

Metro Boston Dike barrier concept

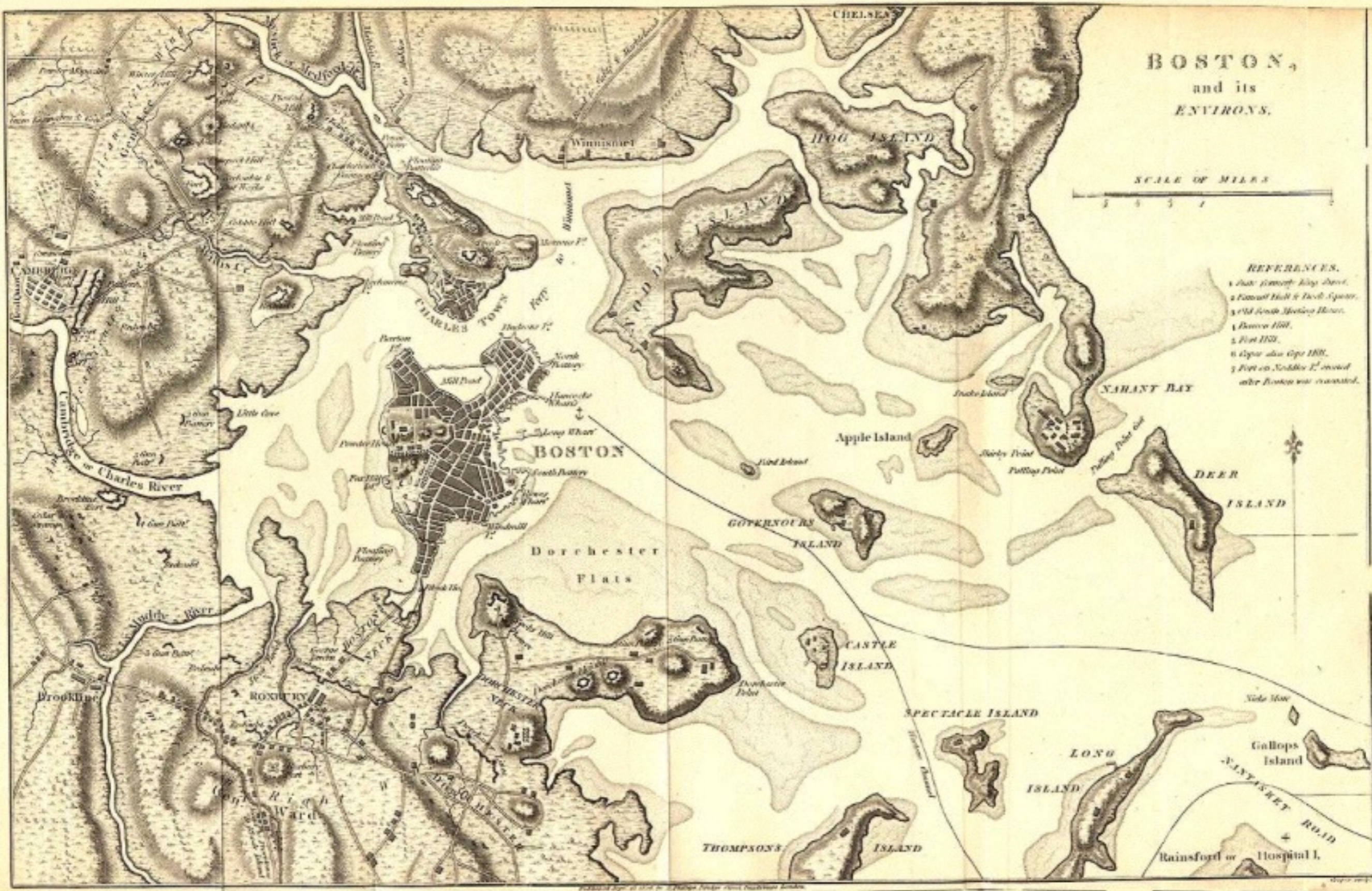
Protect and Create

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**Metropolitan Boston grew out of
and into
the Metro Boston Estuary**





BOSTON
AND ENVIRONS



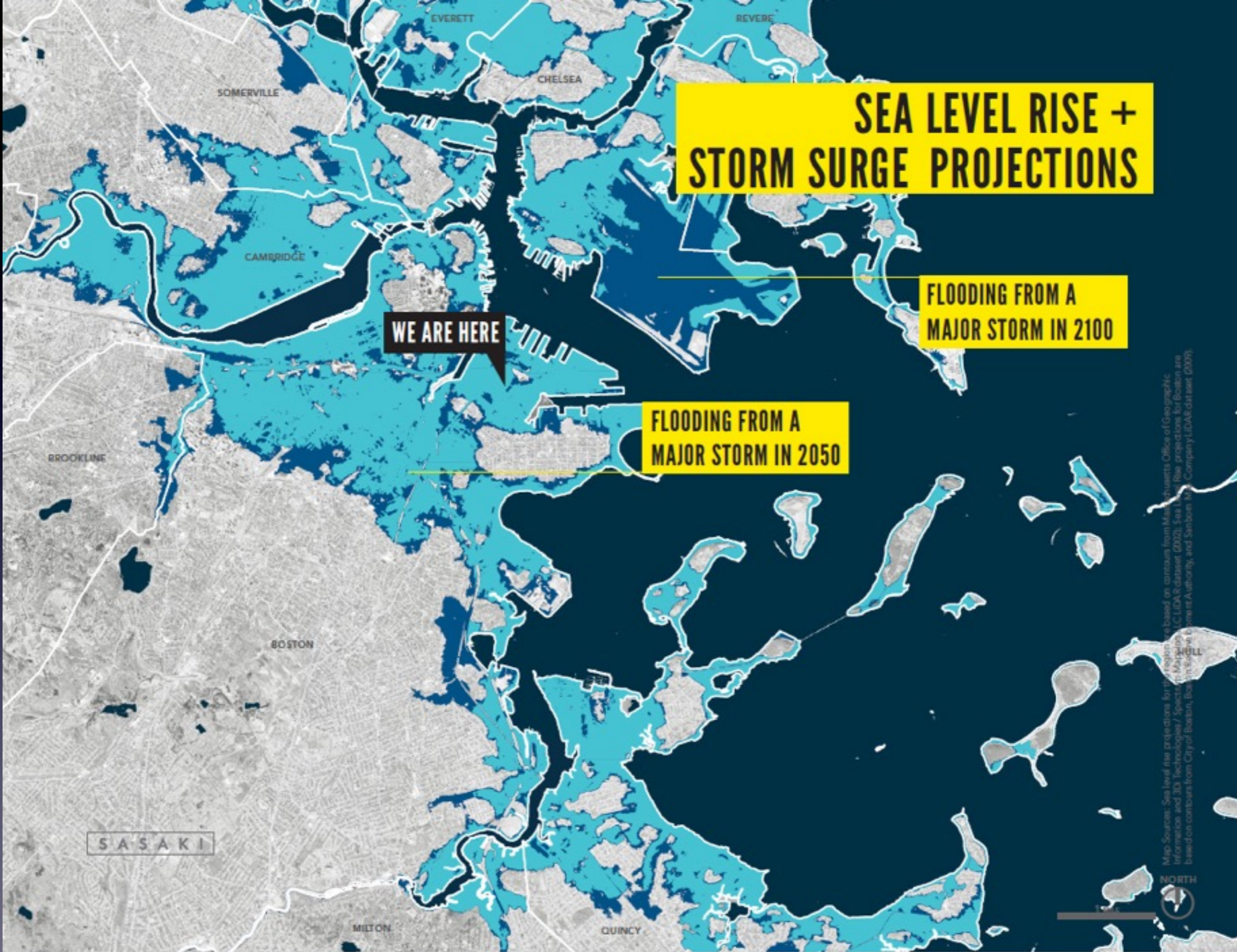
Figure 2. Expected flooding in Boston at a sea level of MHHW+7.5/12.3 ft NAVD (TBHA, 2010).

Source: TBHA Living with Water-2013 Report

BOSTON'S WET FUTURE



© Sasaki Associates (depicts high rise due to a 100-year storm in the year 2100 with 2 level of projected global warming)



Source: Sasaki & The Boston Harbor Association - Designing with Water

A vibrant urban waterway with a river, stone steps, and colorful umbrellas. The scene is set in a city with modern buildings in the background. The river is bordered by lush greenery and a walkway. People are seen walking on the stone steps and along the path. Colorful umbrellas are strung across the river, adding a festive touch. The overall atmosphere is bright and lively.

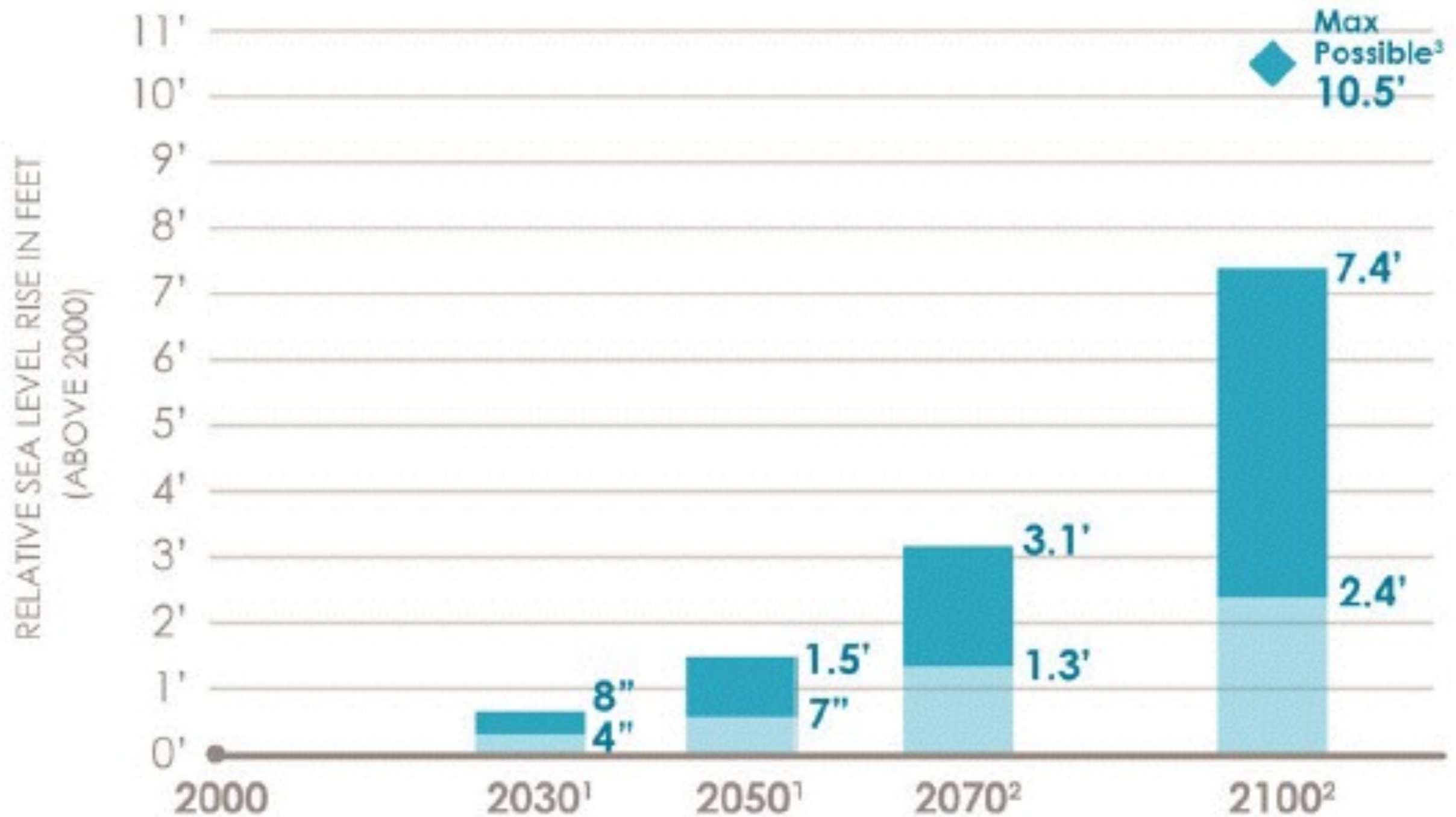
DESIGNING WITH WATER
CREATIVE SOLUTIONS FROM
AROUND THE GLOBE

The Boston Harbor Association
A Voice for the Harbor

SASAKI

PREPARING FOR THE RISING TIDE SERIES
VOLUME 2 | AUGUST 2014

SEA LEVELS IN BOSTON WILL CONTINUE TO RISE



Data Source:
BRAG Report, 2016

- 1 - Likely under all emission scenarios
- 2 - Likely under moderate to high emission scenarios
- 3 - Low probability under high emission scenario

Source: Climate Ready Boston, Dec. 2016 Report

**Climate change will hit New England hard,
report says**



DAVID L. RYAN/GLOBE STAFF/FILE

King tides hit the Boston waterfront in October 2016.

By **David Abel** GLOBE STAFF AUGUST 09, 2017

- “Global average sea levels, without significant cuts to emissions, are now projected to rise by as much as 8.2 feet — 1.6 feet more than previously projected.”
- “Between 1981 and 2015, the Northeast experienced a 17 percent increase in precipitation from the largest storms, compared with similar storms during the first half of the last century. That was substantially more than any other region in the country.”

Without improvements to the stormwater system, over 11,000 structures and 85,000 people will be directly exposed to frequent stormwater flooding as soon as the 2070s.⁴

⁴Current building stock and population in areas expected to be exposed. The building stock and population have not been projected.

“Stormwater flooding” means both
sea-side and riverine flooding!

BUILDINGS EXPOSED TO FREQUENT STORMWATER FLOODING TYPE (2070S-2100S)

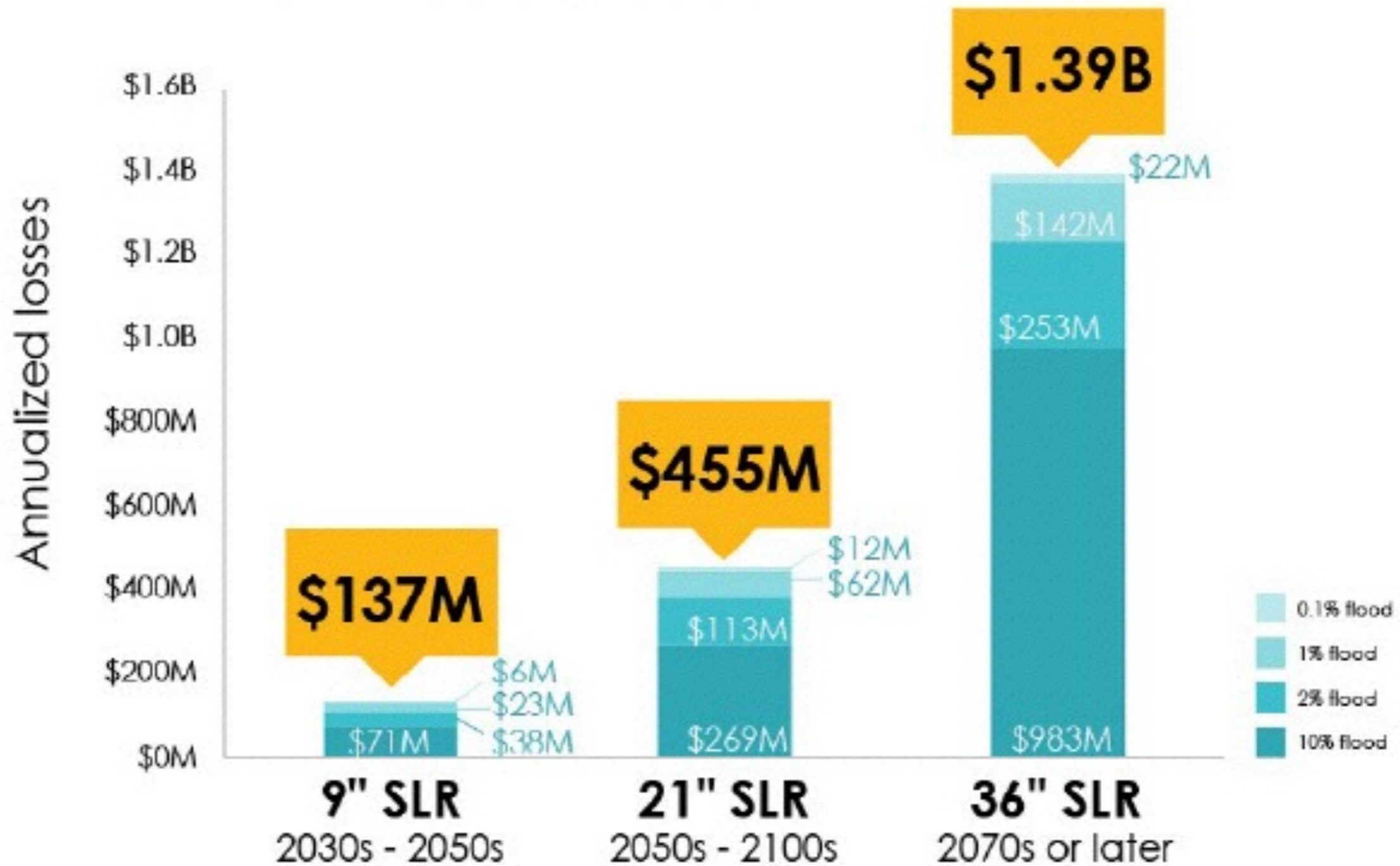


Source: Climate Ready Boston-Dec. 2016 Report

Coastal and riverine flooding can impact the local and regional economy through physical damages, stress factors (mental stress and anxiety and lost productivity), displacement costs, and losses due to business interruption. Loss estimations presented in this assessment are reported as an annualized value for each sea level rise condition; annualized values represent the total of the product of single losses expected for each projected sea level rise condition and the chance of occurring in any given year.

Source: Climate Ready Boston-Dec. 2016 Report

Annualized losses will increase with sea level rise...



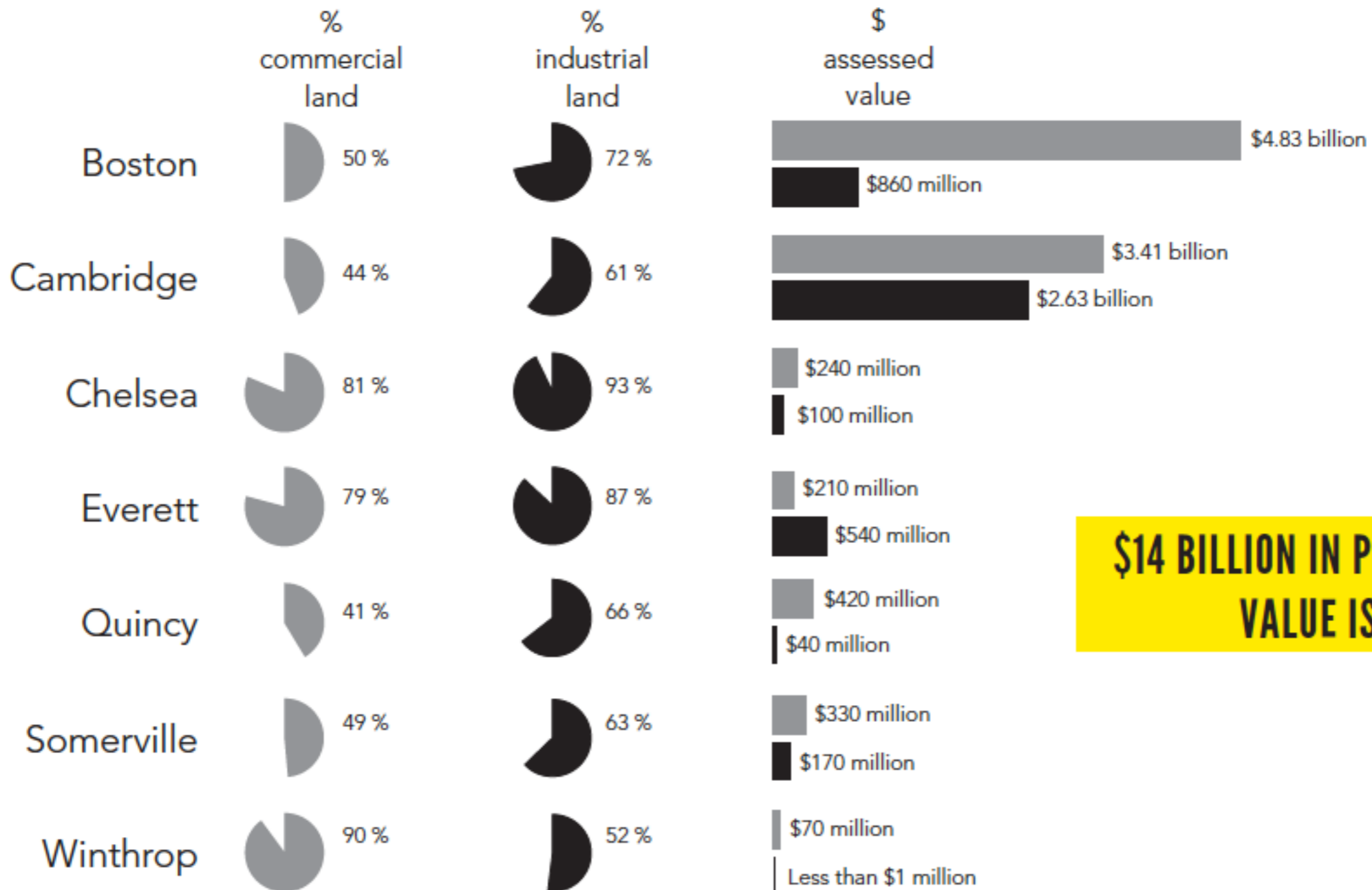
Source: *Climate Ready Boston-Dec. 2016 Report*

These annualized figures are just about Boston.

What about the other vulnerable communities of the Metropolitan Boston estuary?

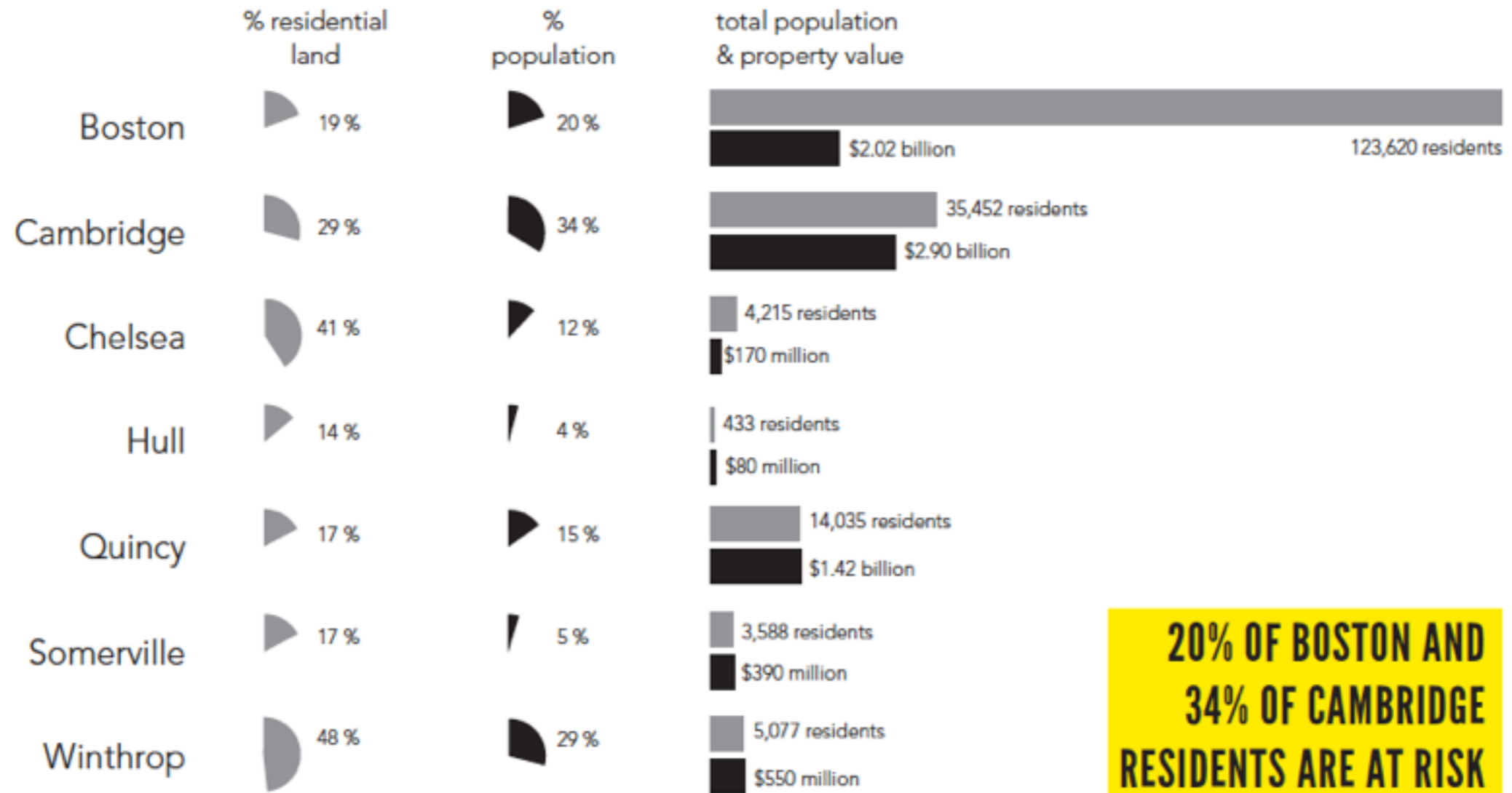
Also, these losses appear attributable **only** to sea level rise, and do not account for **storm surge disruptions** which - if Sandy is any indicator - are probably 10x those numbers in lost productivity (business interruption and physical losses, residents housed temporarily with their own physical losses, plus clean-up and recovery costs, all added to public service and infrastructure **disruptions in any single storm surge incident**).

INDUSTRIAL, COMMERCIAL, & INSTITUTIONAL PROPERTIES AT RISK

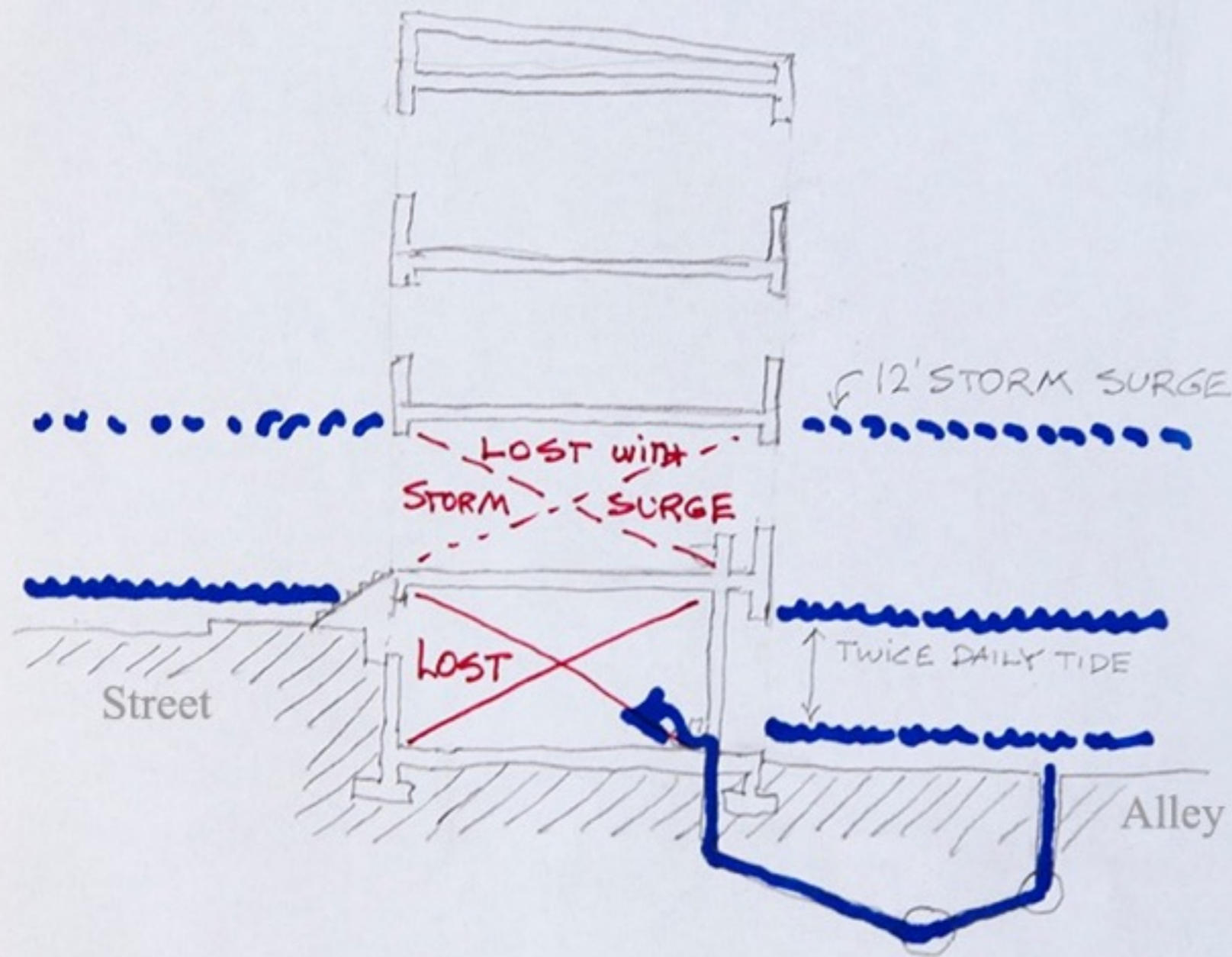


\$14 BILLION IN PROPERTY VALUE IS AT RISK

RESIDENTIAL POPULATIONS AT RISK



**20% OF BOSTON AND
34% OF CAMBRIDGE
RESIDENTS ARE AT RISK**



TYPICAL BACK BAY BLDG.
IN 2100
UNDER 7.5' SEA LEVEL RISE
& UNDER 12' ADDITIONAL STORM SURGE



The challenge:

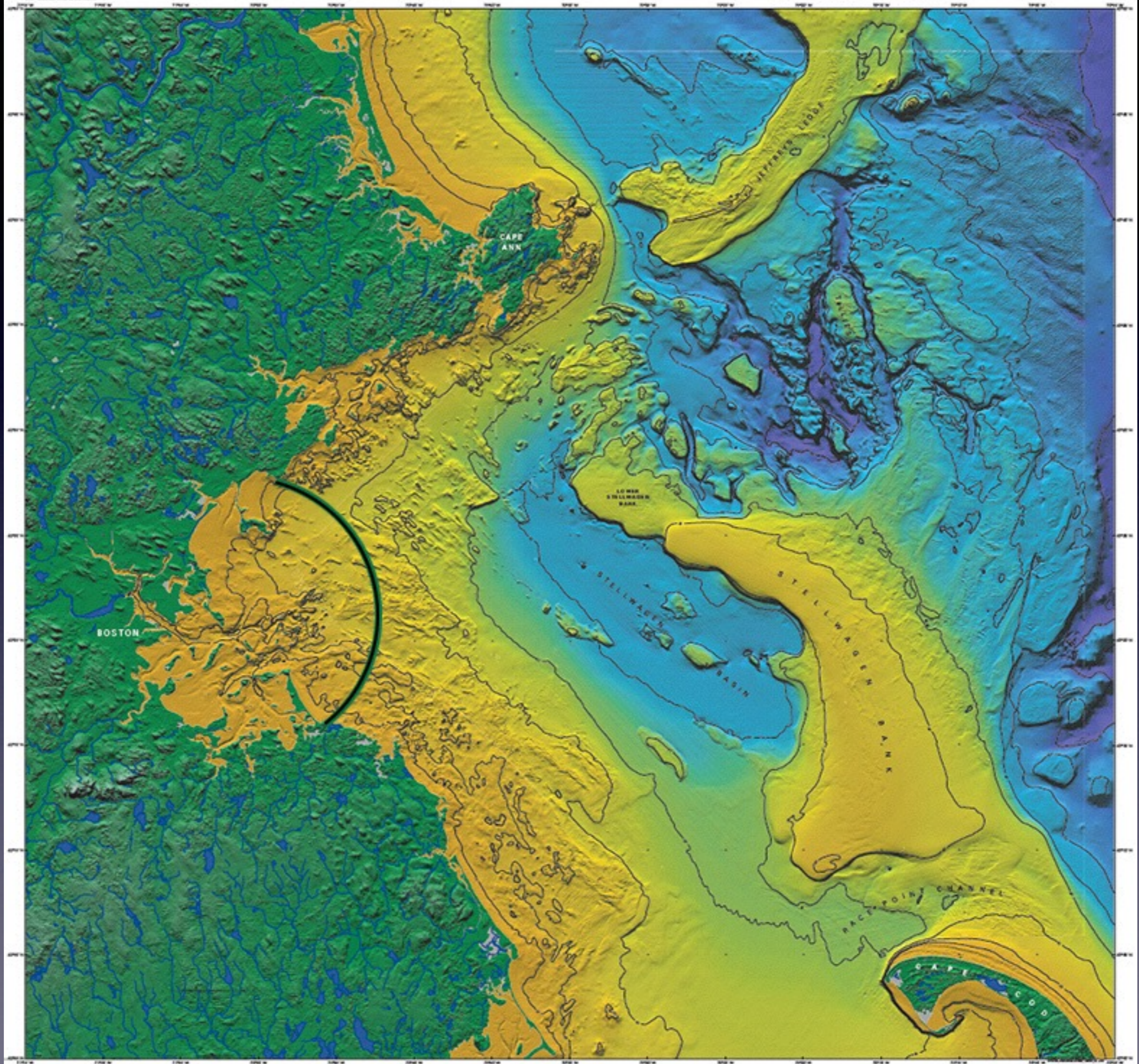
**HOW TO PROTECT ALL THE
VULNERABLE COMMUNITIES OF THE
METROPOLITAN BOSTON ESTUARY?**

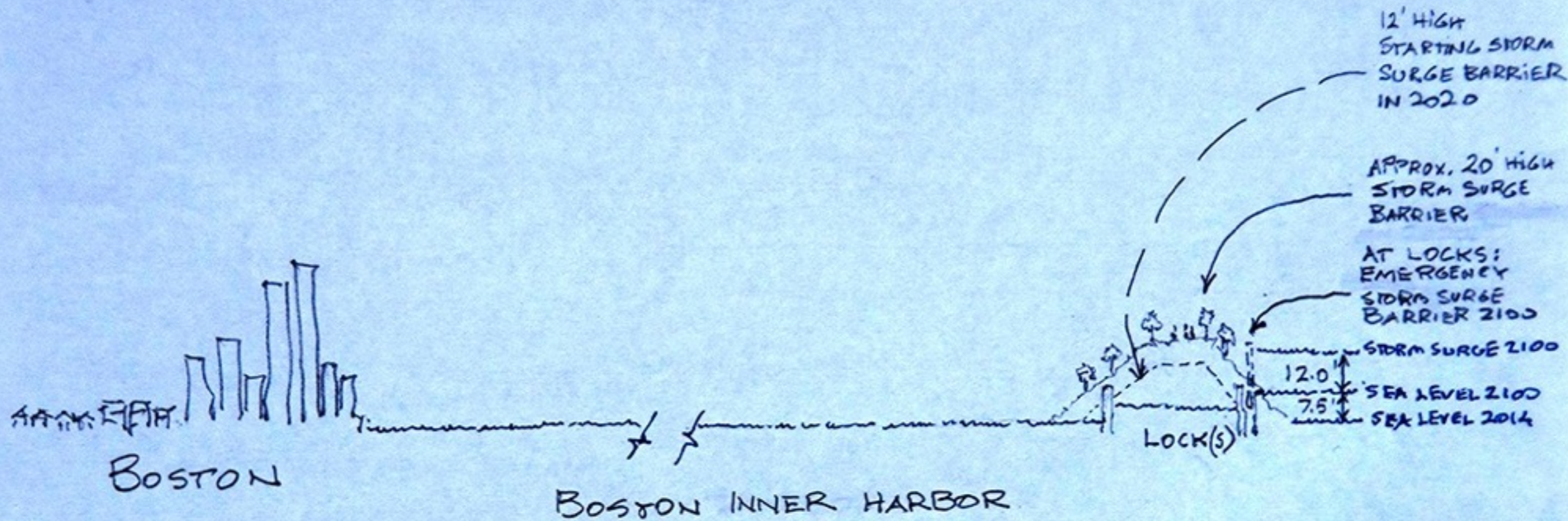
Here's an idea,
a vision,
not in any way yet a plan.

Metro Boston Dike Barrier Concept



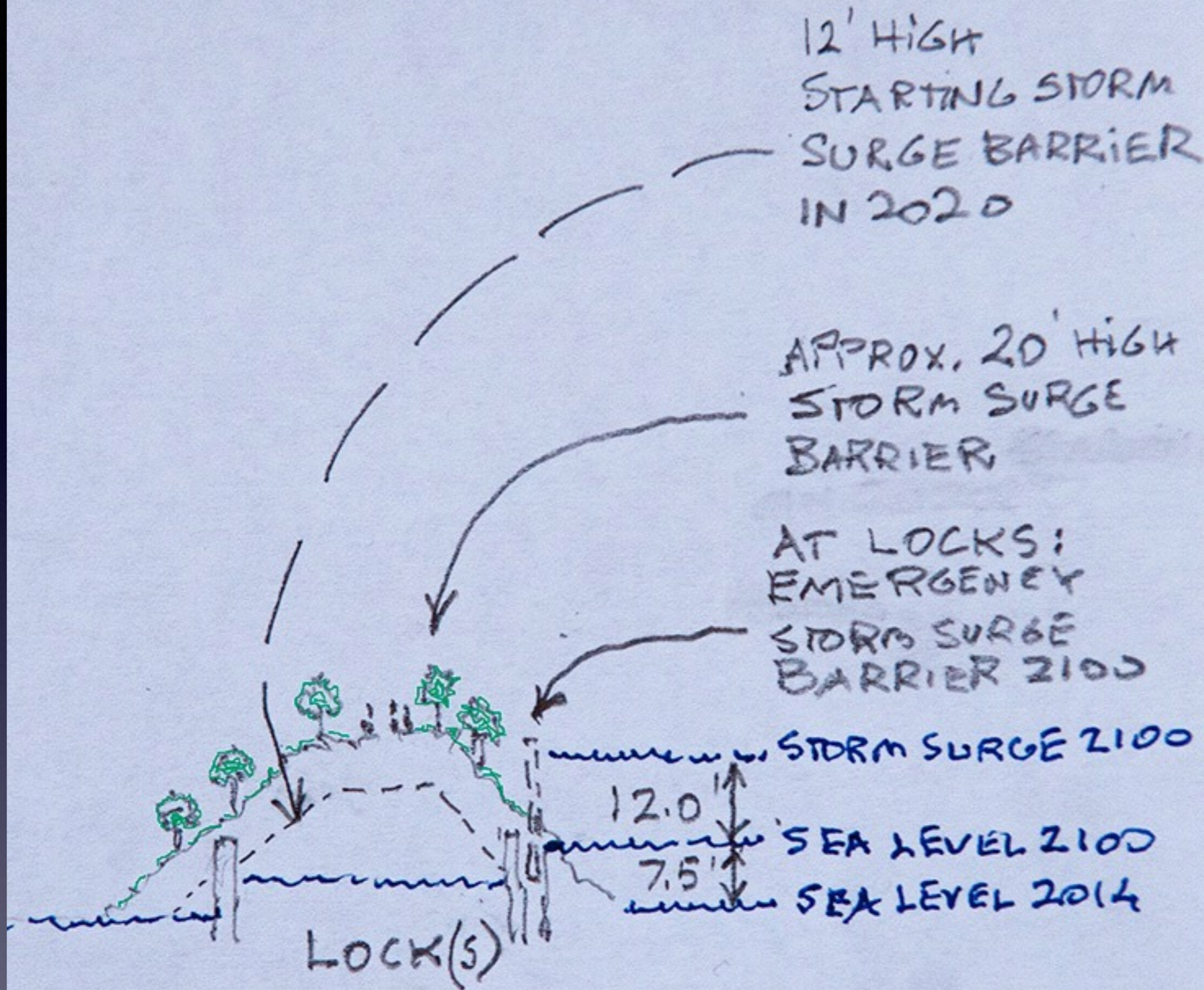
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[Red symbols]



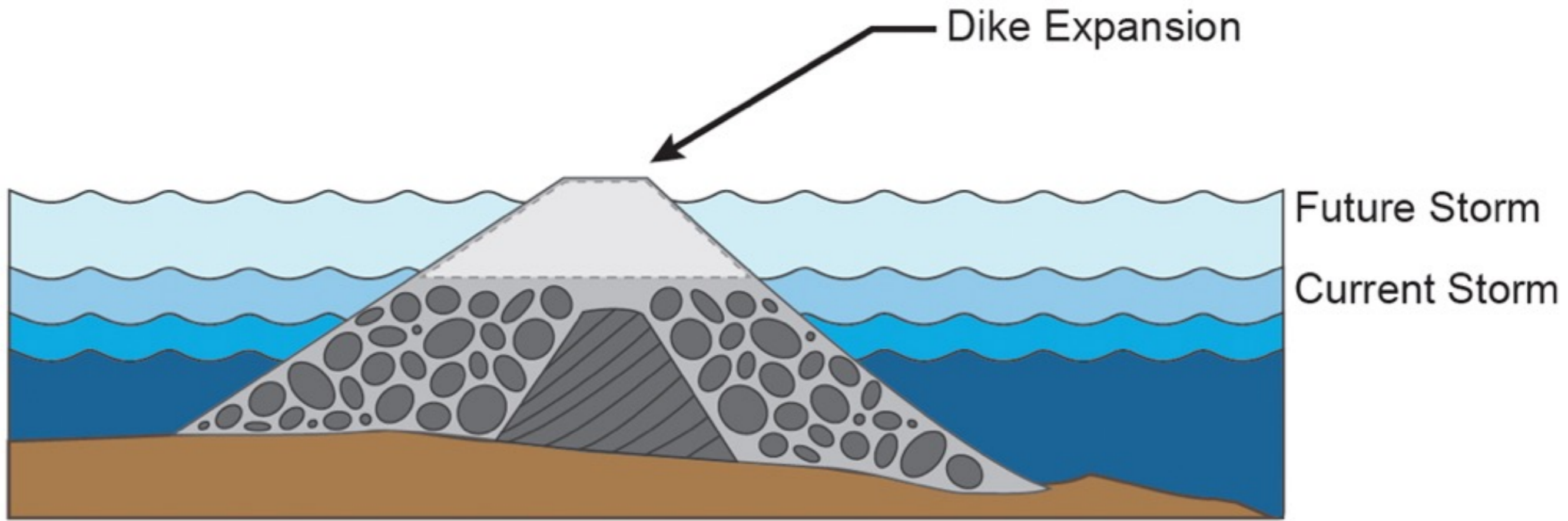


STORM SURGE BARRIER DIAGRAM

STARTING 12' HIGH IN 2020, WITH LOCKS
 RISING TO 20' HIGH BY 2050



Barrier Detail



Rock-Filled Dike Concept

Source: R.F. Daylor-TetraTech

R.F.Daylor's estimates \$100/cu.yd. for placed fill, plus \$500 million for each of 2 shipping locks.

Ancient concrete may stand sea through Roman's work lasted miller

By Ben Guarini
WASHINGTON POST

WASHINGTON
thousand years ago,
builders constructed
walls and harbor pi
concrete they used o
the empire — and still
sons for modern engin
entists say.

A bunch of half-
structures off the Ital
might sound less im
than a gladiatorial co
But underwater, the
in the material. The h
crete, a mixture of ve
and quicklime, has
the sea for two mill
counting. What's n
stronger than when i
mixed.

The Roman stuff
traordinarily rich m
terms of scientific po
said Philip Brune, a
scientist at D. P.

a single stone mass, impregnable to the waves.”) But it’s not the complete picture: It’s one thing to assemble the ingredients, another to know how to bake the cake.

To that end, Jackson and her colleagues peered into the microscopic structures of concrete samples, extracted from the sea walls and piers as part of a project called the Roman Maritime Concrete Study. “This rocklike concrete is behaving, in many ways, like volcanic deposits in submarine environments,” Jackson said.

Where modern concrete is designed to ignore the environment, Roman concrete embraces it. As the scientists report in a study published Monday in the journal *American Mineralogist*, Roman concrete is filled

with tiny growing crystals. The crystals, like tiny armor plates, may keep the concrete from fracturing.

The scientists subjected the concrete samples to a battery of advanced imaging techniques and spectroscopic tests. The tests revealed a rare chemical reaction, with aluminous tobermorite crystals growing out of another mineral called phillipsite.

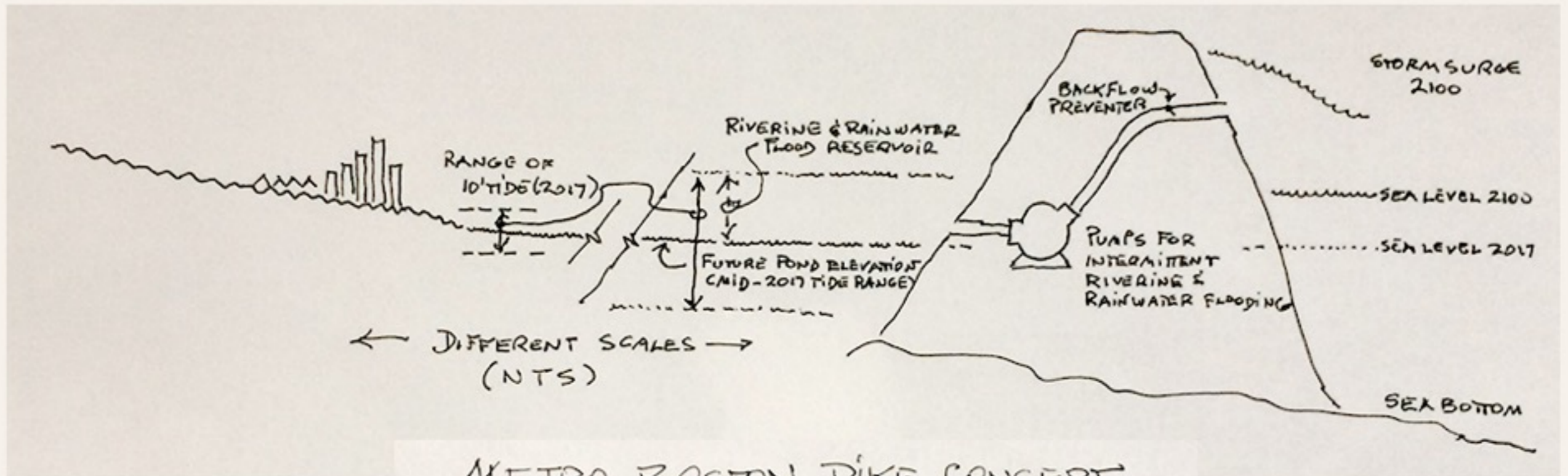
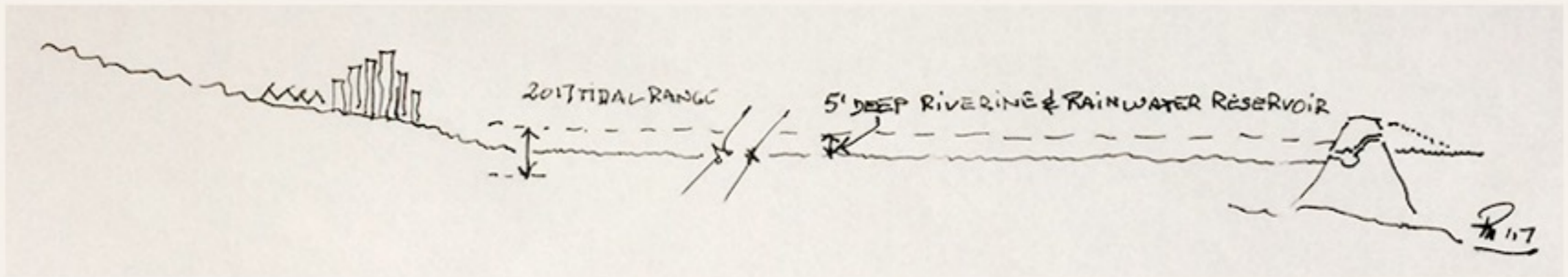
In this instance, the key ingredient proved to be sea water. As sea water percolated within the tiny cracks in the Roman concrete, Jackson said, it reacted with the phillipsite naturally found in the volcanic rock and created the tobermorite crystals.

“Aluminous tobermorite is very difficult to produce,” she



J.P. OLESON

oreline environ-
kson said. (In one
team of European
artists predicted



METRO BOSTON DIKE CONCEPT

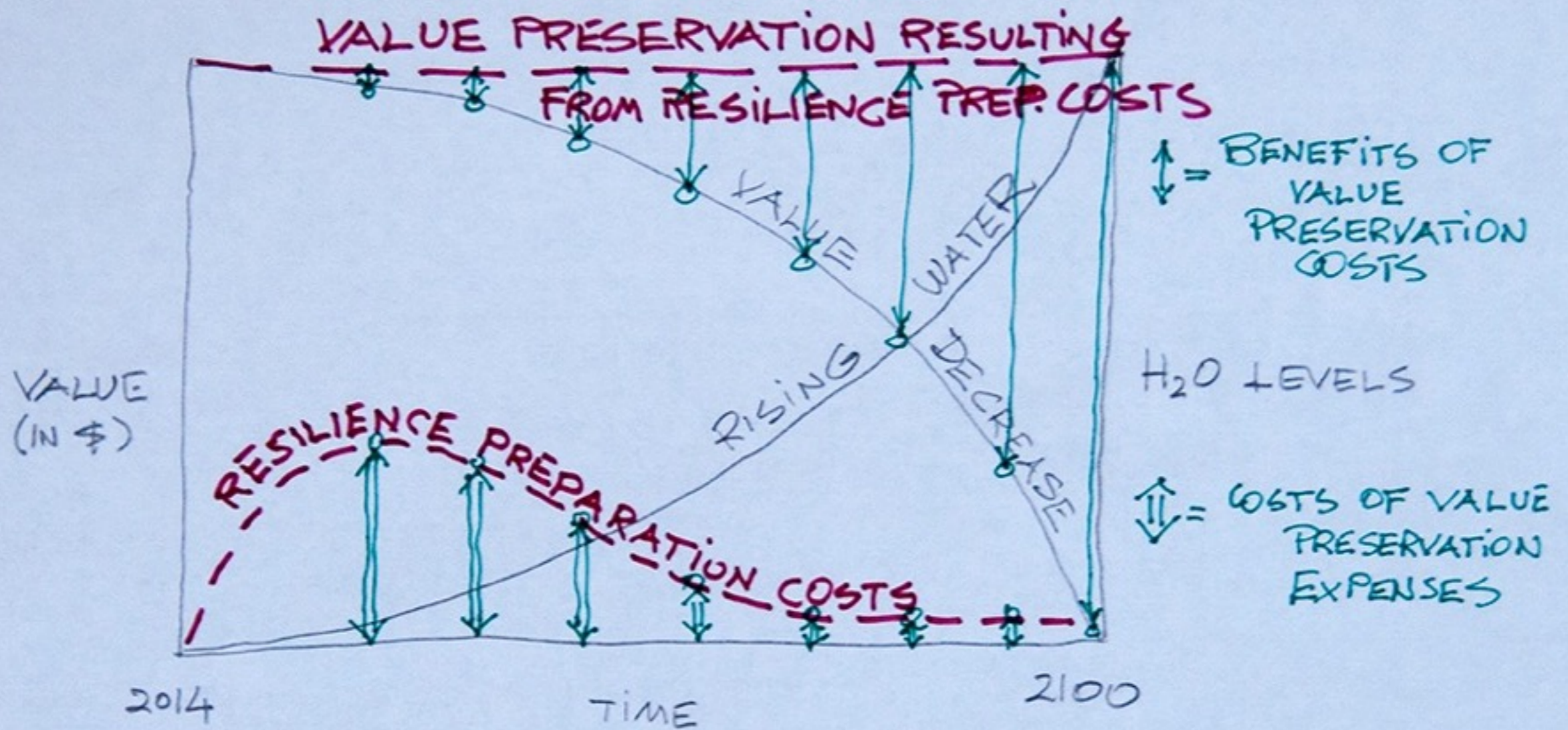
SWAMPSCOTT TO COHASSET

RESERVOIR CALCULATIONS

AREA: $\pi R^2 \times .4$ OF 8-MILE CIRCLE \times
 $3.14 \times 5,280' \times 5,280' \times .4 = 33,900,000$ S.F.
 $\times 5'$ TIDE DEPTH (50% OF FULL TIDE) =
 $33,900,000$ S.F. $\times 5' =$
 $169,500,000$ cu.ft. | FLOOD RESERVOIR |
 $\times 7.48$ gals/cu.ft. \approx
 $5,198,000,000$ gals. FLOOD RESERVOIR CAPACITY
DOUBLE THAT FOR TODAY'S ENTIRE TIDE

5.2 b
 gallons
 @ 5' OF '17
 TIDE





BENEFITS OF VALUE PRESERVATION COSTS
AS WATER LEVELS RISE

BUILDINGS EXPOSED TO FREQUENT STORMWATER FLOODING TYPE (2070S-2100S)

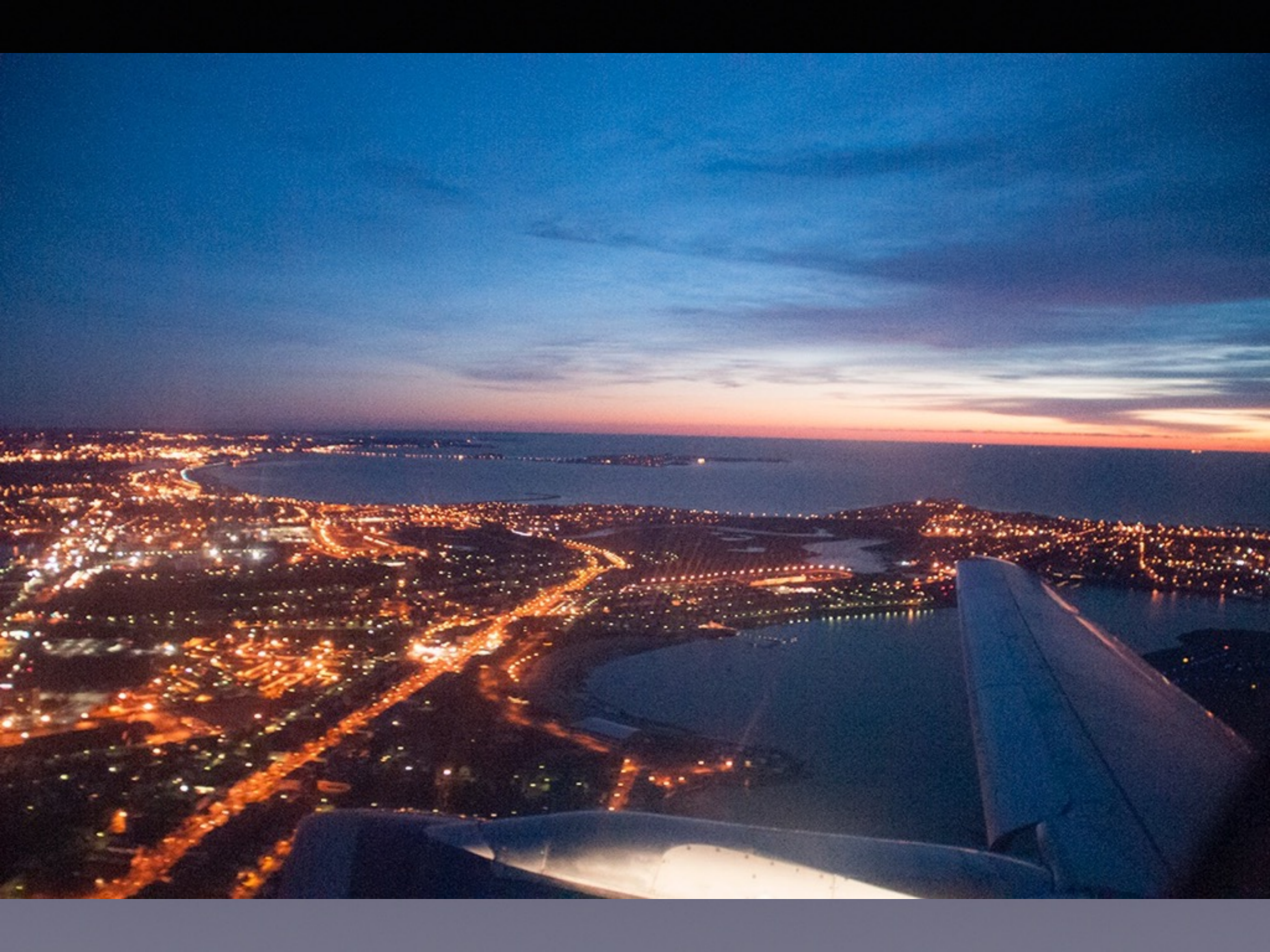


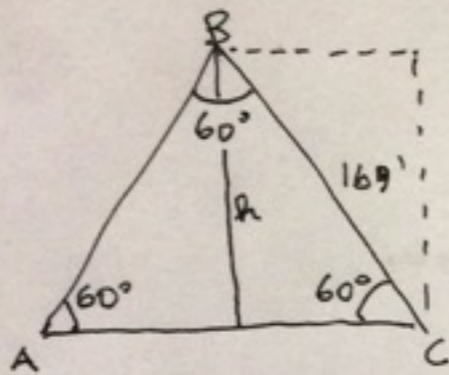
Source: Climate Ready Boston-Dec. 2016 Report



These numbers are only for Boston.

What about all the properties and populations of the other communities in the Metro Boston estuary?



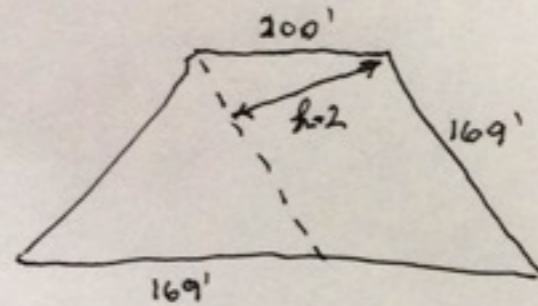


$$AB = BC = AC = h \times 1.41$$

$$h = 120'$$

$$AB = 120' \times 1.41 = 169.2'$$

$$\text{AREA OF } 60^\circ \text{ EQUILATERAL TRIANGLE} = \\ 169' \times 120' = 20,280 \text{ ft}^2$$



$$A_2 = 200 : 1.41 = 141.84 \approx 142'$$

$$\text{AREA OF ADDITIONAL PARALLELOGRAM} = \\ 142' \times 169' = 9,798 \approx 10,000 \text{ ft}^2$$

TOTAL CROSS-SECTION OF A METRO DIKE BARRIER

120' HIGH (100' FROM CURRENT SEA LEVEL TO SEA BOTTOM)

AND 200' WIDE @ TOP $\approx 30,000 \text{ SQ. FT.}$

$$30 \times 10^3 \times (5.28 \times 10^3 \text{ FT/MILE}) \times 14 \text{ MILES} = 158.4 \times 14 = \underline{2,217,600,000 \text{ cu. Ft.}}$$

TOTAL VOLUME OF A METRO DIKE BARRIER =

$$2,217,600,000 : 9 \text{ cu. Ft./yd} = \underline{246,400,000 \text{ cu. yd.}}$$

$$\$100/\text{cu. yd. placed dike material} = \underline{\$24.64 \text{ billion} \approx 25 \text{ billion}}$$

SAY \$30 incl. all soft costs

TOTAL NEW WATERFRONT PROPERTY CREATED =

$$(200' \text{ TOP OF DIKE})^2 \times (5.28 \times 10^3 \text{ sq. ft.}) \times 14 \text{ MILES} =$$

$$40 \times 10^3 \times 5.28 \times 10^3 \times 14 = 2,956.8 \times 10^6 \text{ sq. ft.} / 43,560 \text{ sq. ft./acre} = 67.88 \approx \underline{68 \text{ acres}}$$

XXX

$$68 \text{ ACRES @ } \$3 \text{ mn/acre} = \$130 \text{ billion} - \$30 \text{ b} = \underline{\$100 \text{ b PROFIT}}$$

$$\$5 \text{ mn/acre} = \$218 \text{ b} - \$30 \text{ b} = \underline{\$188 \text{ b PROFIT}}$$

$$\$7 \text{ mn/acre} = \$476 \text{ b} - \$30 \text{ b} = \underline{\$446 \text{ b PROFIT}}$$

Enterprising forebears - investors as well as policymakers - had the vision to fill tidal flats to create Boston's Back Bay in the 19th century.

Their descendants are equally capable of undertaking a comparably visionary project in the 21st century, one which would serve double duty as protective flood system and newly created waterfront property, reshaping and enhancing an entire metropolitan area which began as a slight peninsula and has grown steadily in step with the needs of the times.



A diorama of the infilling of the Back Bay was exhibited at the New England Mutual Life Insurance Company (now The New England) for many years. The train, consisting of thirty-five gondola cars bearing gravel, can be seen on the right with the tip cart dumping its load of fill into the marshes. The gravel train made twenty-five trips per day, moving 2,500 cubic yards of fill daily from Needham to the Back Bay. (Courtesy of *The New England*.)

A potential bonus feature of the Metro Boston Dike freshwater lake and storm flood reservoir might be as small water reservoir for southeast Massachusetts communities whose groundwater is becoming increasingly brackish as sea levels rise.

Somebody with a vision will

PROTECT ALL

COMMUNITIES OF THE

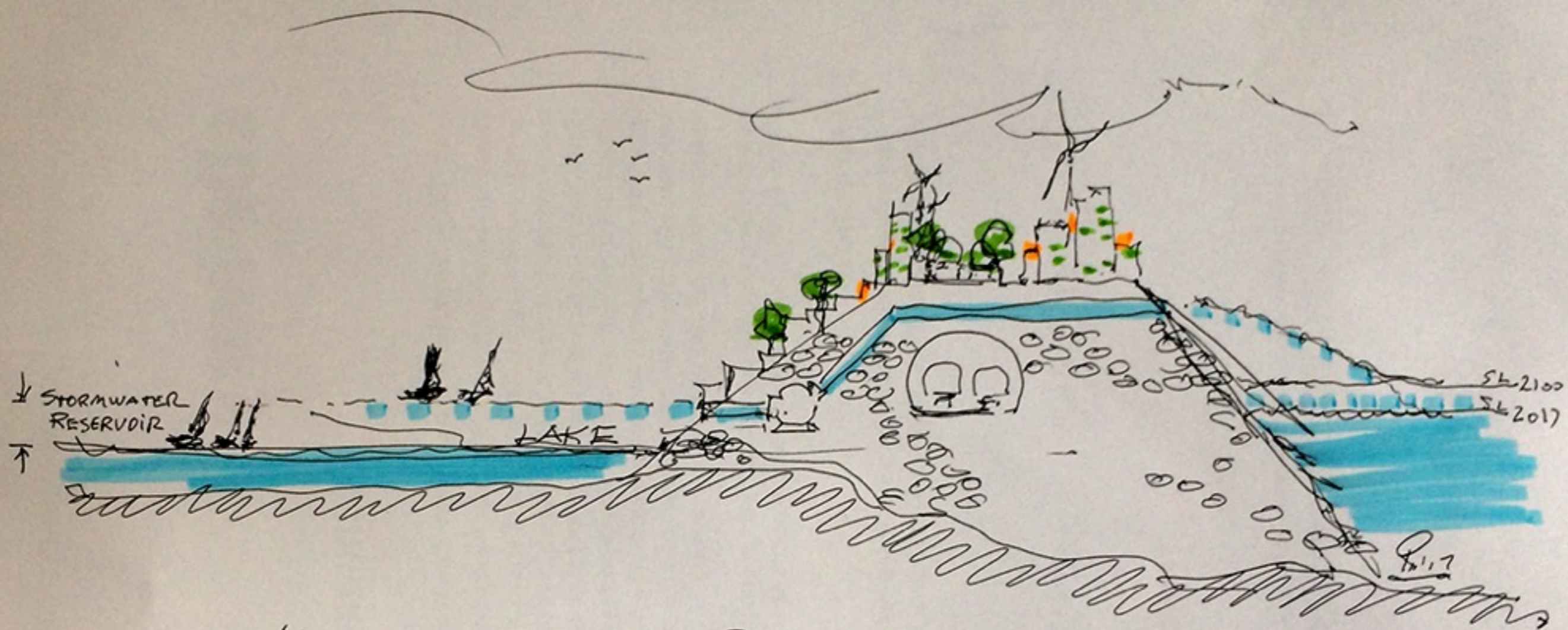
METRO BOSTON ESTUARY

plus

MAKE A LOT OF MONEY

plus

PRODUCE A LOT OF TAXES



METRO BOSTON DIKE BARRIER

SERVING AS NEW WATERFRONT NEIGHBORHOOD

WITH FRESHWATER RESERVOIR & LAKE