

A WAY FORWARD

PDO

Using available information, amend ordinances, policies, and regulations to account for future conditions under climate change.

These policies should reflect the best available science and be subject to regular review and updates.

Making these changes will help communities make better decisions about where, what, and how to build.

Resilient Design Guidelines: Projections

SEA LEVEL RISE

Regional sea level rise planning scenarios

PRECIPITATION

Future precipitation values based on climate models

Resilient Design Guidelines: Applications

FLOODPLAIN MAPPING

Projections of future
floodplains
incorporating sea
level rise and riverine
flooding

TAILWATER ELEVATIONS

Boundary conditions based on watershed tidal elevations with sea level rise

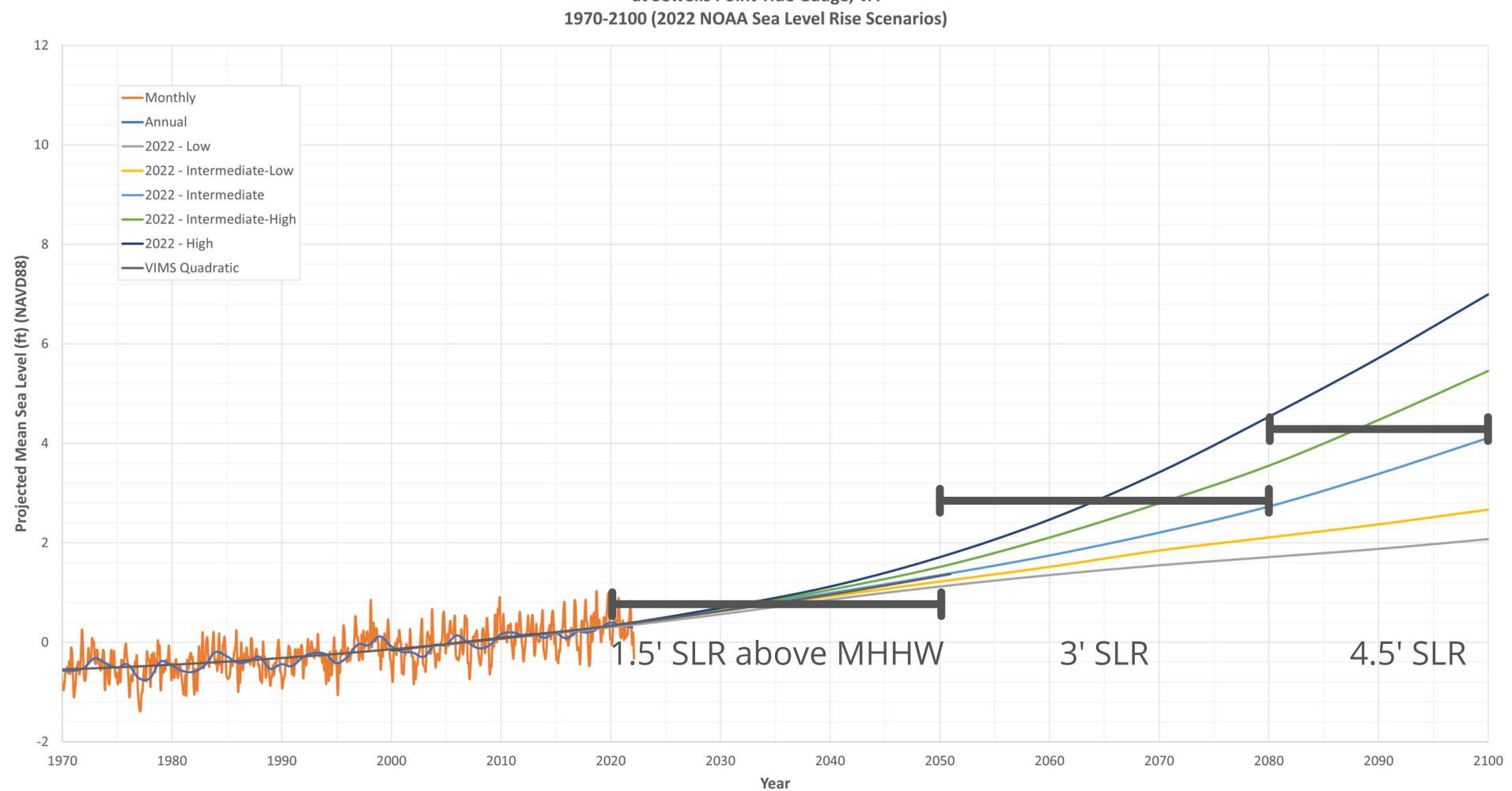
DESIGN STORMS

Rainfall levels
corresponding to
various return
periods

JOINT PROBABILITY EVENTS

Design storms that pair tidal and rainfall events

Observed and Projected Mean Sea Level at Sewells Point Tide Gauge, VA 1970-2100 (2022 NOAA Sea Level Rise Scenarios



Design Tidal Elevations - Chesapeake

Note: All elevations in feet relative to the North American Vertical Datum (NAVD) of 1988

		Design	1-	2-	3-	5-	10-	25-	50-	100-	500-
HUC12	Watershed	Level	Year								
020802080201	New Mill Creek- Southern Branch Elizabeth River	Current	3.9	4.5	4.8	5.2	5.8	6.6	7.2	7.8	9.2
		1.5 ft SLR	5.4	6.0	6.3	6.7	7.3	8.1	8.7	9.3	10.7
		3.0 ft SLR	6.9	7.5	7.8	8.2	8.8	9.6	10.2	10.8	12.2
020802080203	Deep Creek- Southern Branch Elizabeth River	Current	3.4	4.1	4.5	5.1	5.9	6.7	7.3	8.0	10.0
		1.5 ft SLR	4.9	5.6	6.0	6.6	7.4	8.2	8.8	9.5	11.5
		3.0 ft SLR	6.4	7.1	7.5	8.1	8.9	9.7	10.3	11.0	13.0
020802080204	Eastern Branch Elizabeth River	Current	2.9	3.7	4.2	4.8	5.9	6.6	7.3	8.0	10.4
		1.5 ft SLR	4.4	5.2	5.7	6.3	7.4	8.1	8.8	9.5	11.9
		3.0 ft SLR	6.0	6.8	7.3	7.9	9.1	9.8	10.5	11.2	13.6
020802080205	Western Branch Elizabeth River	Current	3.7	4.5	4.9	5.4	6.1	7.0	7.9	8.6	10.3
		1.5 ft SLR	5.2	6.0	6.4	6.9	7.6	8.5	9.4	10.1	11.8
		3.0 ft SLR	6.9	7.7	8.1	8.6	9.3	10.2	11.2	11.9	13.6
030102051104	Indian Creek- Northwest River	Current	-	-	-	-	-	2.0	2.4	2.8	3.8
		1.5 ft SLR	4	-	-	-	-	3.5	3.9	4.3	5.3
		3.0 ft SLR	1	-	- \	-	-	5.2	5.6	6.0	7.1
030102051201	Chesapeake Canal	Current	3.0	3.6	4.0	4.4	5.0	5.8	6.4	7.0	8.4
		1.5 ft SLR	4.5	5.1	5.5	5.9	6.5	7.3	7.9	8.5	9.9
		3.0 ft SLR	6.0	6.6	7.0	7.4	8.0	8.8	9.4	10.0	11.4
030102051203	North Landing	Current	-		-	-	-	2.8	3.4	3.9	4.9
030102051204		1.5 ft SLR	-	-	-	-	-	4.3	4.9	5.4	6.4
030102051205	River	3.0 ft SLR	-	-	-	-	-	6.3	6.9	7.5	8.5

Notes:

- North Landing River watershed includes Upper North Landing River, Pocaty River, and Blackwater Creek-North Landing River watersheds. Sourced from Virginia Beach Public Works Design Standards Manual, June 2020.
- Due to recurring wind tides, it is recommended to use the 25-year design tidal elevations for 1-year to 10-year return periods for the Indian Creek-Northwest River and North Landing River watersheds.

Tailwater Elevations with Sea Level Rise

Recommended Design Rainfall Depths - Chesapeake

Table 5: NOAA Atlas 14 (Vol. 2) Precipitation Values for Chesapeake, Virginia

Design	Minimum	Maximum	Mean	Median	90 th	Centroid
Storm					Percentile	
1-Year	2.95	3.08	3.03	3.03	3.07	3.04
2-Year	3.59	3.75	3.69	3.69	3.74	3.70
5-Year	4.64	4.84	4.76	4.76	4.82	4.78
10-Year	5.53	5.76	5.67	5.67	5.74	5.69
25-Year	6.85	7.12	7.01	7.01	7.10	7.04
50-Year	7.98	8.29	8.17	8.17	8.26	8.19
100-Year	9.23	9.58	9.44	9.44	9.54	9.47

Table 6: Recommended Design Rainfall Depths for Chesapeake, Virginia

Design Storm Frequency	NOAA Atlas 14 Rainfall	Design Rainfall (NOAA Atlas 14 *	CBP Median Rainfall Depth	CBP Median Rainfall Depth	
1-Year	(24-Hour Duration)	Multiplier) 3.65	(RCP 4.5)	(RCP 8.5)	
2-Year	3.70	4.44	3.96	4.11	
5-Year	4.78	5.73	5.20	5.25	
10-Year	5.69	6.83	6.20	6.31	
25-Year	7.04	8.44	7.67	7.81	
50-Year	8.19	9.83	8.93	9.26	
100-Year	9.47	11.36	10.51	10.70	

Notes:

- 1. All values are in inches.
- 2. All values are for the 24-hour duration event.
- 3. NOAA Atlas 14 rainfall values for Recommended Design Rainfall Depths are based on the centroid of the city (latitude 36.6793761, longitude -76.3017883).
- 4. CBP Median Rainfall Depths are not available for the 1-Year event.

Future Rainfall Projections



Incorporating Resilience into Planning

The Portsmouth-Chesapeake Joint Land Use Study was a collaboration between the HRPDC, local governments, and the Navy. It included modeling flooding from high tides, sea level rise, and rainfall.

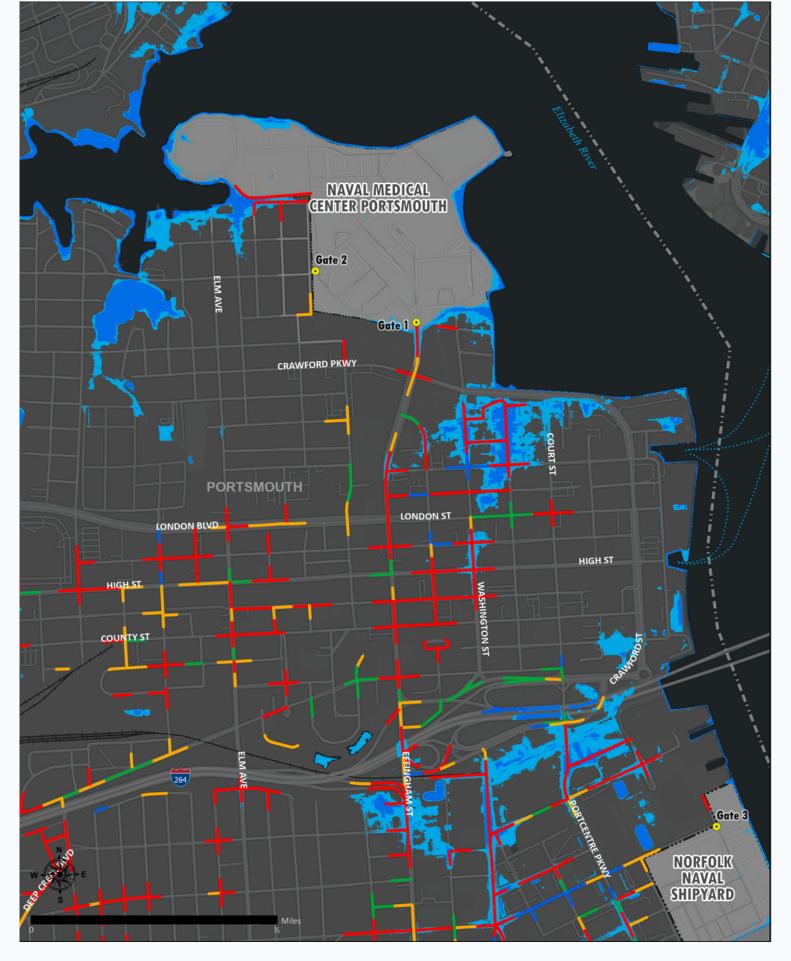
Table 4.3 JLUS Flood Scenario Descriptions

#	Scenario	Scenario Description	River Level (ft NAVD88)	24-Hour Rainfall (inches)					
	Tidal Flooding In Absence of Rainfall								
1	No rain, no SLR	Present-day 1-year-return-period (RP) river level, with no rainfall, no SLR	3.0	0					
2	No rain, 1.5′ SLR	Present-day 1-year-RP river level, with no rainfall, plus 1.5 feet of future SLR	4.5	0					
3	No rain, 3.0' SLR	Present-day 1-year-RP river level, with no rainfall, plus 3.0 feet of future SLR	6.0	0					
	Combined Tidal and Present Day Rainfall Flooding								
4	Present day 10 year rainfall, no SLR	Present-day 1-year-RP river level and present-day 10-year-RP rainfall, no SLR	3.0	6.2					
5	Present day 10 year rainfall, 1.5' SLR	Present-day 1-year-RP river level and present-day 10-year-RP rainfall with 1.5 feet of SLR	4.5	6.2					
6	Present day 10 year rain, 3.0' SLR	Present-day 1-year-RP river level and present-day 10-year-RP rainfall with 3.0 feet of SLR	6.0	6.2					
Combined Tidal and Future Rainfall Flooding									
7	Future 10 year rain, 1.5' SLR	Present-day 1-year-RP river level and future (2050-2080) 10-year-RP rainfall with 1.5 feet of SLR	4.5	6.8					
8	Future 10 year rain, 3.0' SLR	Present-day 1-year-RP river level and future (2050- 2080) 10-year-RP rainfall with 3.0 feet SLR	6.0	6.8					

Source: Portsmouth & Chesapeake Joint Land Use Study

Incorporating Resilience into Planning

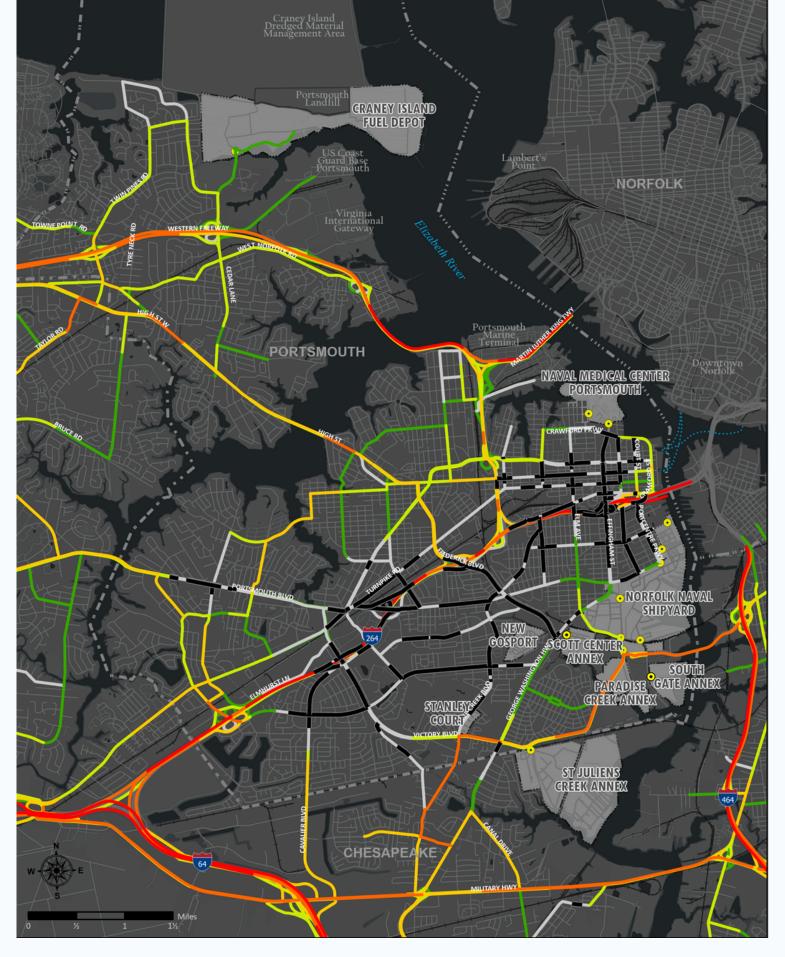
The results of the flood modeling were used to analyze the extent of tidal and rainfall flooding on area roadways.



Source: Portsmouth & Chesapeake Joint Land Use Study

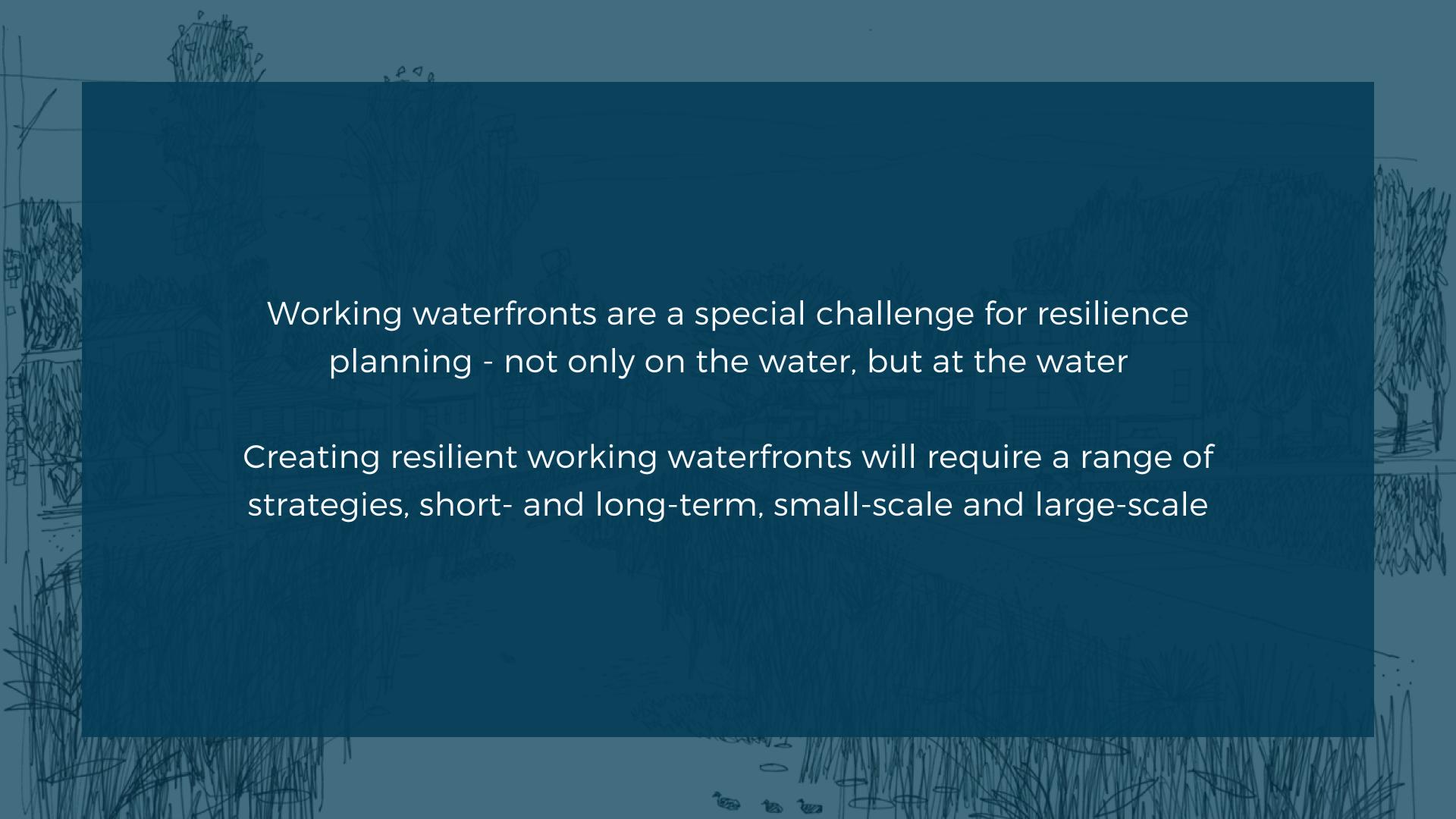
Incorporating Resilience into Planning

The results of the flood modeling were used to analyze the impacts of flooding on key transportation corridors using the region's Travel Demand Model.



Source: Portsmouth & Chesapeake Joint Land Use Study





Examples

Boston

New York City

Port of Long Beach



Resilient Working Waterfronts

Key project requirements to consider to create resilient working waterfronts

- Location
- Design life
- Application

Strategies for Resilient Working Waterfronts

Move uphill/inland

Elevate buildings or critical systems

Wet or dry floodproof

Keep the water out through seawalls or flood barriers

Adapt as you upgrade

Work with partners

