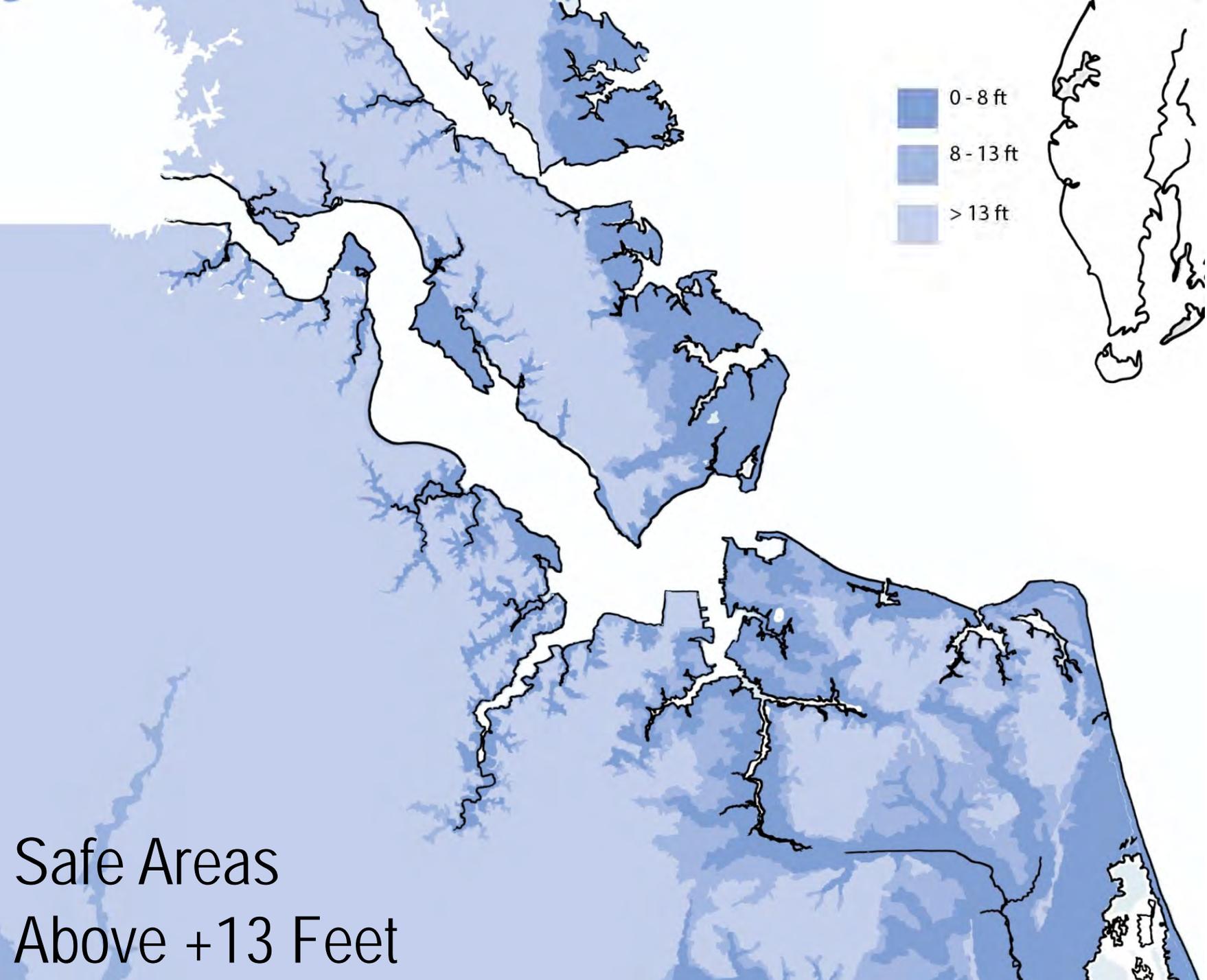
SEWELLS POINT WATER LEVELS

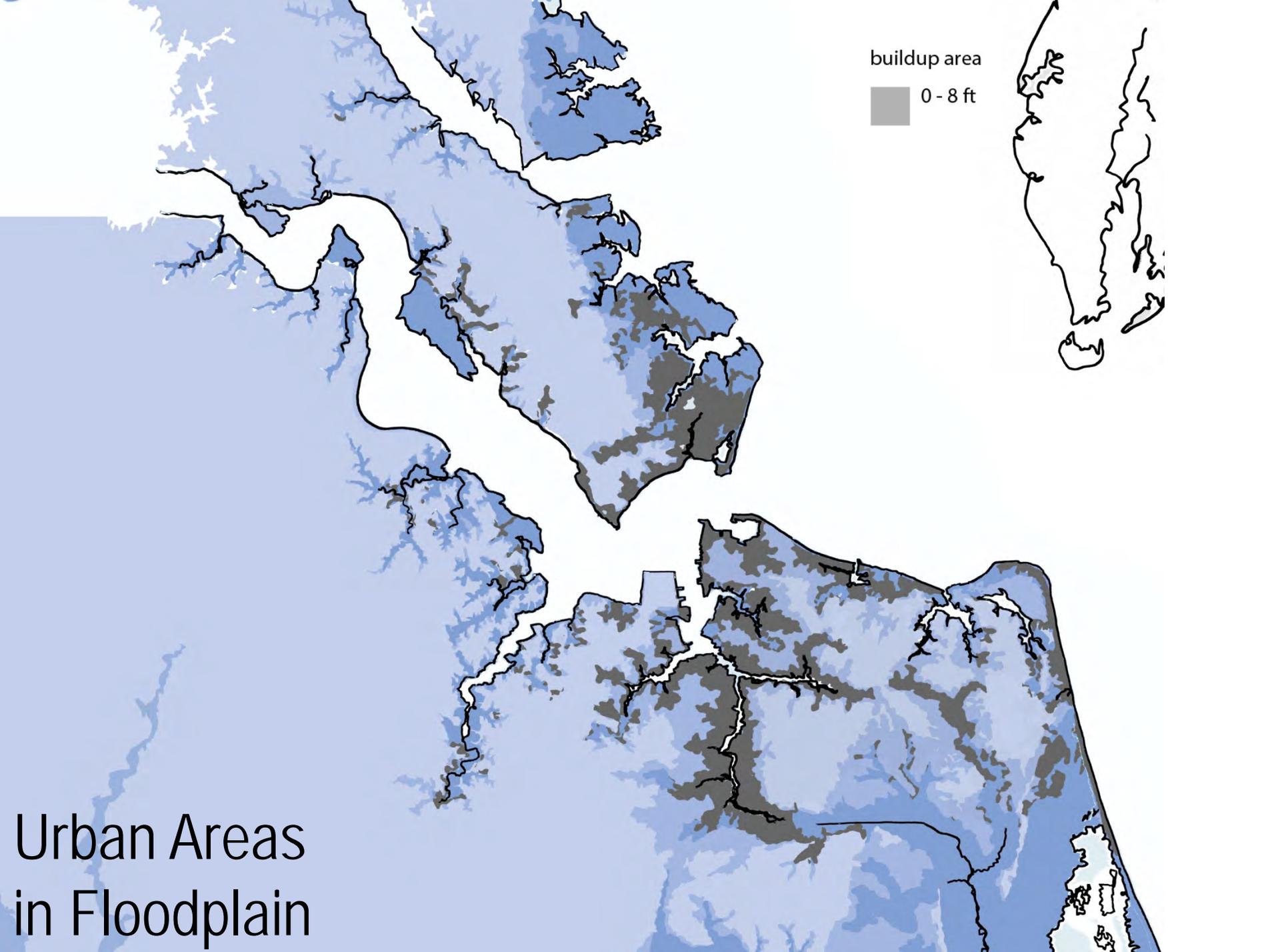


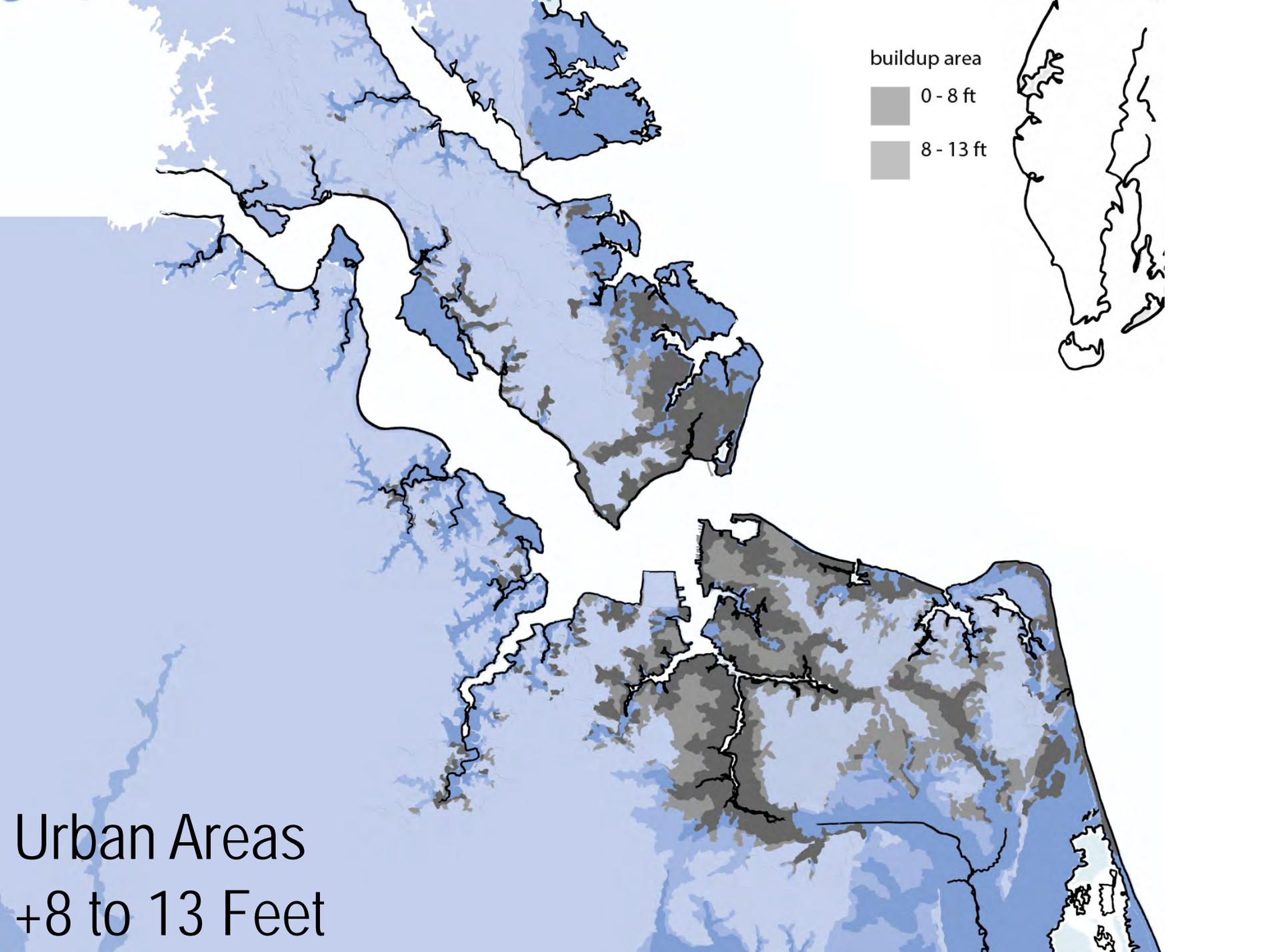
Safety level for 100yr storm in 2100: 13ft

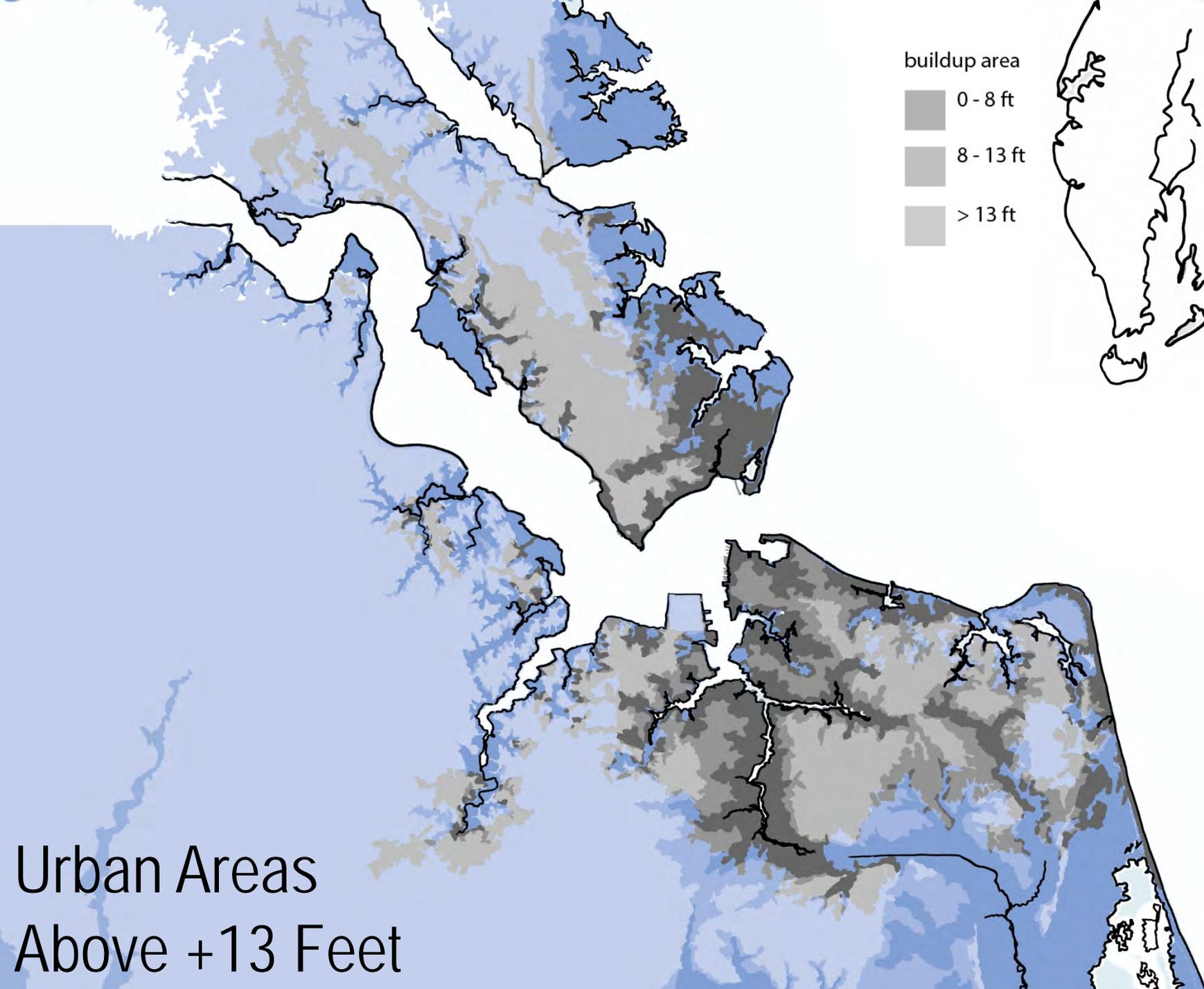


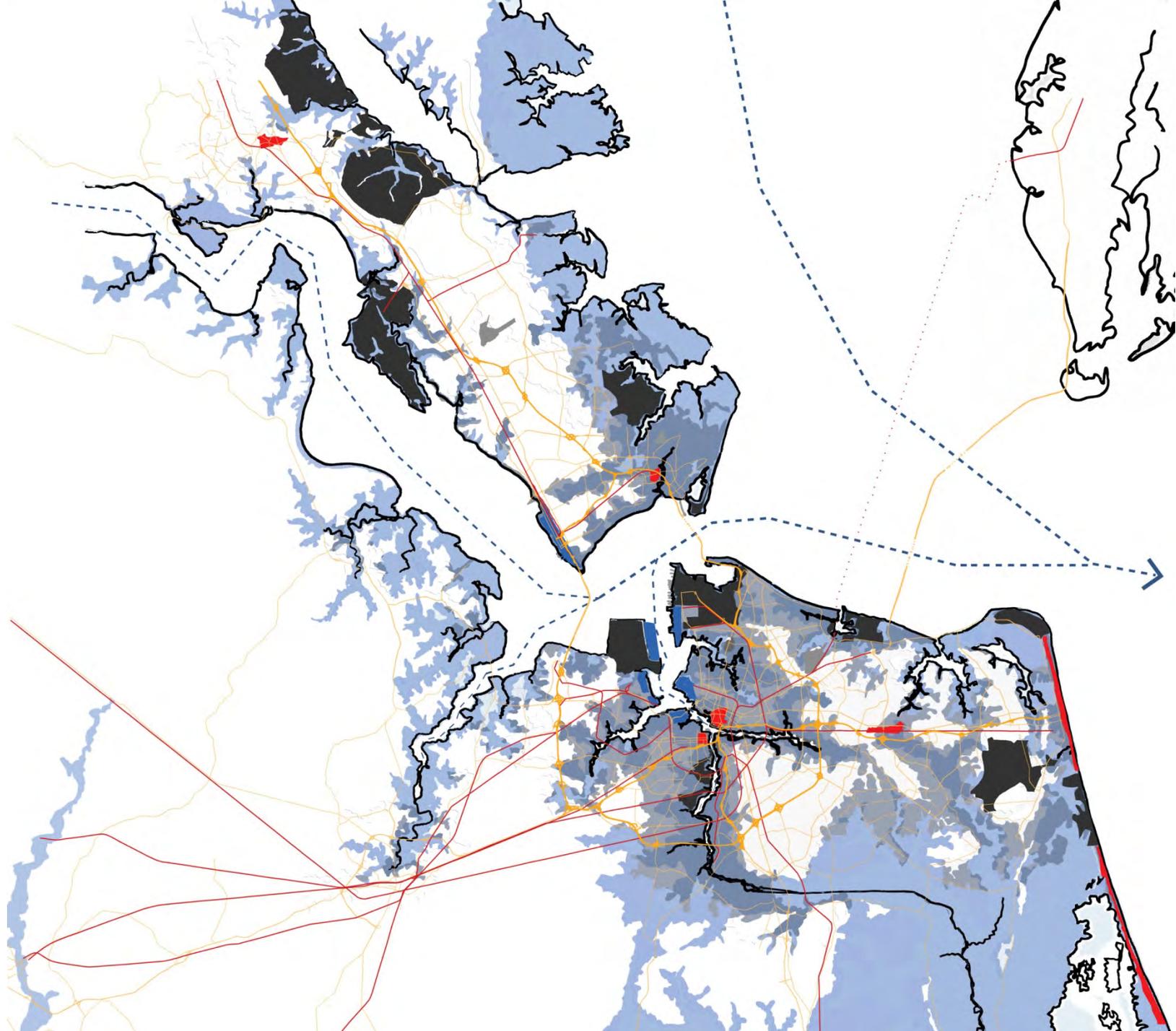


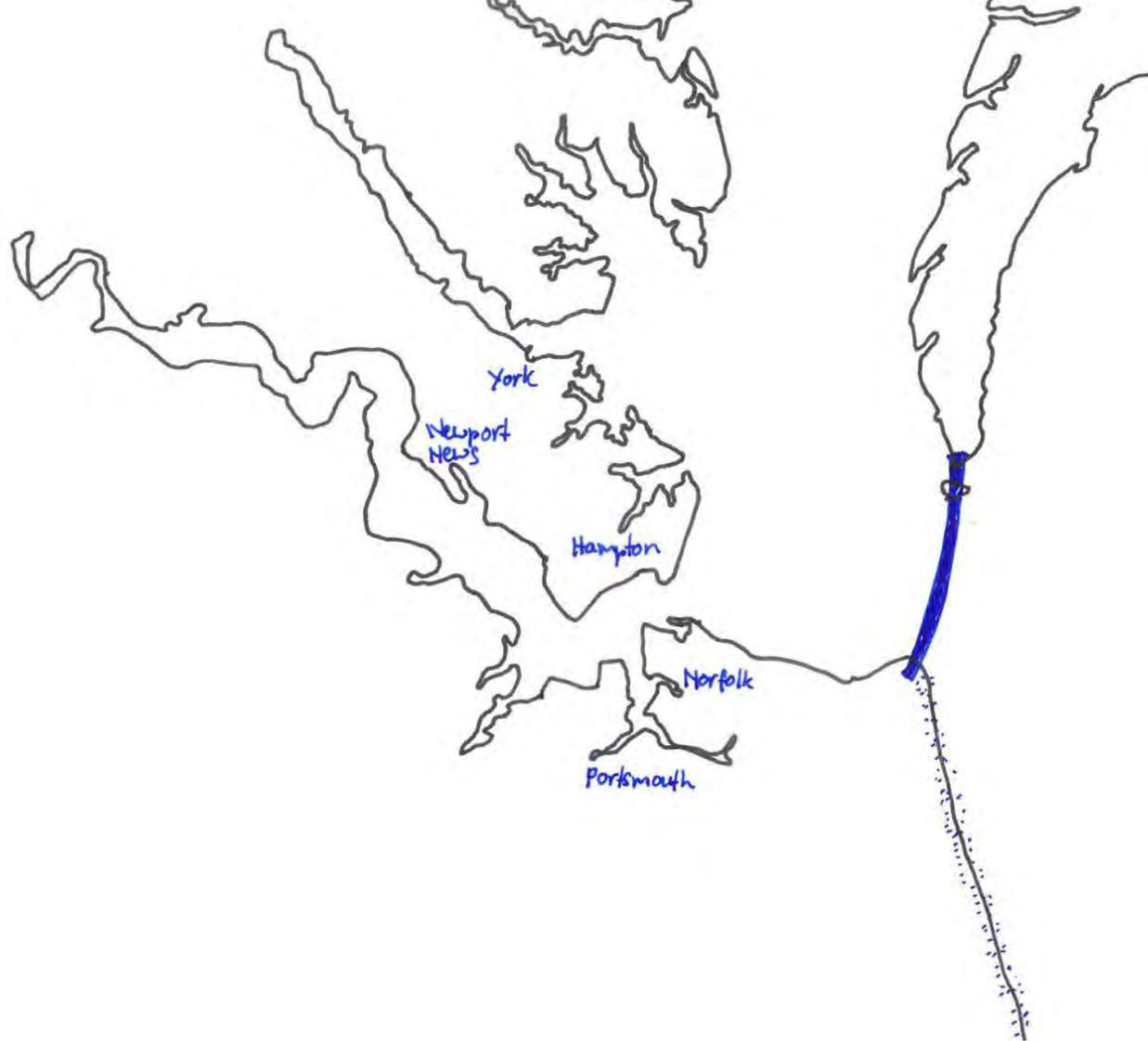












DUTCH DIALOGUES

Virginia: Life at Sea Level

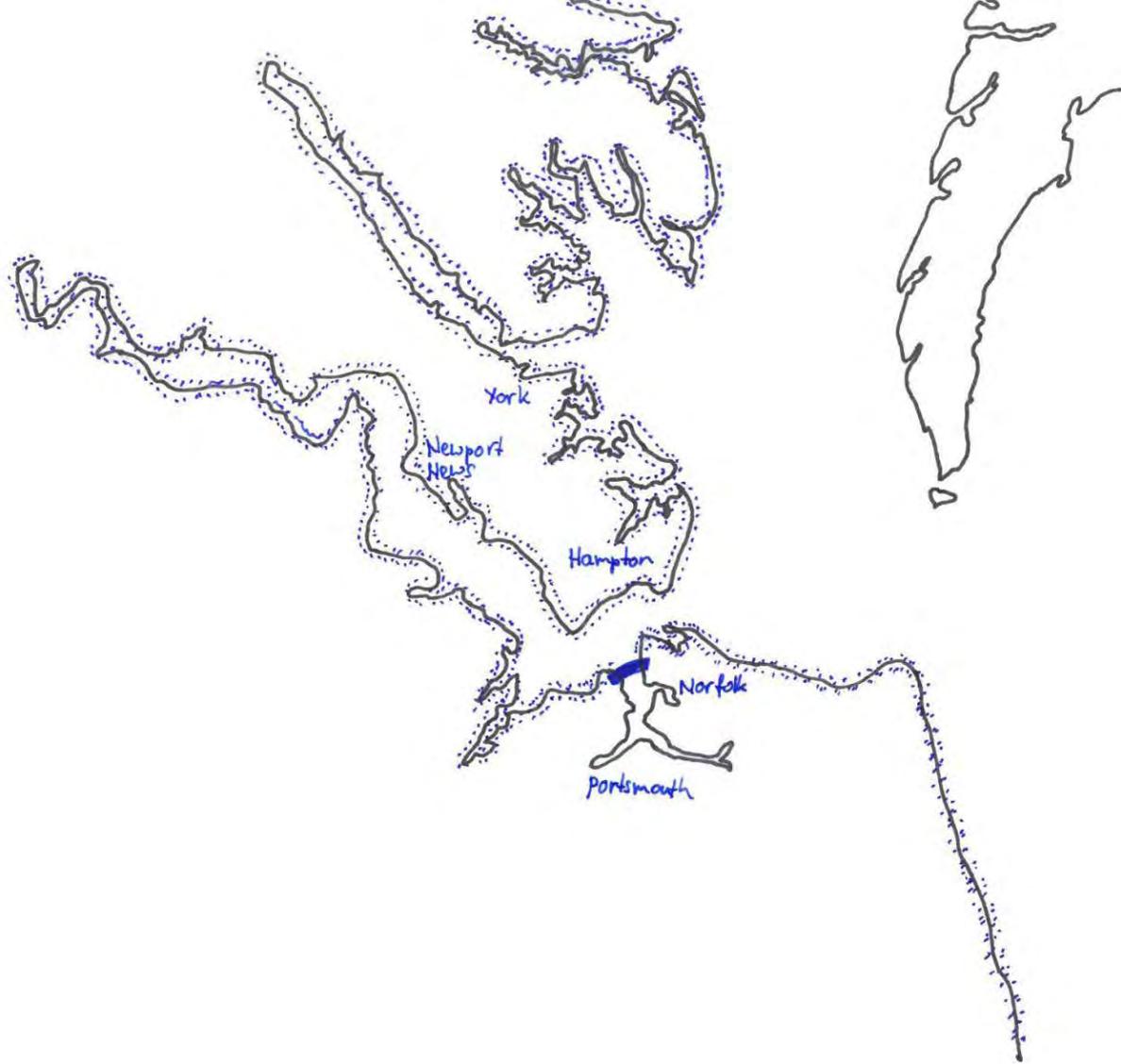
Will Storm Surge
Barriers Work?



DUTCH DIALOGUES

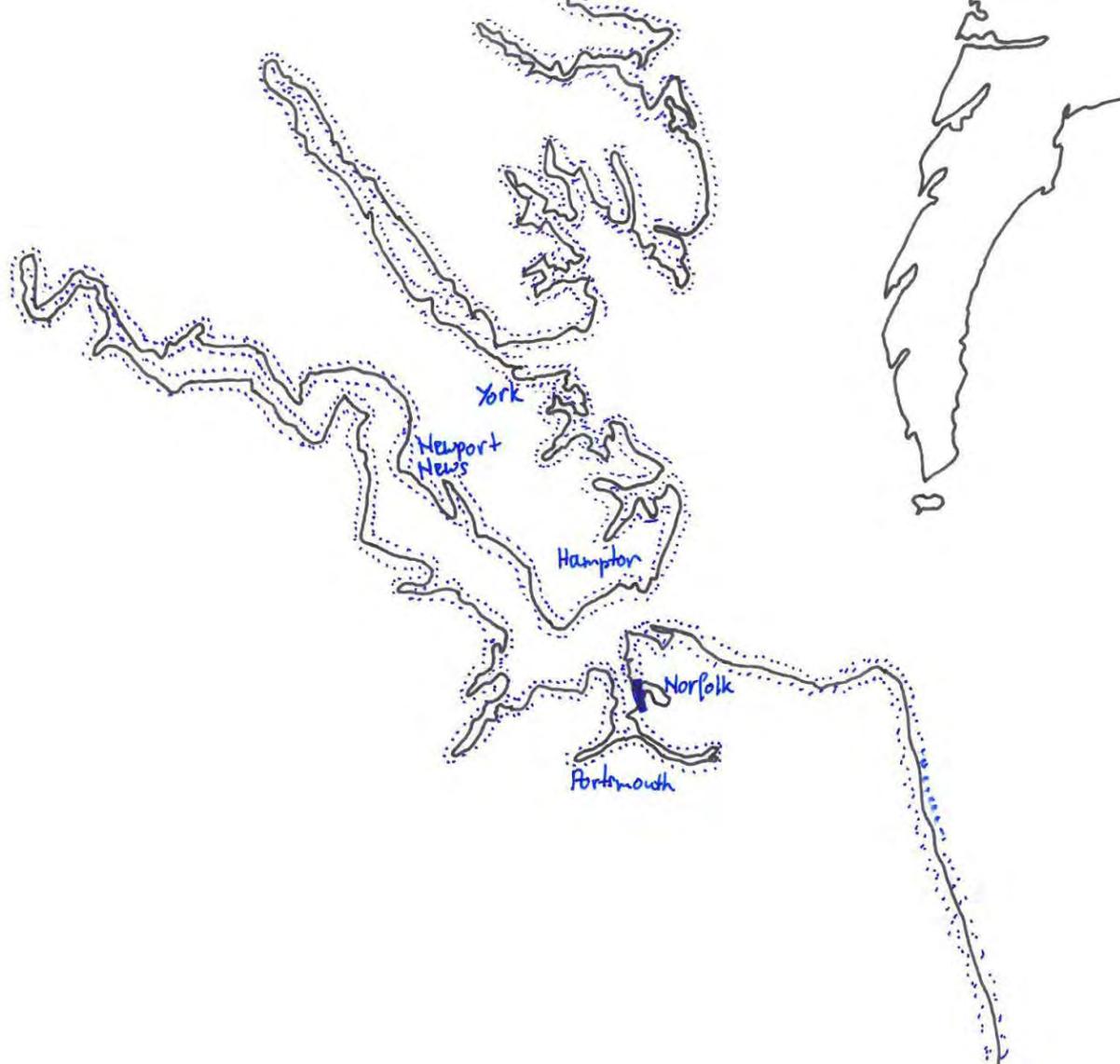
Virginia: Life at Sea Level

Will Storm Surge
Barriers Work?



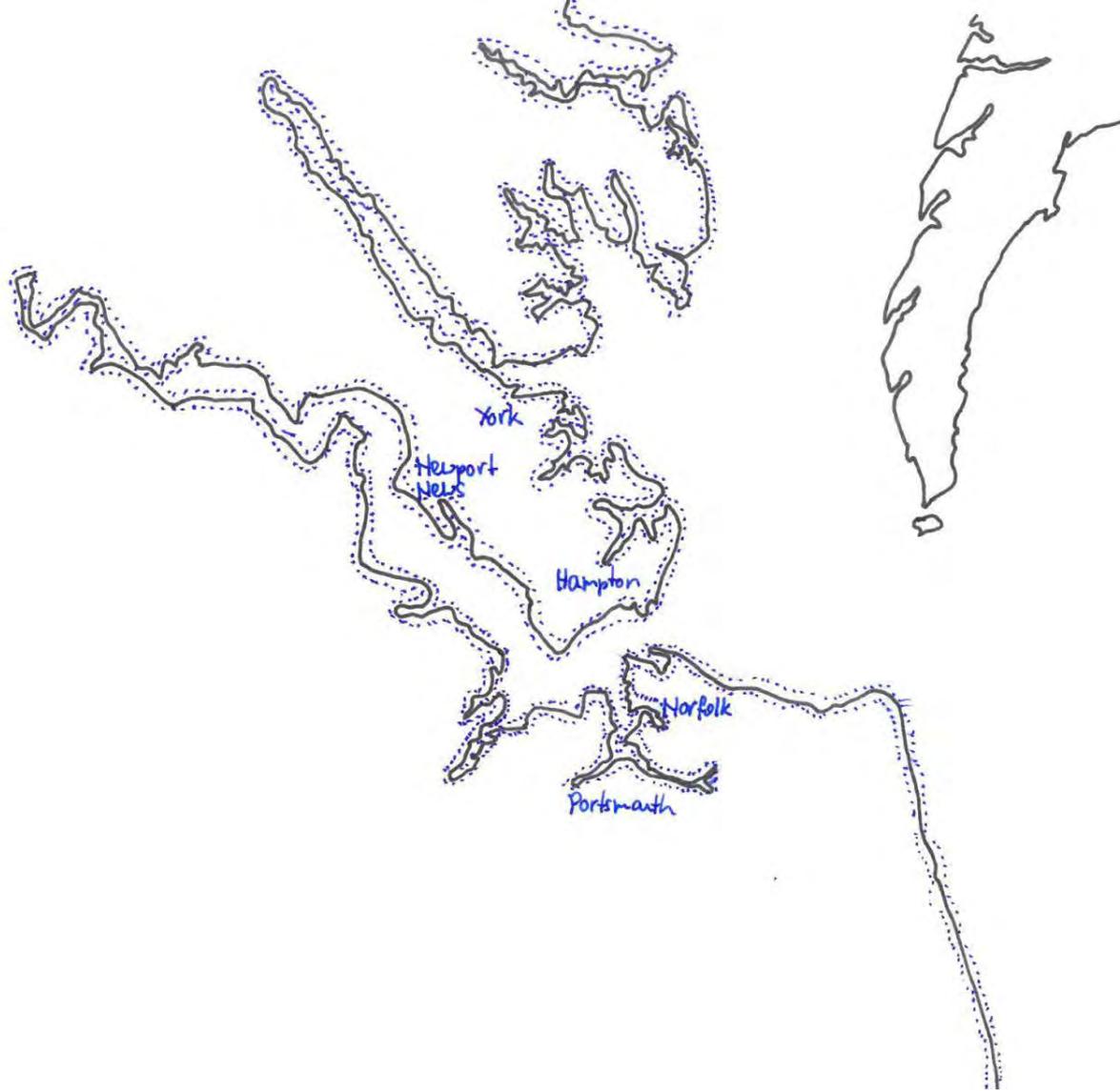
DUTCH DIALOGUES
Virginia: Life at Sea Level

Will Storm Surge
Barriers Work?



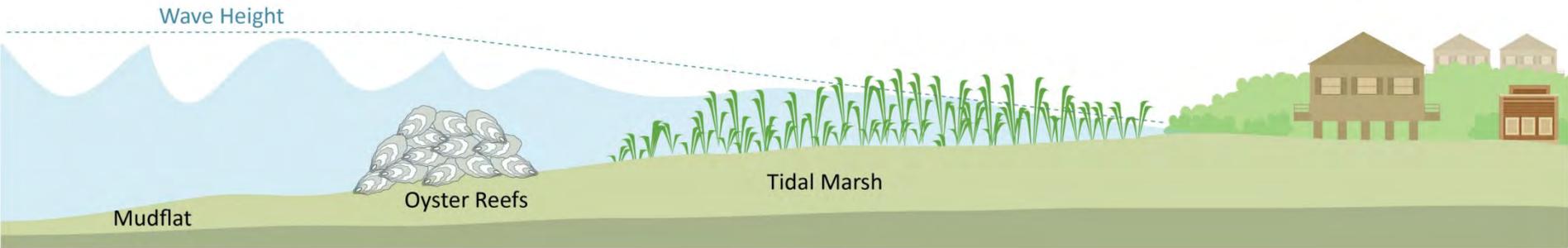
DUTCH DIALOGUES
Virginia: Life at Sea Level

Will Storm Surge
Barriers Work?



DUTCH DIALOGUES
Virginia: Life at Sea Level

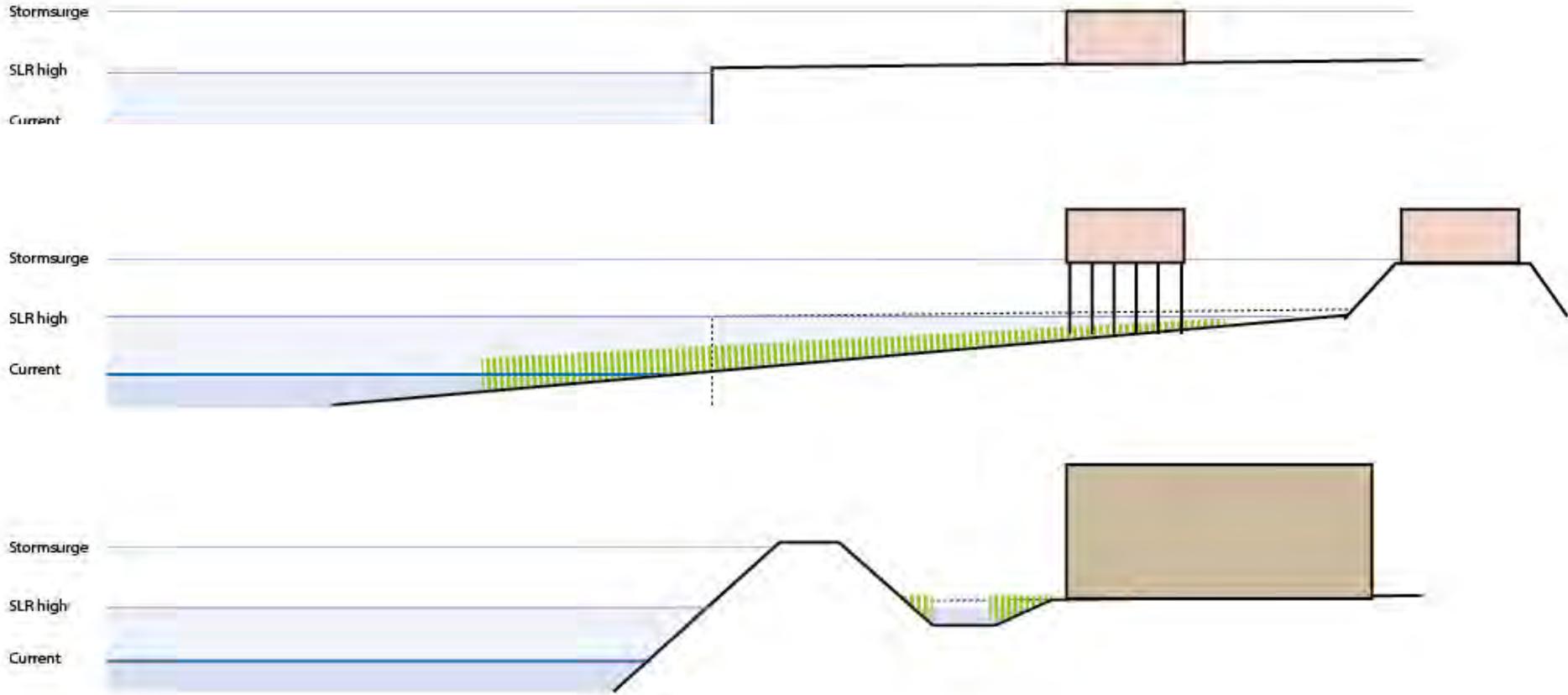
Adaptive Shorelines
Always a Good Choice





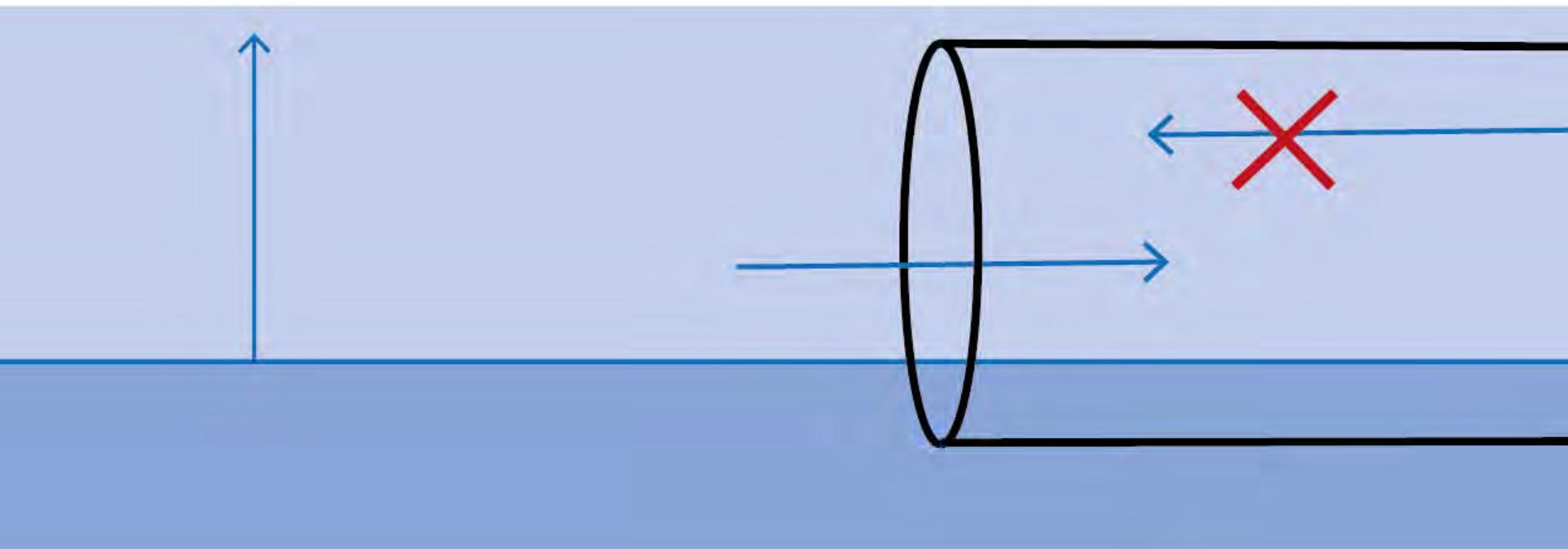
DUTCH DIALOGUES

Virginia: Life at Sea Level



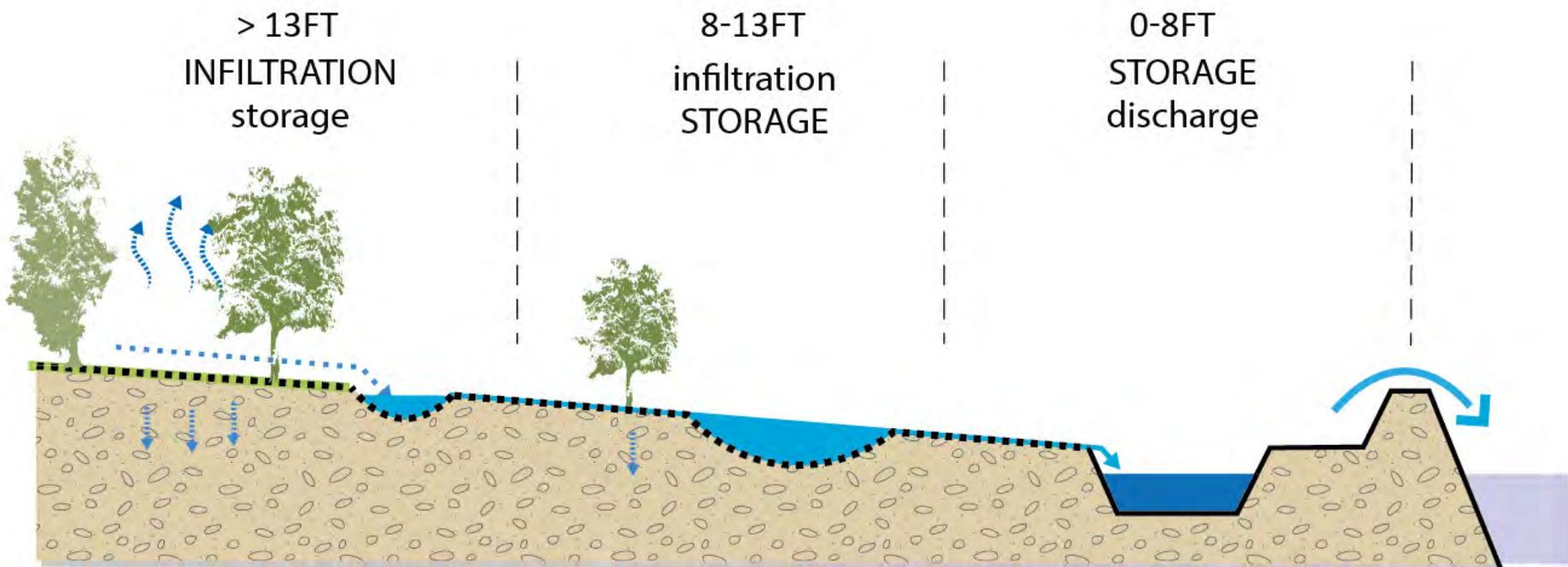
DUTCH DIALOGUES
Virginia: Life at Sea Level

Development in the
Floodplain < 8 Feet



DUTCH DIALOGUES
Virginia: Life at Sea Level

Stormwater meets High Tide



Sea Level Rise and storm water management: three zones

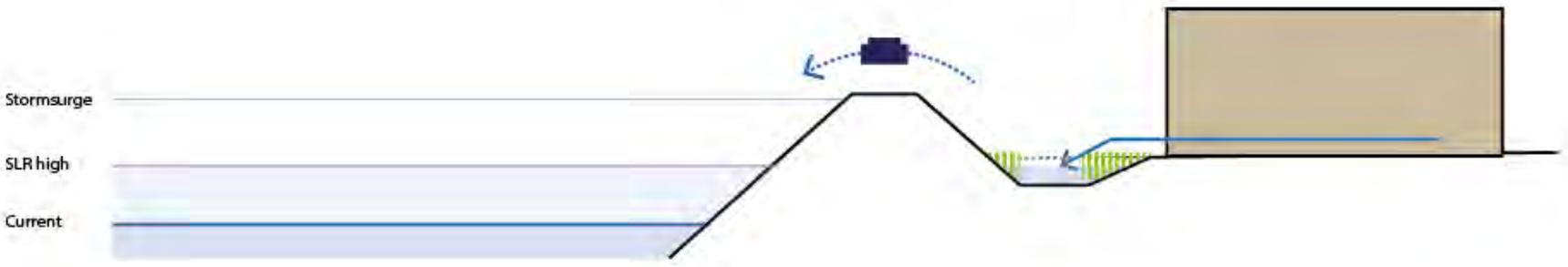


DUTCH DIALOGUES

Virginia: Life at Sea Level



Sea Level Rise and storm water treatment in the floodplain



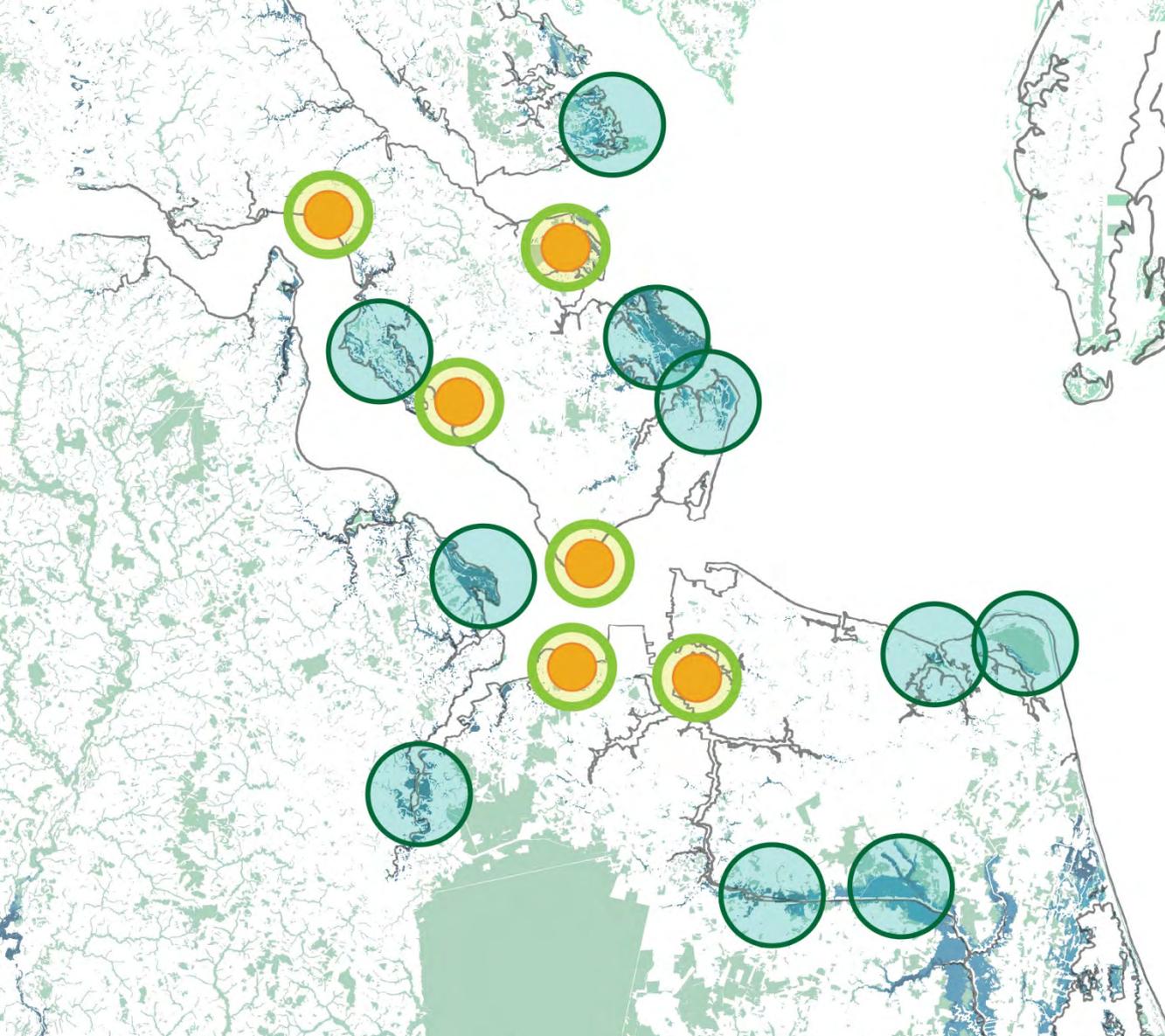
Sea Level Rise and storm water treatment: in the floodplain





DUTCH DIALOGUES

Virginia: Life at Sea Level

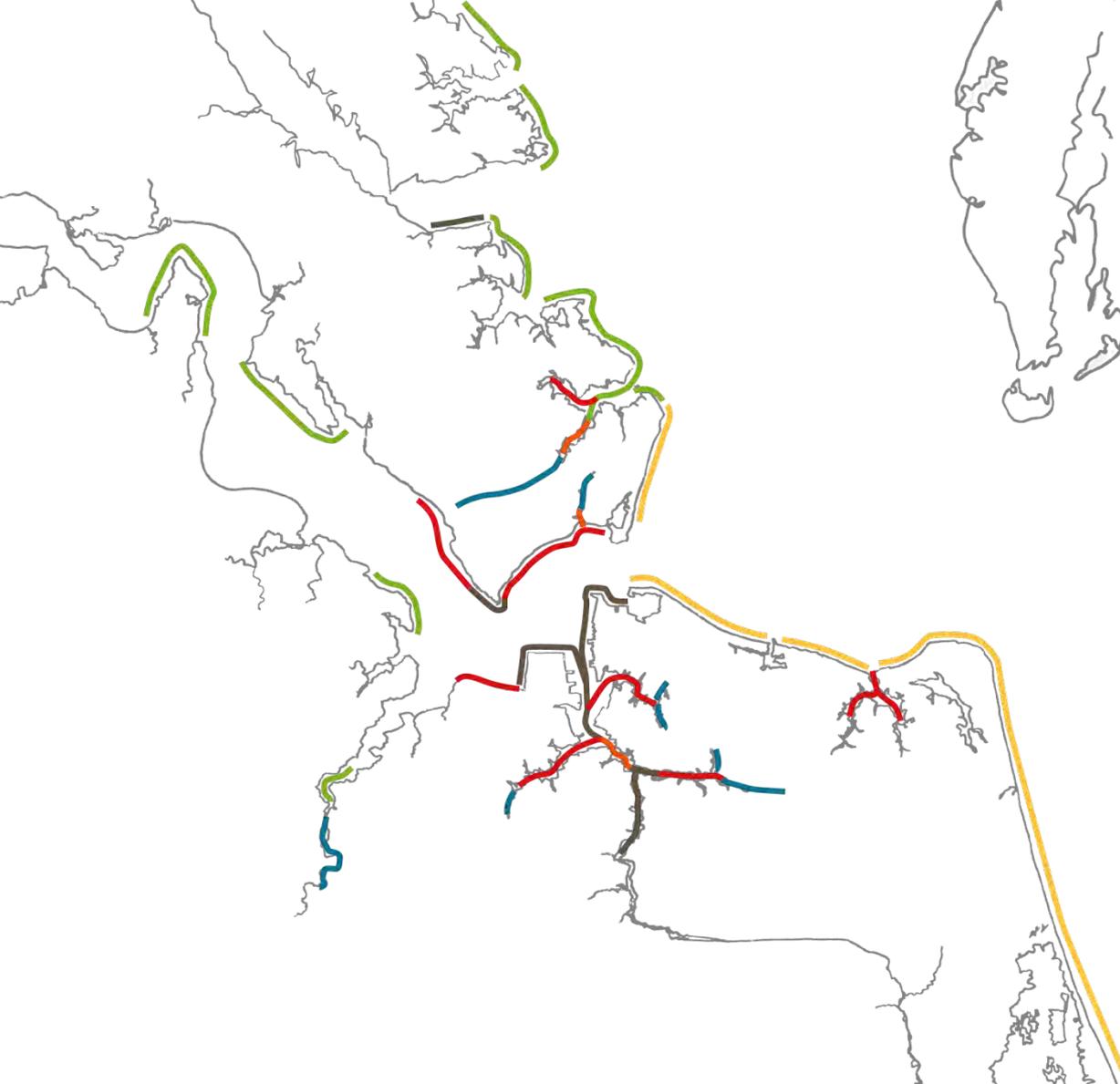


-  Nourishment of core remaining wetlands
-  Effluent treatment near WWTP



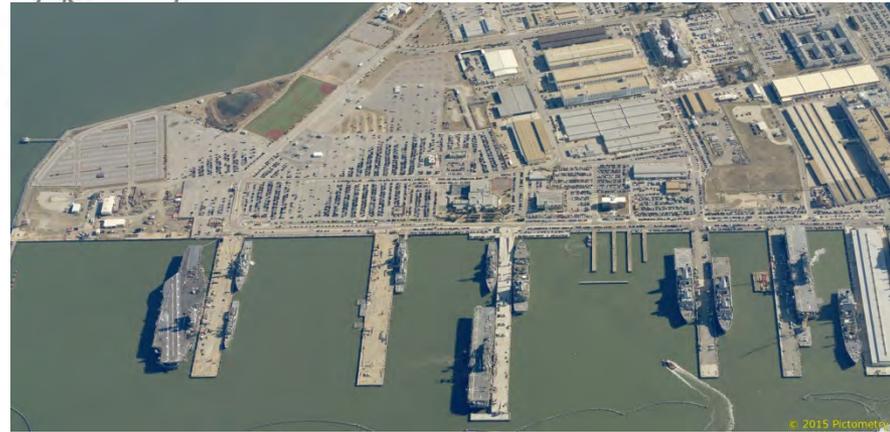
DUTCH DIALOGUES
Virginia: Life at Sea Level

Wetland Quality & Preservation



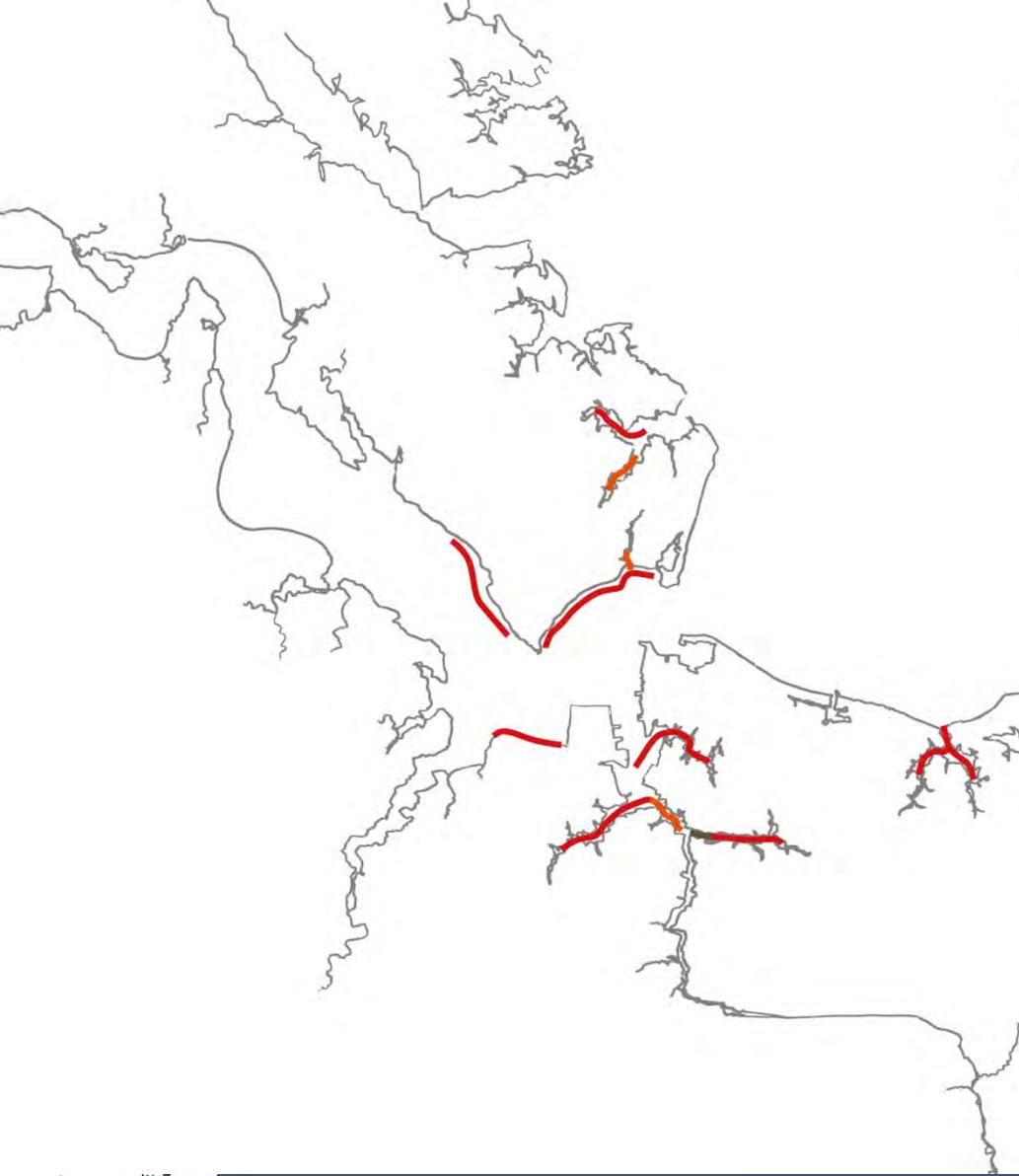
DUTCH DIALOGUES
Virginia: Life at Sea Level

Edge Conditions



DUTCH DIALOGUES
Virginia: Life at Sea Level

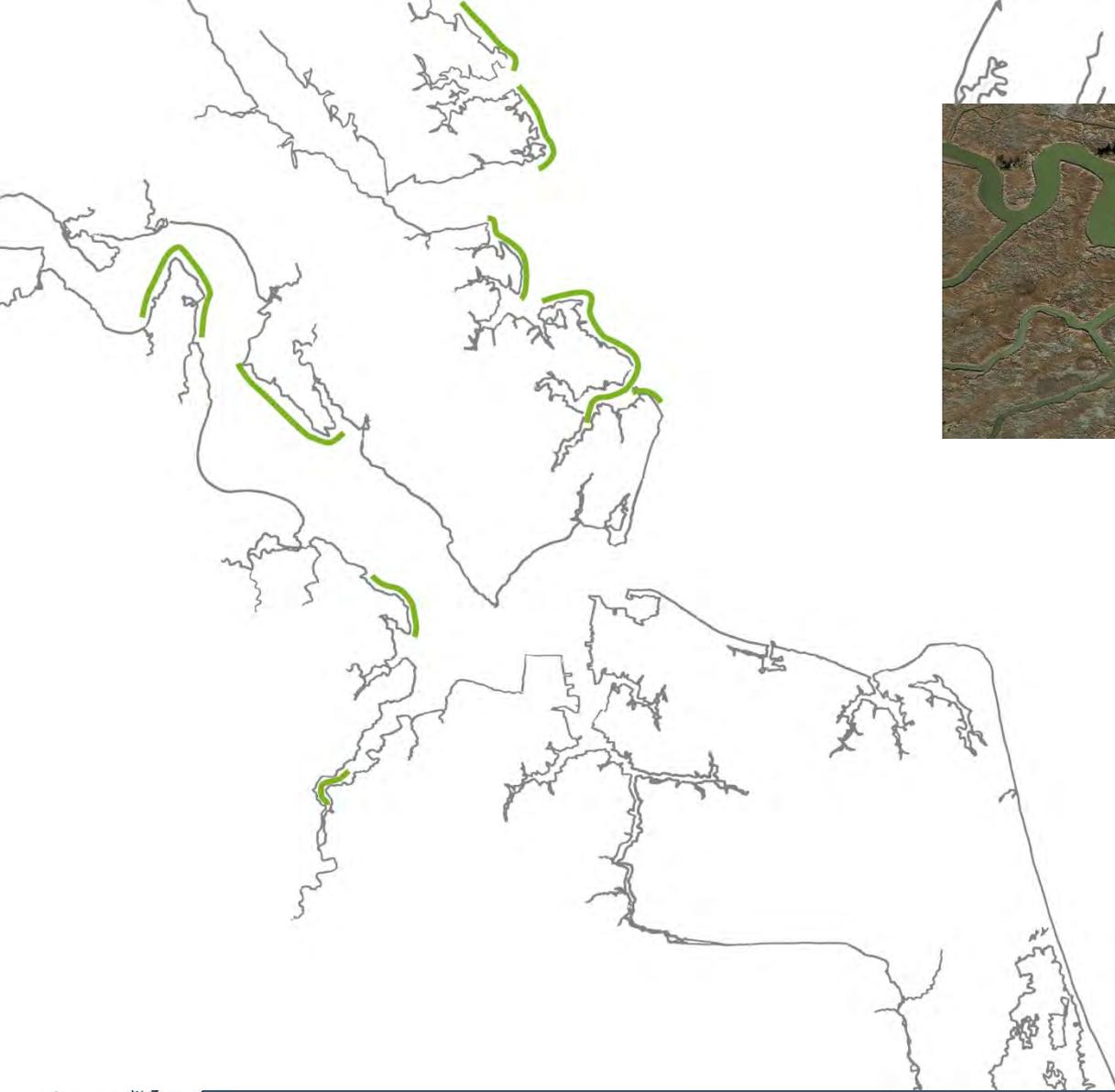
Industrial



DUTCH DIALOGUES
Virginia: Life at Sea Level

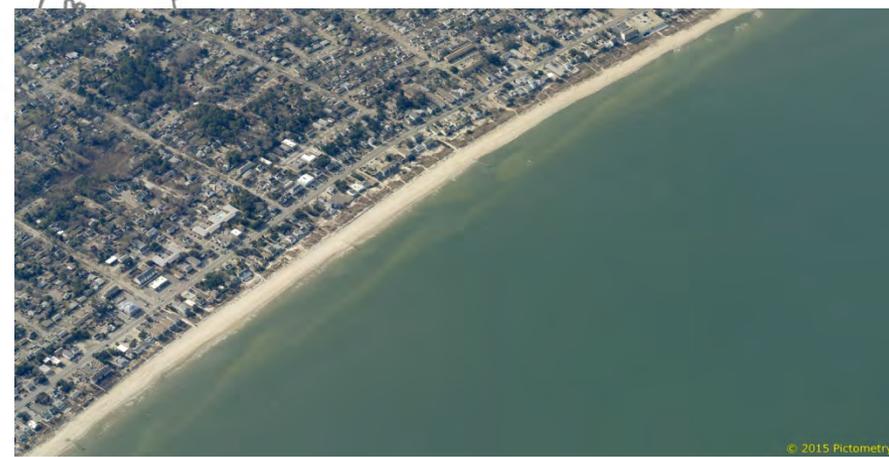
Developed





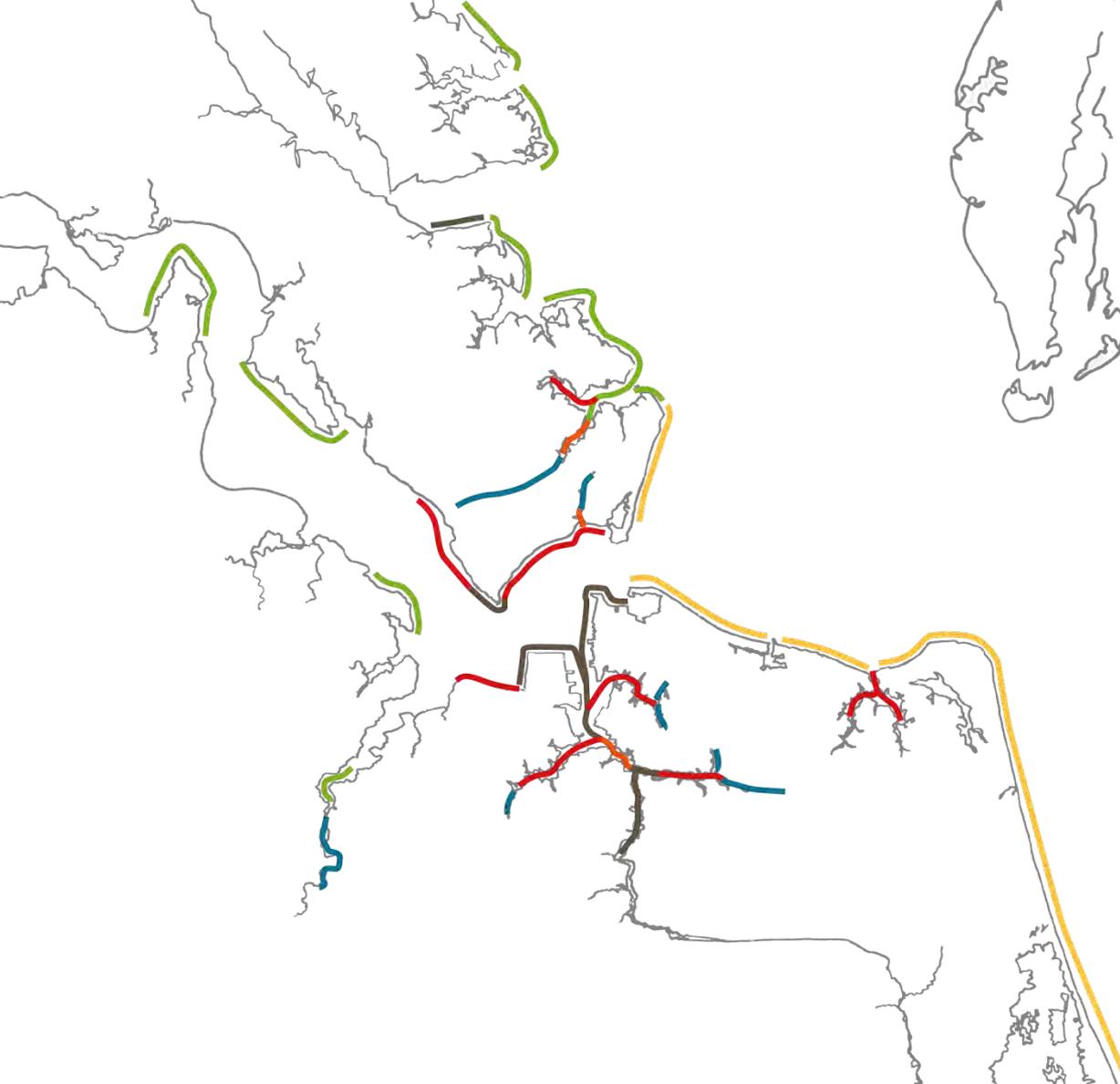
DUTCH DIALOGUES
Virginia: Life at Sea Level

Wetlands



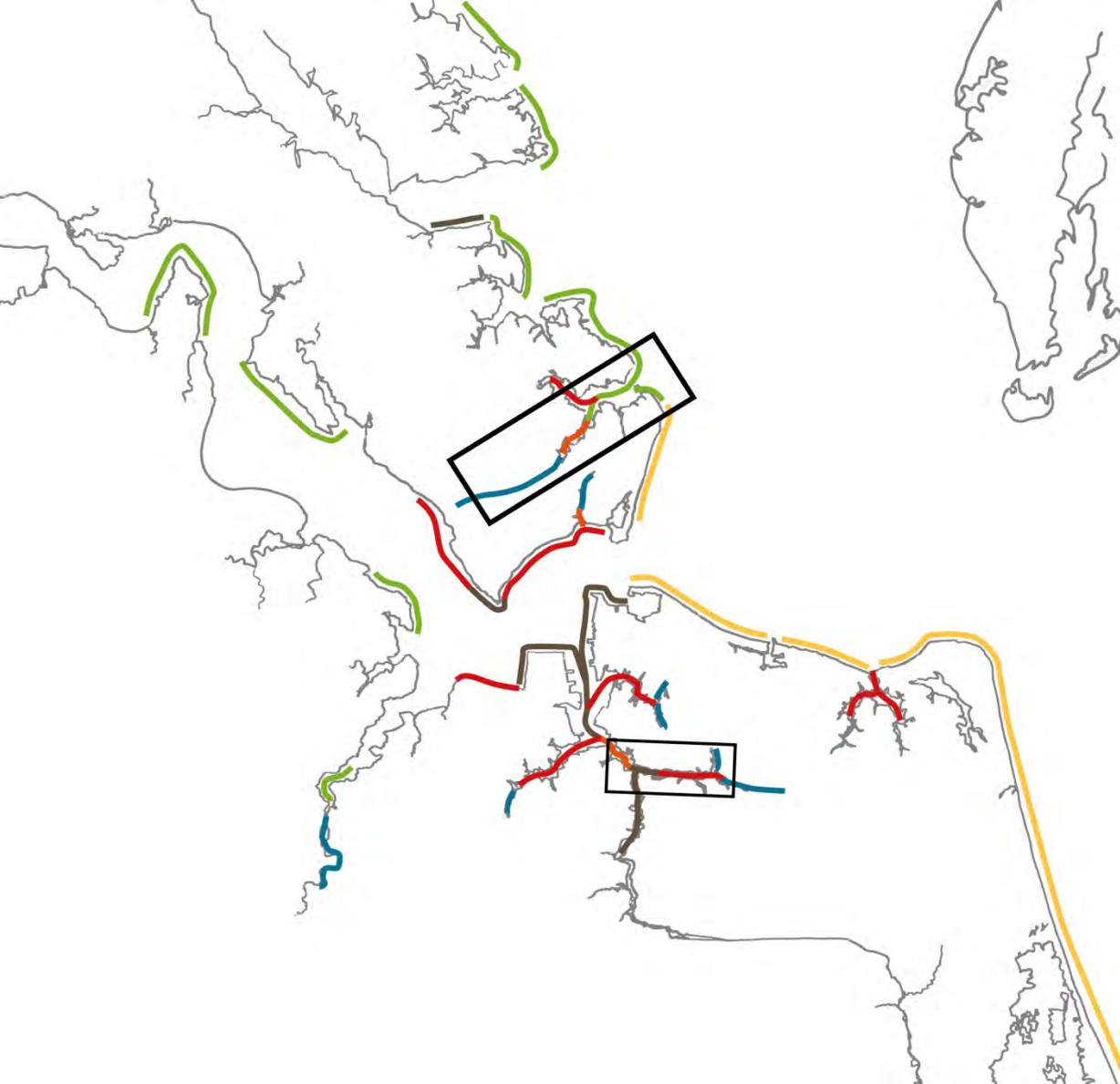
DUTCH DIALOGUES
Virginia: Life at Sea Level

Beaches



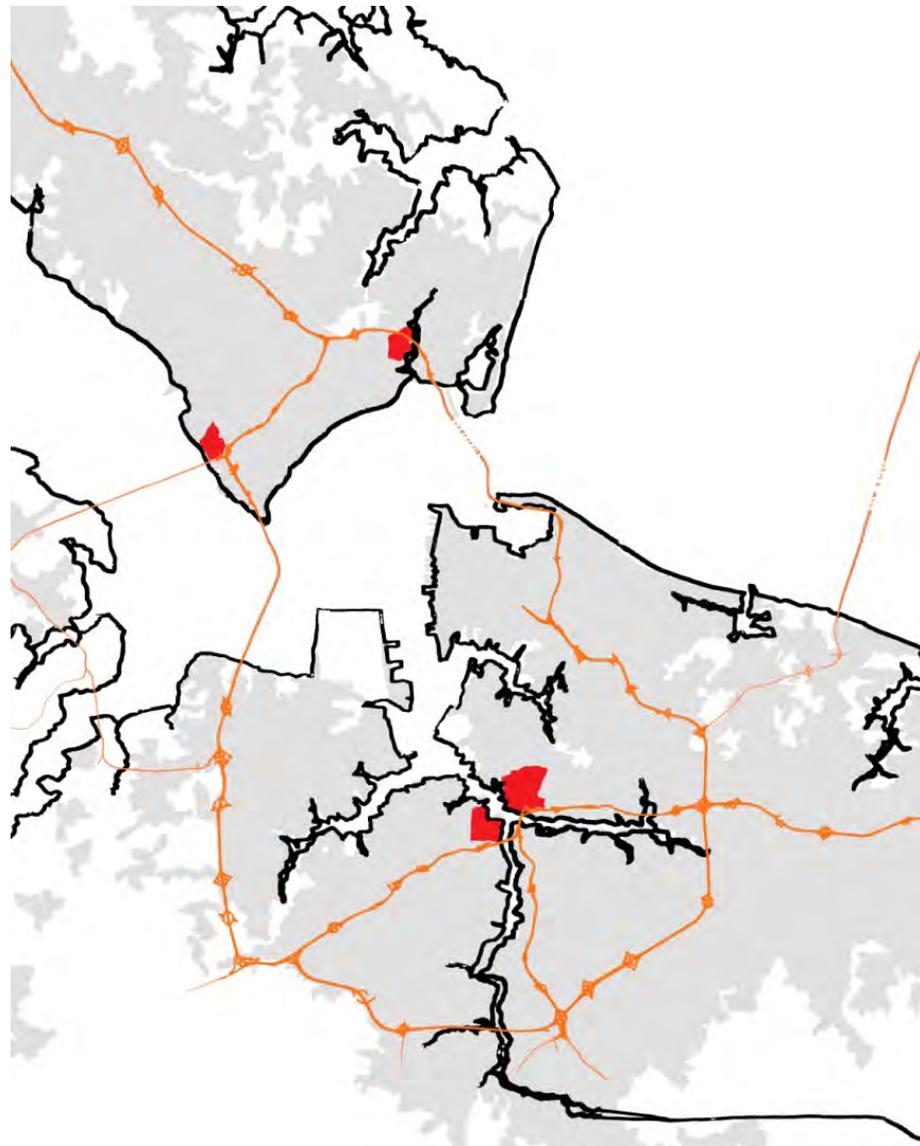
DUTCH DIALOGUES
Virginia: Life at Sea Level

Edge Conditions



DUTCH DIALOGUES
Virginia: Life at Sea Level

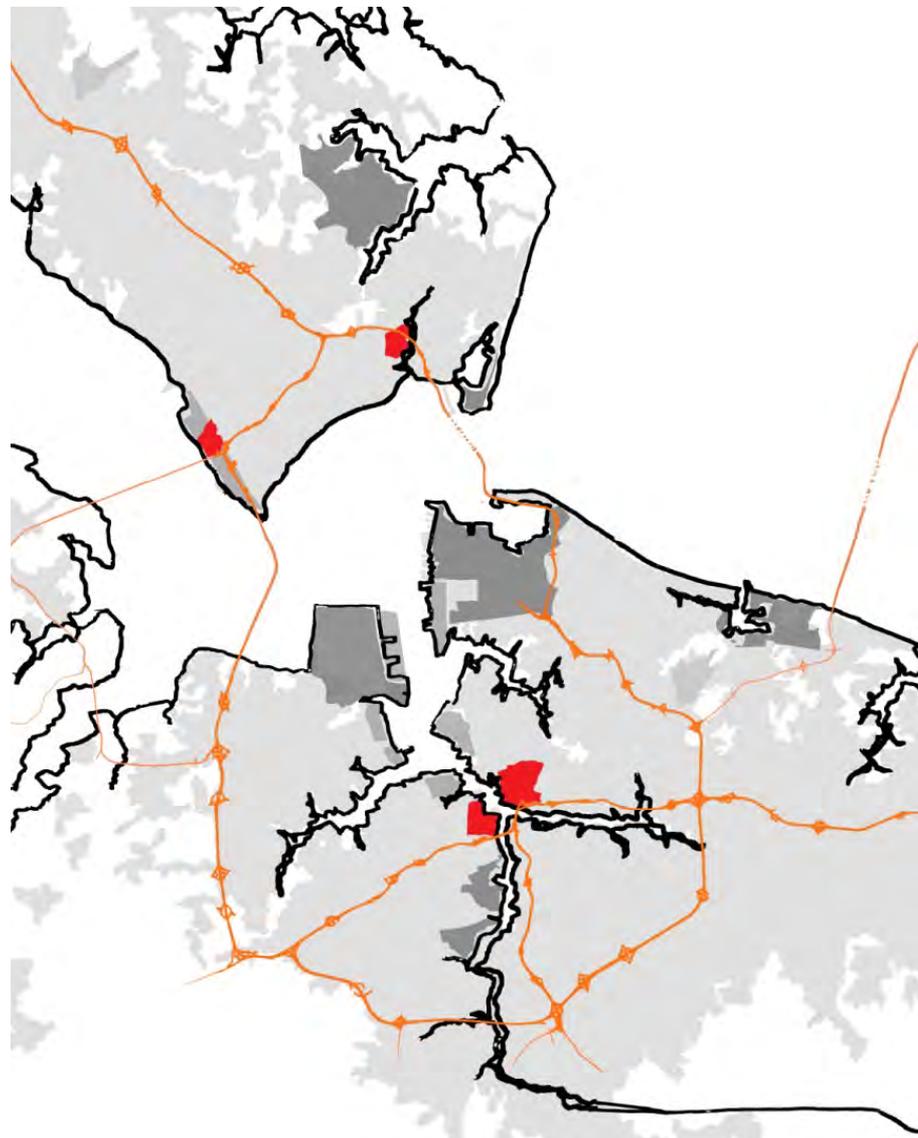
Two Sites



DUTCH DIALOGUES

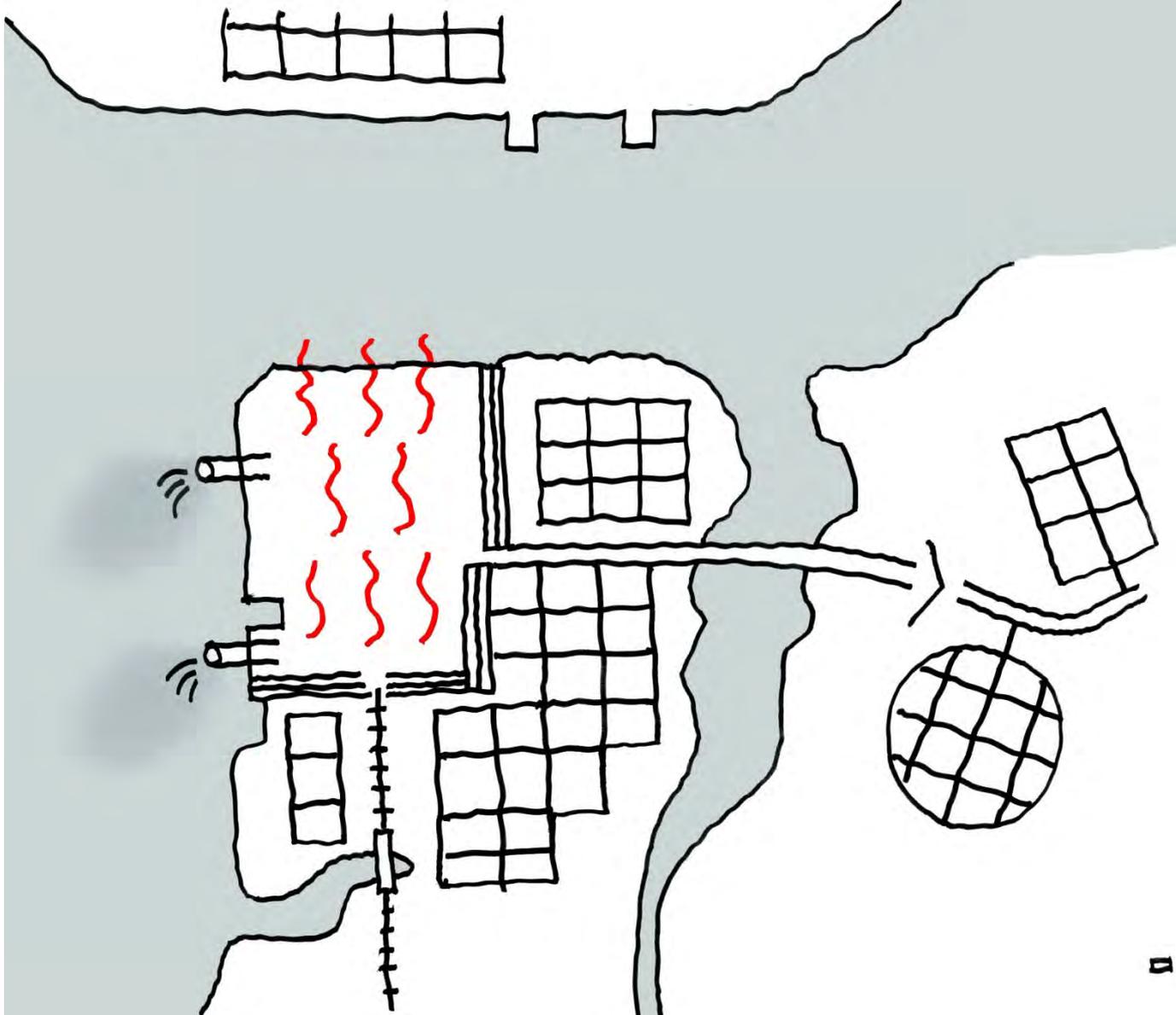
Virginia: Life at Sea Level

Urban Cores



DUTCH DIALOGUES
Virginia: Life at Sea Level

Urban Cores and XL



DUTCH DIALOGUES

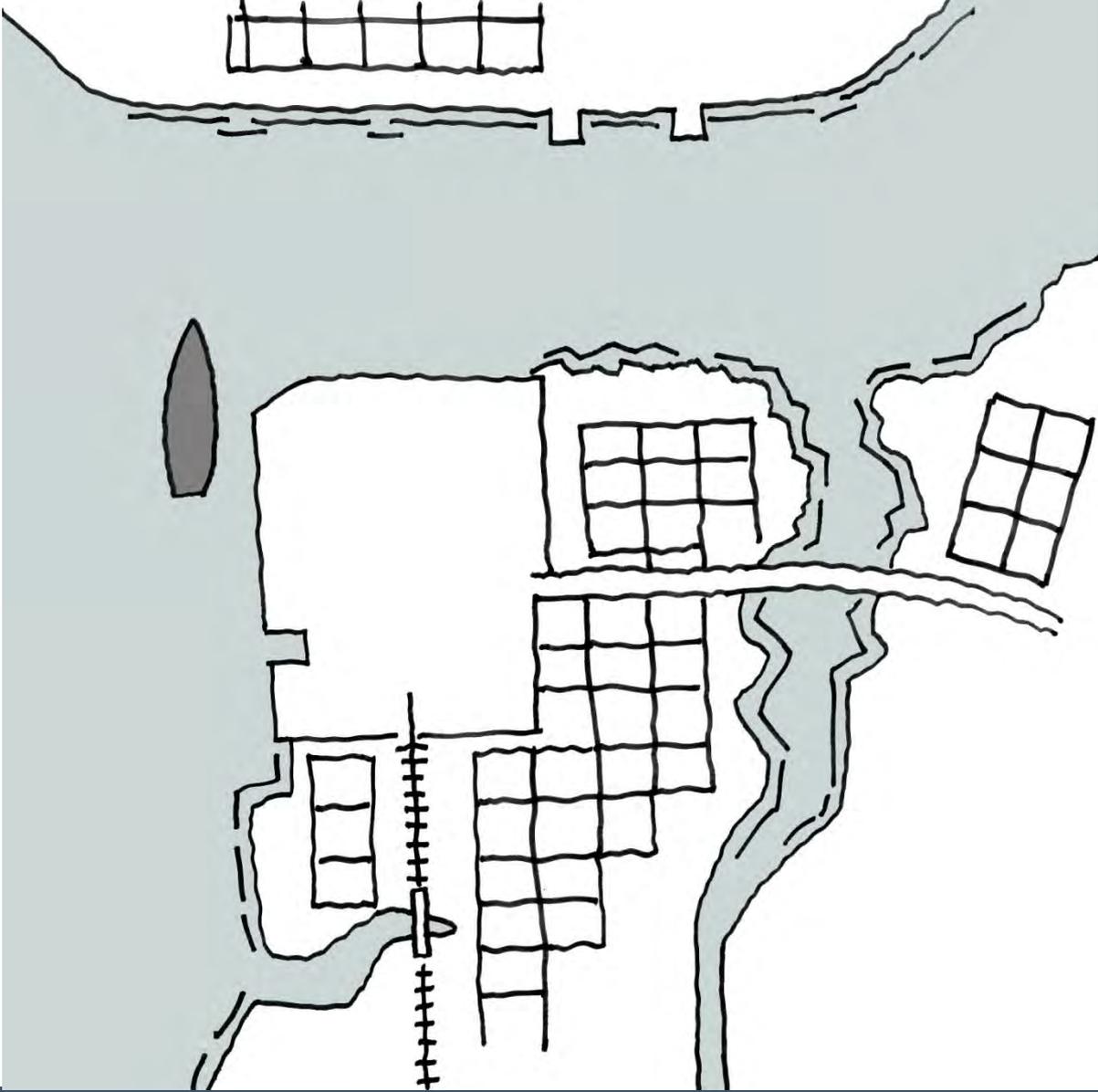
Virginia: Life at Sea Level

Company Town



DUTCH DIALOGUES
Virginia: Life at Sea Level

Company Town +



DUTCH DIALOGUES

Virginia: Life at Sea Level

Water's Edge

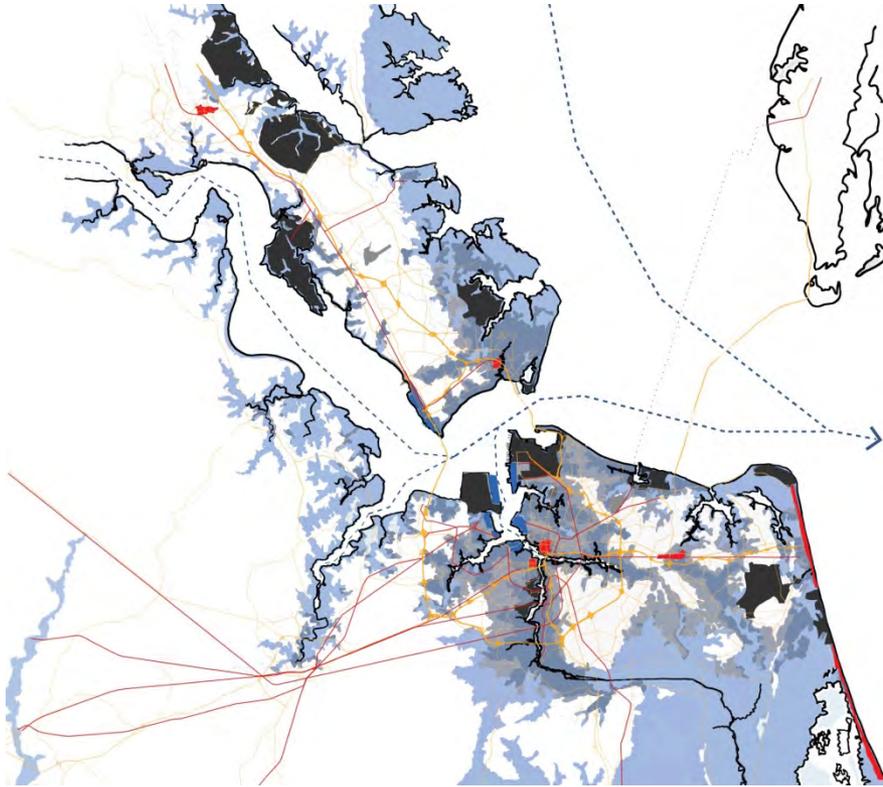


DUTCH DIALOGUES

Virginia: Life at Sea Level

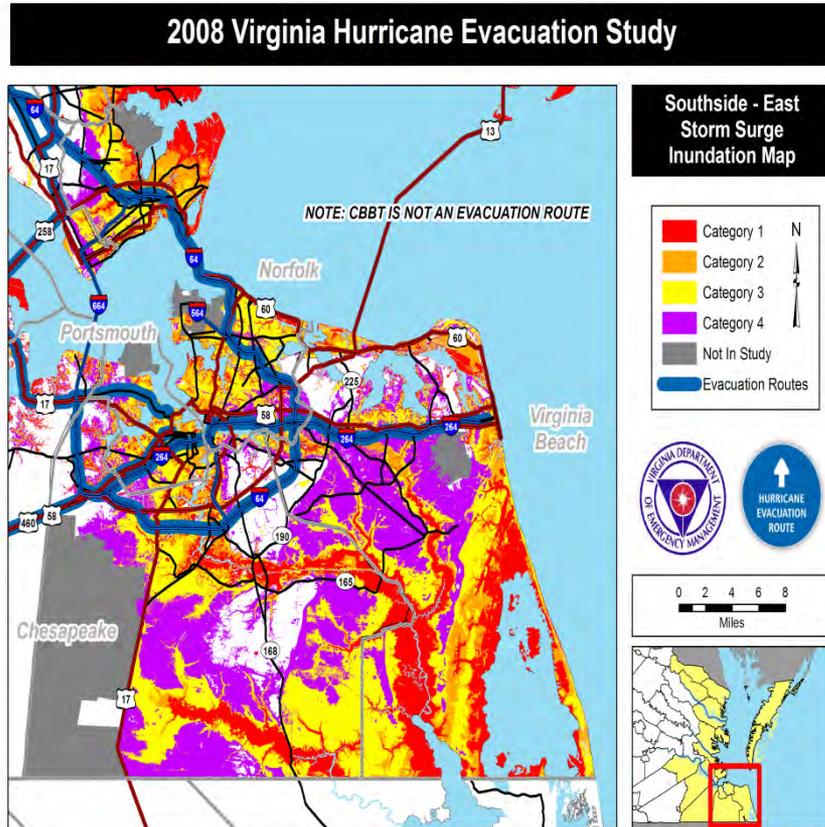
Active Living

The Intersection of Critical Infrastructure and the Economy



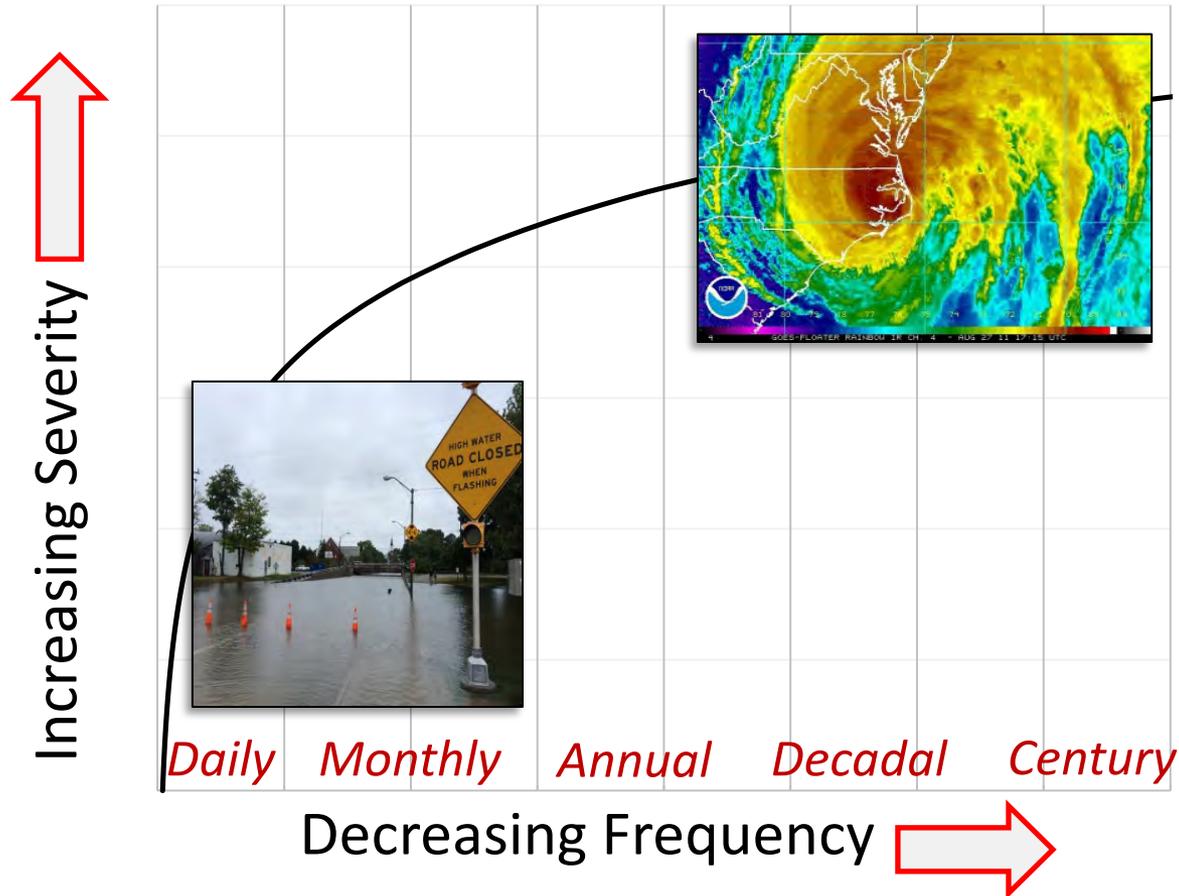
- Where are the jobs?
- What assets are crucial to employment opportunities?
- Prioritize the inventory of critical infrastructure components

Surge Flooding Impact on Infrastructure

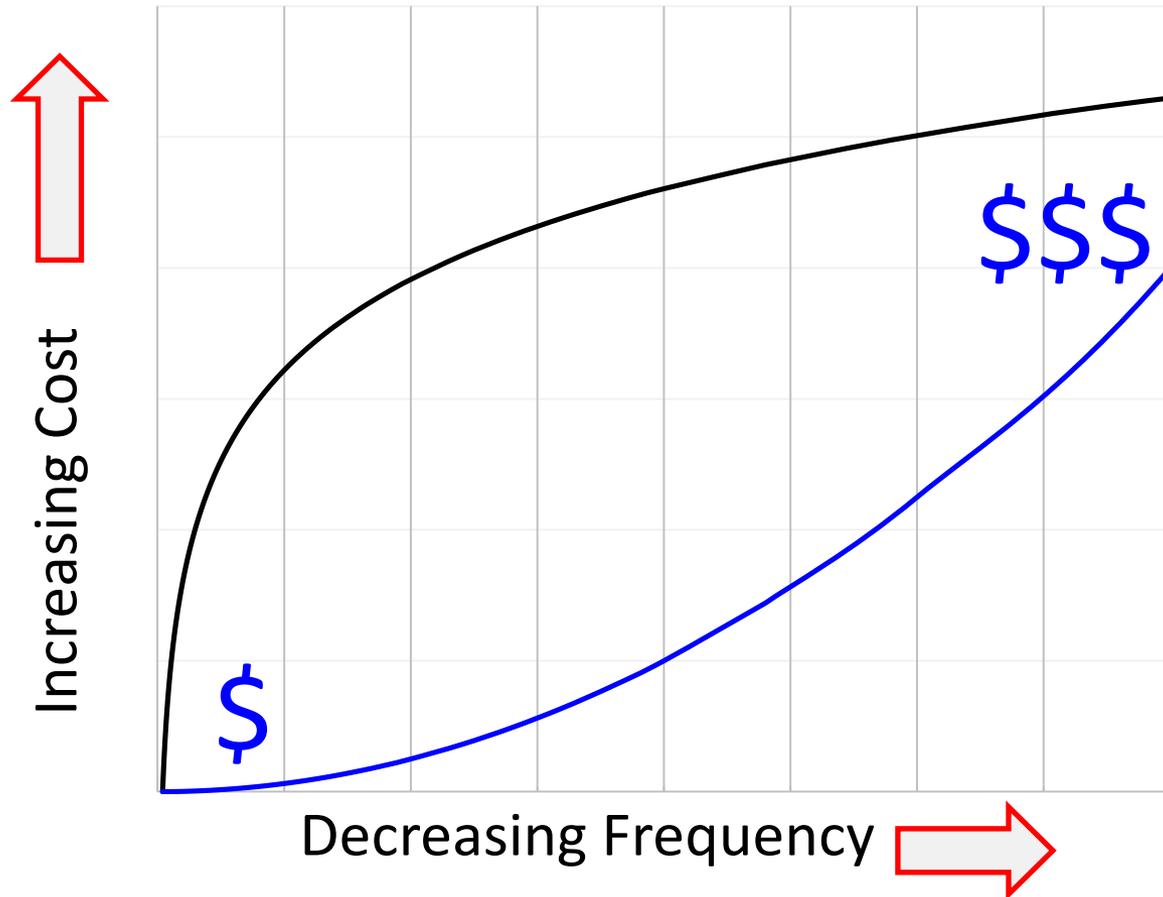


- Overlay infrastructure assets with surge risk
- Flood risk is spatially variable
- Compare different levels of flood risk:
 - Nuisance flooding
 - Large scale storm surge

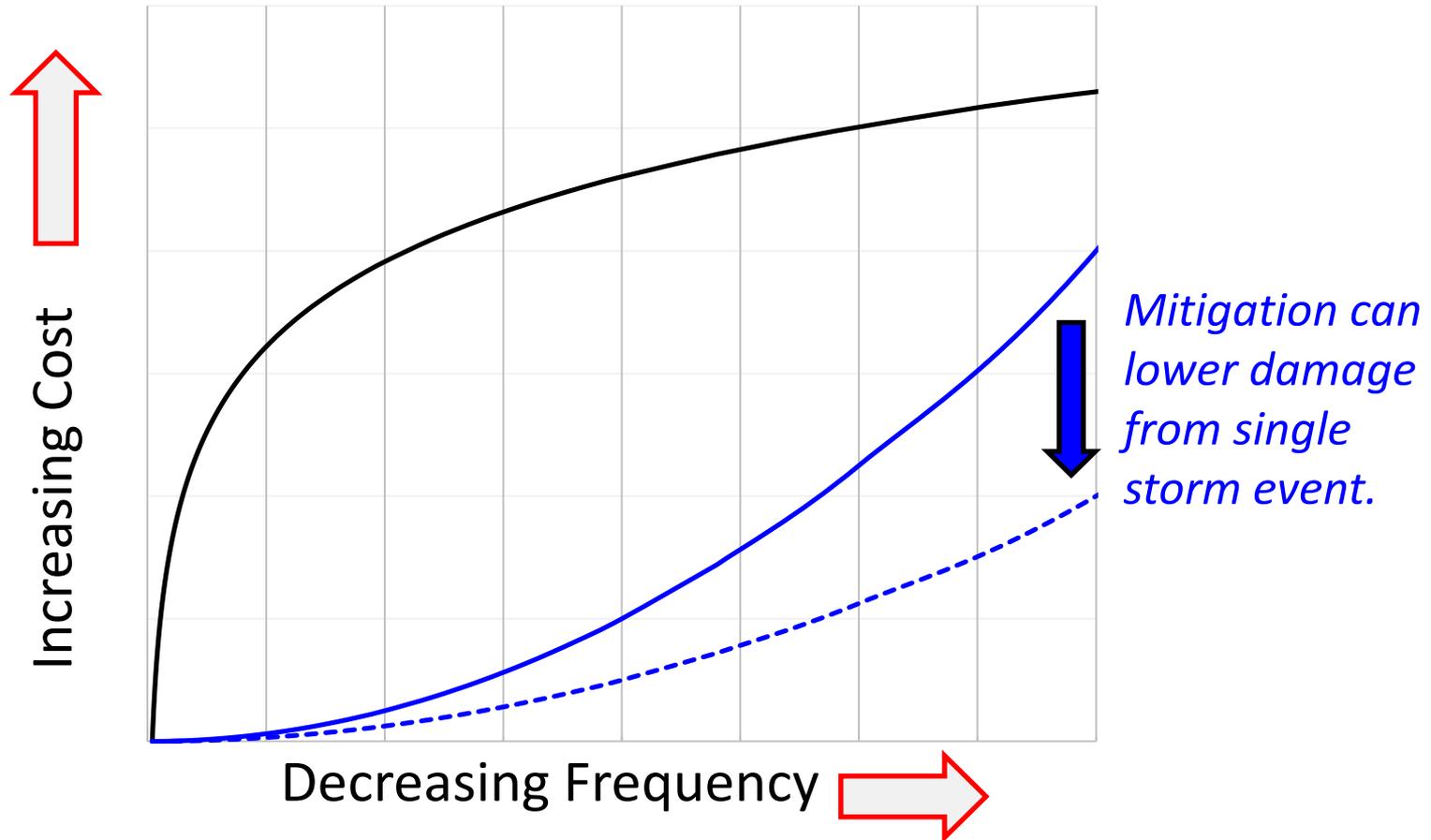
Vulnerability Spans a Range of Severity



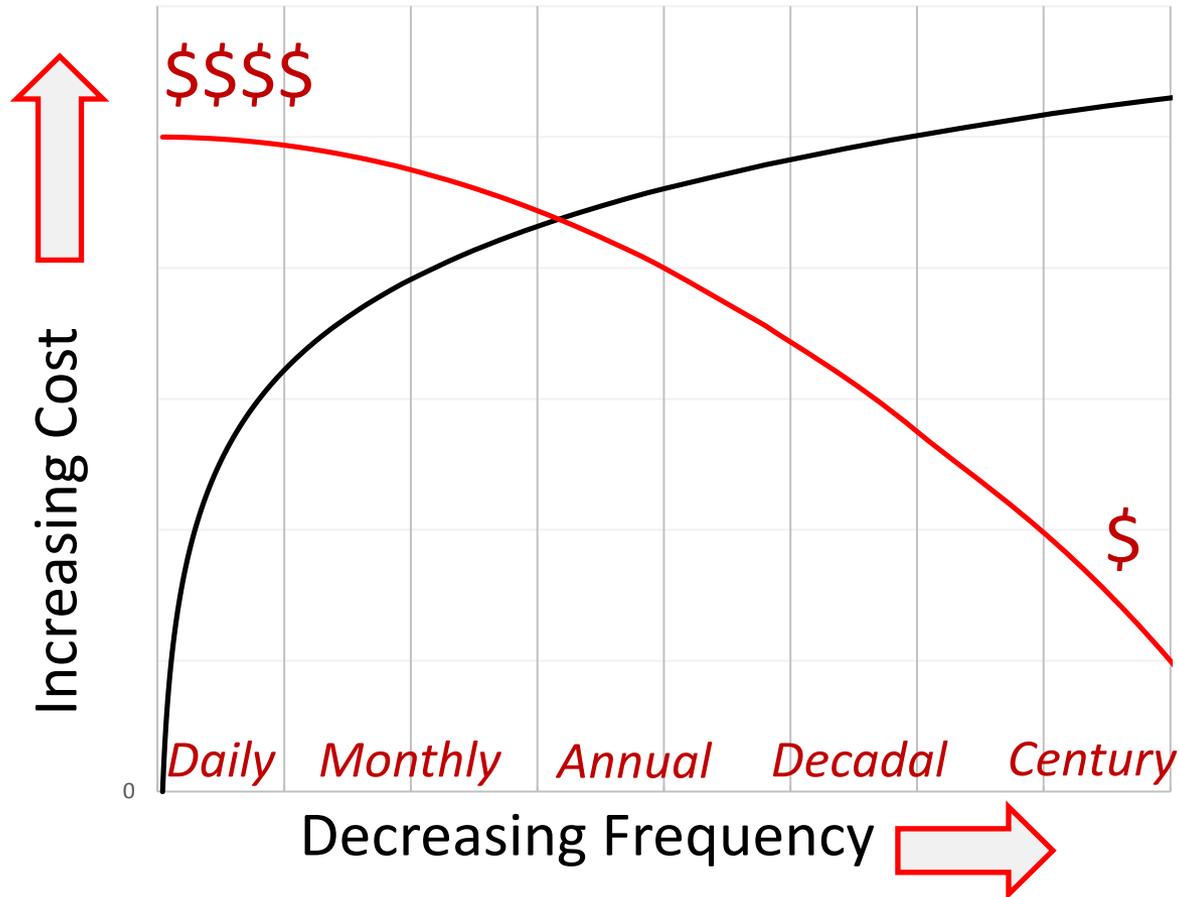
Event Specific Cost Increases with Severity



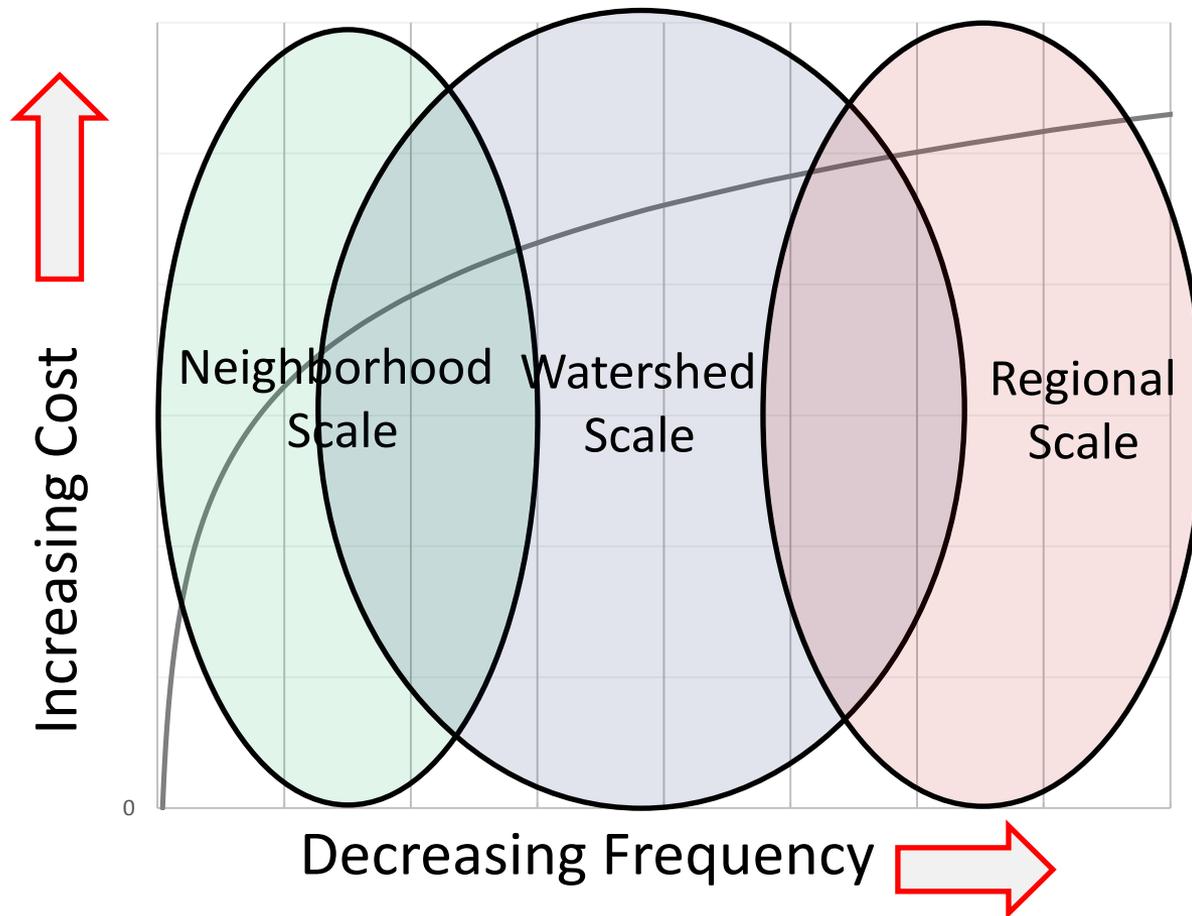
Effect of Mitigation



Cumulative Economic Impact



Size of Flood Impact



Watershed Scale Flooding



DUTCH DIALOGUES

Virginia: Life at Sea Level

Example: Lafayette Watershed

Vulnerabilities:

Roads & Transport Facilities

Water/sewer lines

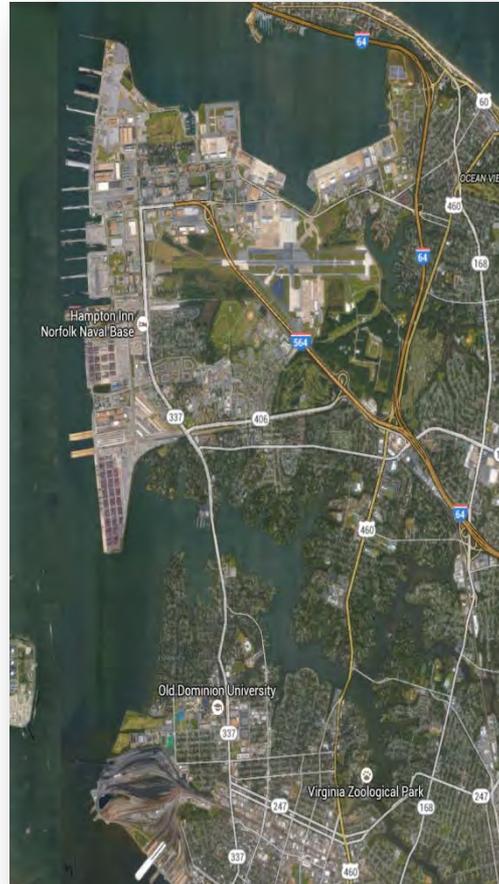
Sewage treatment

Power stations/lines

Emergency responders

Medical facilities

Schools/shelters



Strategies:

Local Storm Water

Co-Location and Bundling

Fortify

Move

Redundancy



Example: Lafayette Watershed

Vulnerabilities:

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Water/sewer lines

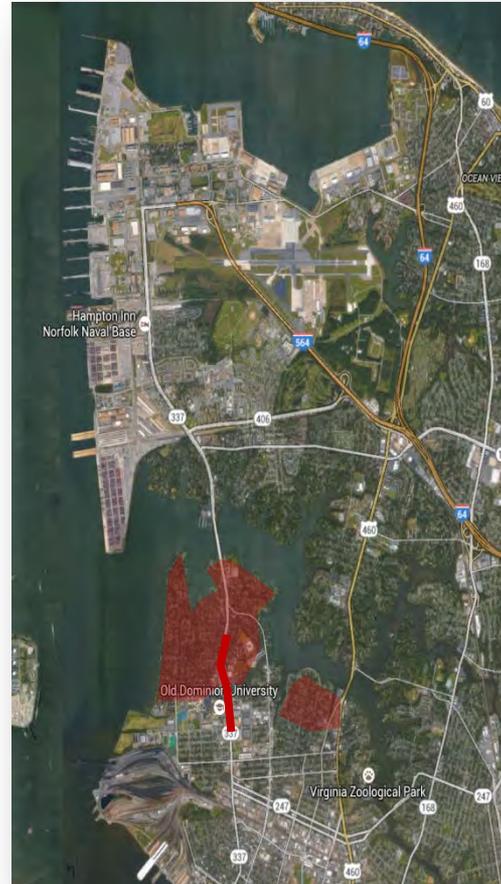
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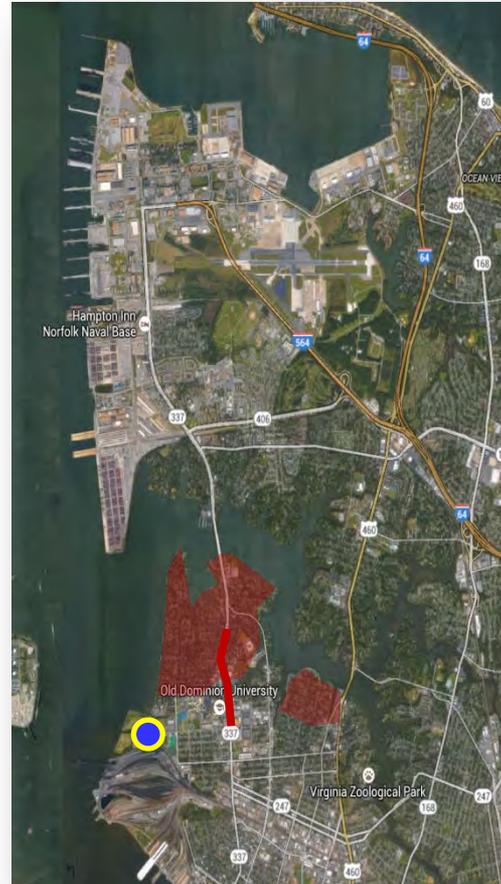
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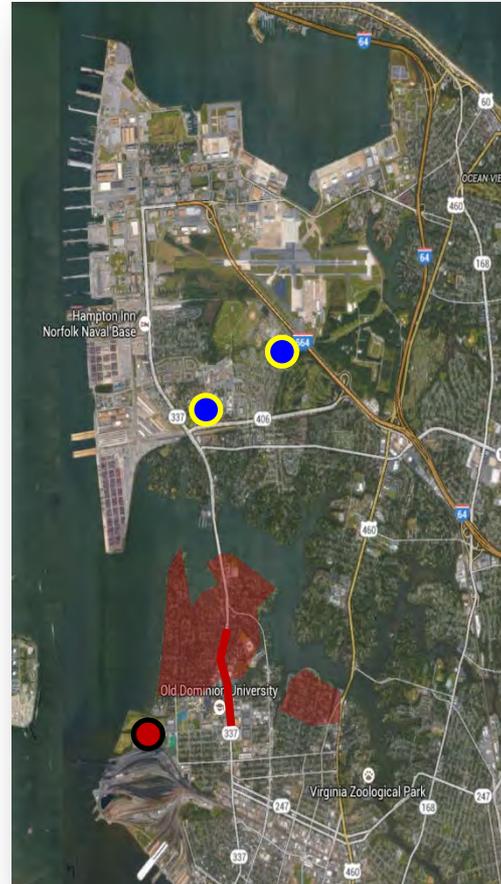
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DUTCH DIALOGUES

Virginia: Life at Sea Level

Example: Lafayette Watershed

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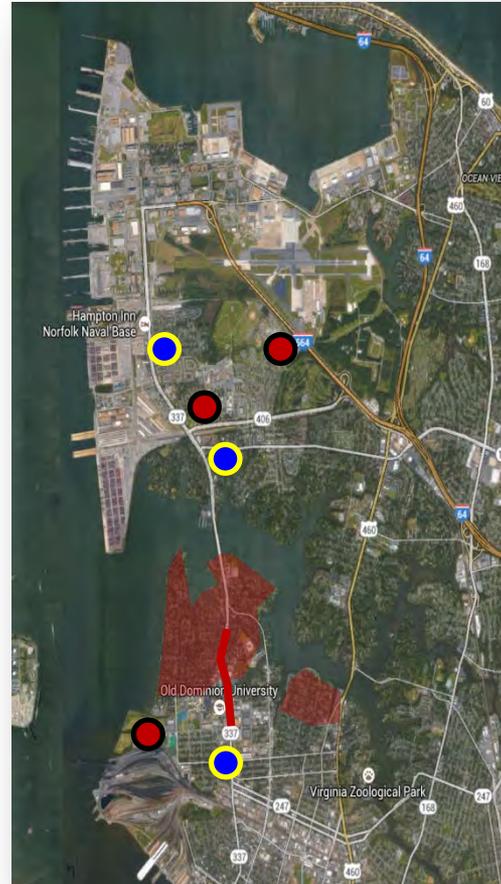
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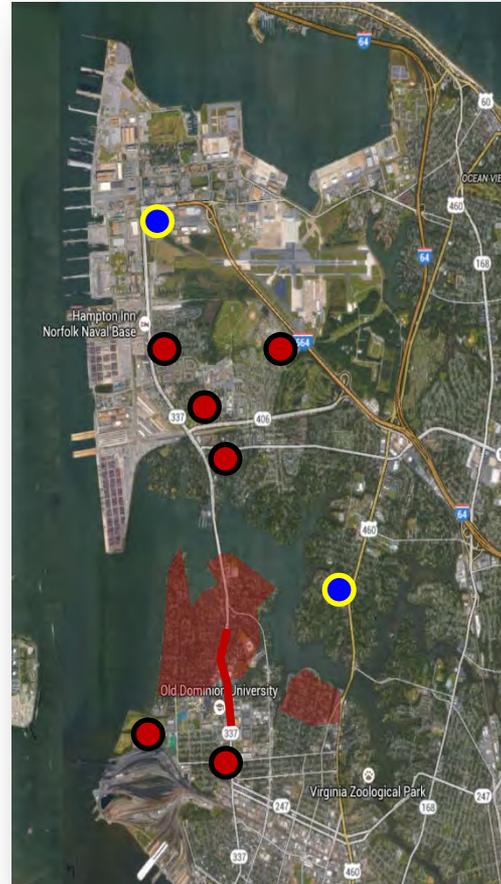
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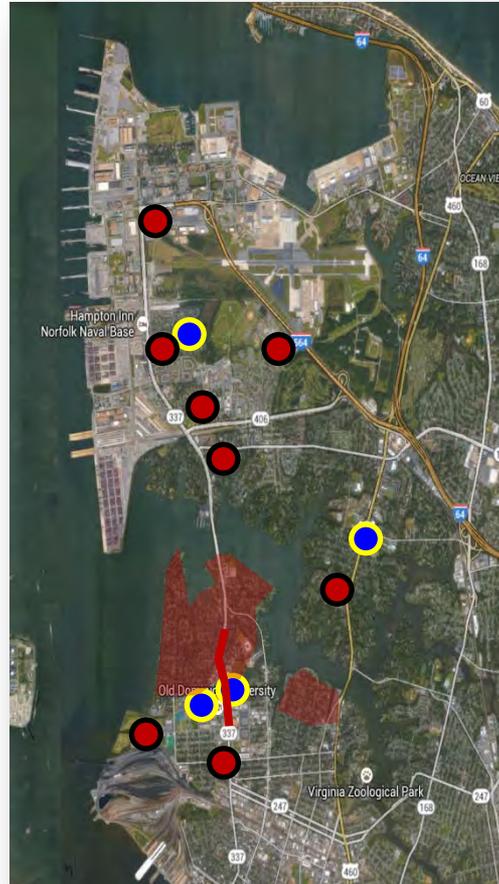
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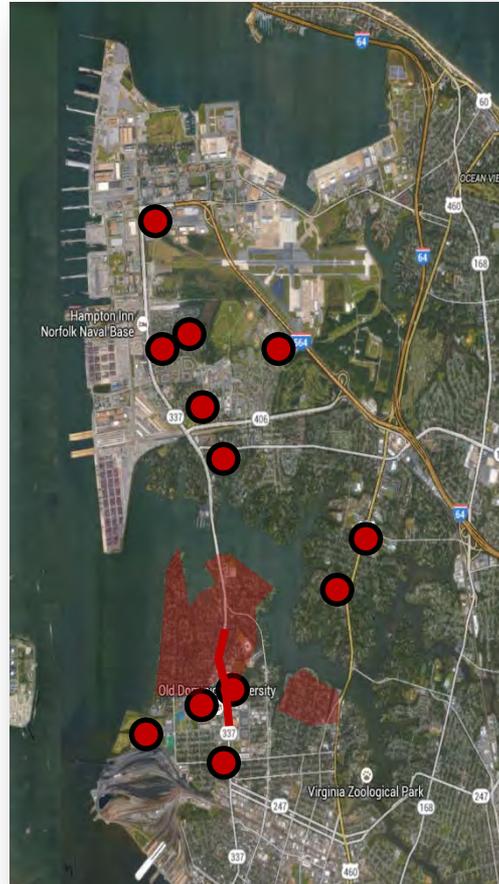
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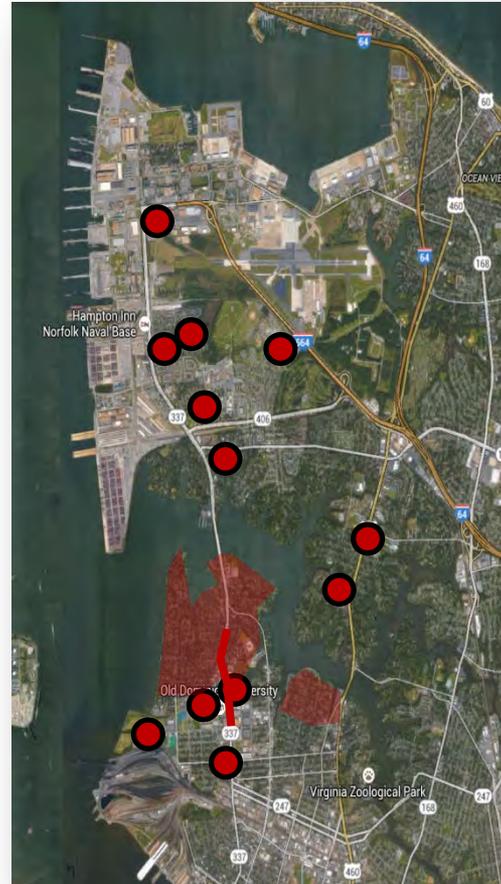
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Strategies:

Local Storm Water

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Fortify

Move

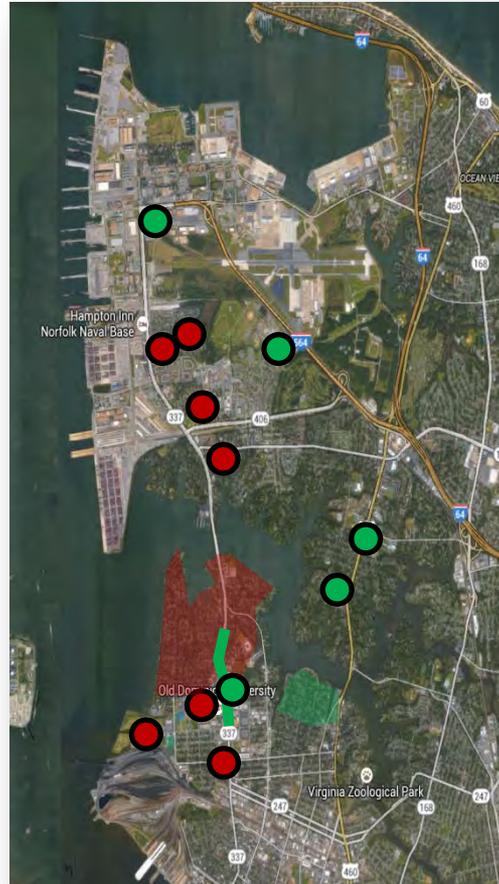
Redundancy



Example: Lafayette Watershed

Vulnerabilities:

- Roads & Transport Facilities
- Water/sewer lines
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- Power stations/lines
- Emergency responders
- Medical facilities
- Schools/shelters



Strategies:

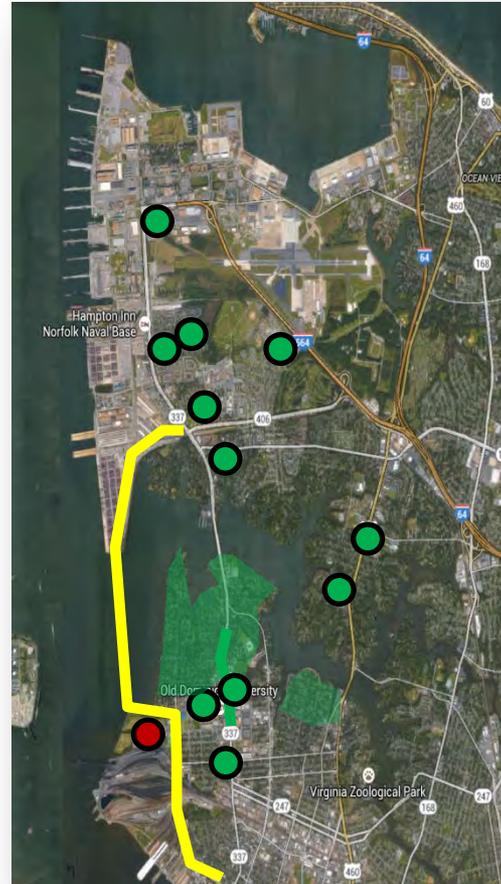
- Local Storm Water**
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Strategies:

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- Fortify**
- Move
- Redundancy





DUTCH DIALOGUES

Virginia: Life at Sea Level

National significance of the military installations
DoD supports 40% of all regional employment



DUTCH *DIALOGUES*

Virginia: Life at Sea Level

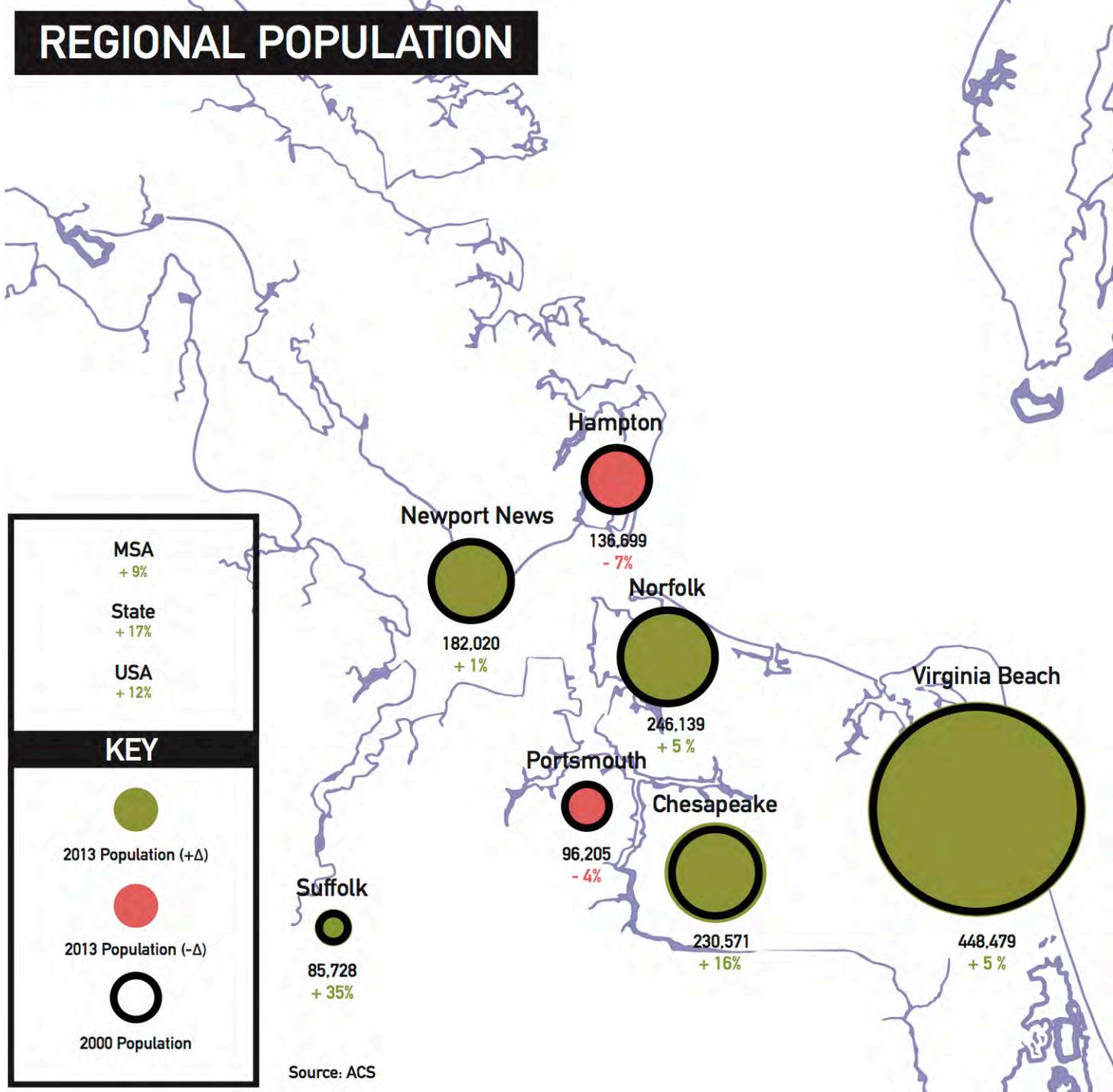
Hampton Roads Bridge-Tunnel on Wednesday,
Sept. 11, 2013



DUTCH DIALOGUES
Virginia: Life at Sea Level

Midtown tunnel flooding - August 28, 2011

REGIONAL POPULATION



MSA

+9%

State

+17%

USA

+12%

KEY



2013 Population (+Δ)



2013 Population (-Δ)



2000 Population

Suffolk



85,728

+35%

Newport News



182,020

+1%

Hampton



136,699

-7%

Norfolk



246,139

+5%

Portsmouth



96,205

-4%

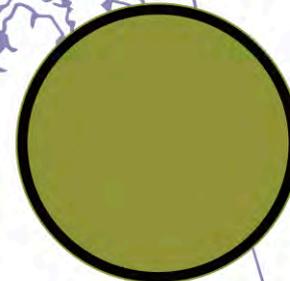
Chesapeake



230,571

+16%

Virginia Beach

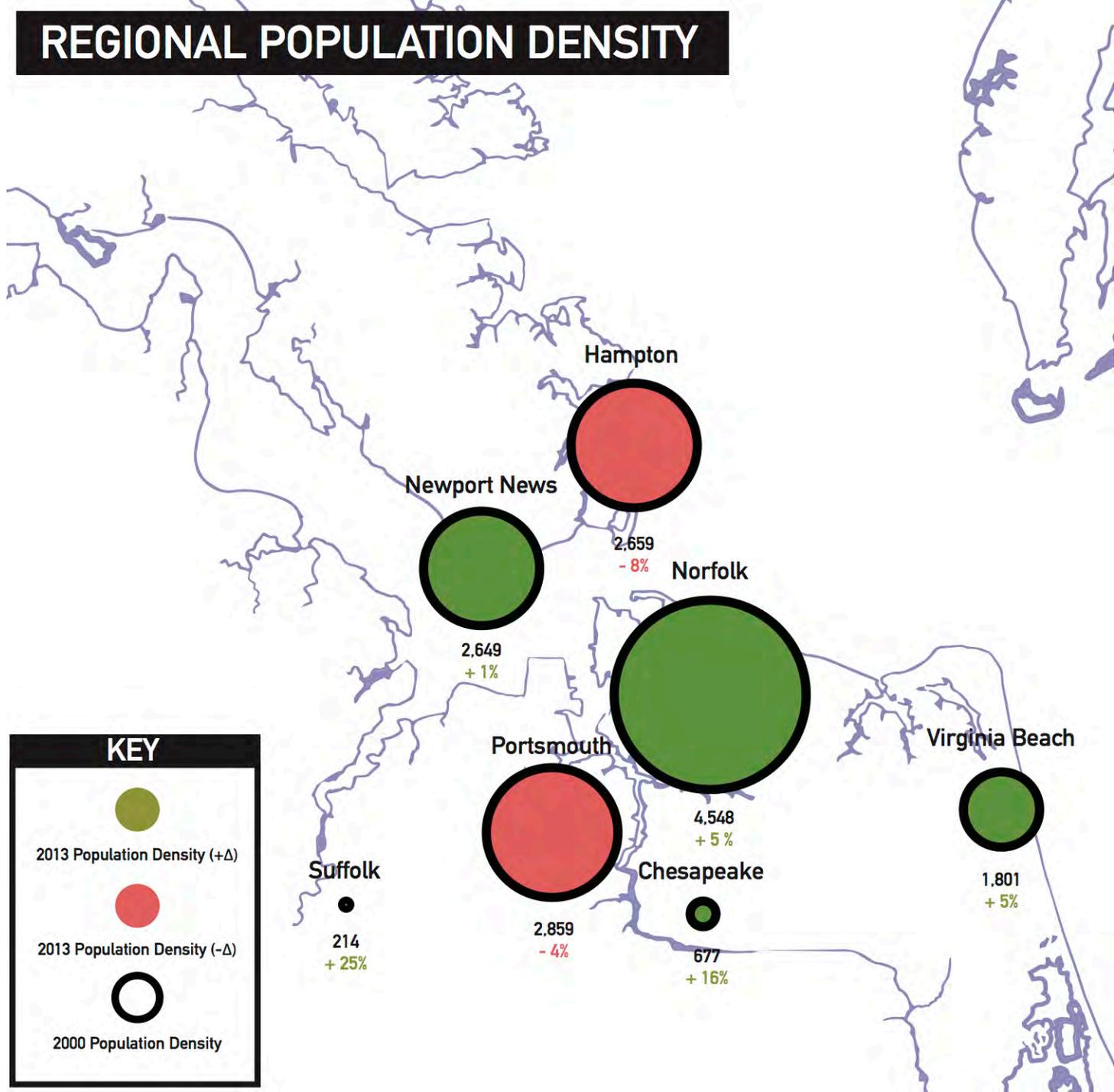


448,479

+5%

Source: ACS

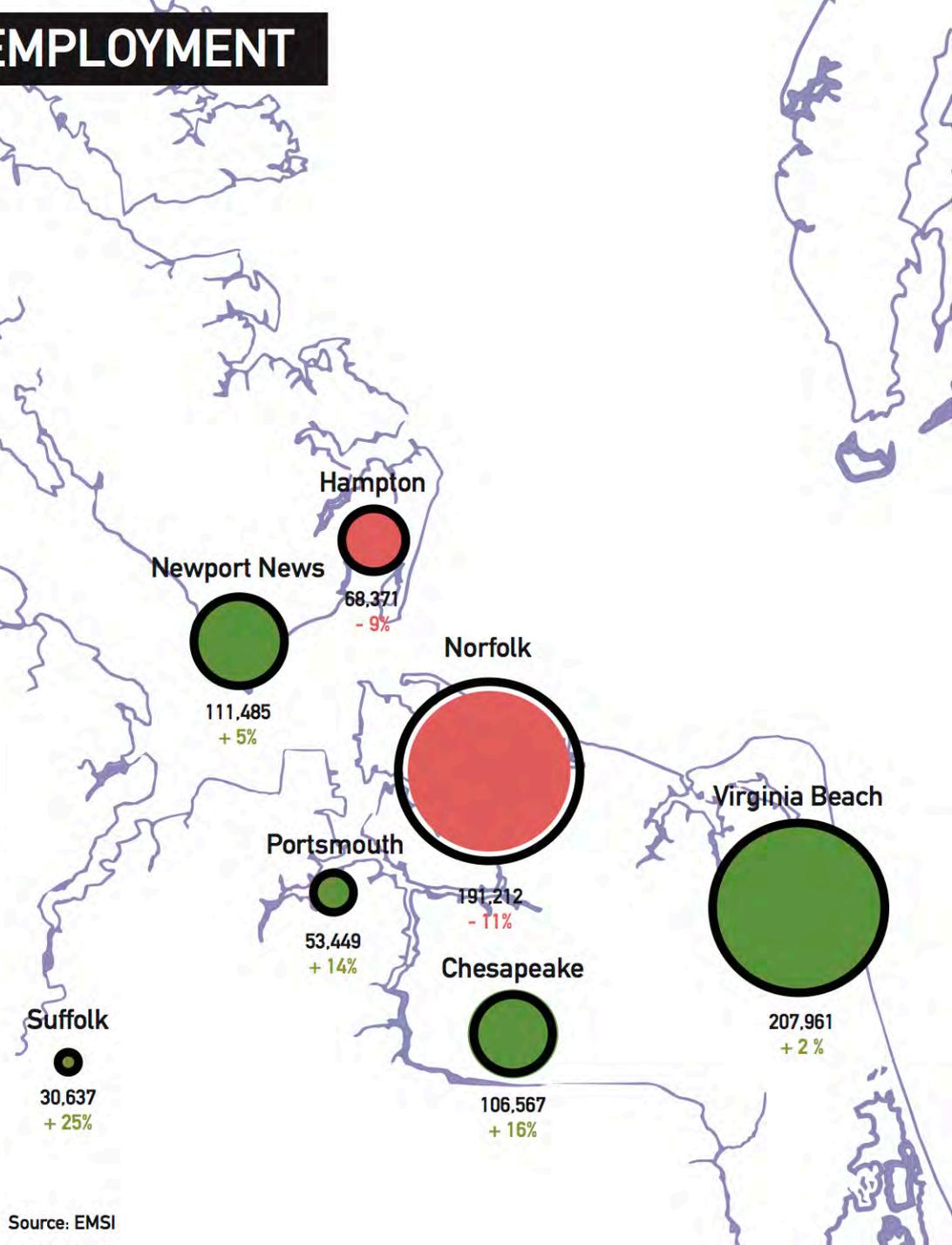
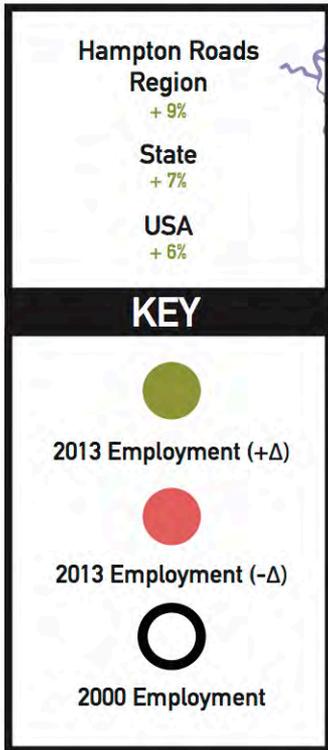
REGIONAL POPULATION DENSITY



KEY

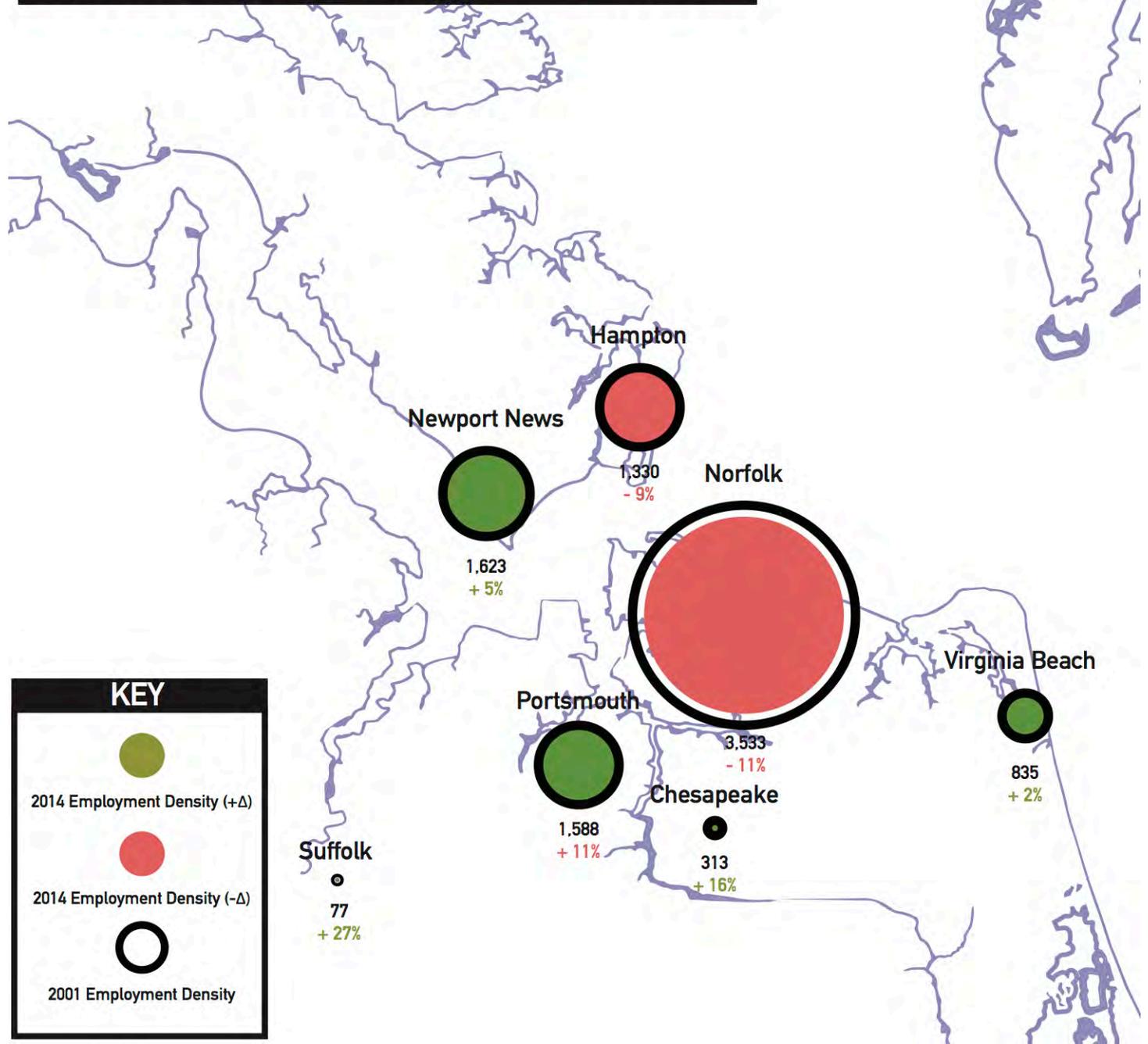
- 2013 Population Density (+Δ)
- 2013 Population Density (-Δ)
- 2000 Population Density

REGIONAL EMPLOYMENT



Source: EMSI

REGIONAL EMPLOYMENT DENSITY



KEY

- 2014 Employment Density (+Δ)
- 2014 Employment Density (-Δ)
- 2001 Employment Density

Governance – it can be done!

Conditions:

- Collaborate when it makes sense
- With respect to existing initiatives and taking advantage of new opportunities
- With the support of the business community/leaders
- With strong leadership



Considered options

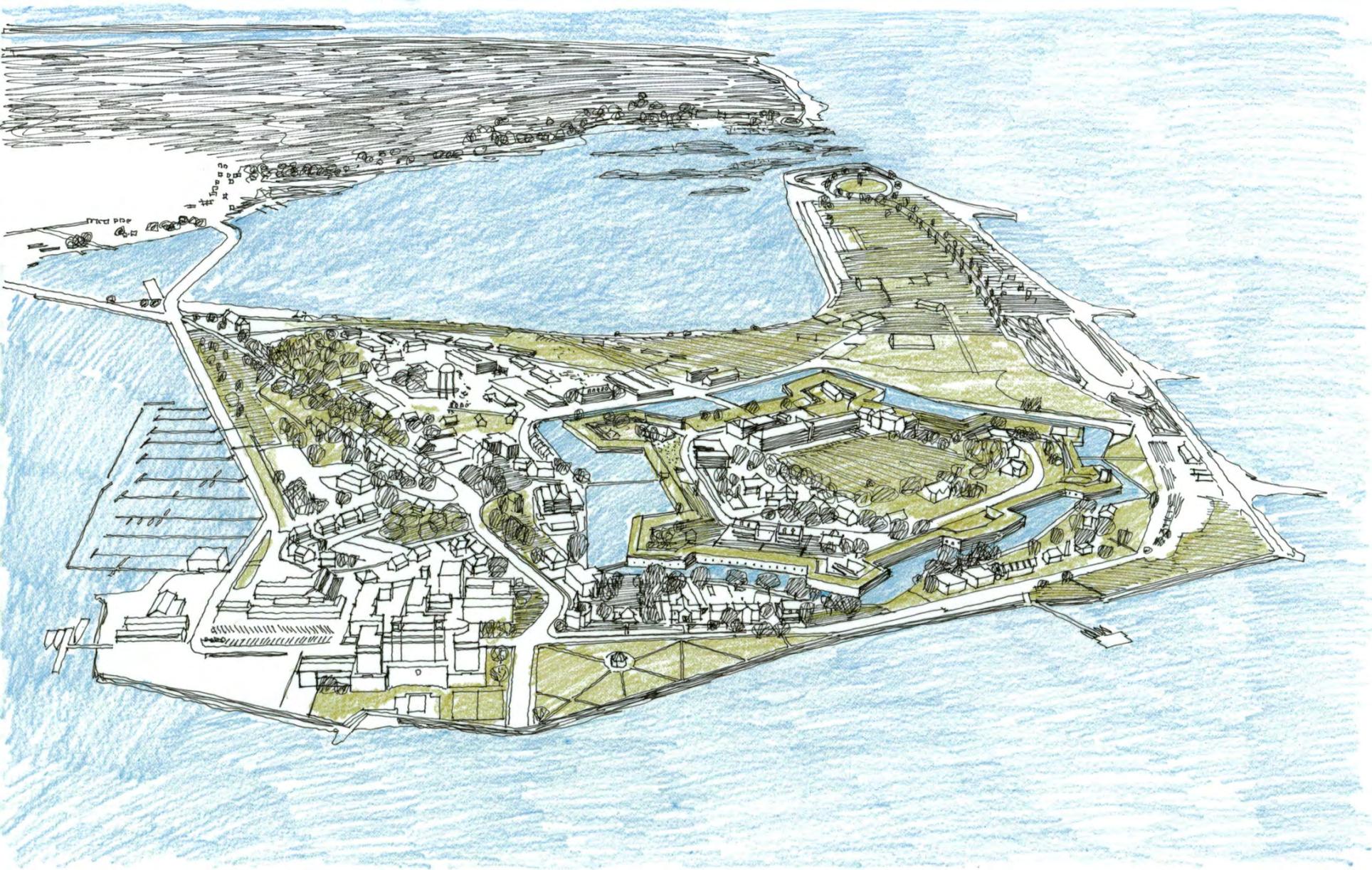
- New legislation to form a political subdivision with a SLR focus
- Regional investment authority for water management + infrastructure
- Business as usual (fragmented approach)
- Federal government steps in, takes over and runs it (Tennessee Valley Authority)



Preferred options

1. Start a SLR compact with frontline cities (city managers) with the support of business alliance (CEO roundtable).
2. SLR planning and implementation in HR demands regional leadership and resources. PDC leads the regional effort, using statutory authority.







HAMPTON: *FROM THREAT TO AMENITY*

New Market Creek 1953



New Market Creek 1968



New Market Creek 1973



**NO
DUMPING**
VIOLATORS
WILL BE
PROSECUTED
AREA UNDER
SURVEILLANCE







+JenCare
MEDICAL CENTERS

oclaphama plasma

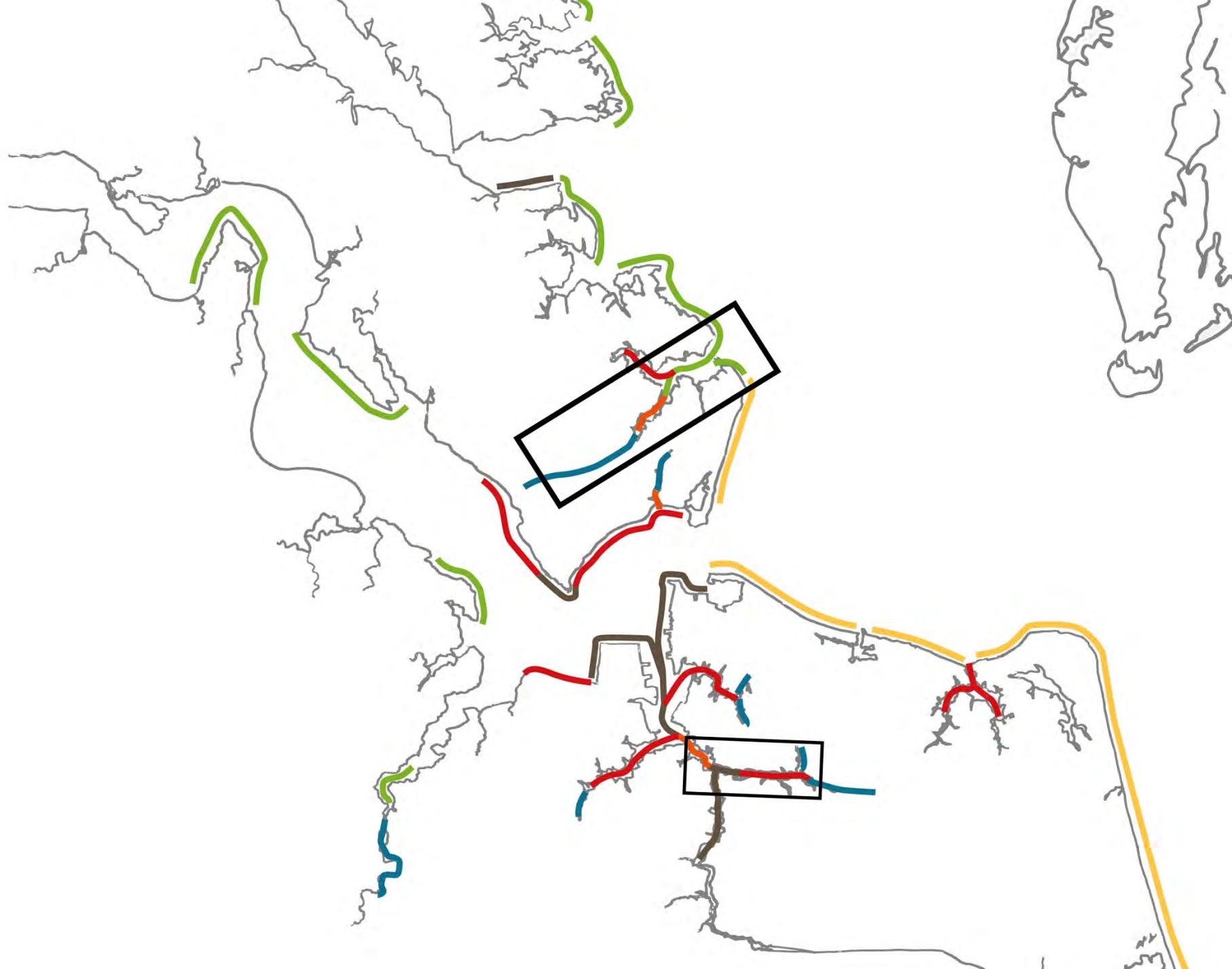
GOLDMAN
SACHS









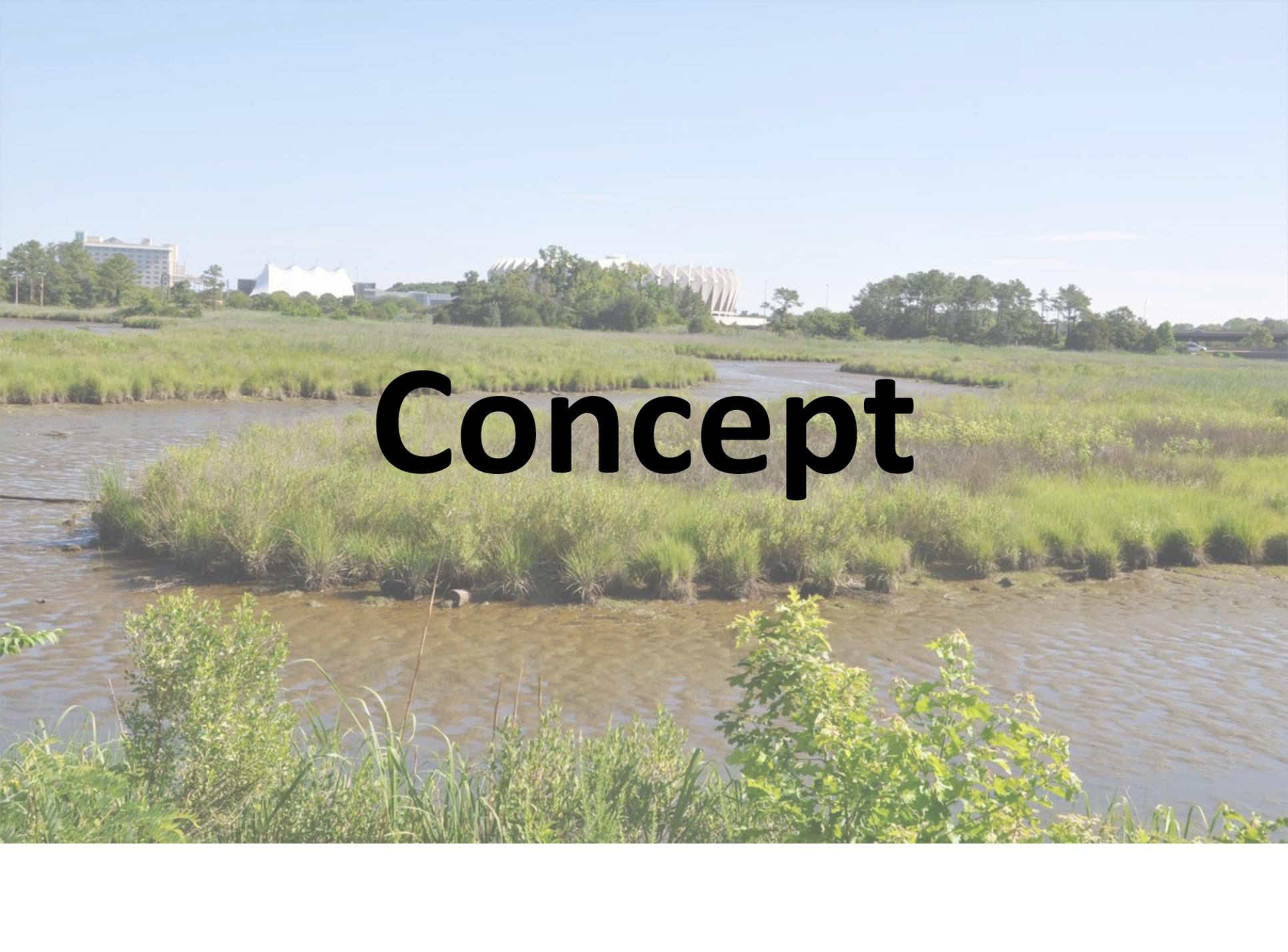


A landscape photograph showing a wide expanse of green marshland in the foreground and middle ground. A body of water, likely a bay or estuary, is visible on the left and right sides. In the background, a large, modern stadium with a distinctive white, curved roof is visible, surrounded by trees and other buildings. The sky is clear and blue.

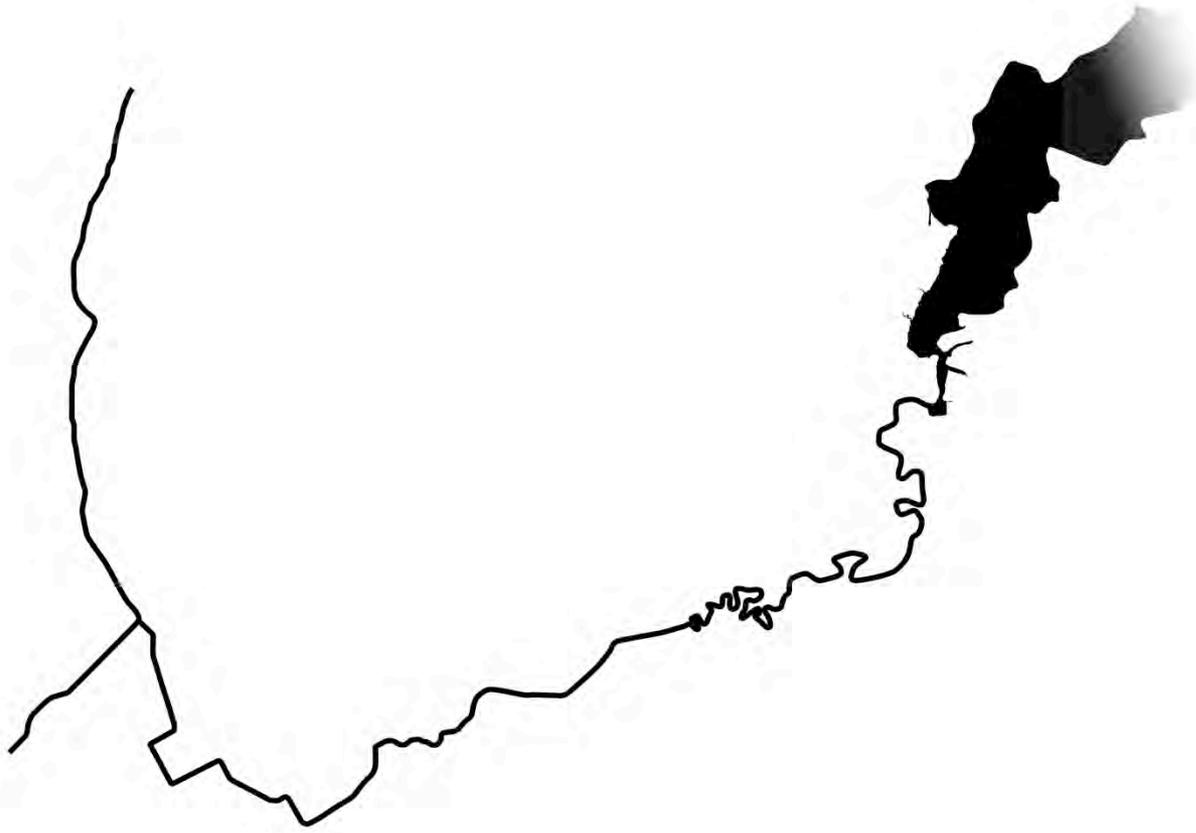
Ambition



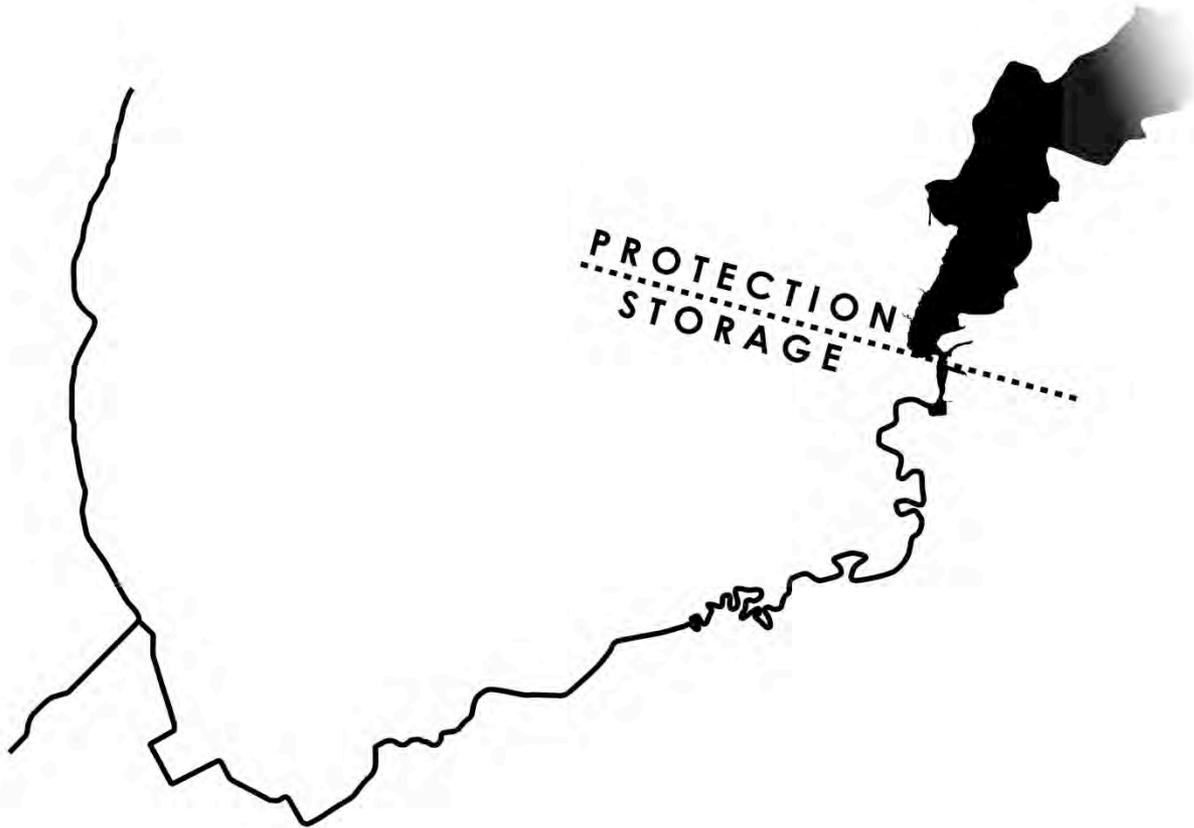


A landscape photograph showing a wide river or estuary with muddy water. The banks are covered in lush green marsh grasses and reeds. In the background, there are several buildings, including a large white tent-like structure and a modern building with a curved facade. The sky is clear and blue.

Concept







PROTECTION
STORAGE

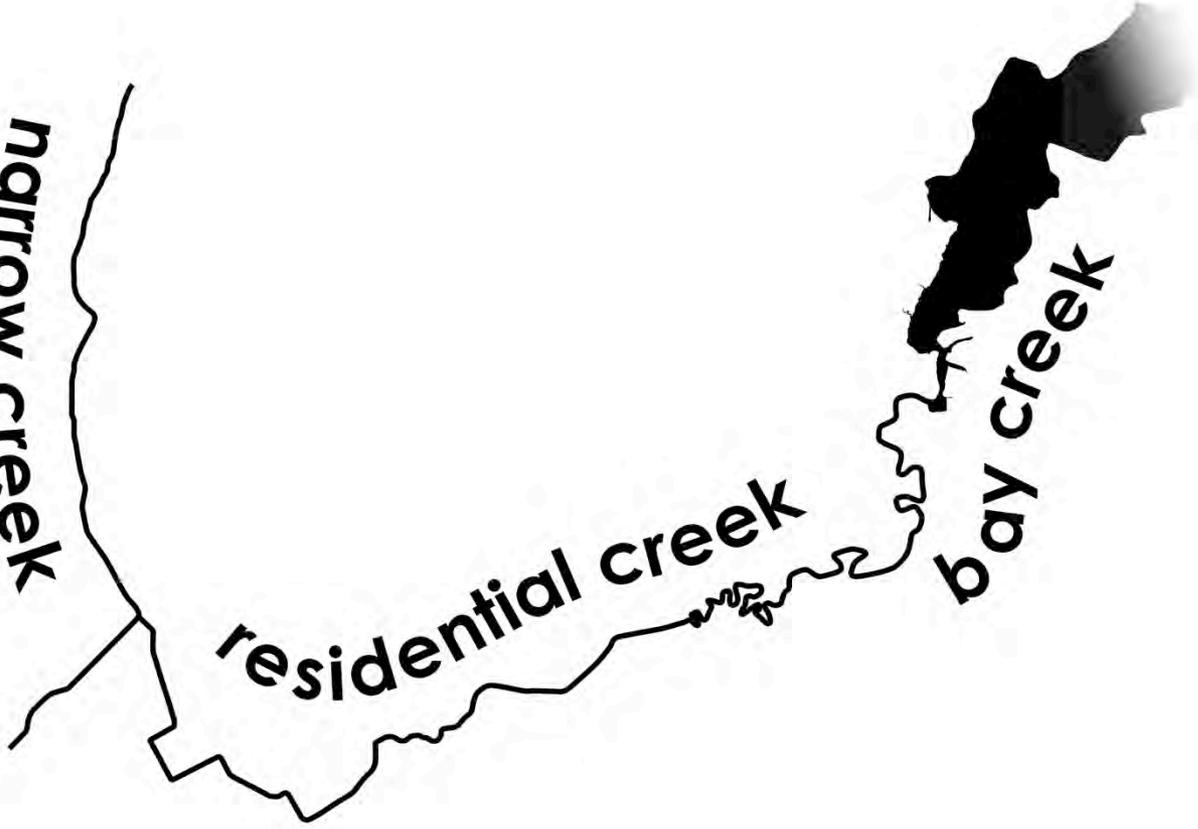
1/100 yr event

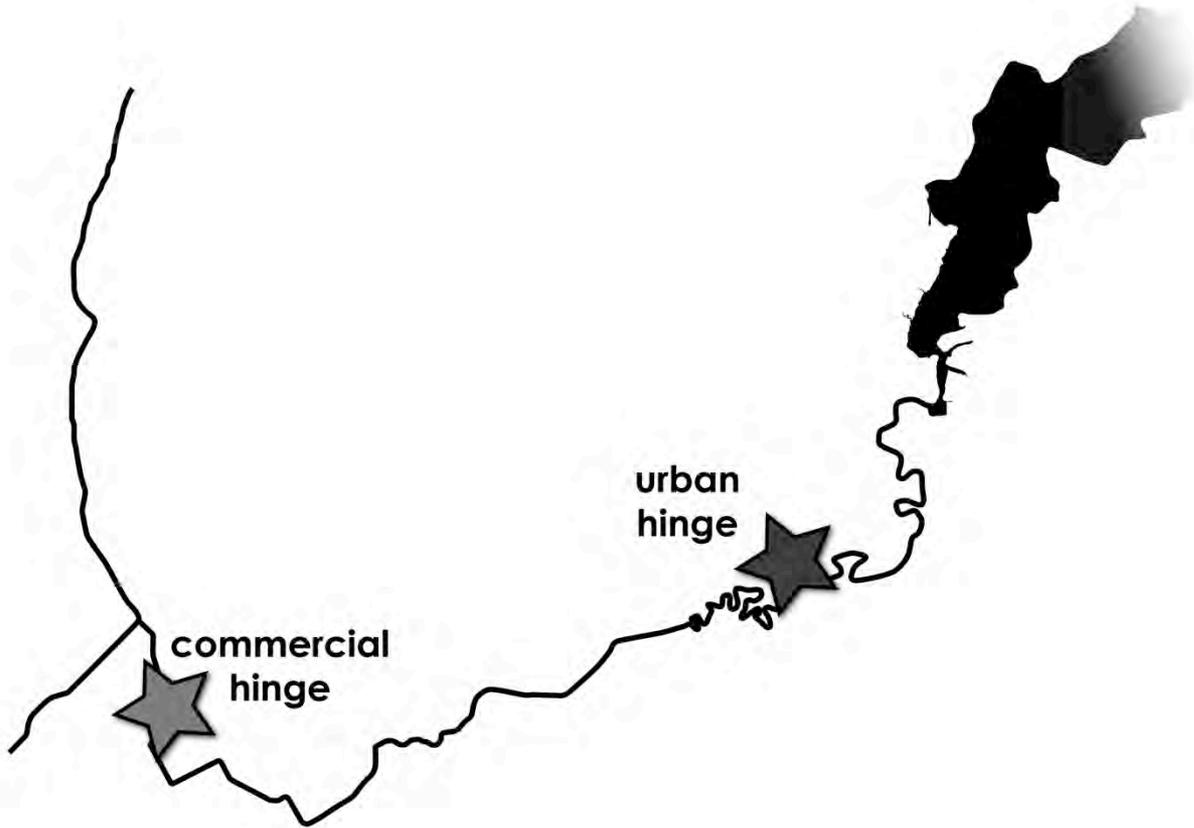
- \approx **3000** acrefeet of volume
- 10% reduction
 - (i) environmental requirement (EPA, Environmental Protection Agency)
 - (ii) climate change (rough estimate)
10%= 300 acrefeet
 - 3 ft deep \rightarrow **100** acres in catchment (0.4 km², 1.5%)
 - 6 ft deep \rightarrow **50** acres (0.7%)
 - Higher parts of the floodplains: possible with flood gate

narrow creek

residential creek

bay creek



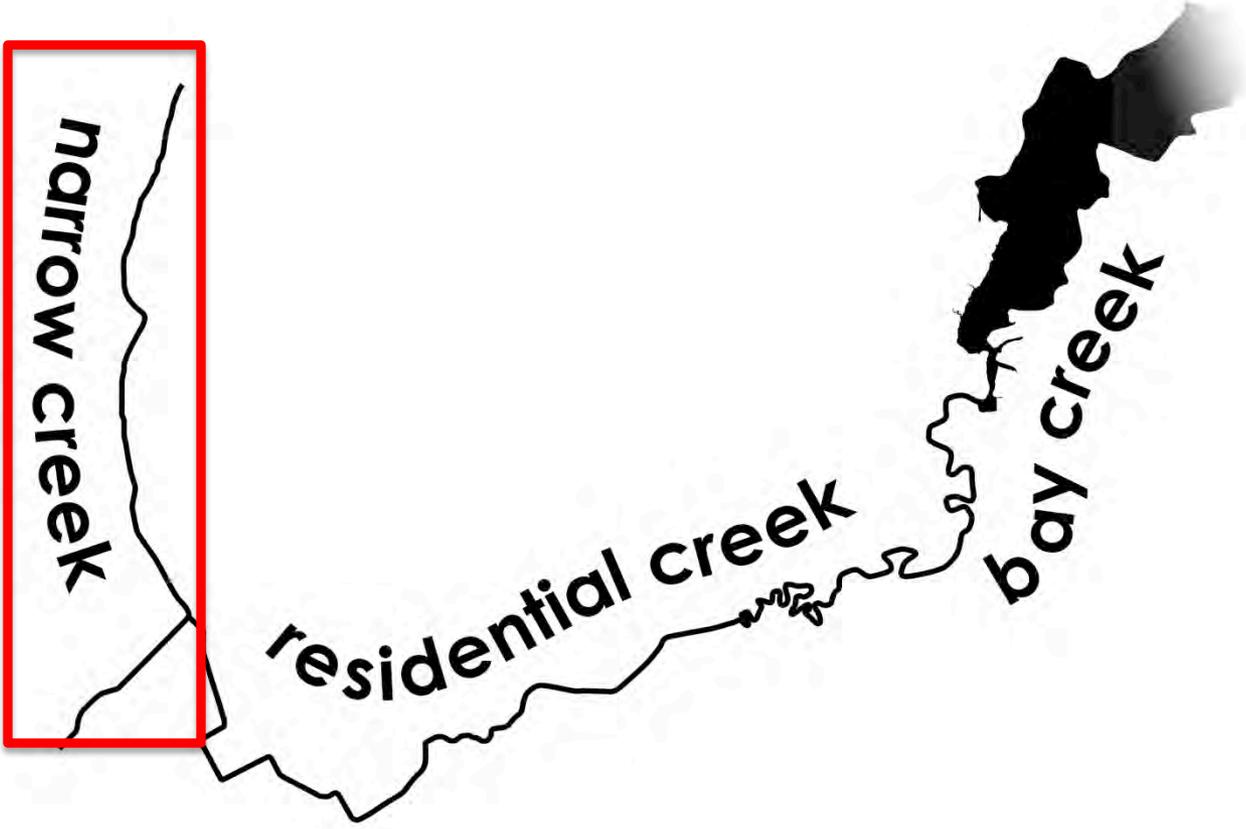




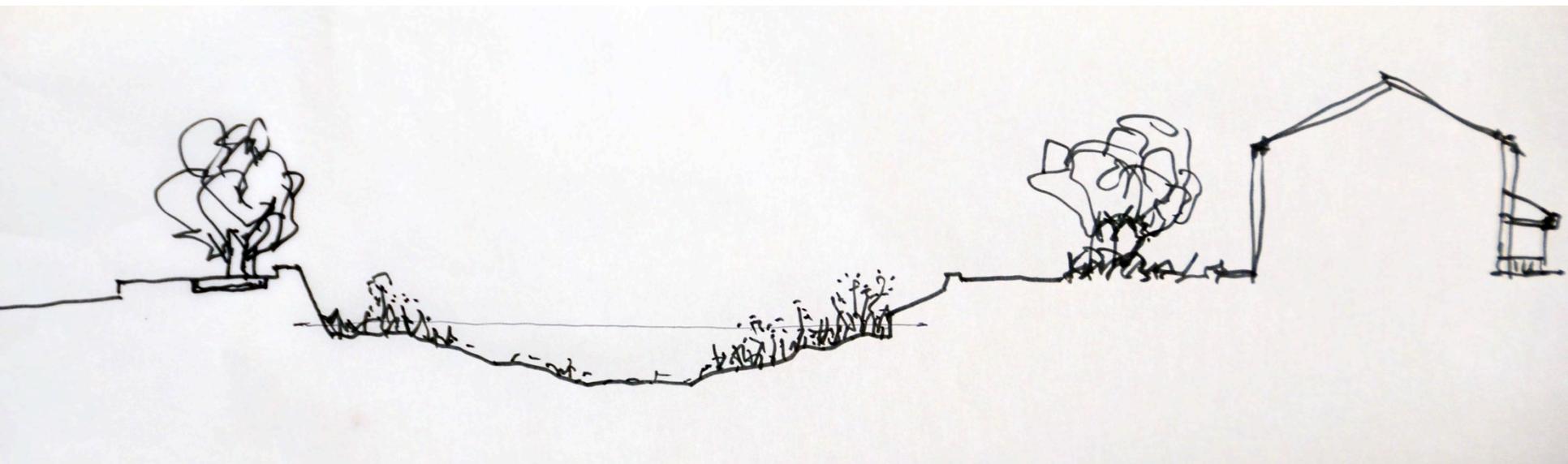
narrow creek

residential creek

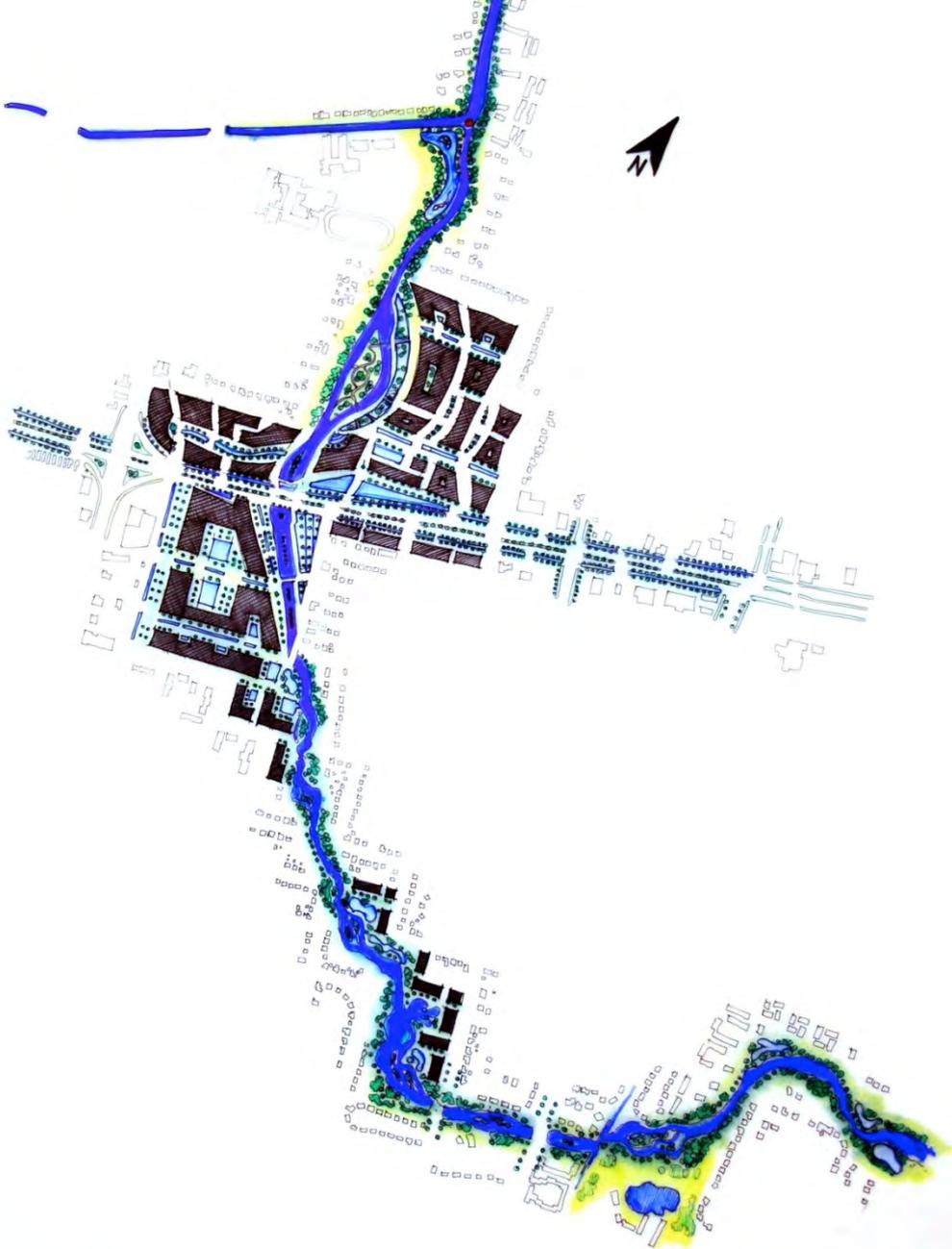
bay creek









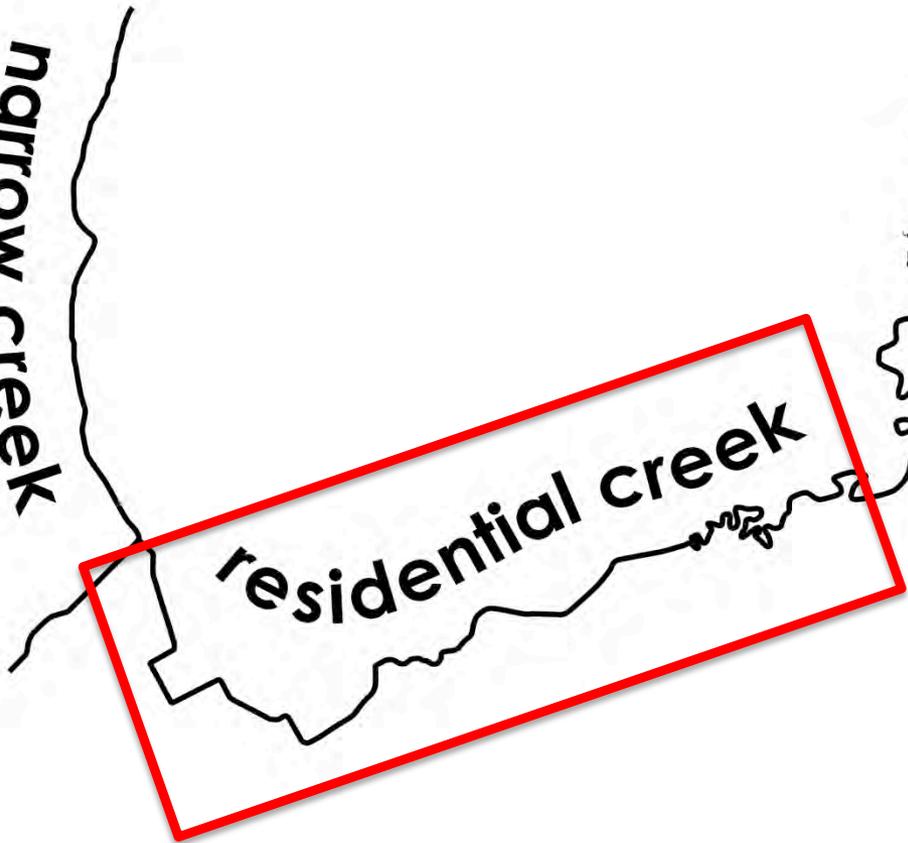




narrow creek

residential creek

bay creek





1.regulate the waterlevel

If gate closed when water level > 2ft

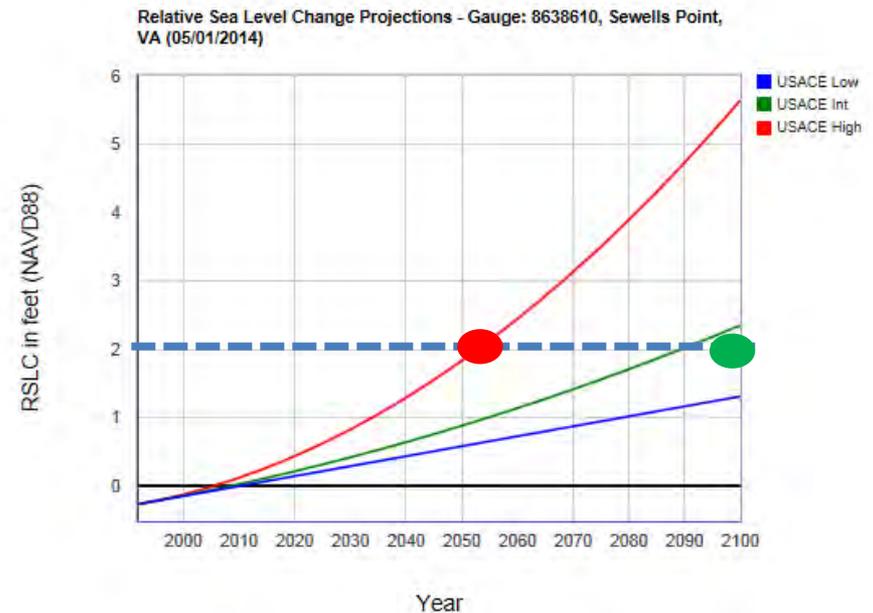
period	Max time gate closed [% of time]
1927-2014	1%
1927-1987	0.42%
Last 25 yrs (1988-2014)	2%
Last 25 yrs +CC (+2ft)	46%

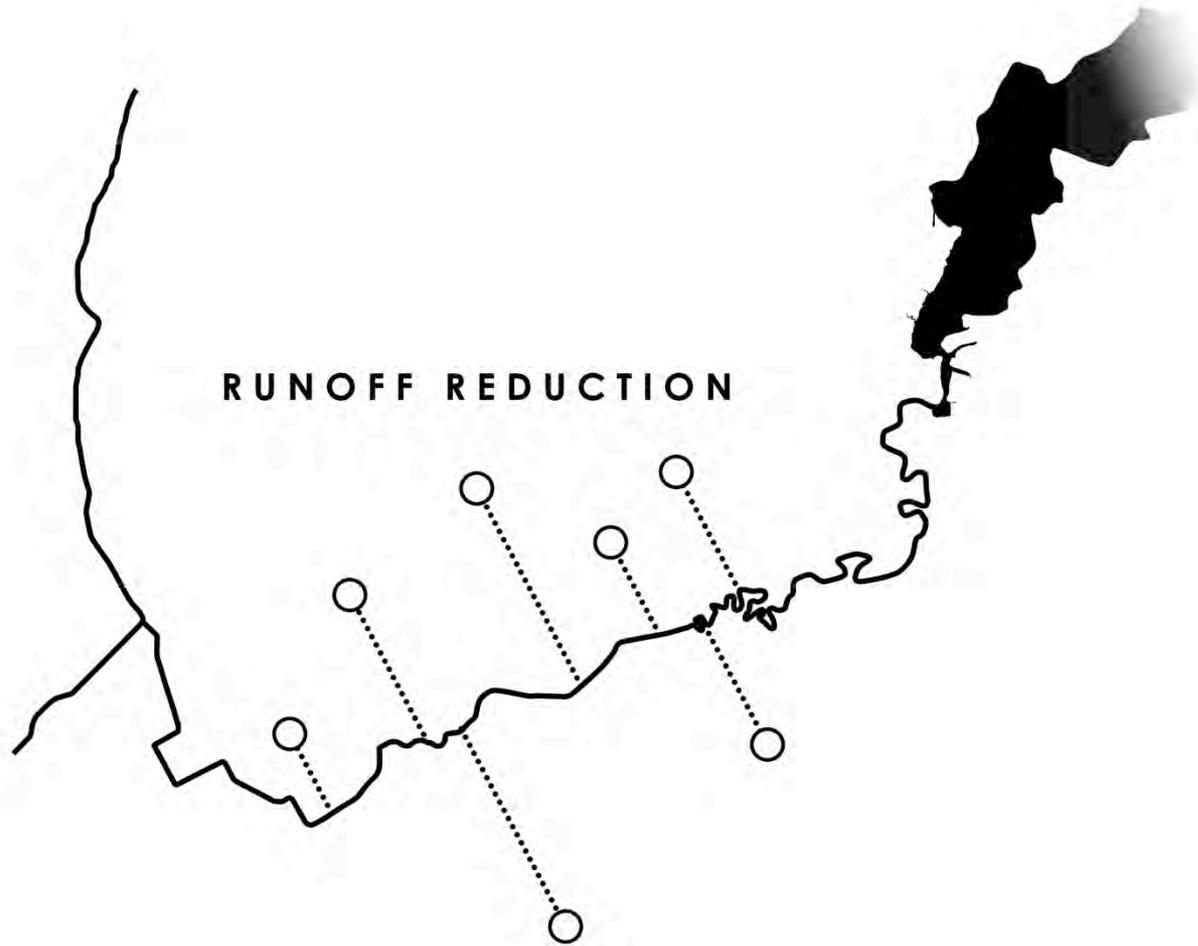
2ft increase relative tidal water level=

1. ~ High scenario 2050
2. ~ Intermediate scenario 2100

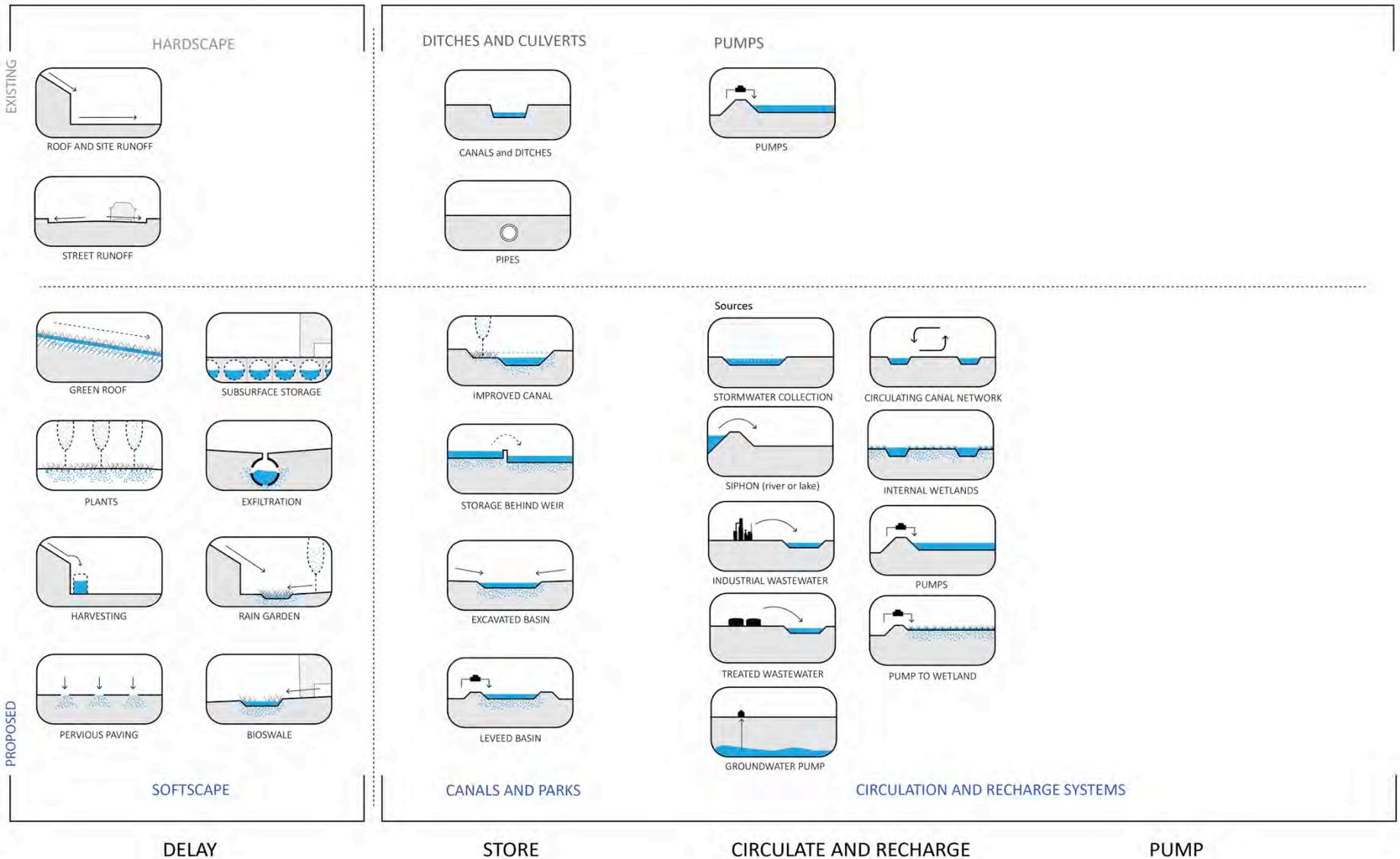
Implication:

- More optimal operation (forecast of surges and rainfall) so as to reduce the time the gate is closed (2 times/yr)
- Find more storage in catchment





2.runoff reduction



2.runoff reduction



3.enlarge storage capacity











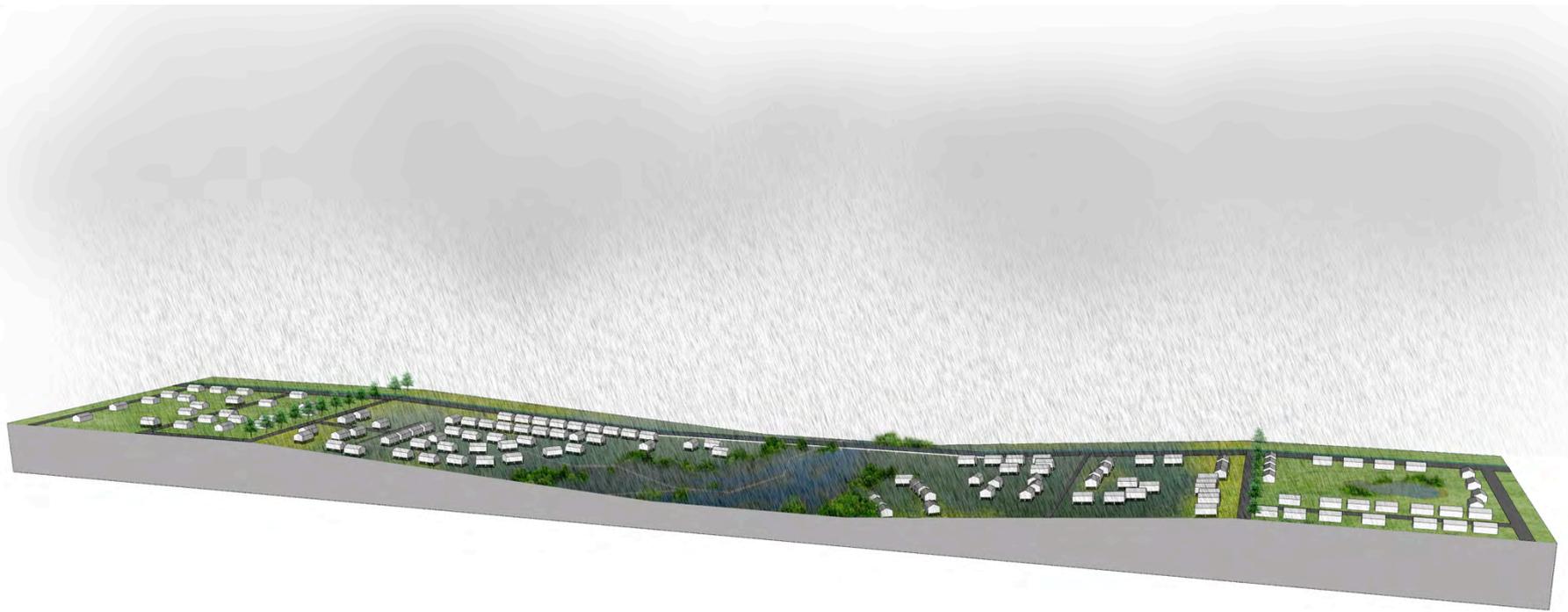
Current situation



Proposed situation (dry)



Proposed situation (heavy rainfall)



Proposed situation (extreme circumstances)





- barrels
- rooftop disconnects

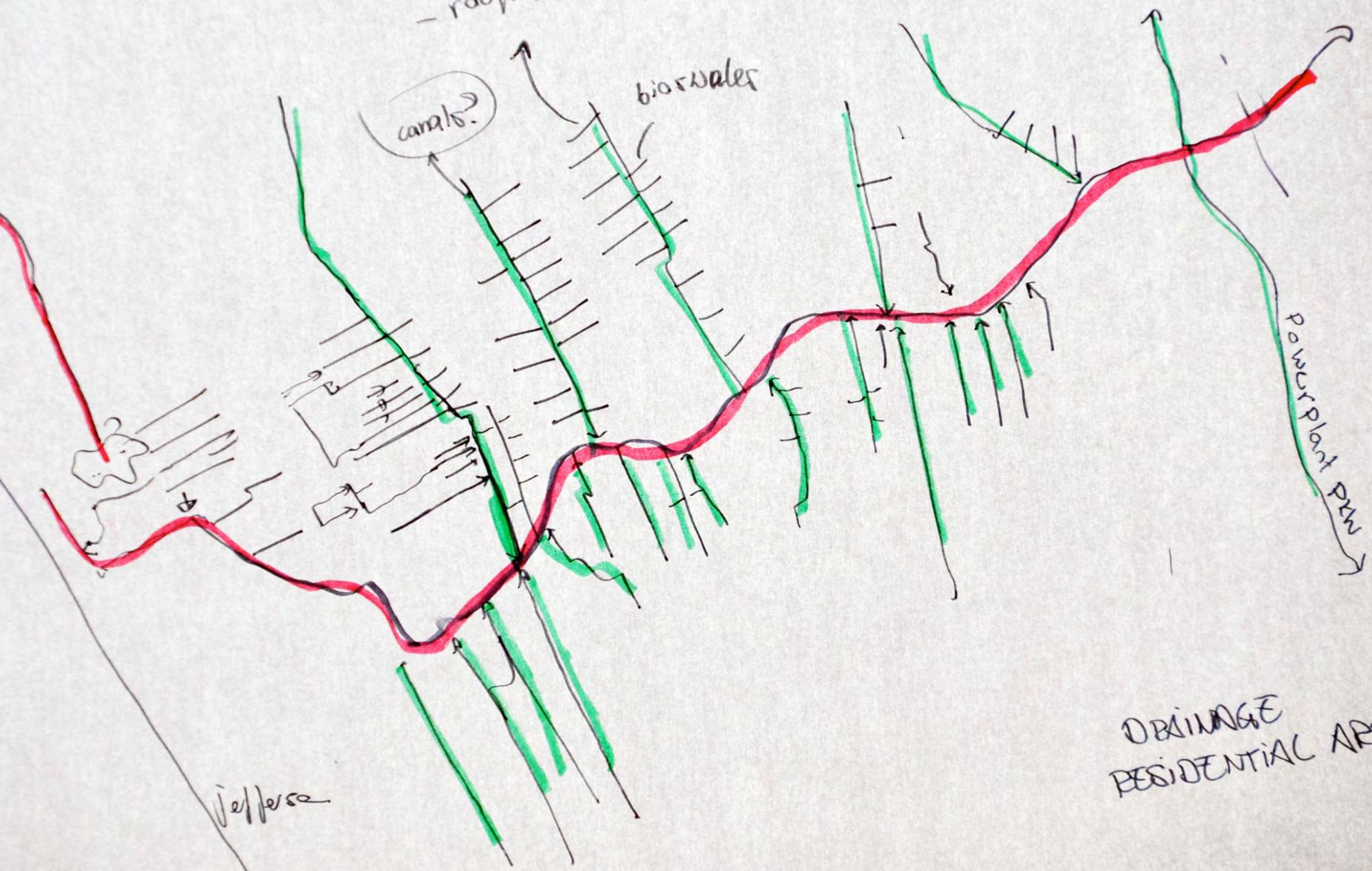
canals?

bioretains

populart plant PMW

Jefferson

ORANGE
RESIDENTIAL AREA

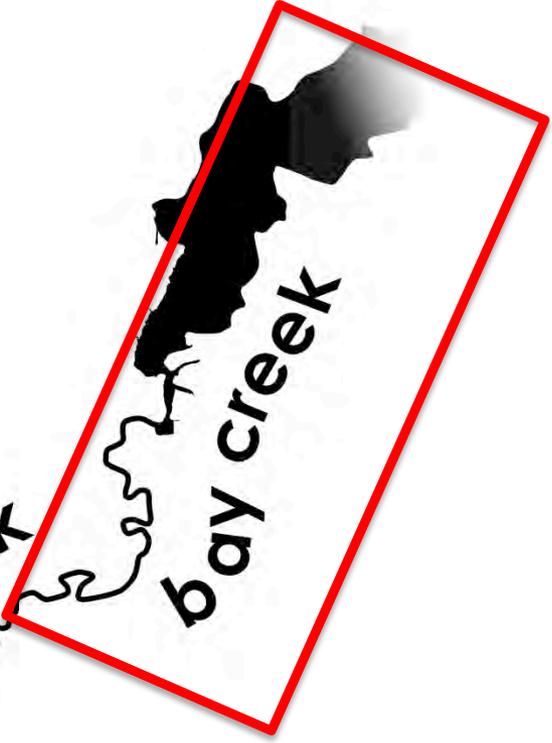


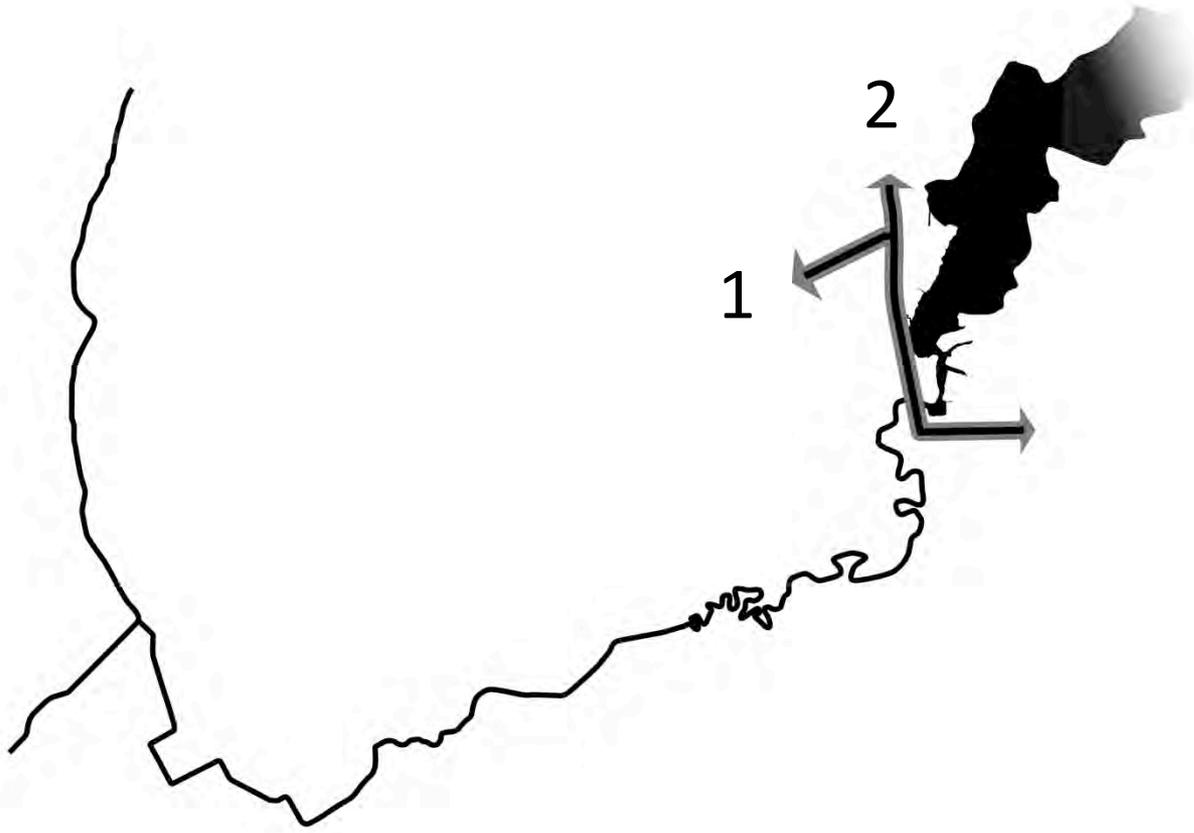


narrow creek

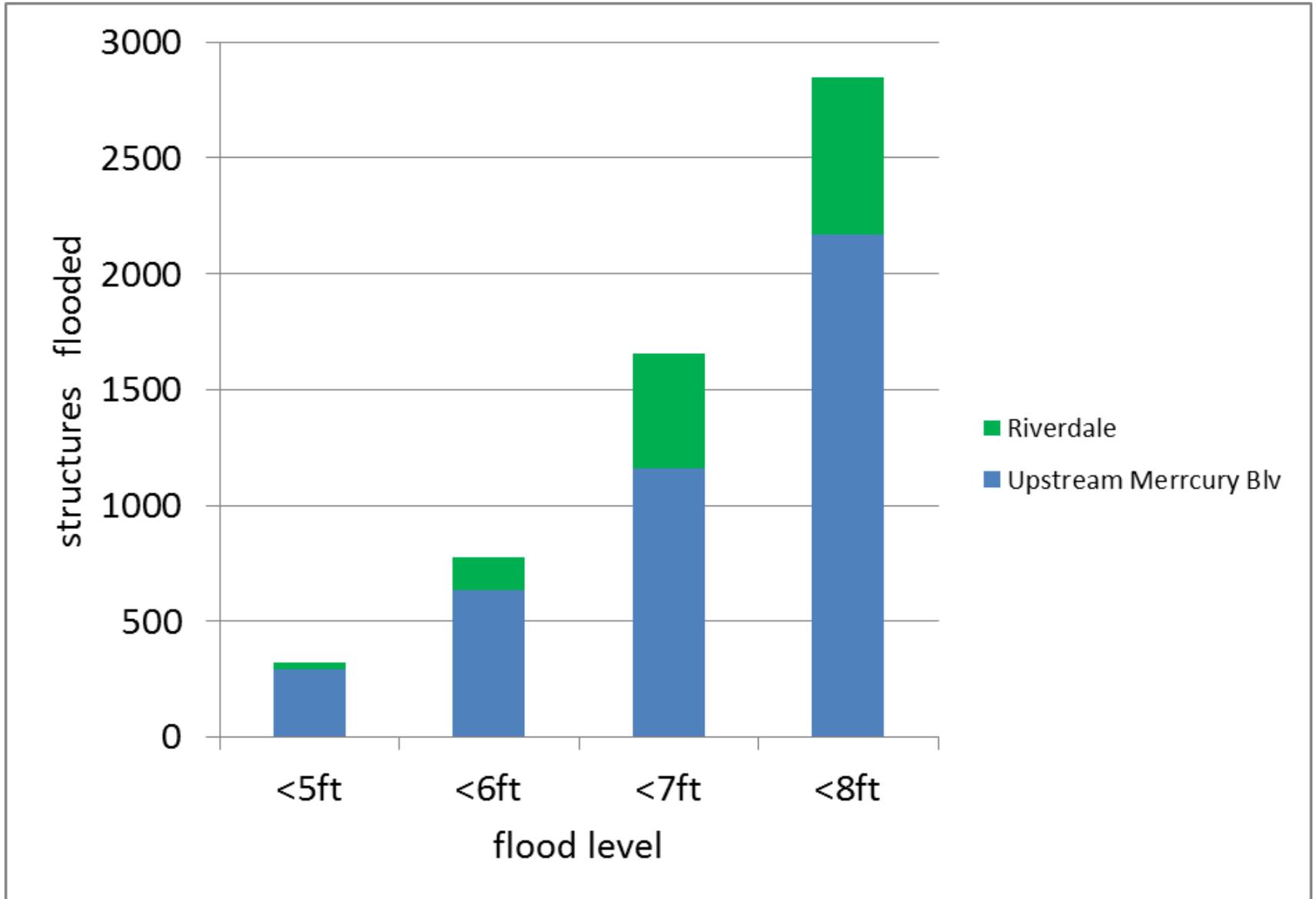
residential creek

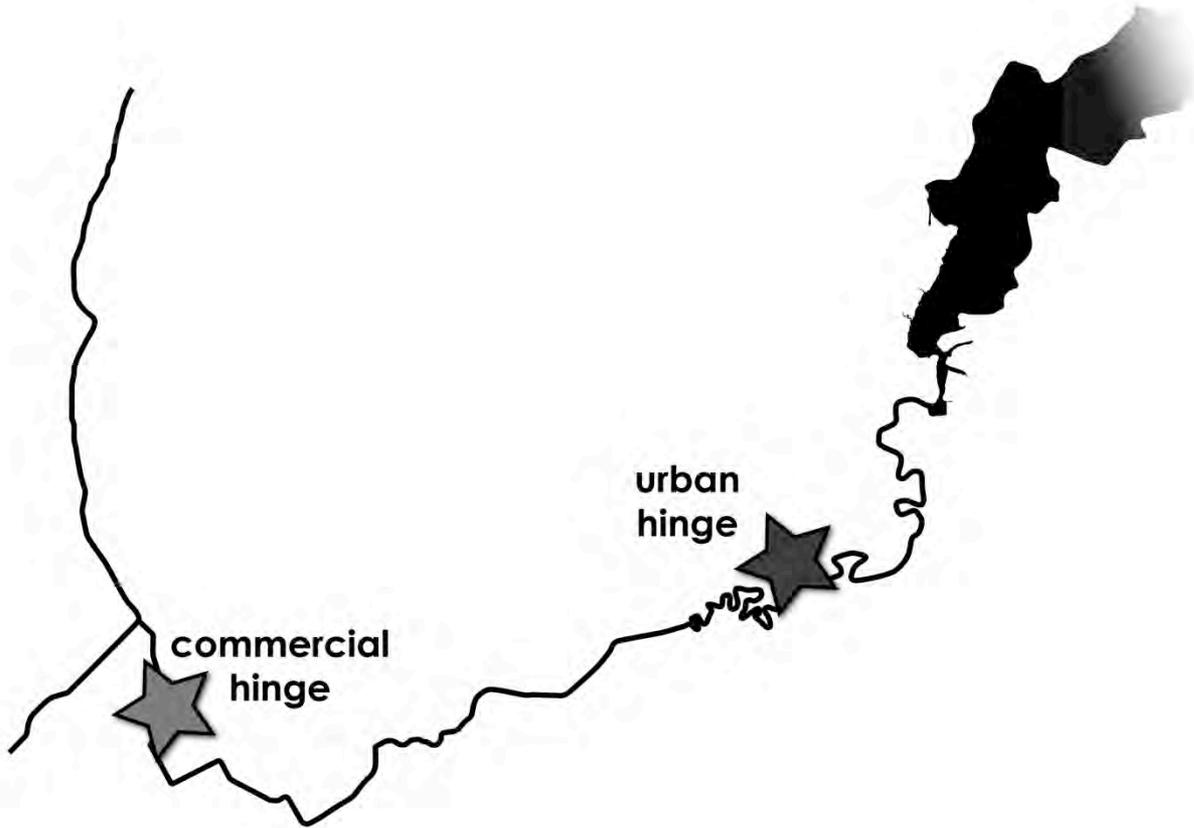
bay creek





Infrastructure protected by gate

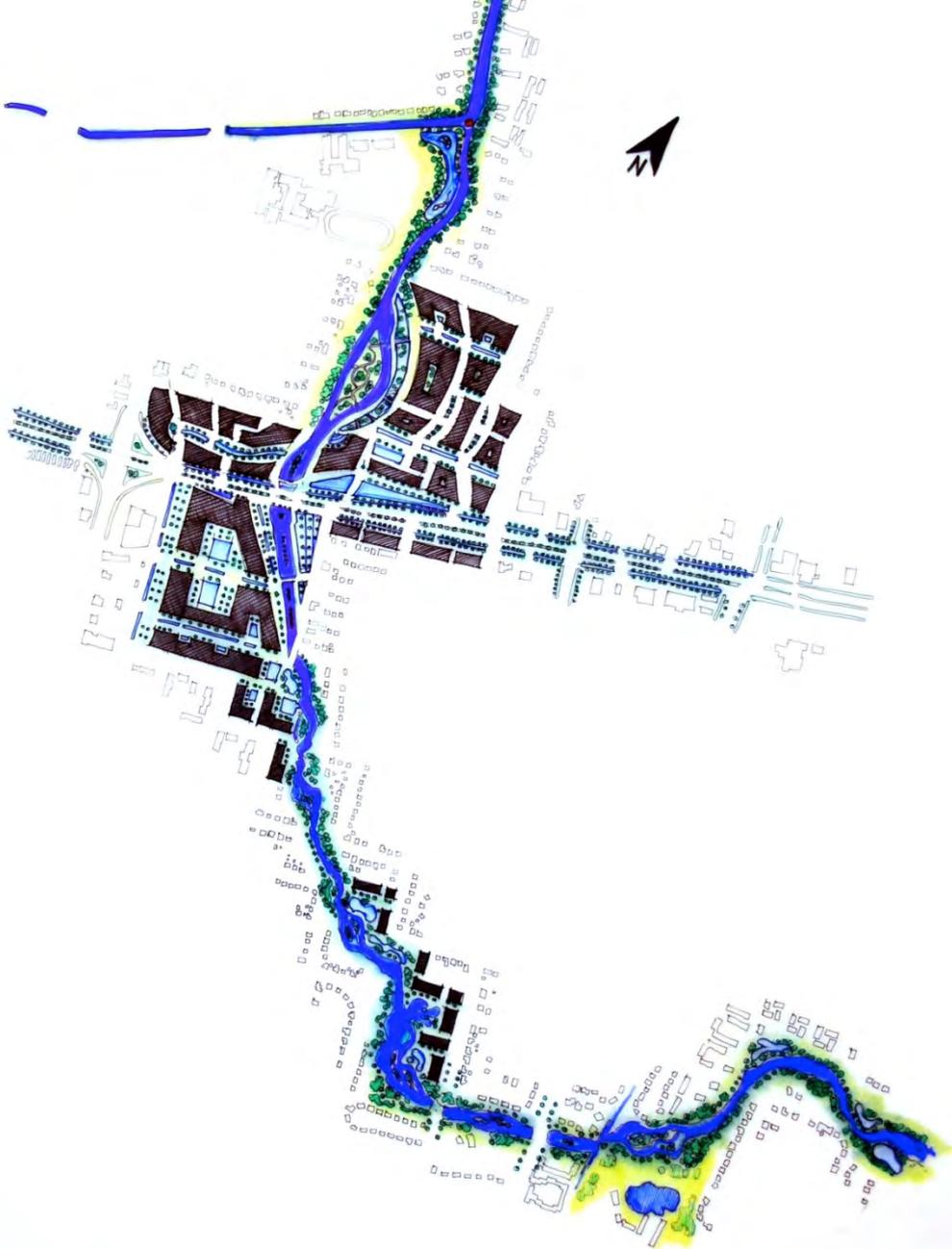




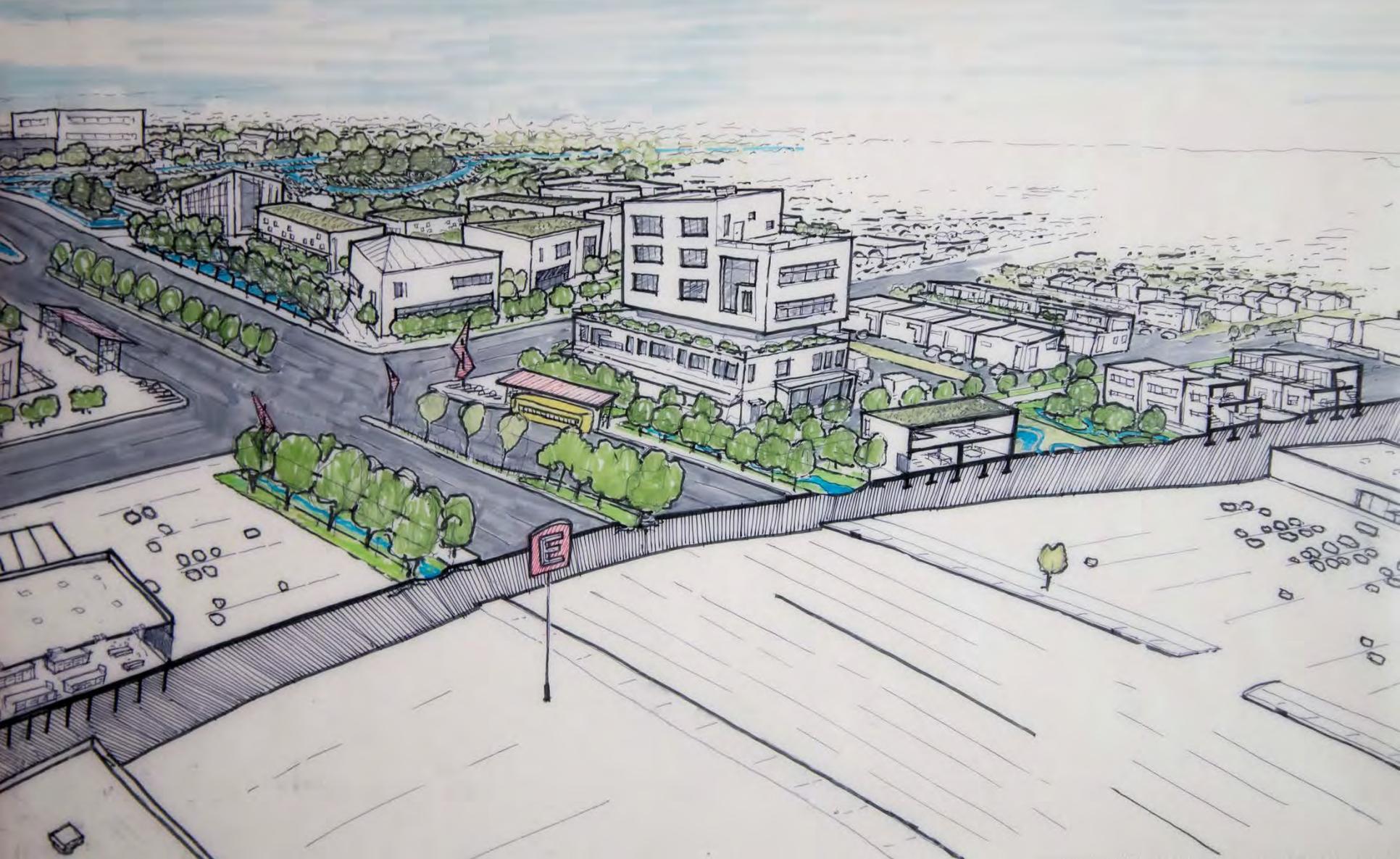
commercial
hinge

urban
hinge





Mercury Gateway











langley



back river

downtown



hampton university

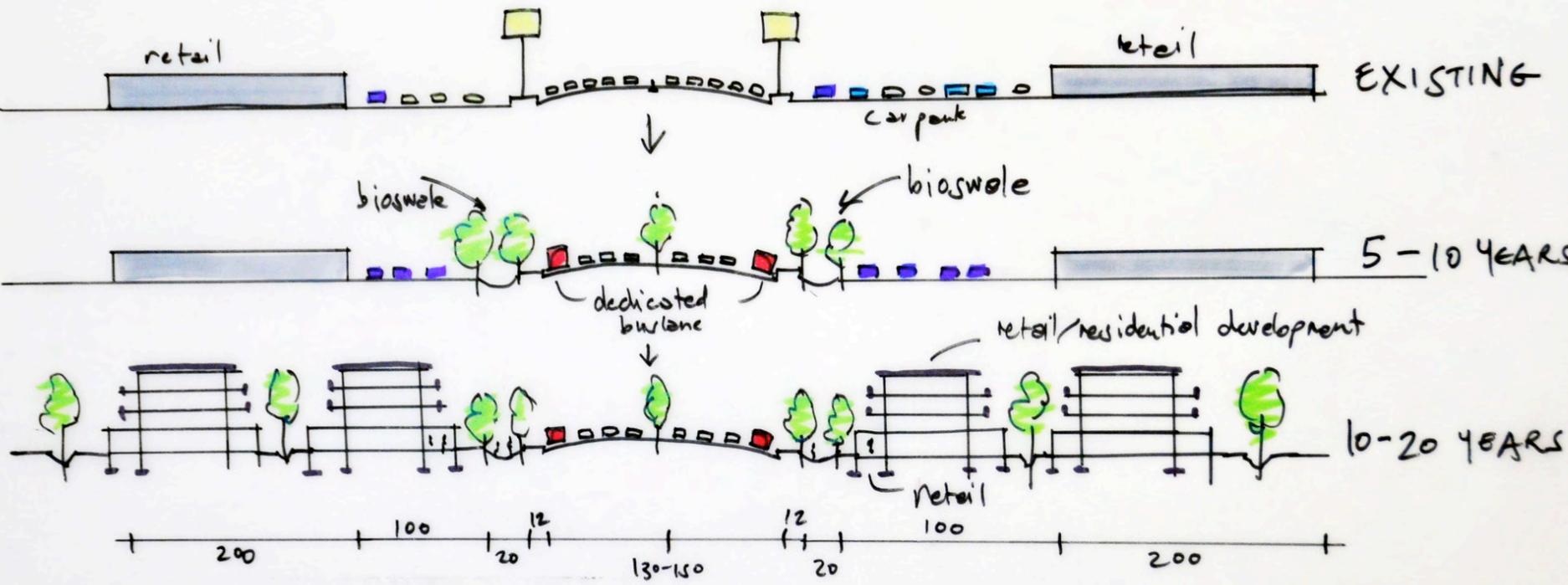
fort monroe

james river

harbor & shipyard



to norfolk



MERCURY BOULEVARD



CEMETERIES

CANAL

01 5

2016

HOW'S MY DRIVING
CALL 1-877-300

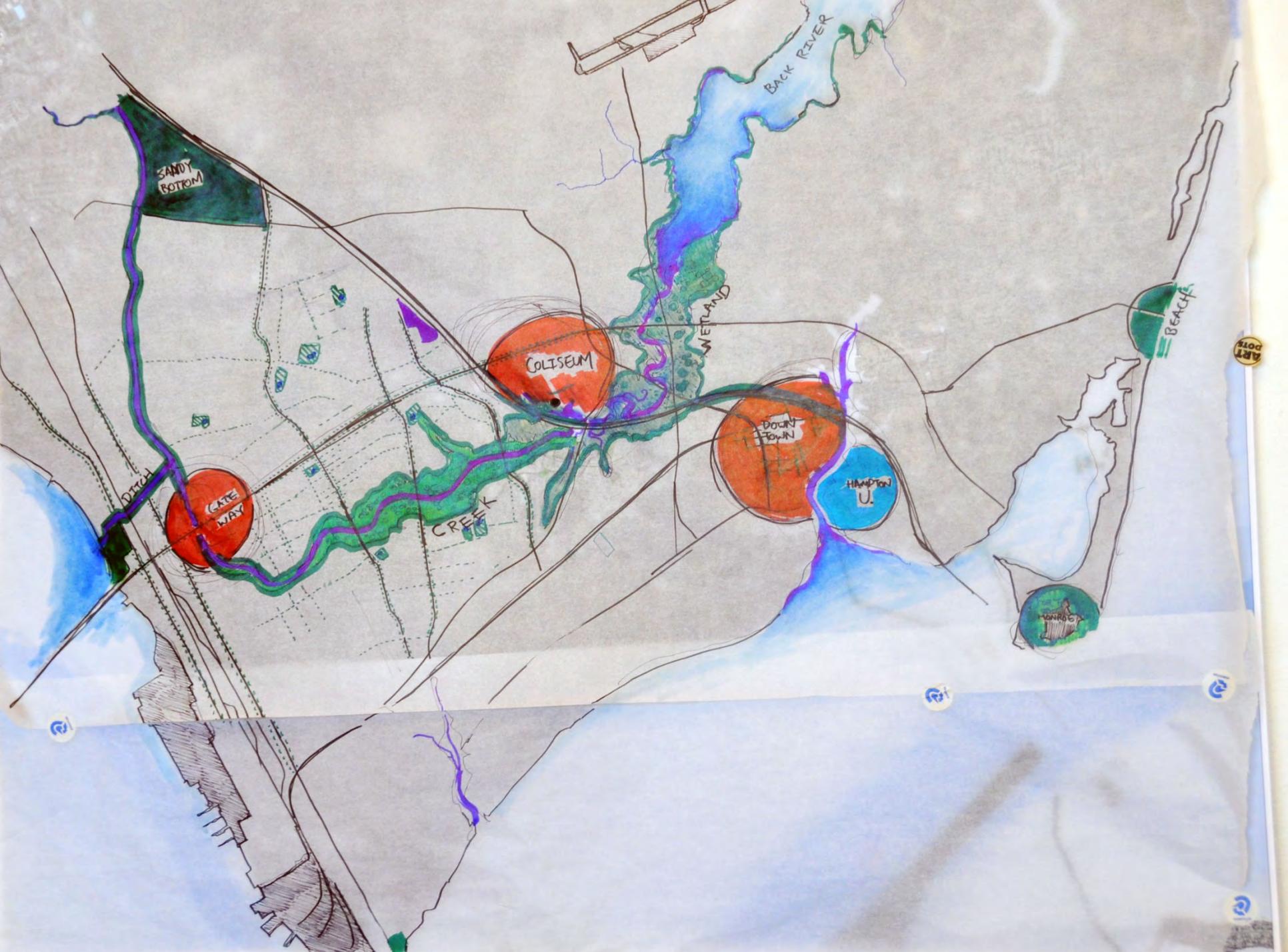
Please Have Exact Fare
Or RTA Pass Ready

HOP

@
the INSECTARIUM

ecatur

2001



Lessons learned

guiding principles

**1 Start from a larger perspective,
in scale as well in time**

**You need a regional approach
and a dot at the horizon**

**The trick is to connect long term
perspective and concrete short
term measures**

2 Dare to be innovative

3 Work with the system, not against it.

**Analyze the system,
when you understand how it works
you can work along with it**

**4 Don't accept solutions
that only work**

**Strive for solutions that
both work and add value**

**5 Be careful with
water**

Retain, store, drain

6 Use drawing as Esperanto between different disciplines

**Speeding up the process,
Focussing the debate**

7 Dare to think outside the box

When you dare to leave the box you will discover brand new perspectives





NORFOLK: *THRIVING WITH WATER*



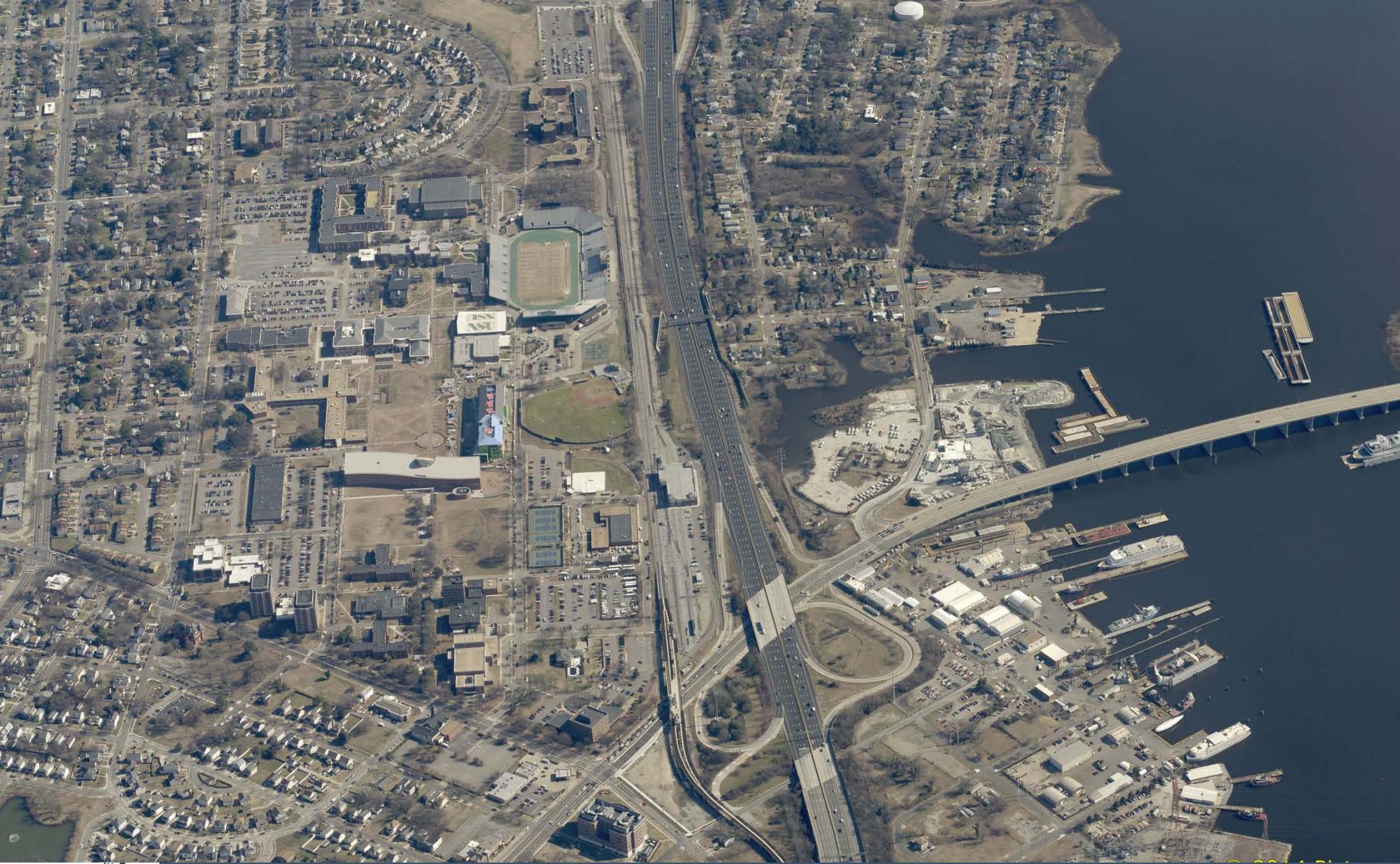
DUTCH DIALOGUES
Virginia: Life at Sea Level

Tidewater Drive District



DUTCH DIALOGUES
Virginia: Life at Sea Level

Harbor Park



DUTCH DIALOGUES
Virginia: Life at Sea Level

South of Brambleton



DUTCH DIALOGUES
Virginia: Life at Sea Level

Chesterfield Heights



DUTCH DIALOGUES
Virginia: Life at Sea Level

Tidewater Drive District Goals



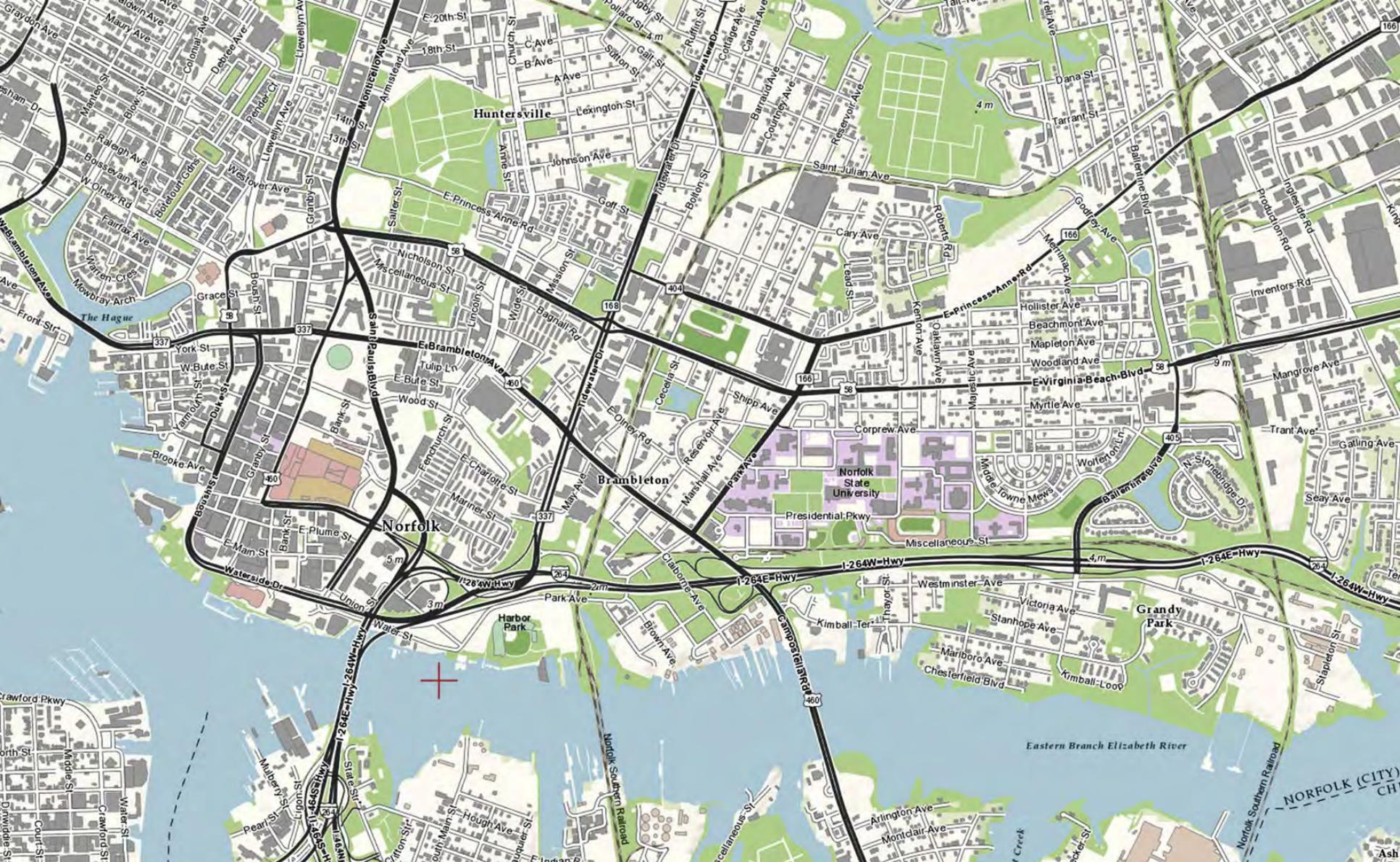
DUTCH DIALOGUES
Virginia: Life at Sea Level

Norfolk 1890's



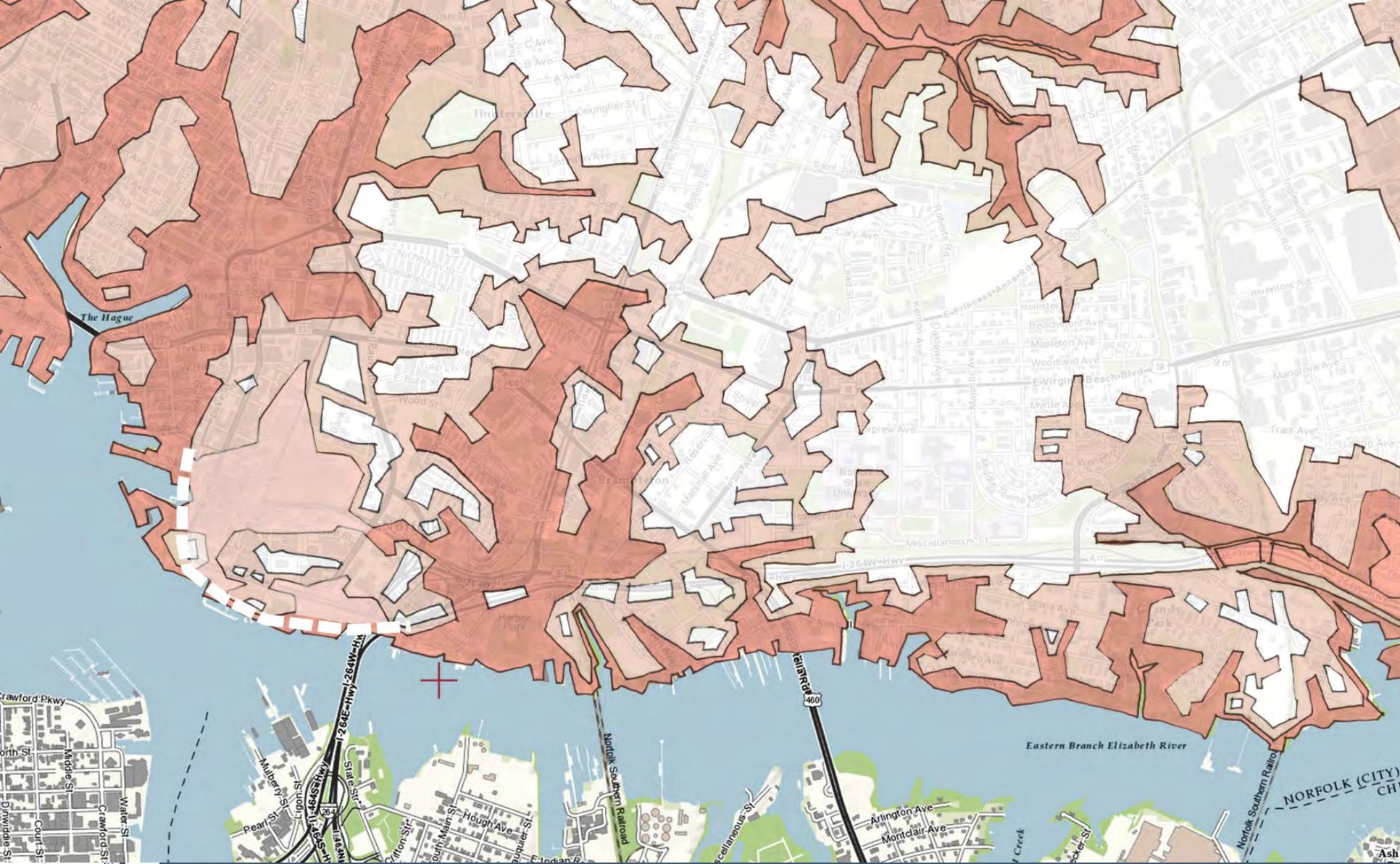
DUTCH DIALOGUES
Virginia: Life at Sea Level

Historic Pattern & Density



DUTCH DIALOGUES
Virginia: Life at Sea Level

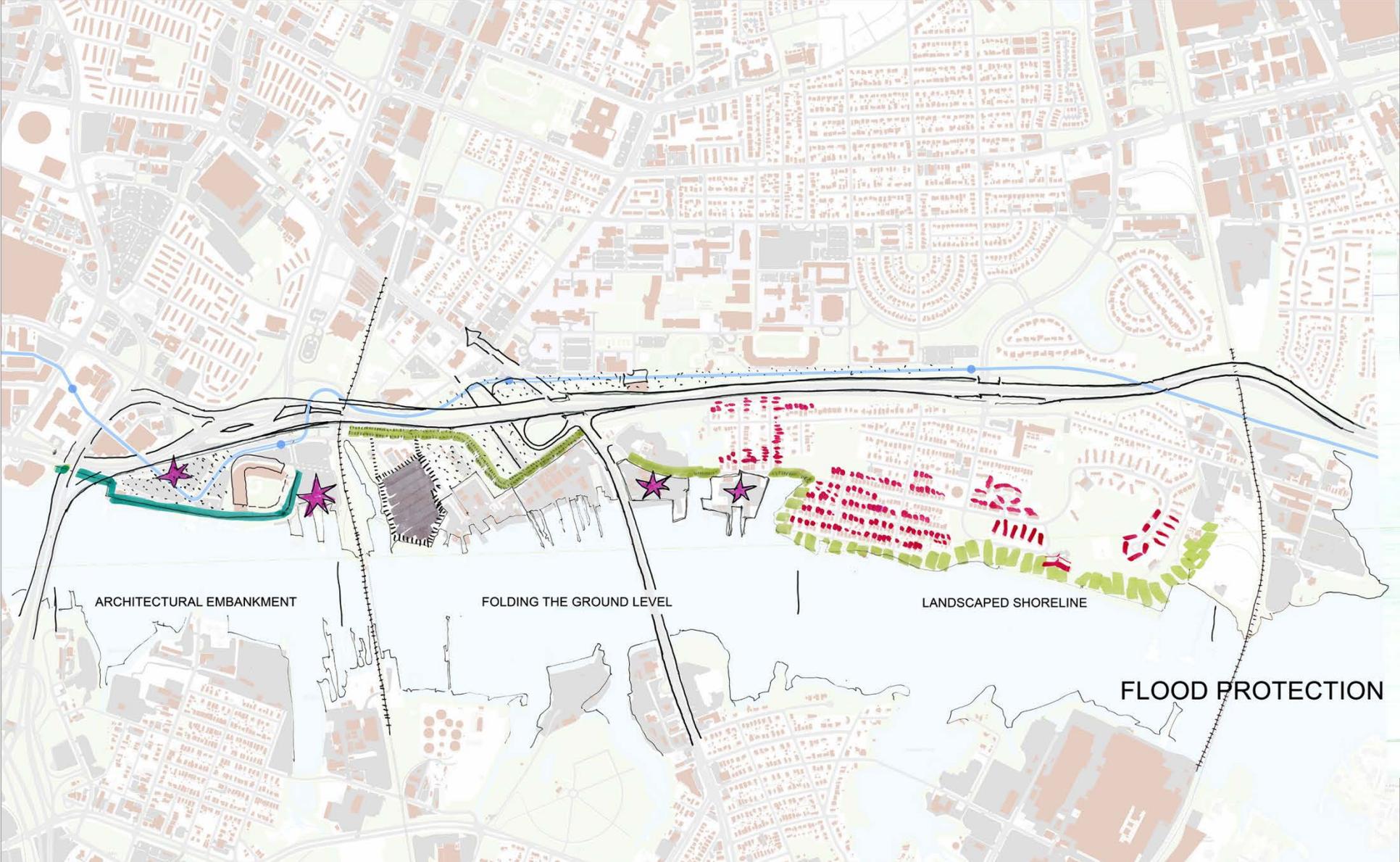
Existing Topography



High + Low Ground with Existing Sea Wall

DUTCH DIALOGUES
Virginia: Life at Sea Level





ARCHITECTURAL EMBANKMENT

FOLDING THE GROUND LEVEL

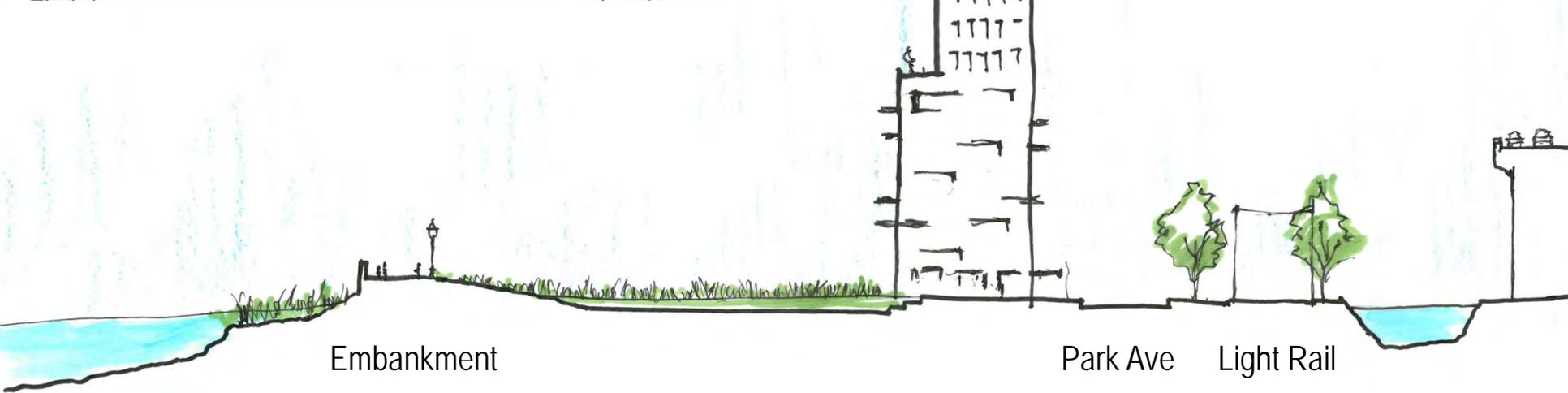
LANDSCAPED SHORELINE

FLOOD PROTECTION



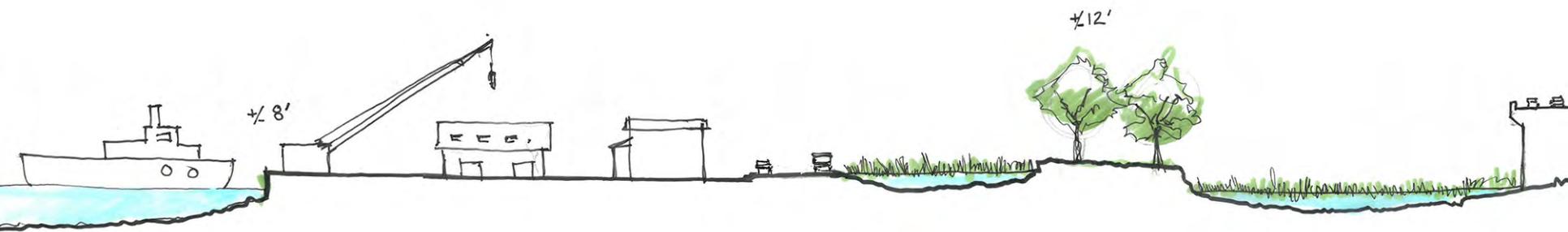
DUTCH DIALOGUES
Virginia: Life at Sea Level

Flood Protection



DUTCH DIALOGUES
Virginia: Life at Sea Level

Architectural Embankment



DUTCH DIALOGUES
Virginia: Life at Sea Level

Folding Ground Level



LANDSCAPED SHORELINE



DUTCH *DIALOGUES*
Virginia: Life at Sea Level

Landscaped Shoreline

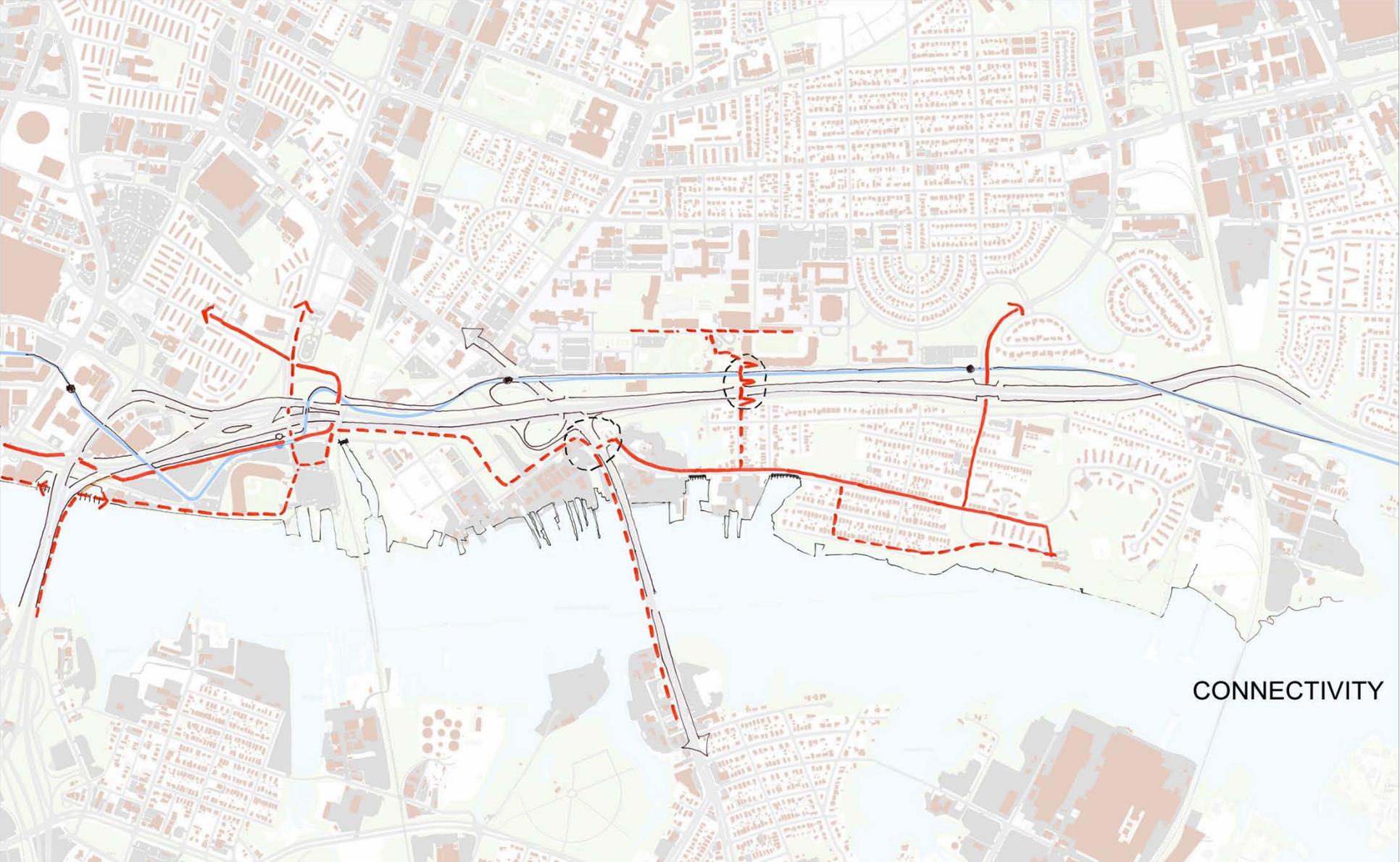


WATER STORAGE



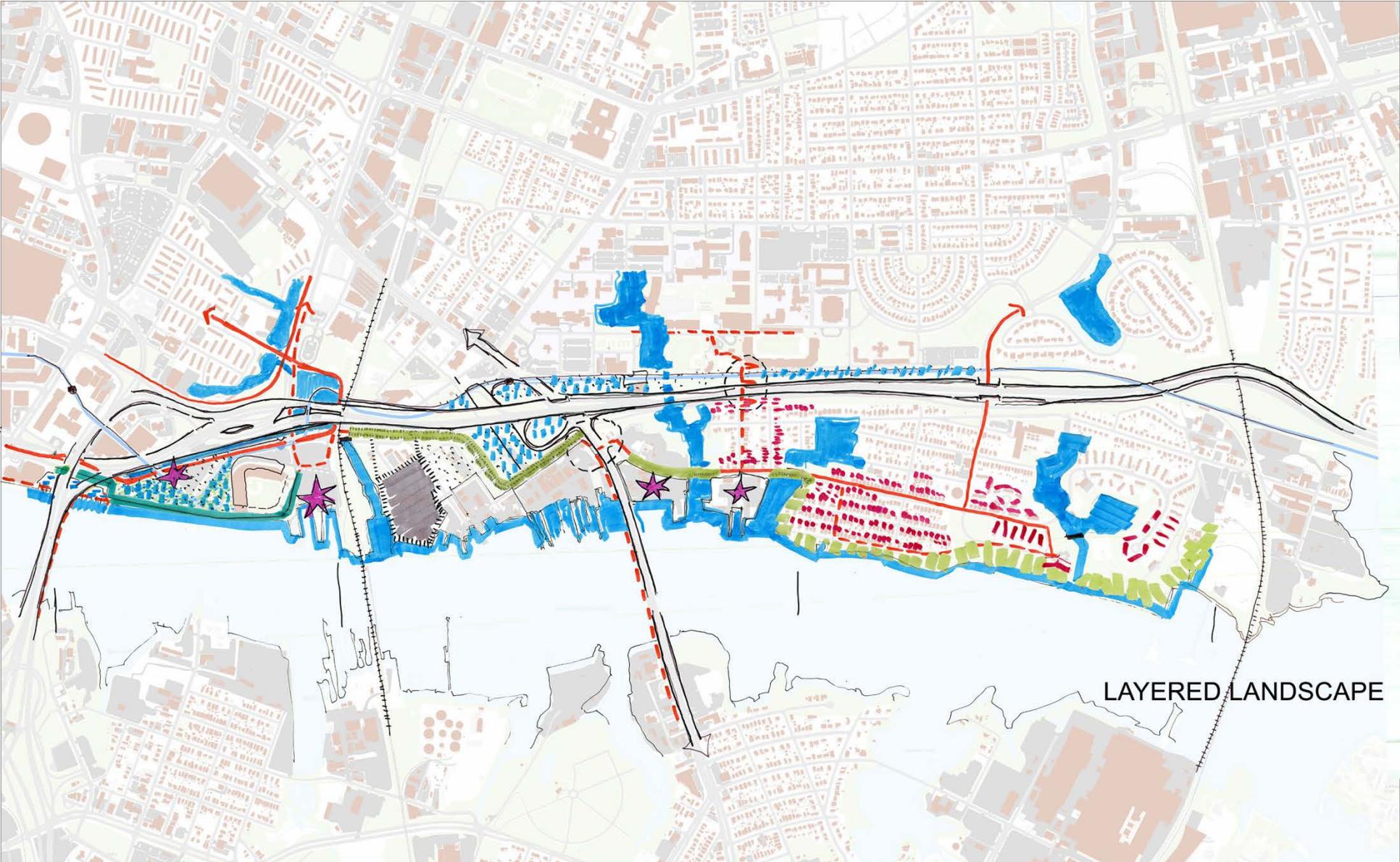
DUTCH DIALOGUES
Virginia: Life at Sea Level

Water Storage



CONNECTIVITY



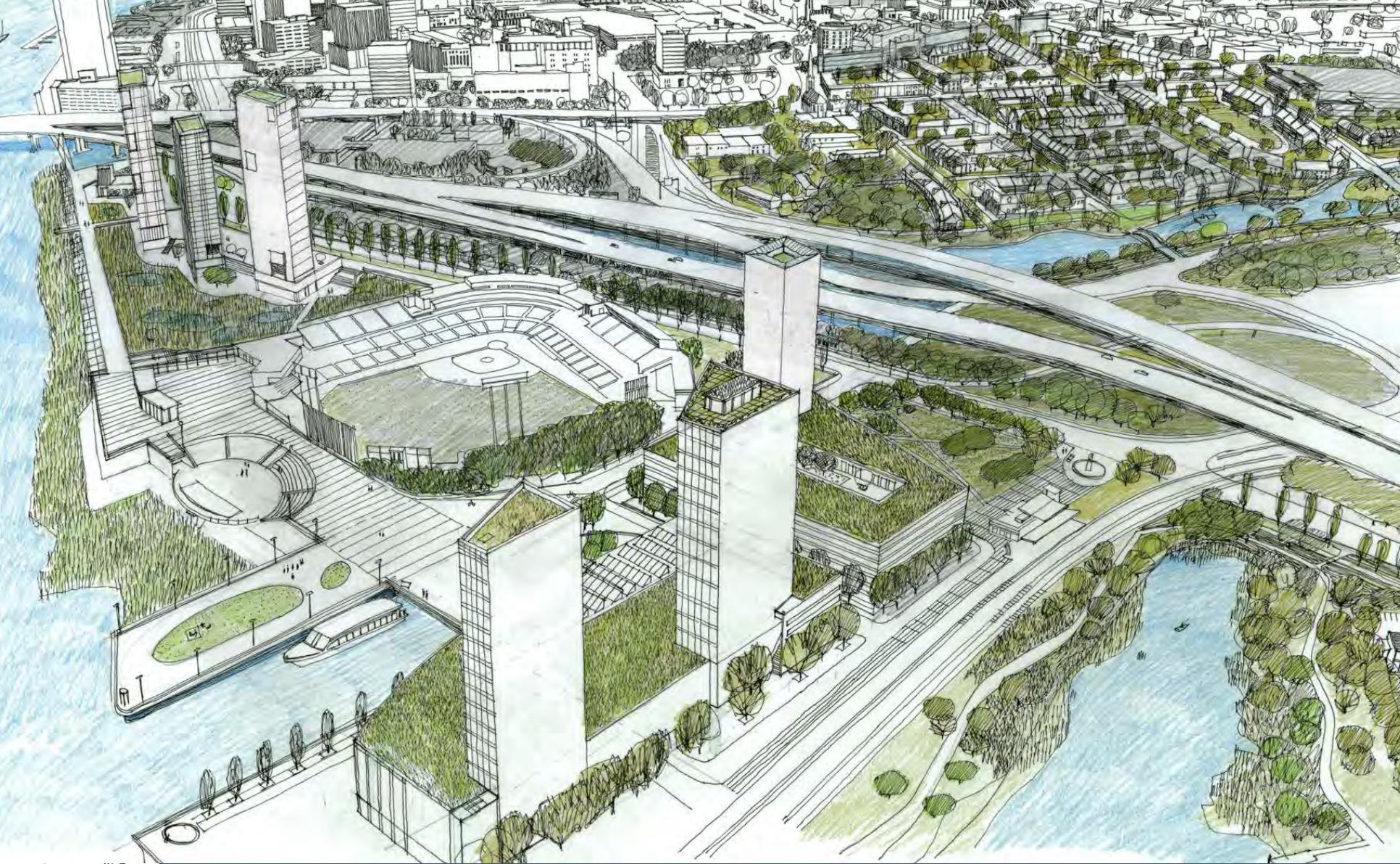


LAYERED LANDSCAPE



DUTCH *DIALOGUES*
Virginia: Life at Sea Level

Layered Landscape



DUTCH DIALOGUES

Virginia: Life at Sea Level

Harbor Park



DUTCH DIALOGUES
Virginia: Life at Sea Level

South of Brambleton



**CAMPOSTELLA
BRIDGE**

**NORFOLK STATE
UNIVERSITY**

**CHESTERFIELD
HEIGHTS**

**GRANDY
VILLAGE**



DUTCH *DIALOGUES*
Virginia: Life at Sea Level

Chesterfield Heights



DUTCH DIALOGUES
Virginia: Life at Sea Level

Stormwater Flooding



DUTCH DIALOGUES
Virginia: Life at Sea Level

Storm Surge Flooding



DUTCH DIALOGUES
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Disconnect and Re:Store



DUTCH DIALOGUES
Virginia: Life at Sea Level

Disconnect...



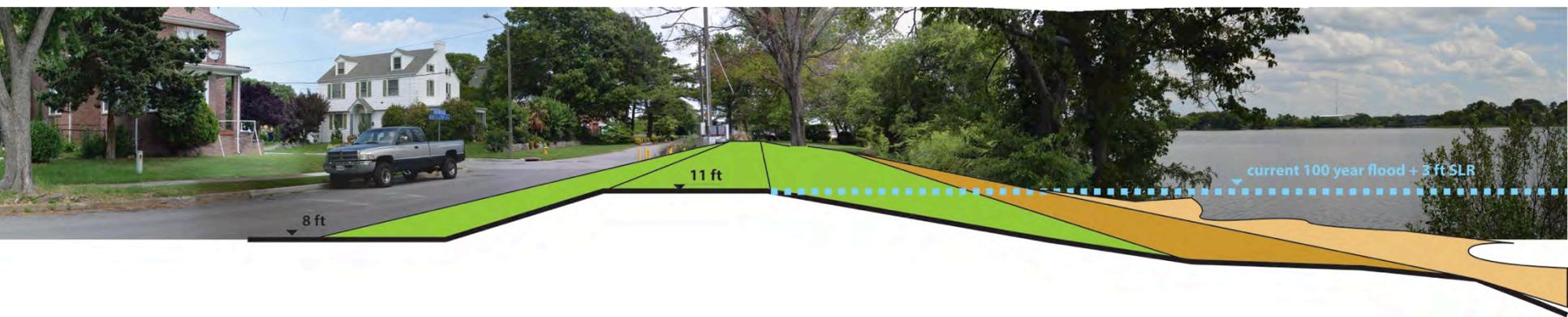
DUTCH DIALOGUES
Virginia: Life at Sea Level

...and Re:Store



DUTCH DIALOGUES
Virginia: Life at Sea Level

Protect and Re:Shore



DUTCH DIALOGUES
Virginia: Life at Sea Level

Protect...

Graded Bank

**Backfill & Planted
Marsh**

25 ft

**3 Gapped Sills + 1
Marsh Toe**



DUTCH DIALOGUES

Virginia: Life at Sea Level

...and Re:Shore



Green Streets



Green Roofs



Green Retention Landscape



DUTCH DIALOGUES
Virginia: Life at Sea Level

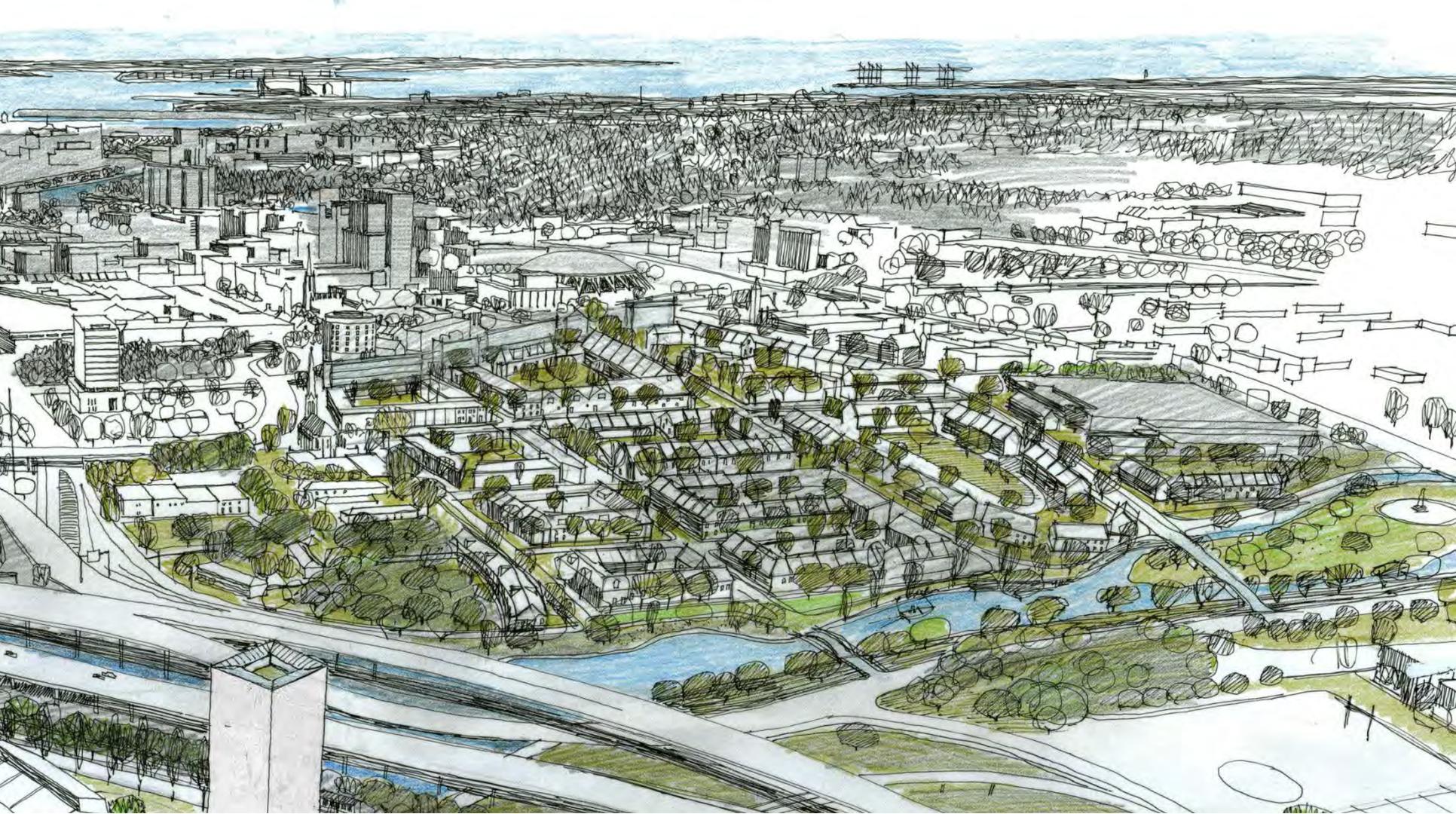
Store (and more)



DUTCH DIALOGUES

Virginia: Life at Sea Level

Rising into Resilience



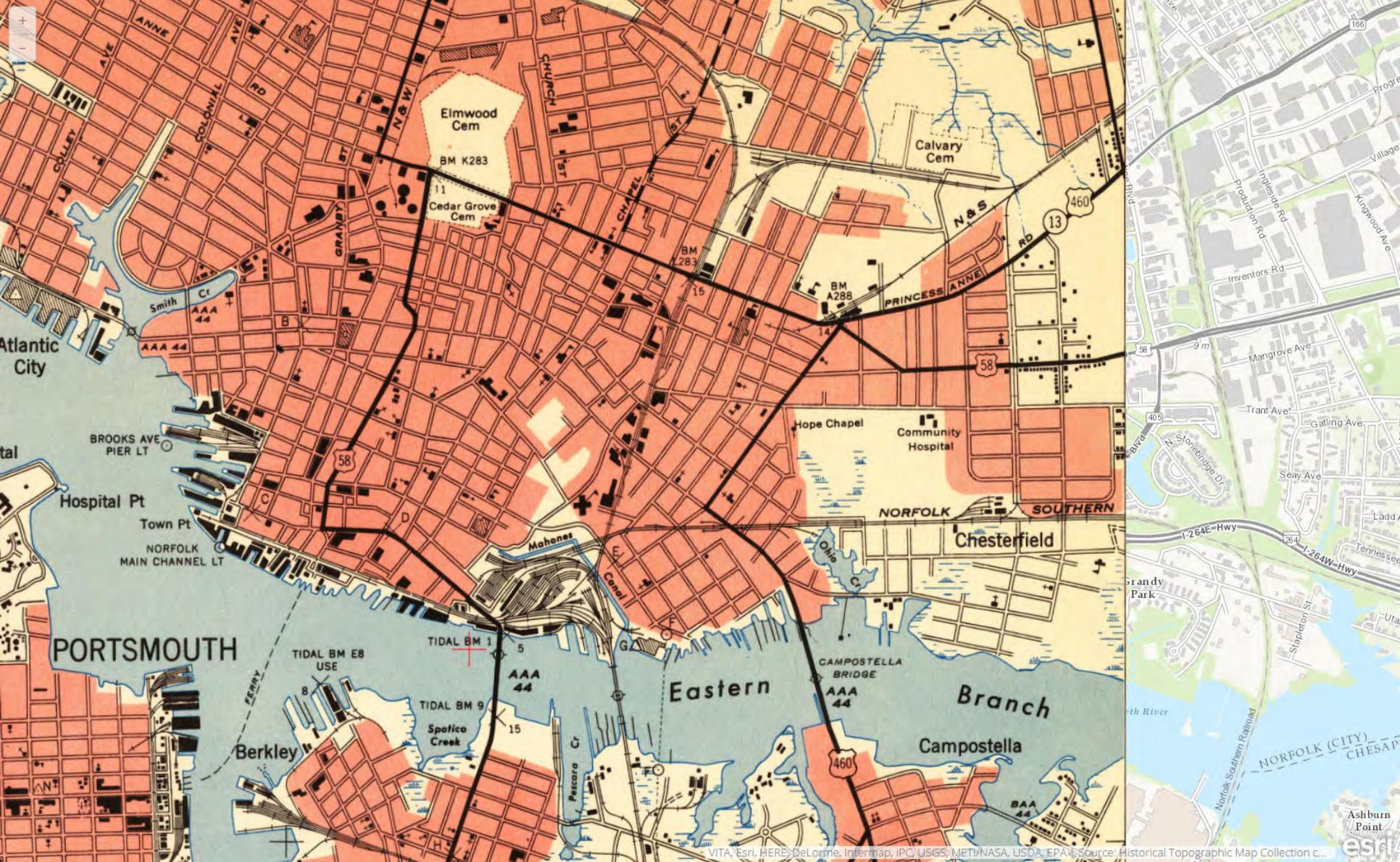
DUTCH DIALOGUES
Virginia: Life at Sea Level

St. Paul's Quadrant



DUTCH DIALOGUES
Virginia: Life at Sea Level

St. Pauls Quadrant & Newton Creek



VITA, Esri, HERE, DeLorme, Intermap, iPC, USGS, METI/NASA, USDA, EPA, Source: Historical Topographic Map Collection c...



DUTCH DIALOGUES

Virginia: Life at Sea Level

1945



DUTCH DIALOGUES
Virginia: Life at Sea Level



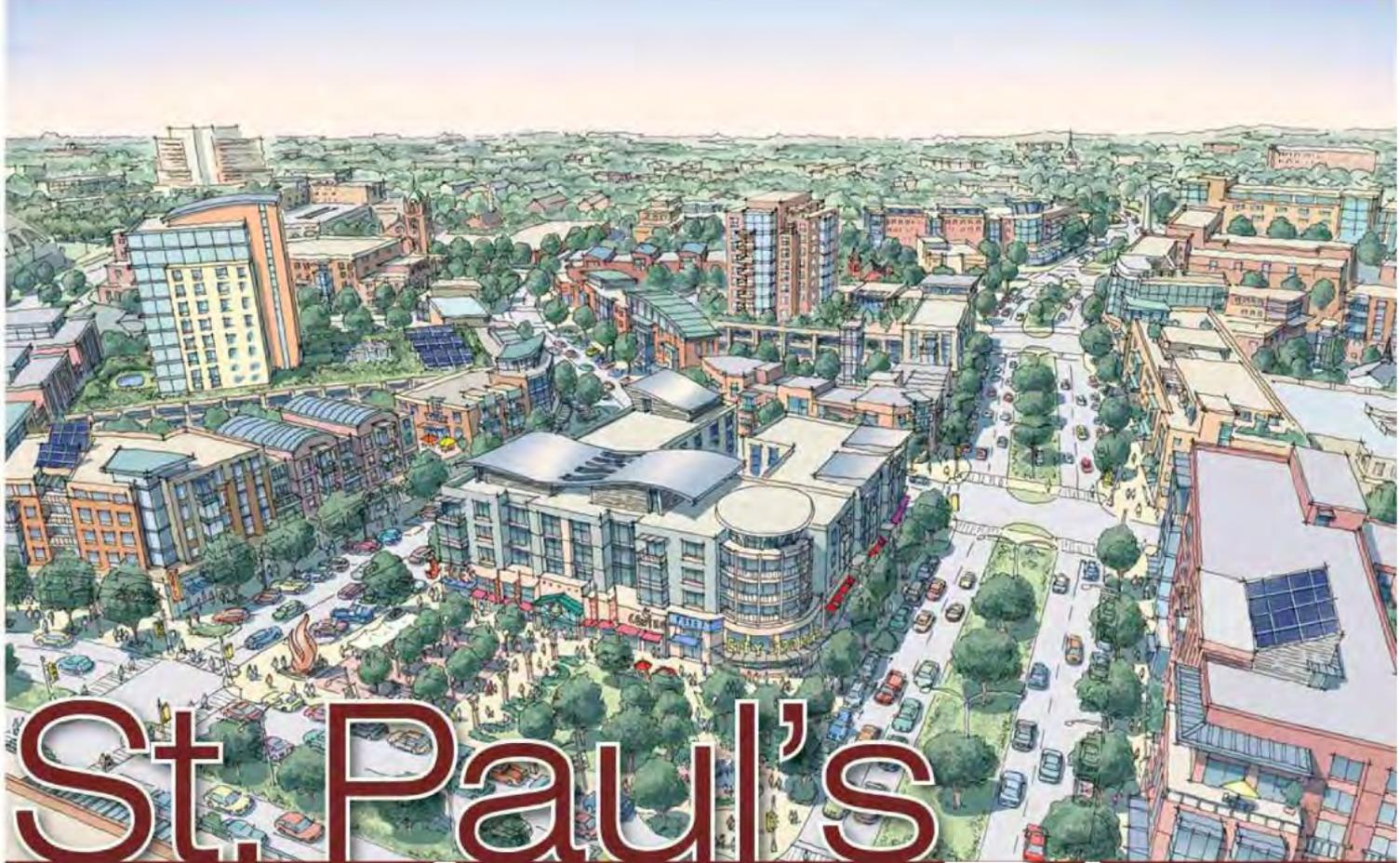
DUTCH DIALOGUES

Virginia: Life at Sea Level



DUTCH DIALOGUES

Virginia: Life at Sea Level

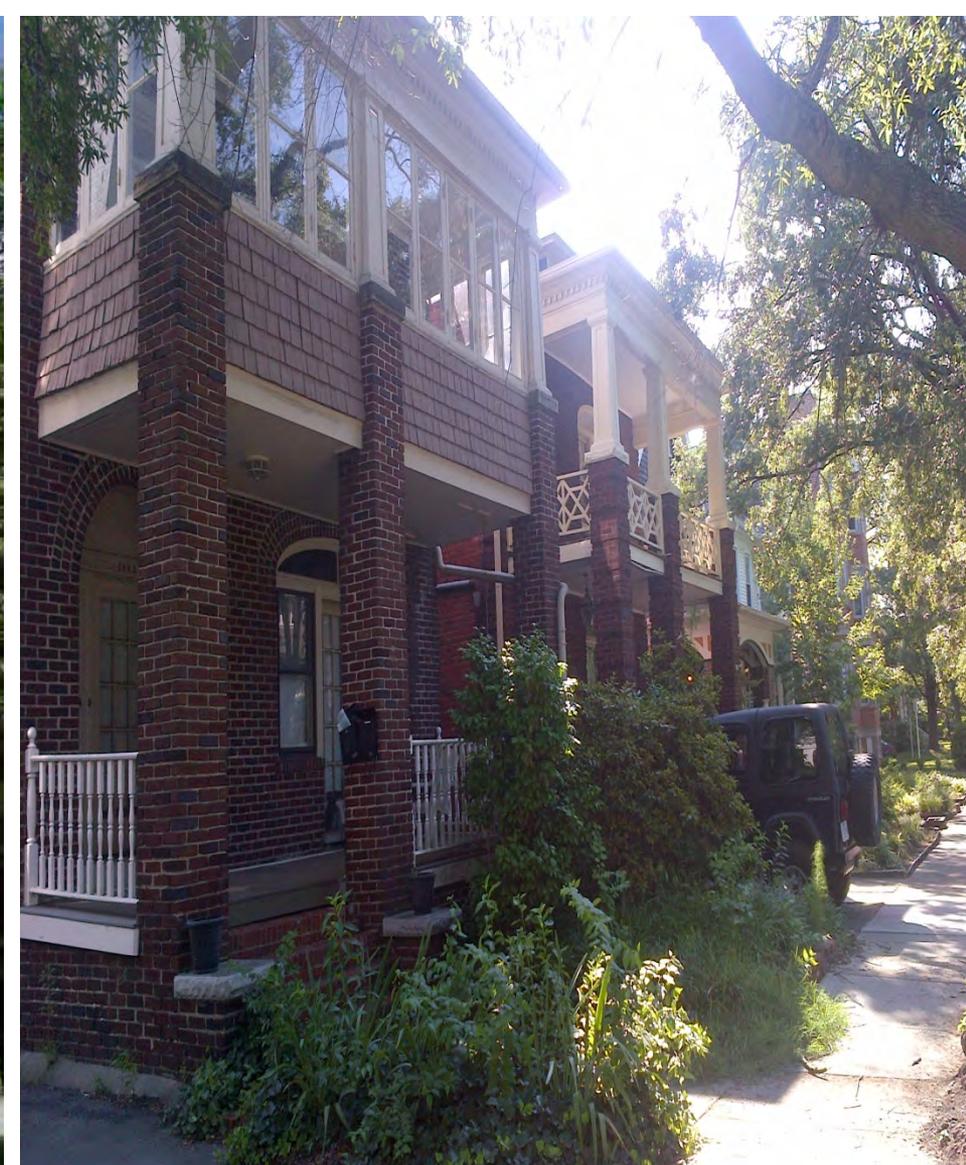


St. Paul's Area Plan



DUTCH DIALOGUES

Virginia: Life at Sea Level



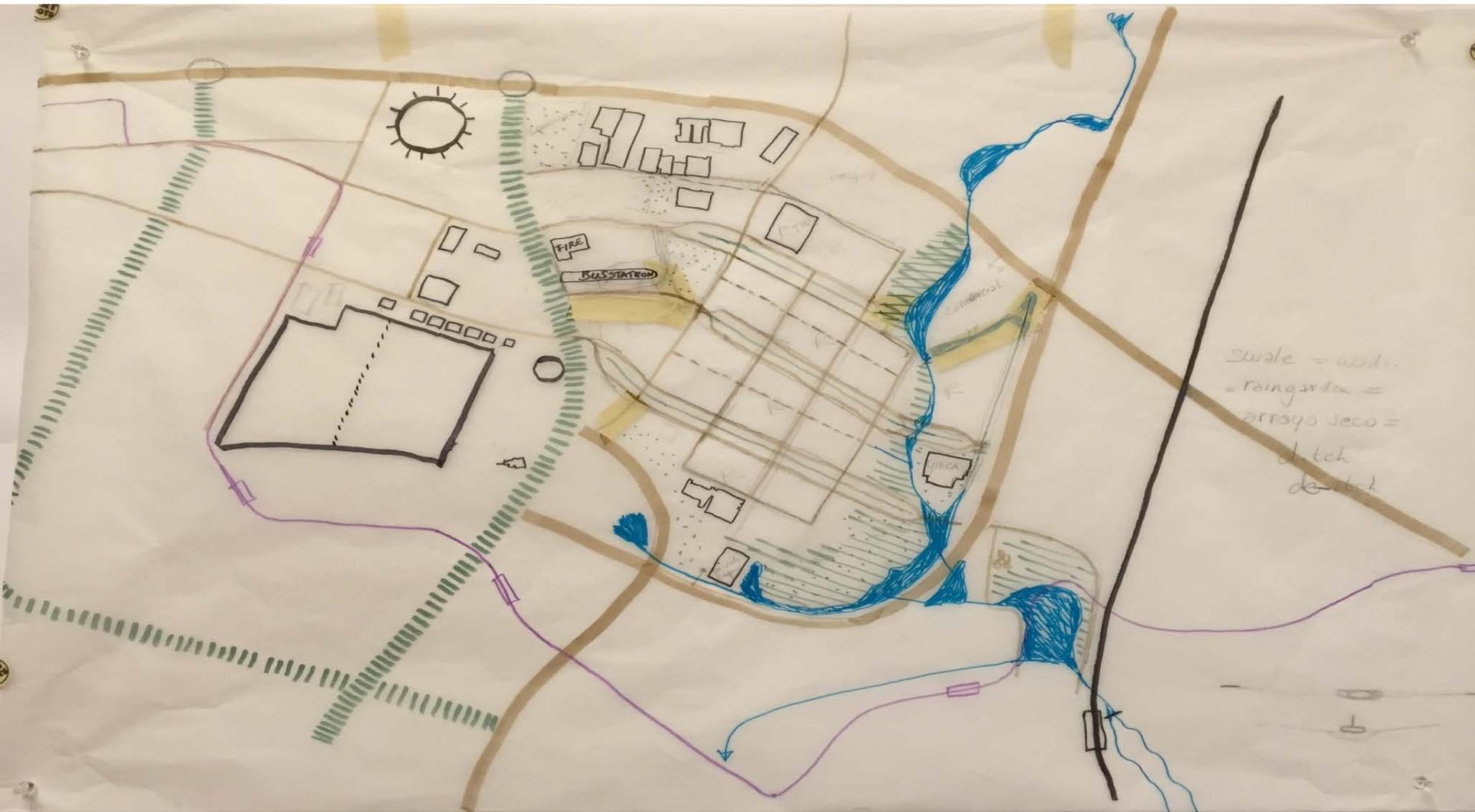
DUTCH DIALOGUES

Virginia: Life at Sea Level



DUTCH DIALOGUES

Virginia: Life at Sea Level



DUTCH DIALOGUES

Virginia: Life at Sea Level



DUTCH DIALOGUES

Virginia: Life at Sea Level



DUTCH DIALOGUES

Virginia: Life at Sea Level



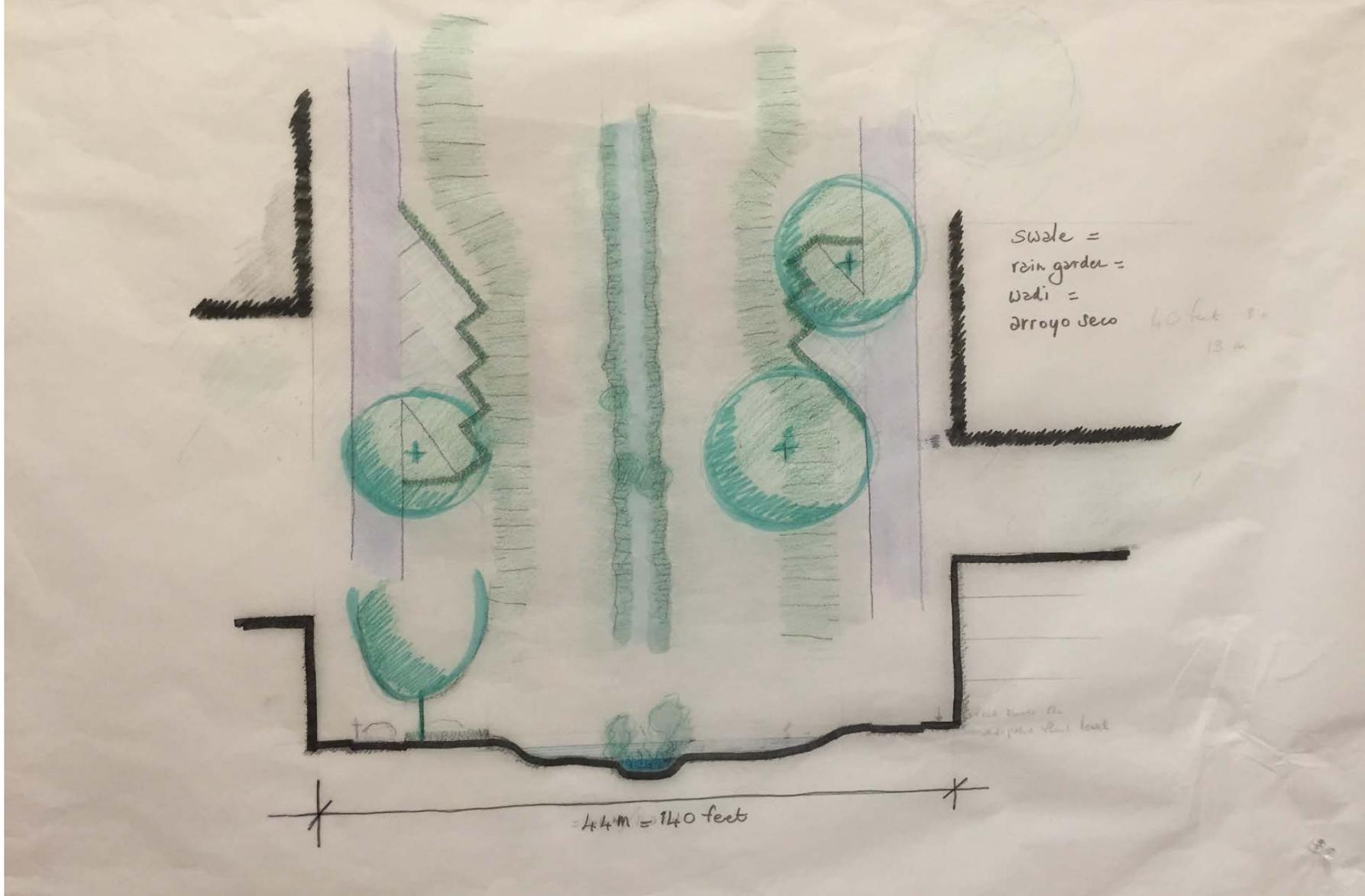
DUTCH DIALOGUES

Virginia: Life at Sea Level



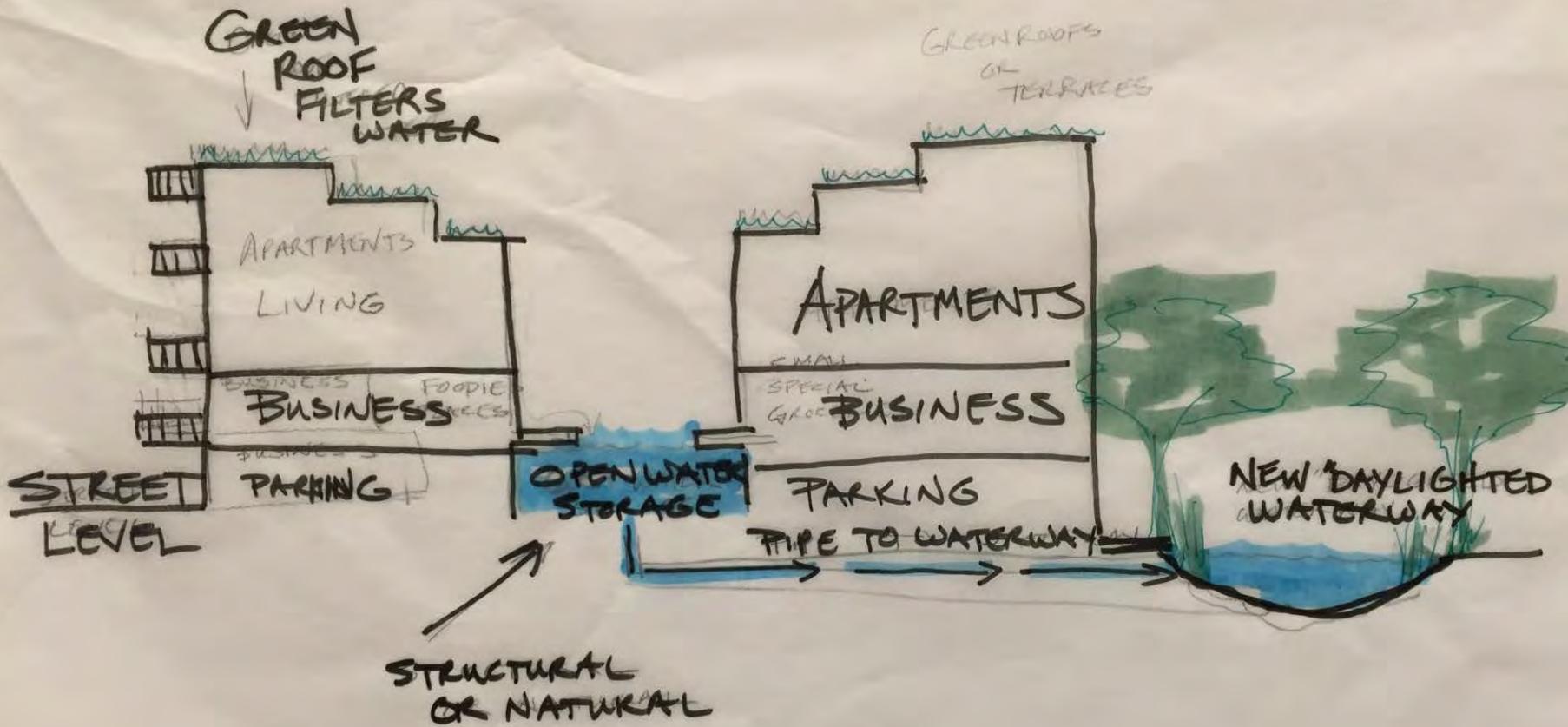
DUTCH DIALOGUES

Virginia: Life at Sea Level



DUTCH DIALOGUES

Virginia: Life at Sea Level



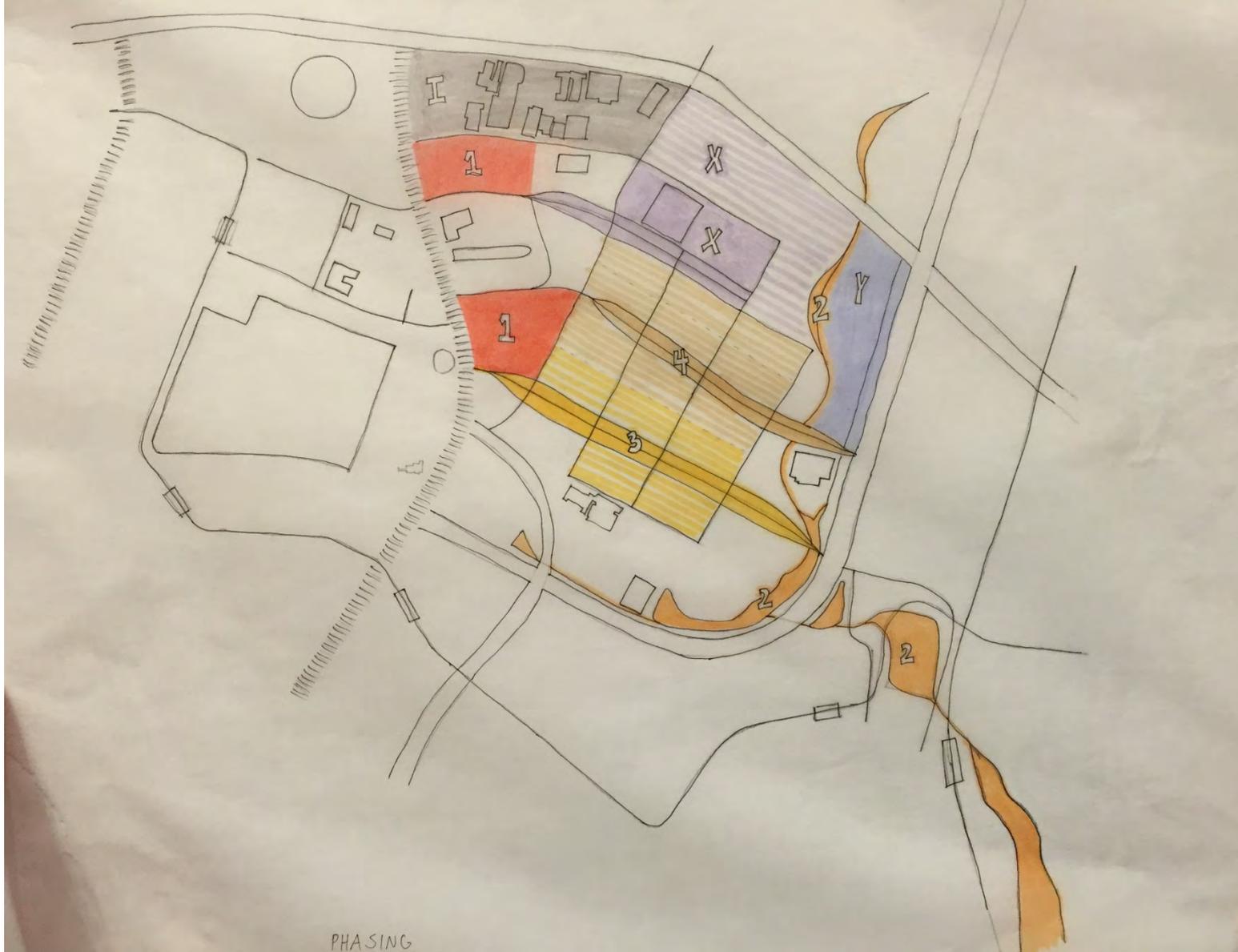
DUTCH DIALOGUES

Virginia: Life at Sea Level



DUTCH DIALOGUES

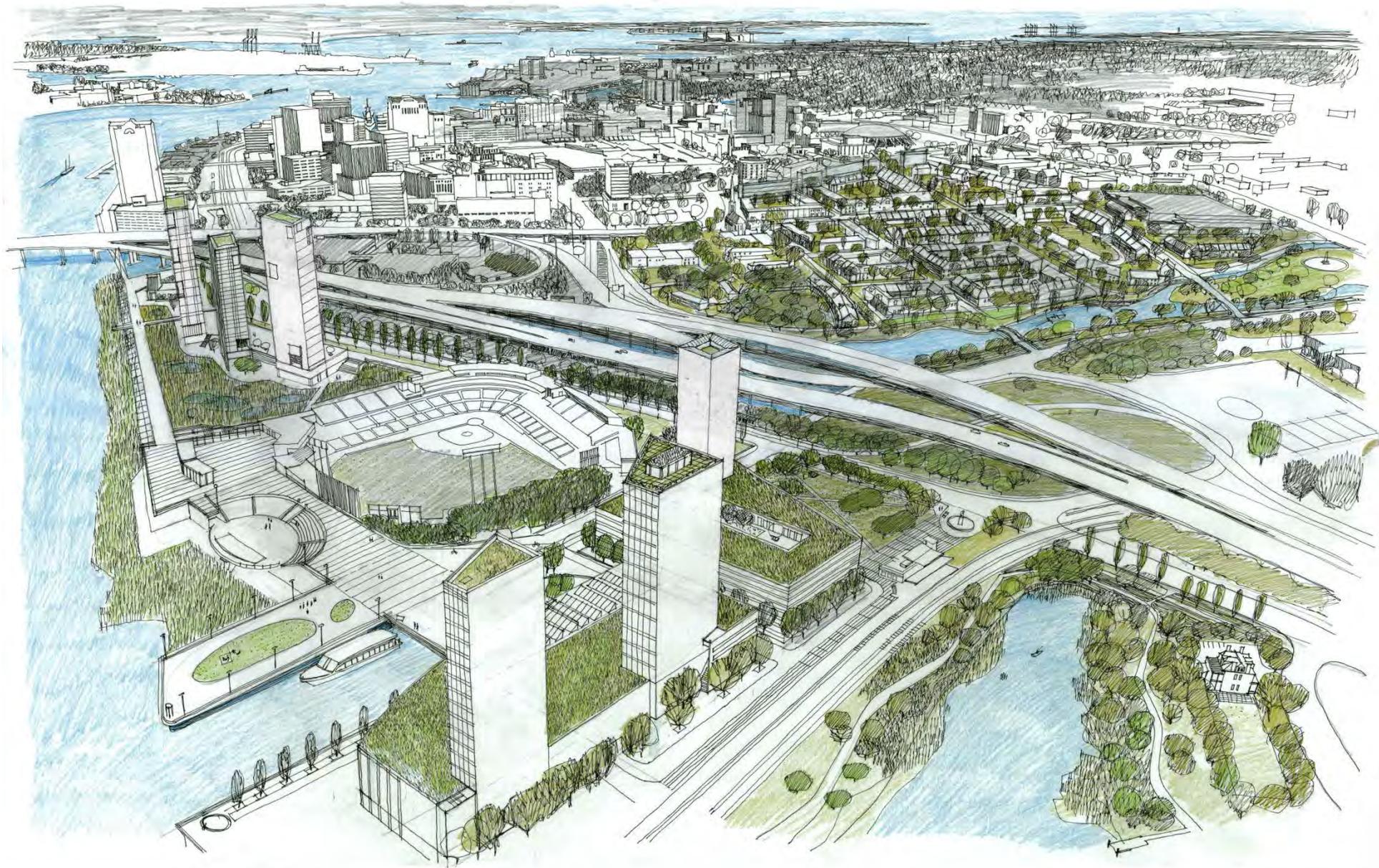
Virginia: Life at Sea Level





DUTCH DIALOGUES

Virginia: Life at Sea Level





DUTCH *DIALOGUES*

Virginia: Life at Sea Level

