DRAFT
Assessment of Seawall Structural Integrity and Potential for Seawall Over-Topping For Balboa Island and Little Balboa Island

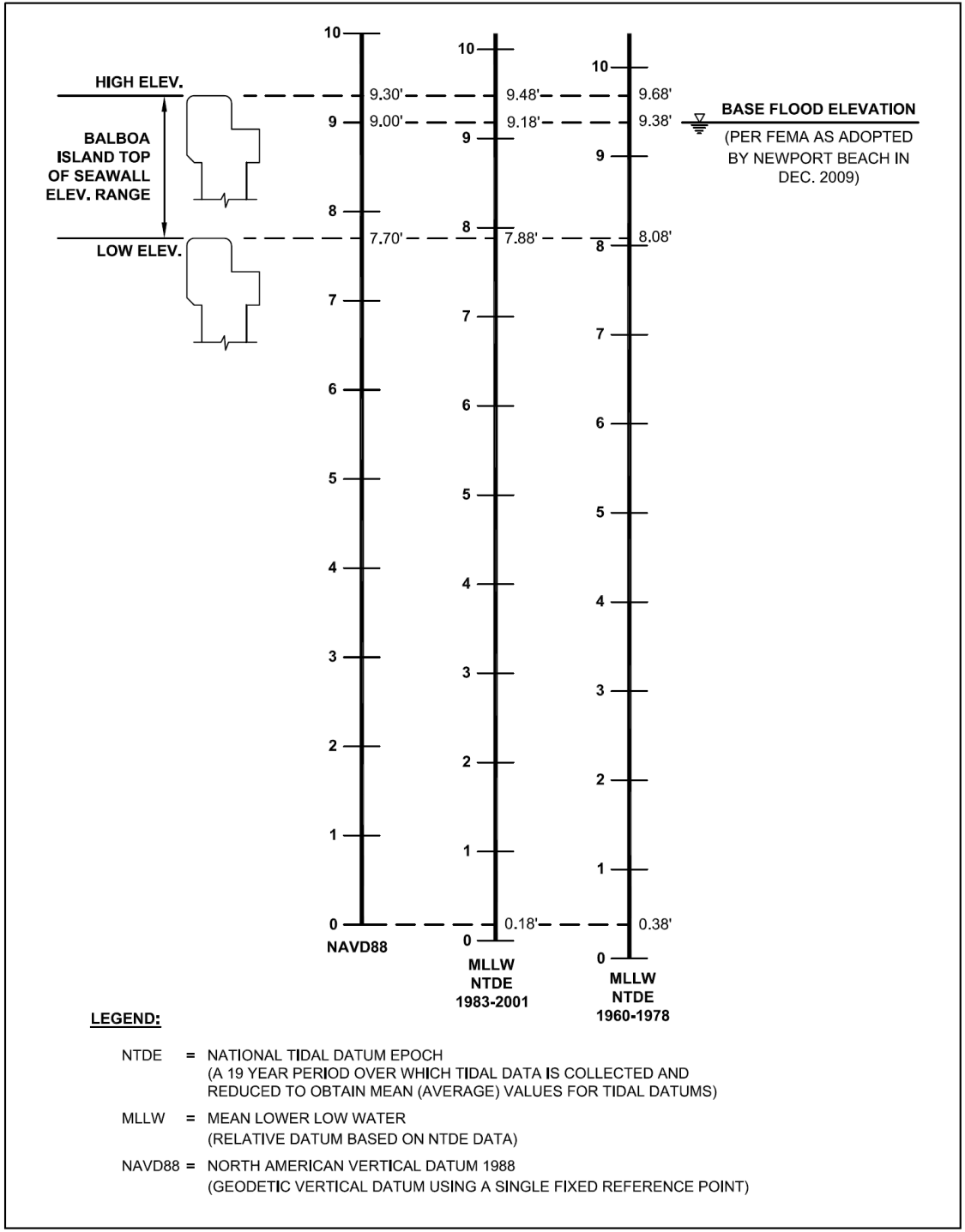
Tidelands Management Committee

May 18, 2011

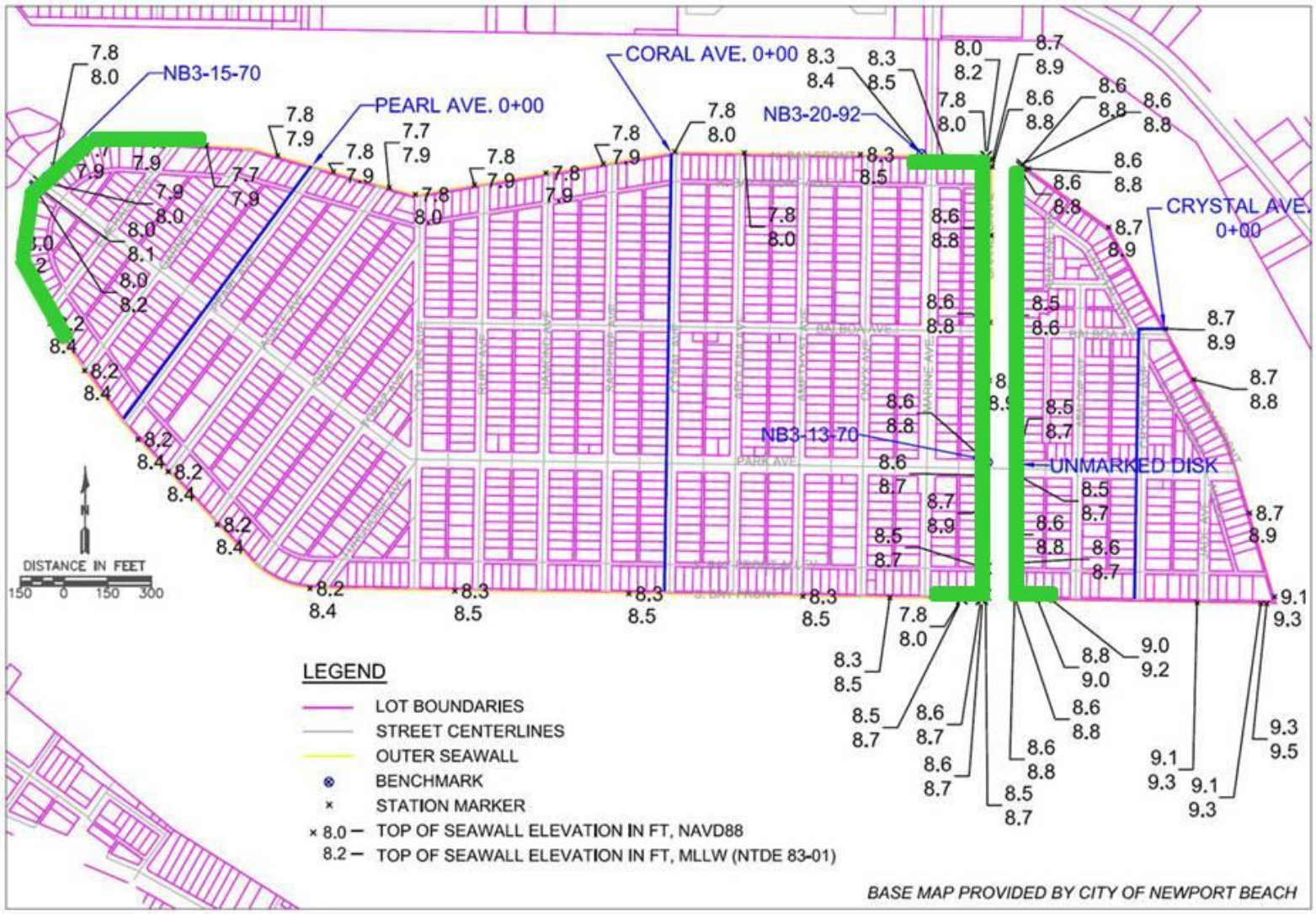
Topics

1. Aging Seawall
2. Rising Seawater
3. Protection Options
4. Costs

Comparison of Different Tidal Datums



Top of Seawall Elevation [ft]



Anatomy of a Seawall

Little Balboa Seawall Cap Extension

Crack Repairs with Corroding Rebar

Earth Anchors at Balboa Island Ferry Landing

Sidewalk Separation from Seawall

Distresses in Bulkhead Cap

Seawall Condition

- Seawall Age: 73-82 years
- Overall Condition: Holding together well with widespread cracking and some concrete spalling and evidence of corroding rebar.
- Estimated Useful Life: 10-25 years

Waves Splashing over the Balboa Island Seawall at Turquoise Avenue and South Bay Front

(December 22, 2010)

City Personnel Pumping Flood Water Back into the Bay at Turquoise Ave and South Bay Front

(December 22, 2010)

Street Flooding Overtopping Curb

(December 22, 2010)

Flood Inundation Modeling

Seawall overtopping depends on:

1. Seawall elevation
    a. Existing
    b. w/ 6-inch cap
    c. w/ new of seawall at Elev. 10.0’ MLLW

2. Predicted Future Seawater level

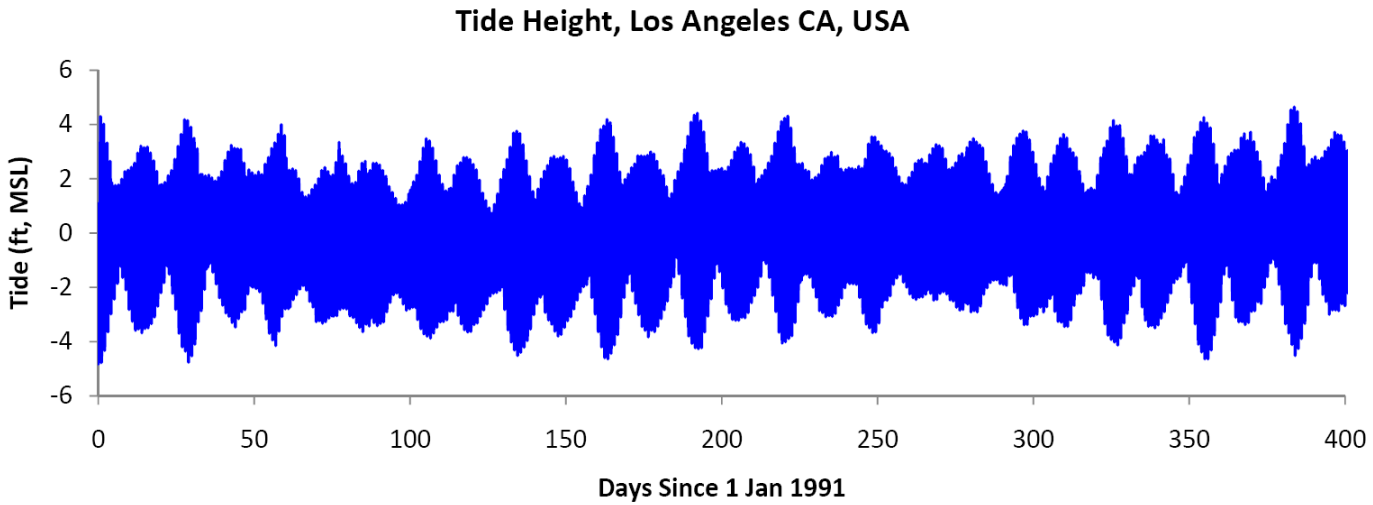
Predicting Seawater Level

Model uses:

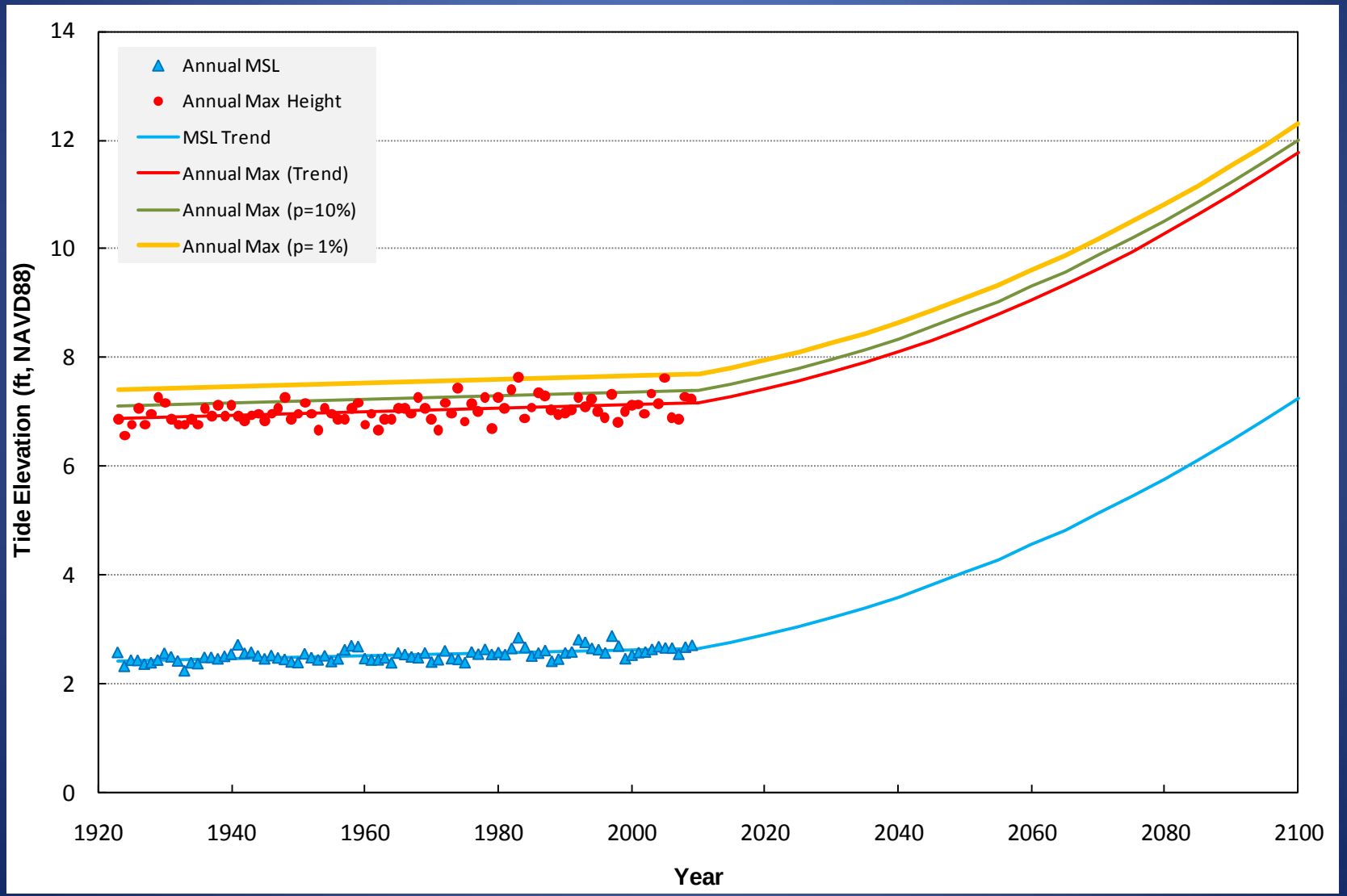
1. Extreme high tide
2. Accounts for expected rise is mean sea level
3. Adds ocean swell or wind waves

Extreme High Tide

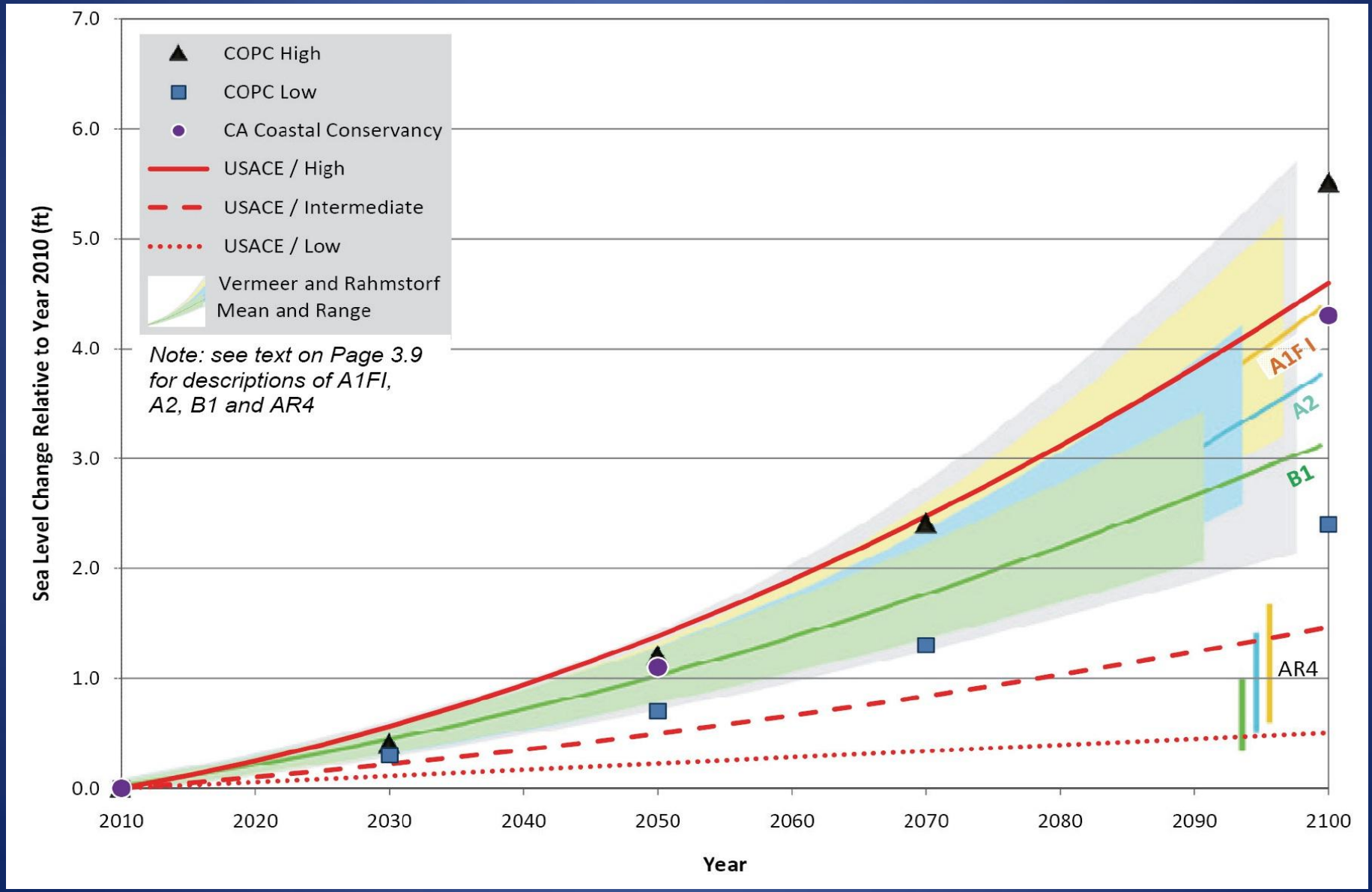
Extreme High Tide



Projections of Mean Sea Level and Extreme Tide Heights Through Year 2100



Sea Level Rise Projections



Sea Level and Annual Maximum Tide Height Projections Through Year 2100

Year	Mean Sea Level (FT, NAVD88)	10% Tide Height (FT, NAVD88)	1% Tide Height (FT, NAVD88)	Projected Sea Level Rise (FT)*
2010	2.65	7.41	7.71	-
2025	3.05	7.81	8.11	0.40
2050	4.03	8.79	9.09	1.38
2100	7.25	12.01	12.31	4.60

* equals change in mean sea level from Year 2010.

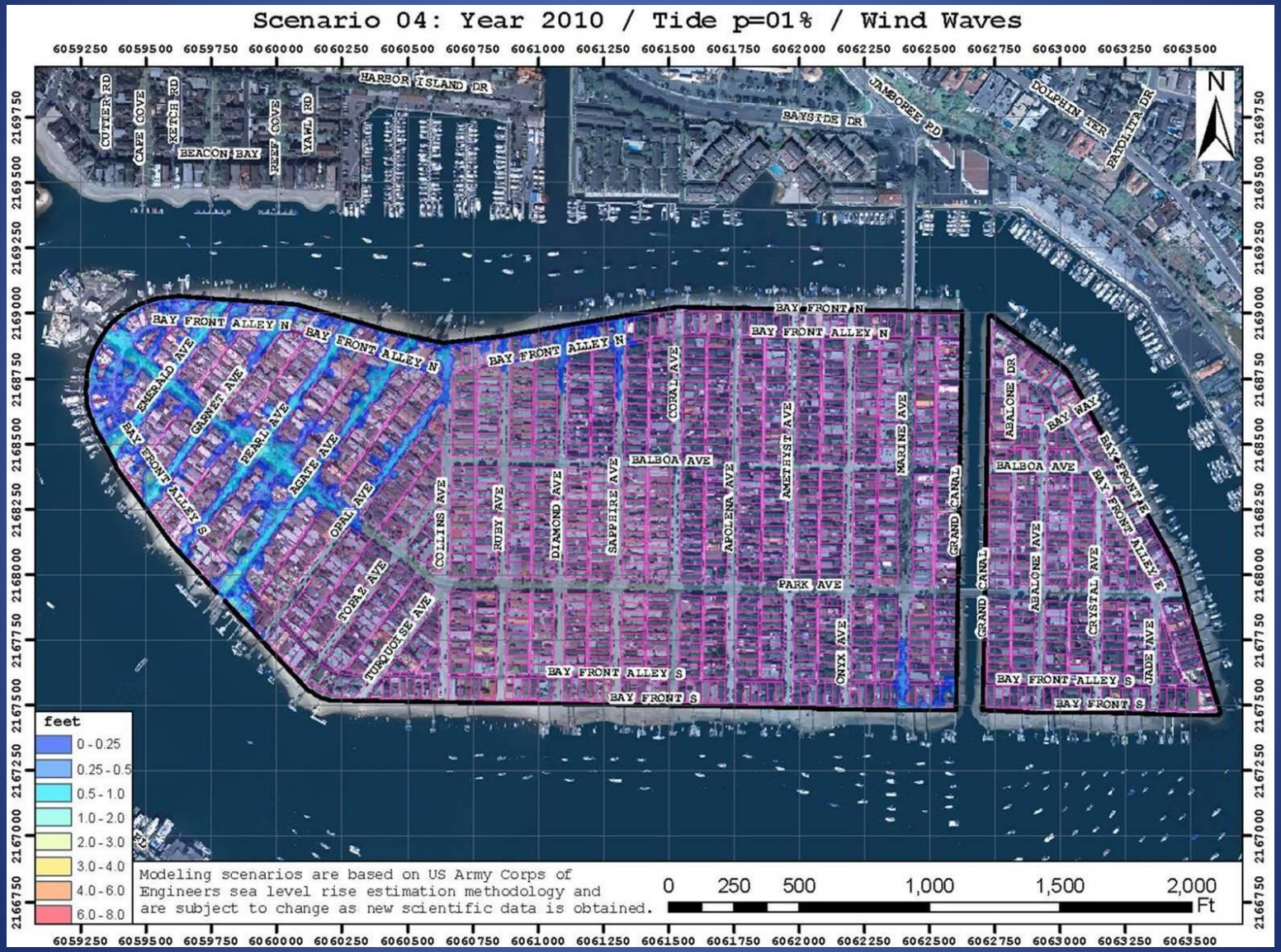
Flood Inundation Modeling Scenarios

Scenario	Seawall Condition	Year	Sea Level Rise From 2010	Tide Height (Annual Exceedance Probability)	Wave Scenario
1	Existing Conditions	2010	NA	10%	No Waves
2	Existing Conditions	2010	NA	10%	Wind Waves
3	Existing Conditions	2010	NA	10%	Ocean Swell
4	Existing Conditions	2010	NA	1%	Wind Waves
5	Existing Conditions	2025	0.40 ft	10%	Wind Waves
6	Existing Conditions	2025	0.40 ft	10%	Ocean Swell
7	Existing Conditions	2025	0.40 ft	1%	Wind Waves
8	Existing Conditions	2050	1.38 ft	10%	No Waves
9	Existing Conditions	2050	1.38 ft	1%	No Waves
10	Existing Conditions	2100	4.60 ft	10%	No Waves
11	6-inch extension	2010	NA	1%	Wind Waves
12	6-inch extension	2025	0.40 ft	1%	Wind Waves
13	10 ft (MLLW) seawall	2010	NA	1%	Wind Waves
14	10 ft (MLLW) seawall	2025	0.40 ft	1%	Wind Waves
15	10 ft (MLLW) seawall	2050	1.38 ft	1%	Wind Waves
16	10 ft (MLLW) seawall	2050	1.38 ft	10%	Wind Waves
17	10 ft (MLLW) seawall	2100	4.60 ft	1%	Wind Waves

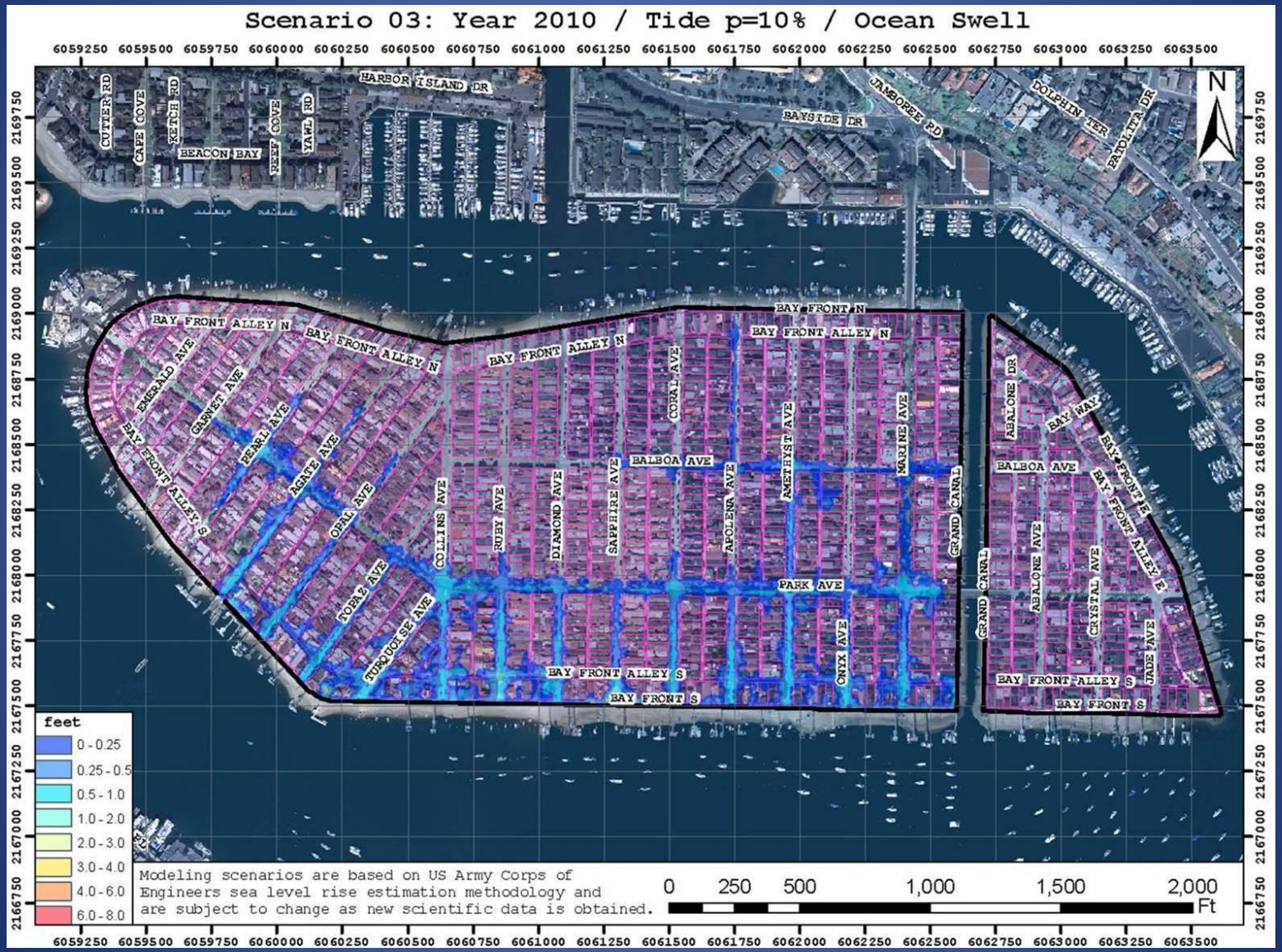
Average Flood Depth, Parcel and Building Impacts Associated with Each Model Scenario

Scenario	Year	Tide Height (Annual Exceedance Probability)	Wave Scenario	Average * Flood Depth (ft)	Impacted** Parcels (number)	Parcels Impacted (%)	Impacted*** Buildings (number)	Impacted Buildings (%)	Flood Extent Figure Number
Existing Condition Scenarios									
1	2010	10%	No Waves	0.26	61	4.0	3 ± 2	0.2	Figure 3.5
2	2010	10%	Wind Waves	0.26	61	4.3	3 ± 2	0.2	Figure 3.6
3	2010	10%	Ocean Swell	0.29	514	36.5	24 ± 5	1.7	Figure 3.7
4	2010	1%	Wind Waves	0.36	324	23.0	22 ± 4	1.5	Figure 3.8
5	2025	10%	Wind Waves	0.48	681	48.3	66 ± 7	4.7	Figure 3.9
6	2025	10%	Ocean Swell	0.79	1,176	83.4	235 ± 13	16.6	Figure 3.10
7	2025	1%	Wind Waves	1.16	1,179	83.6	420 ± 14	29.8	Figure 3.11
8	2050	10%	No Waves	1.84	1,410	100.0	894 ± 17	63.4	Figure 3.12
9	2050	1%	No Waves	2.15	1,410	100.0	1047 ± 15	74.3	Figure 3.13
10	2100	10%	No Waves	5.02	1,410	100.0	1410 ± 1	100.0	Figure 3.14
6-inch Extension Scenarios									
11	2010	1%	Wind Waves	0.03	0	0.0	0	0.0	Figure 3.15
12	2025	1%	Wind Waves	0.12	12	0.9	0-1	<0.1	Figure 3.16
10-foot Seawall Scenarios									
13	2010	1%	Wind Waves	0	0	0.0	0	0.0	Figure 3.17
14	2025	1%	Wind Waves	0	0	0.0	0	0.0	Figure 3.18
15	2050	1%	Wind Waves	0	0	0.0	0	0.0	Figure 3.19
16	2050	10%	Wind Waves	0	0	0.0	0	0.0	Figure 3.20
17	2100	1%	Wind Waves	5.30	1,410	100.0	1410 ± 1	100.0	Figure 3.21

2010 Flood Scenario 4: Wind Waves



2010 Flood Scenario 3: Ocean Swell



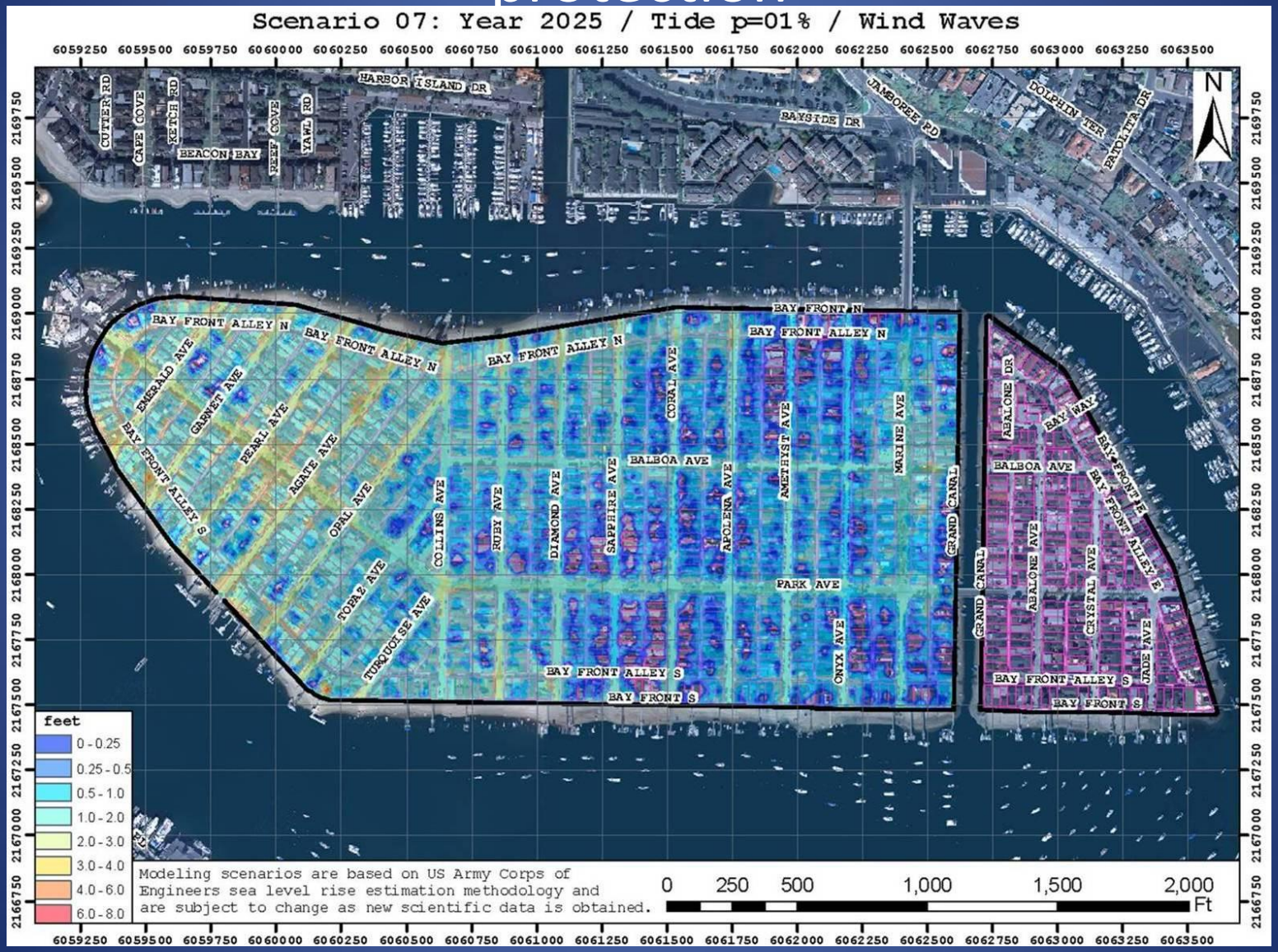
December 2010 Flooding on Turquoise

Extreme Tide p=40% w/ Ocean Swell

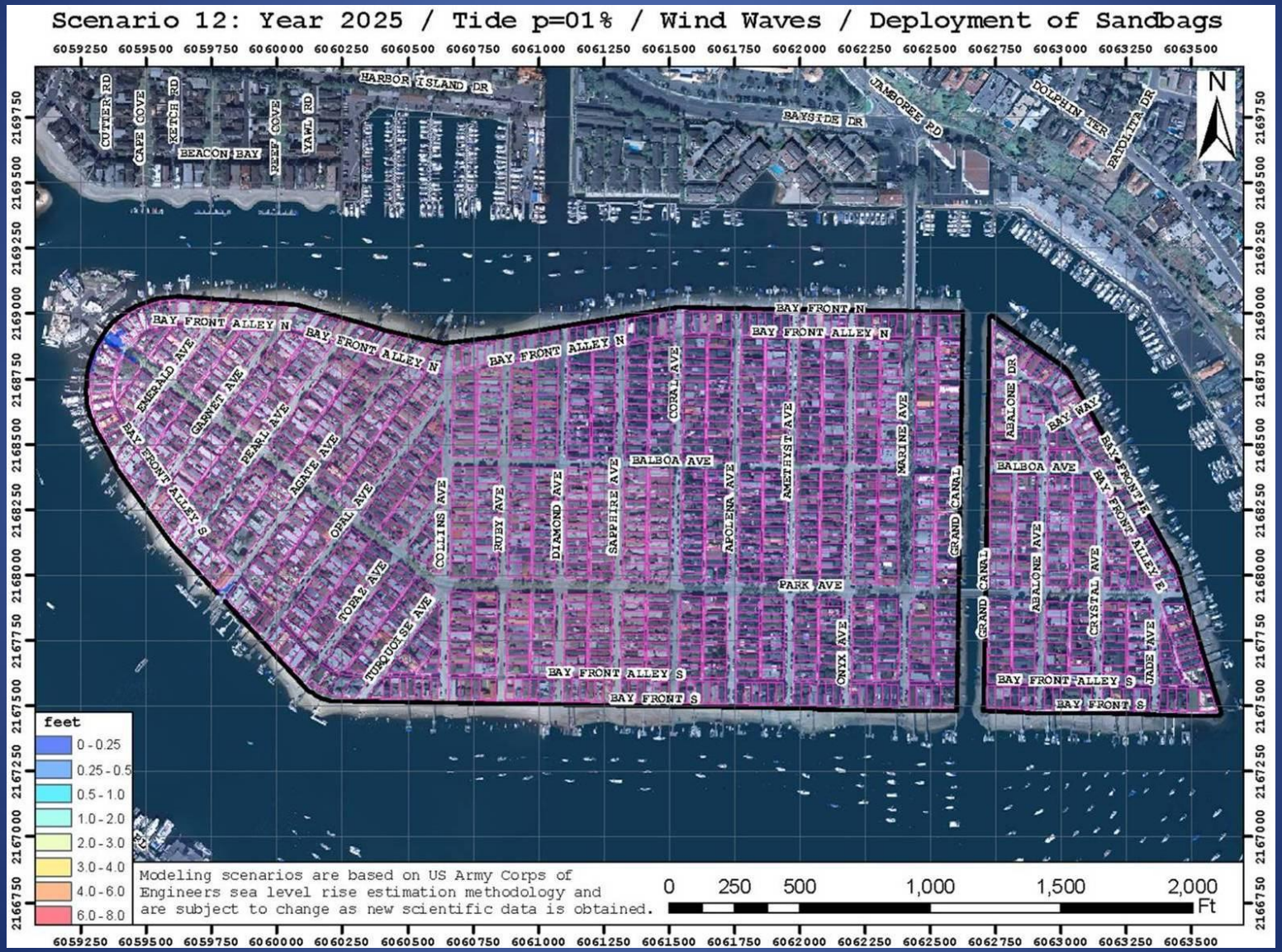
Flooding at Balboa Island Ferry Landing

(2005 Flood Event)

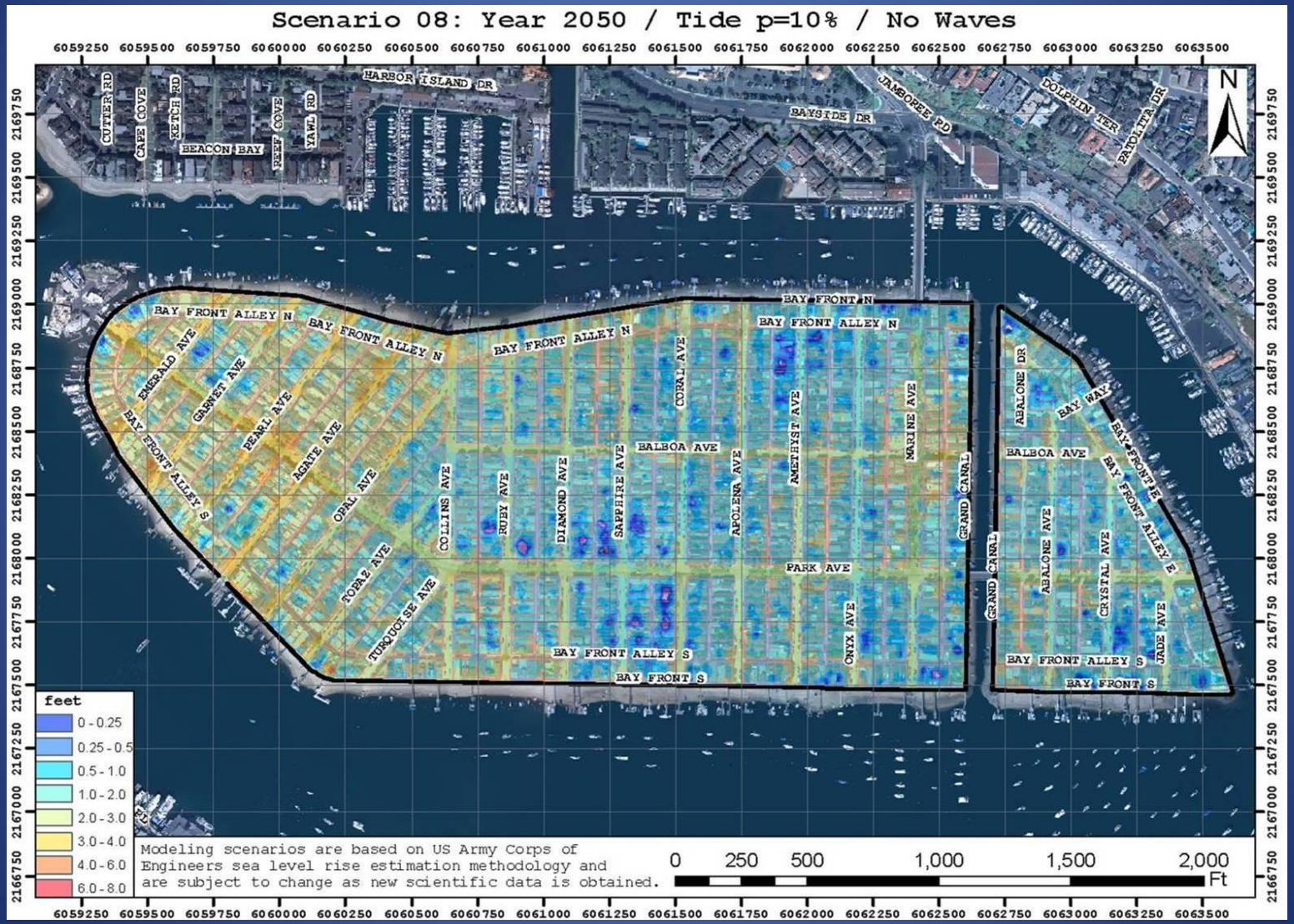
2025 Flood Scenario 7: w/o additional protection



2025 Flood Scenario 12: w/ 6-inch cap

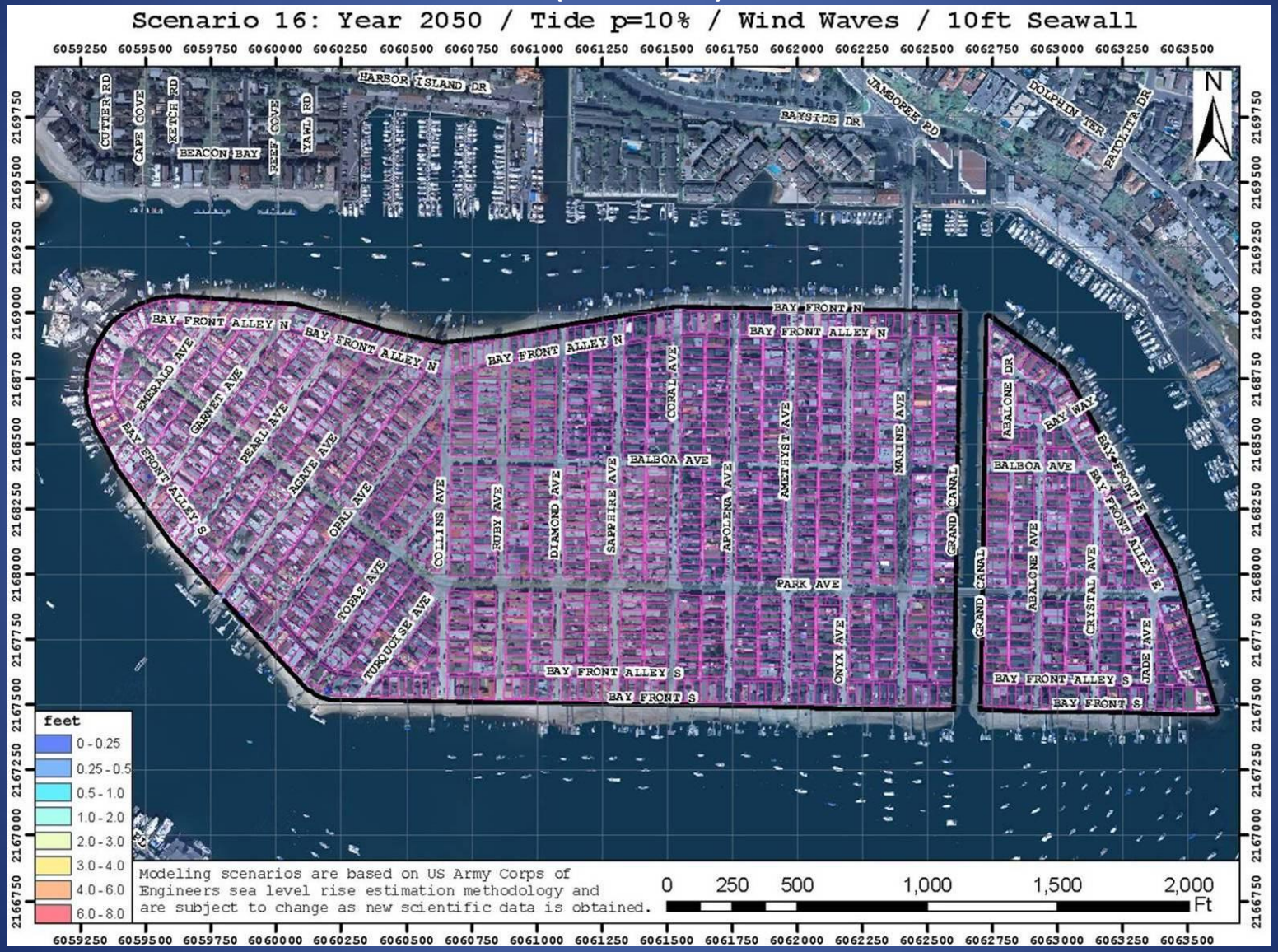


2050 Flood Scenario 8: w/o additional protection

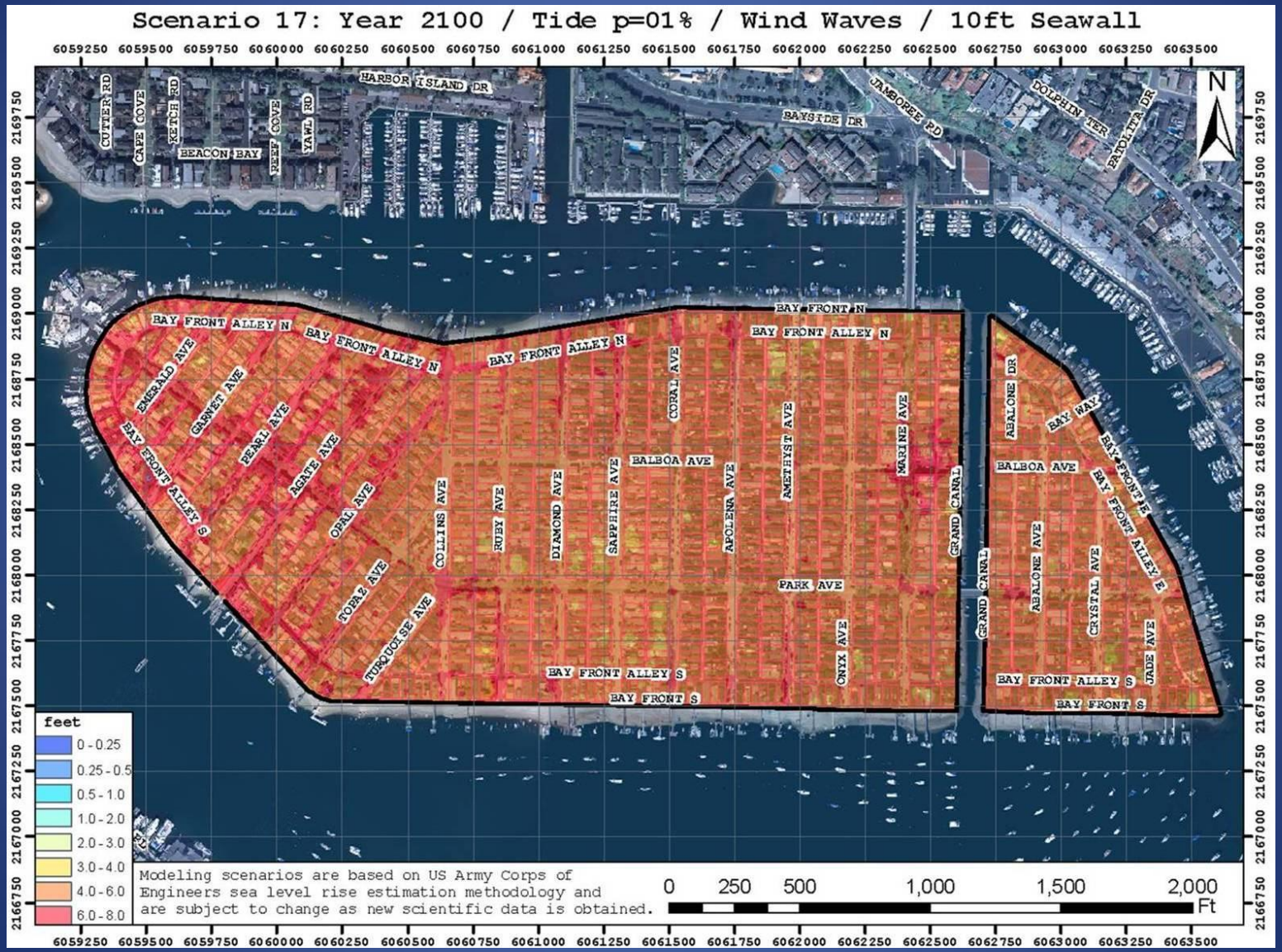


2050 Flood Scenario 16 w/ New Seawall at 9.8 feet

(NAVD88)



2100 Flood Scenario 17: w/o Seawall Extensions



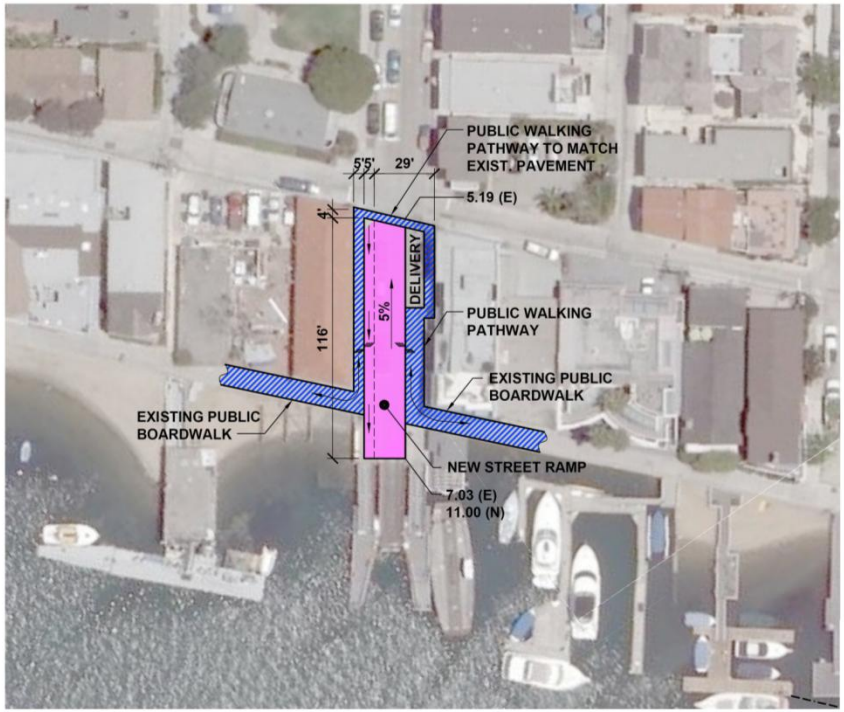
Protection Option: Seawall Extension

1. Extend existing cap 6 inches
2. Remove existing cap and replace with 6-inch taller cap
3. Lower cost option: Use sandbags or geotextile bags

New Seawall – Option 1
H-piles and Concrete Wall (Lag) Panels
(No tiebacks)

New Seawall – Option 2
Steel Sheet Pile Bulkhead
(No tiebacks)

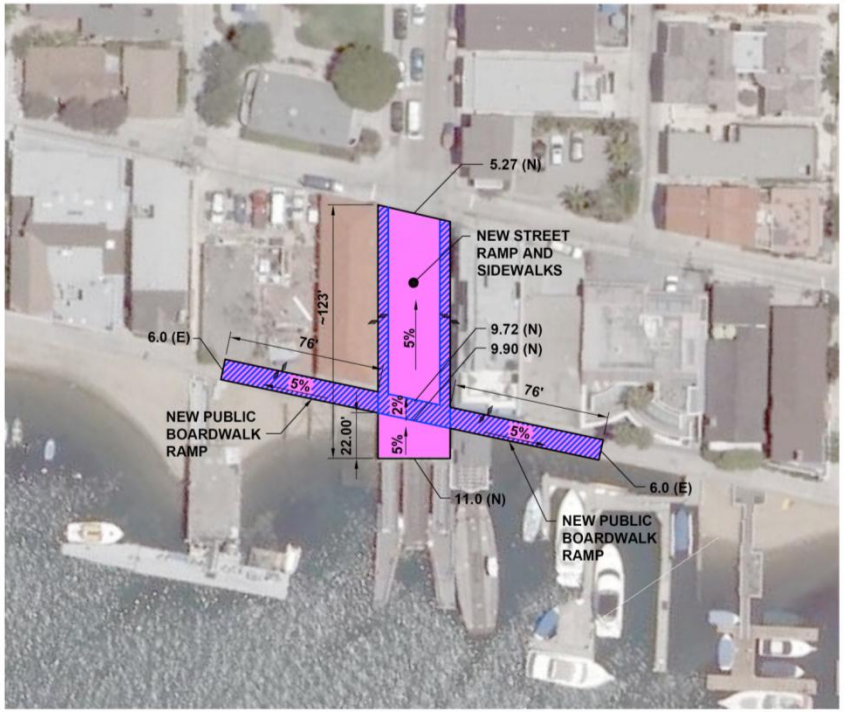
Two Options to Raise the Launch Ramp at Balboa Island Ferry Landing



Option 1

Street Approach Ramp with Diverted Walking Path

@ 8% : ELEV. 14.0



Option 2

Street Approach & Boardwalk Ramps

@ 8% : ELEV. 12.5

N

0 10' 20' 30' 60'

GRAPHIC SCALE

Datum: NAVD 88

Balboa Island Ferry Modification Option

Rising Groundwater

- First Floor Elevations: 6.2 to 11.6 feet (NAVD88)
- 2050 Groundwater elevation at High Water 6.1 feet
- 2100 Groundwater Elevation at High Water 9.3 feet

Seawall Construction Cost Estimates (Concept-Level)

Mitigation Component	Unit Price ($/LF) [1]	Conceptual Cost [2]
Interim Seawall Height Extension		
Alt. 1: New Seawall Cap	$625 - $725	$8.25 - $9.57 million
Alt. 2: Existing Seawall Cap Extension		
Option 1: Mechanical Extension	$250 - $300	$3.30 - $3.63 million
Option 2: Polypropylene Sandbags	$170 - $190	$2.26 - $2.52 million
Option 3: Geotextile Bags/Tubes	$130 - $160	$1.72 - $2.12 million
New Seawall		
Option 1: Steel H-Piles w/ Conc. Panels	$3,800 - $4,000	$50.20 - $52.80 million
Option 2: Steel Sheet Piles	$4,100 - $4,300	$54.10 - $56.80 million
Subsequent Seawall Extension: 3 – 4 feet (When/If Required)	$400 - $500	$5.30 - $6.60 million
Ferry Landing and Bridges		
Ferry Boat Landing and Fuel Dock Retrofit (All 3 Options)		$3.50 -$5.00 million
Bridge Retrofit (3 bridges)	$250,000 - $350,000 per bridge	$0.75 - $1.05 million
Total Estimated Program Cost [3]		**$61.47 - $79.02 million**

Potential Funding for the Balboa Islands Seawalls

1. City funded feasibility studies
2. Assessment District Formation
3. Possibility of limited Federal or State Grants

Summary & Recommendations

1. 2011-2020
   a. Review of codes, standards & policies
   b. Implement a community awareness program
   c. Establish new lowest floor elevation
   d. Harbor-wide planning for new seawalls at minimum 10 feet MLLW
   e. Balboa Islands seawall and bridge retrofit design and permitting
   f. Design for new ferry boat landing
   g. Identify funding sources

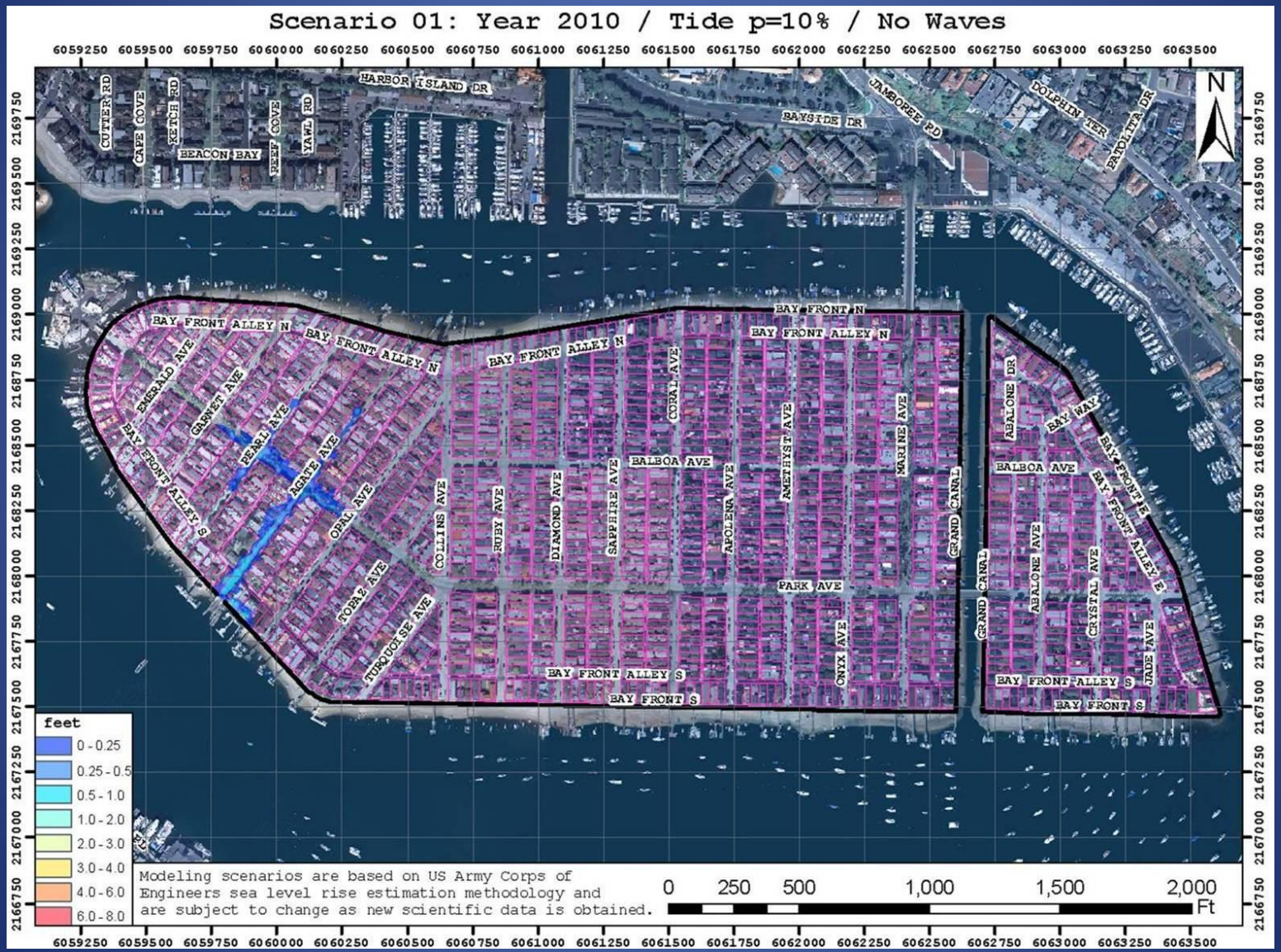
Summary & Recommendations

2. 2021-2035
   a. Construct new seawalls at 10’ MLLW.
   b. If needed, construct 6-inch cap on existing seawalls as an interim measure.

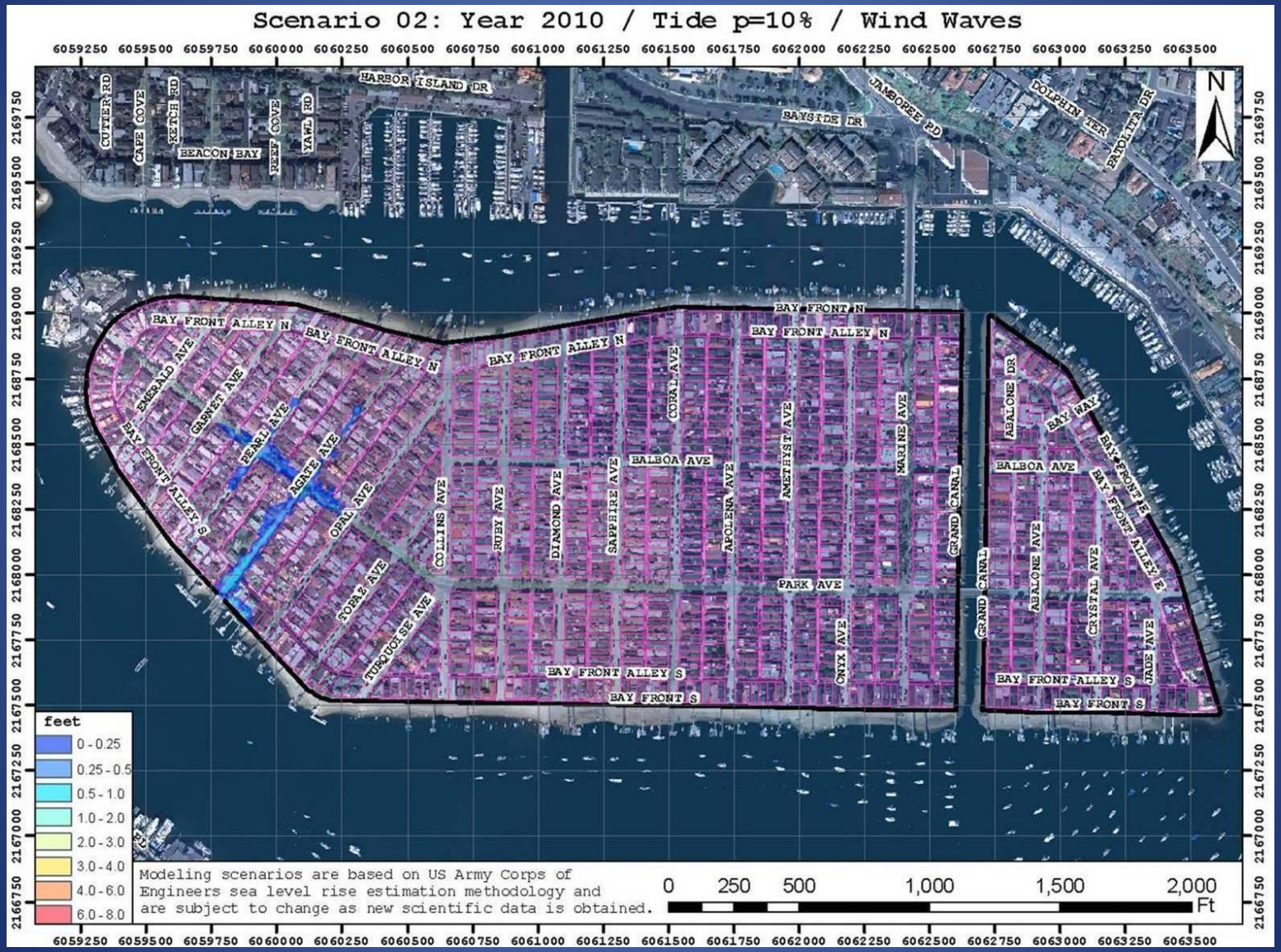
3. 2050-2060
   a. Extend new seawalls if necessary to 13 or 14 feet MLLW.
   b. Implement dewatering system or other means to address groundwater

Supplementary slides follow

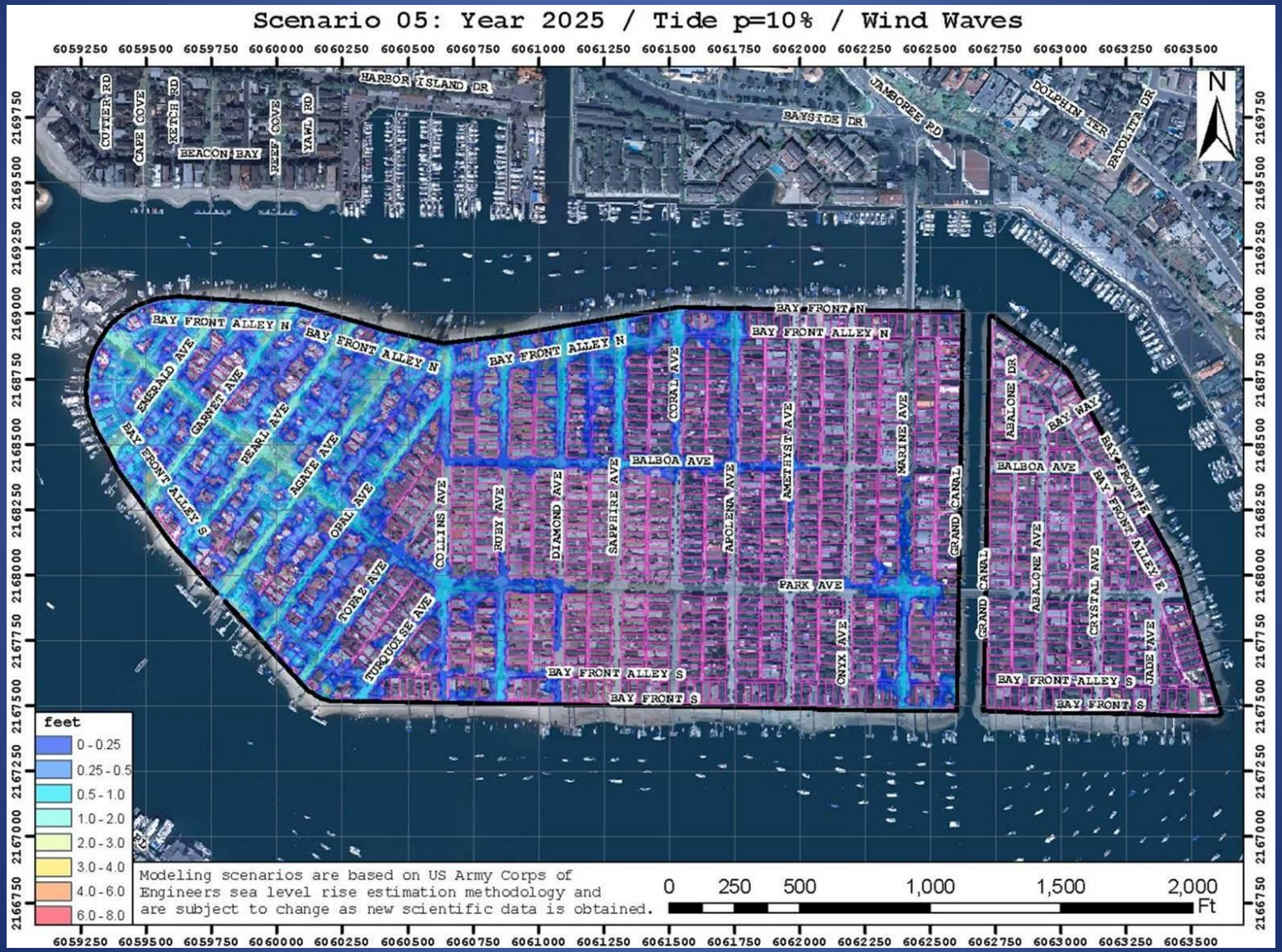
Flood Scenario 1



Flood Scenario 2



Flood Scenario 5



Flood Scenario 6