The ART Exposure Analysis:

A stepwise approach that saves time and resources, helping to pinpoint the most pressing issues or areas of vulnerability

The Assess Step

The **ART assessment** is designed to clearly and efficiently identify the underlying causes and components of vulnerability and risk

The assessment has three parts:

- Assessment questions that help efficiently gather information needed for action identification
- A step-wise exposure analysis that saves time and resources by pinpointing the most pressing issues and vulnerable areas
- Review and validation of assessment outcomes by stakeholders, asset managers, local and topical experts

A Step-wise Exposure Analysis

Determine if data, maps or studies are available for the selected climate impact scenarios

YES

- Gather available data and analyze exposure using:
  - Print/paper maps
  - On-line mapping tools
  - Geospatial data
- Ground truth exposure maps and findings with local experts
- Flag areas where further investigation may be needed
- Investigate trouble spots, cross-reference with assessment outcomes, and conduct refined analysis and mapping where necessary

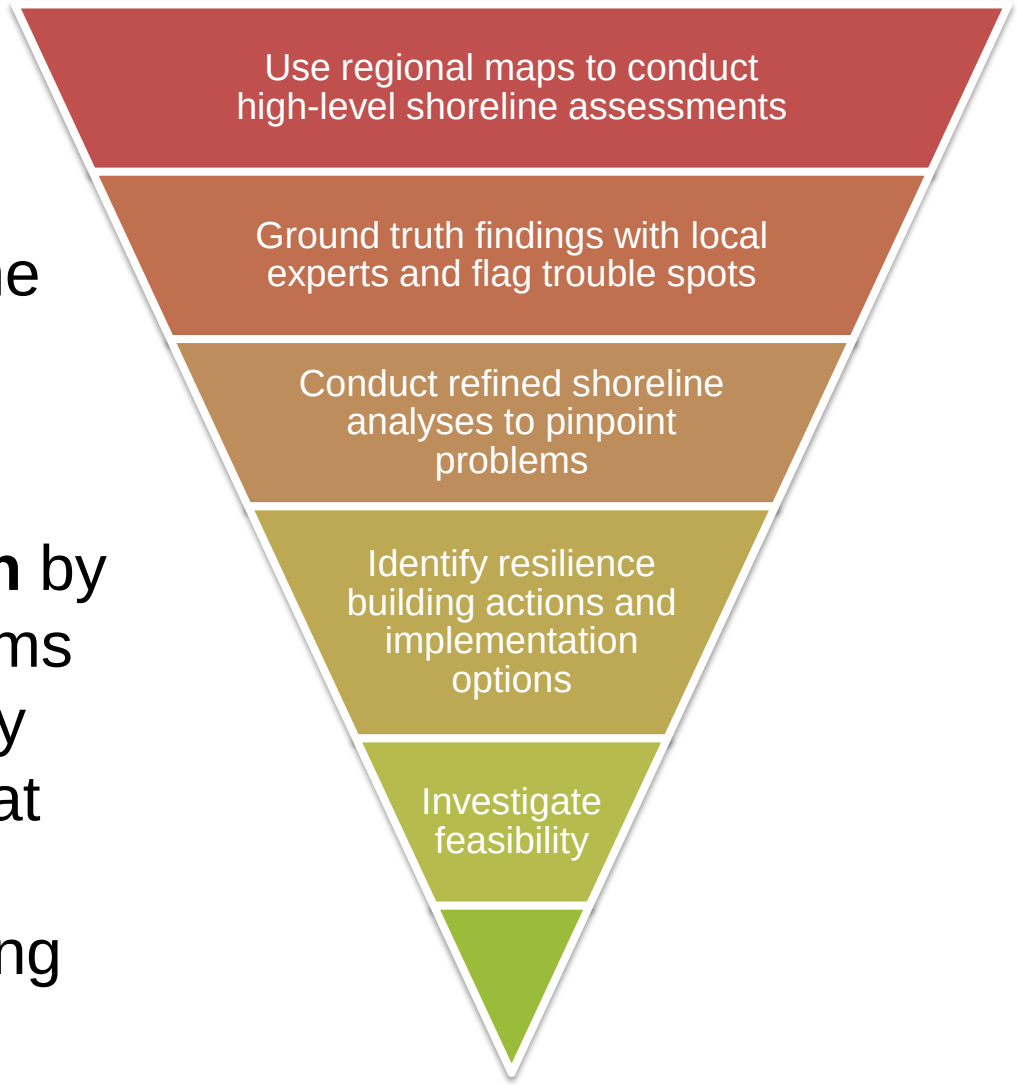
NO

- Use a scenario planning approach
- Re-purpose or re-analyze existing data
- Conduct new studies or analyses

Benefits of a Stepwise Approach

Results in a **robust and transparent vulnerability assessment** that makes the case for adaptation

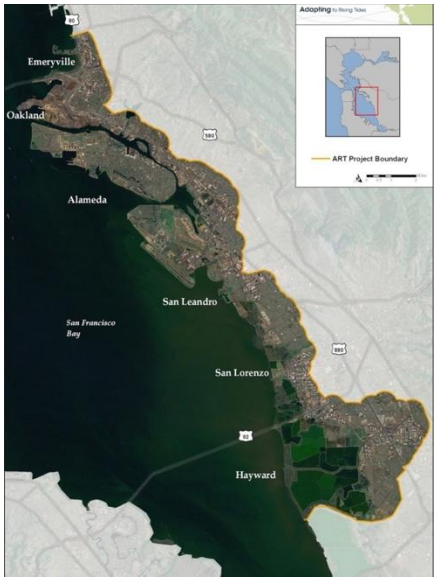
Helps establishes a clear **roadmap for taking action** by identifying localized problems that can be addressed early and system-wide issues that will require long term collaborative problem solving



Example: ART Alameda

Initiated in 2010, the **ART Alameda County Project** was the first cross jurisdictional, multi-sector adaptation planning effort to evaluate sea level rise and storm event flooding in the Bay Area

Project Area

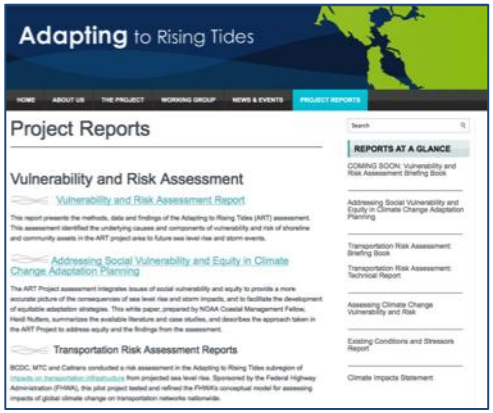


Working Group

ART emphasizes close collaboration among stakeholders to ensure a shared understanding of the issues, build trust, and achieve buy-in for shared solutions and joint action

Asset Categories

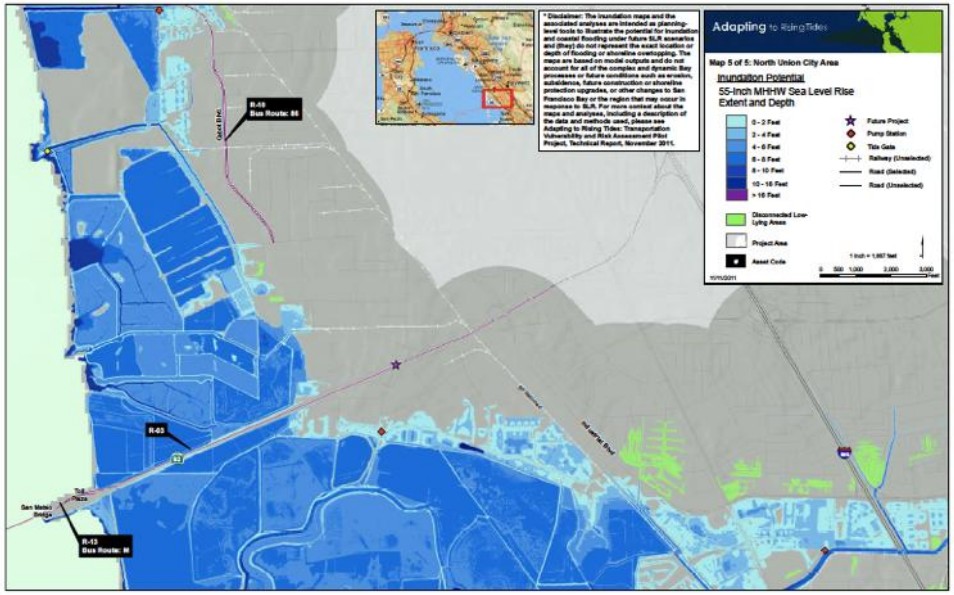
- Airport
- Community characteristics
- Community services
- Contaminated lands
- Energy, pipelines and telecom
- Flood control
- Hazardous material sites
- Ground transportation
- Parks and recreation
- Natural shorelines
- Residential land uses
- Seaport
- Storm water
- Structural shorelines
- Wastewater

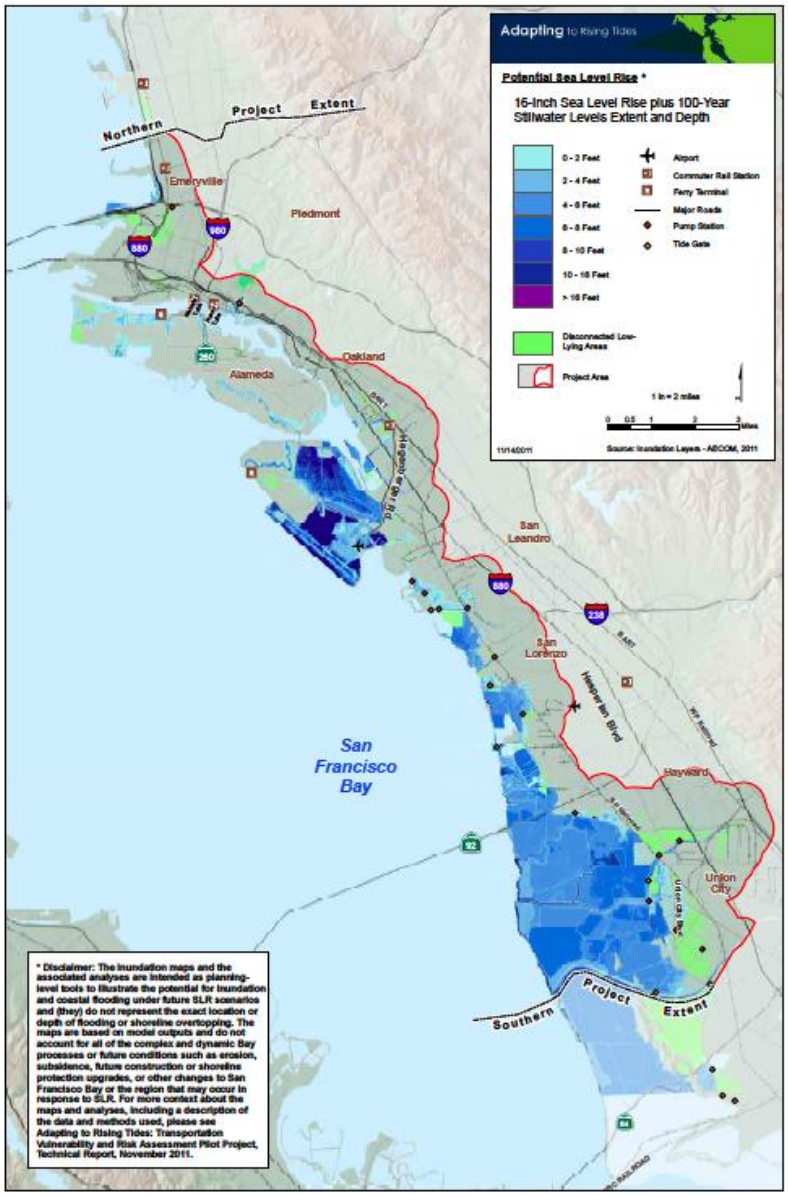


Inundation maps

Example: ART Alameda

Available inundation maps were too coarse and out of date, so ART developed project-specific maps using available topographic and water level data





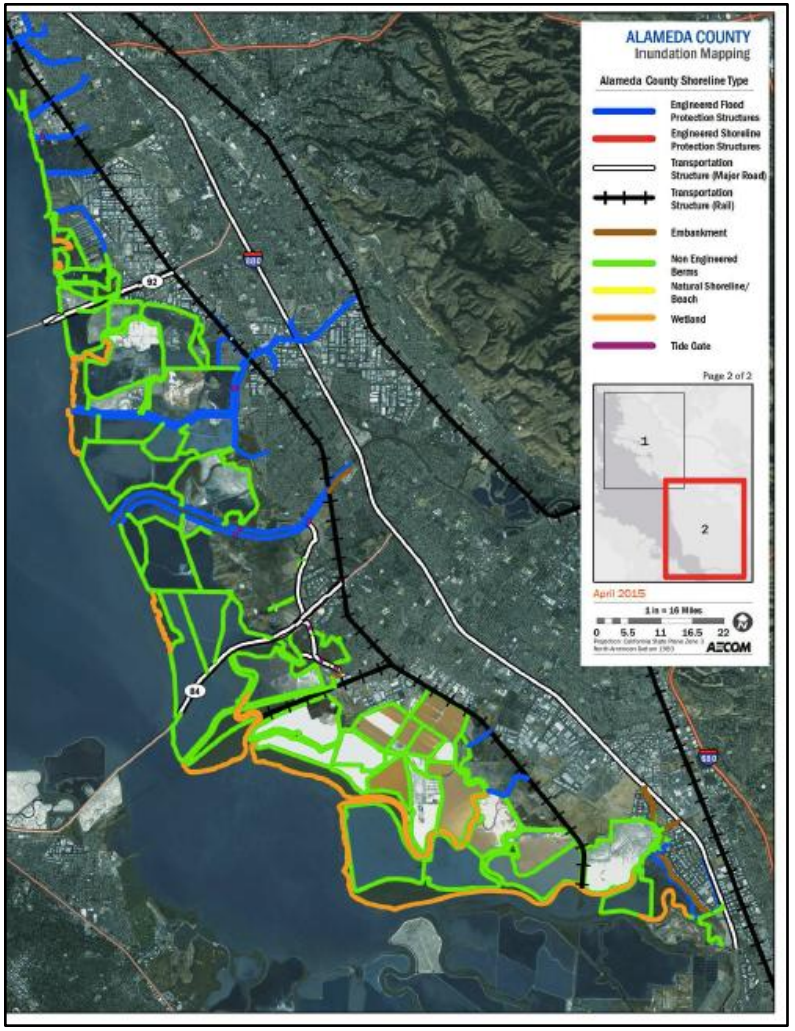
Shoreline studies

Example: ART Alameda

In addition, detailed studies were conducted to understand where and when the shoreline in the project area was vulnerable

Seven types shoreline identified:

- Engineered Flood Protection
- Engineered Shoreline Protection
- Embankments
- Transportation Structures
- Non Engineered Berms
- Wetlands
- Natural Shoreline/Beach



bcdc NOAA Alameda County Flood Control & Water Conservation District AECOM

Overtopping potential

Example:
ART Alameda

Overtopping potential was determined to inform where the existing shoreline would be lower than the water surface elevation of different sea level rise and storm scenarios

Different measures were used to understand overtopping potential, including length and percent of shoreline overtopped, and average and maximum overtopping depth

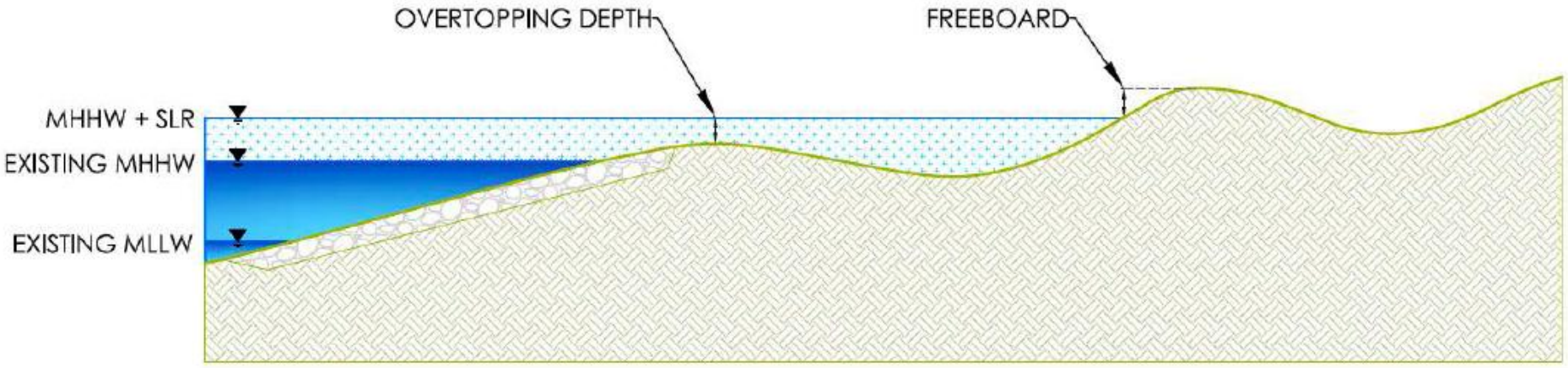
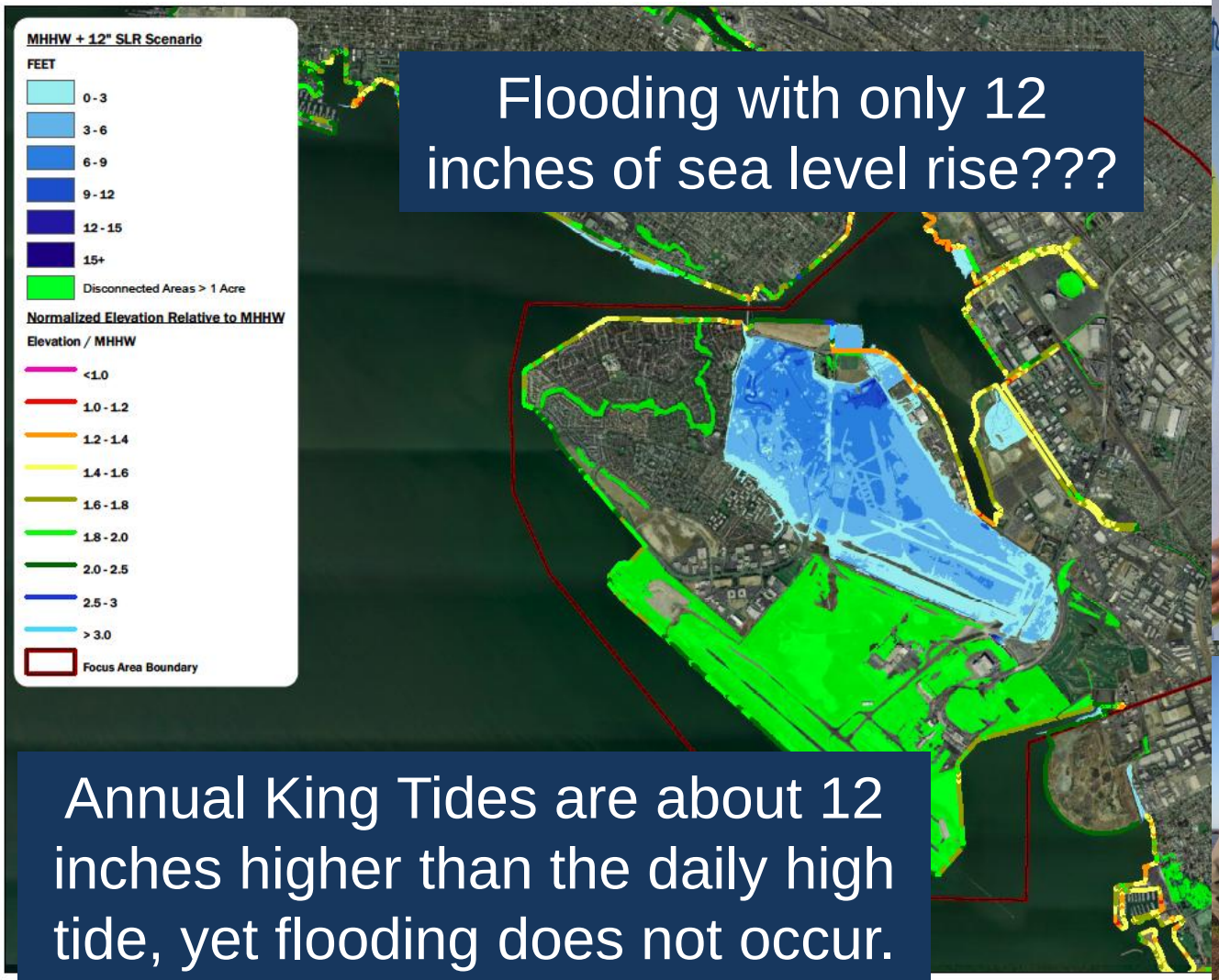


Figure 5-1. Representative Shoreline Cross Section Illustrating Overtopping Depth and Freeboard

Maps were reviewed locally

Example:
ART Alameda



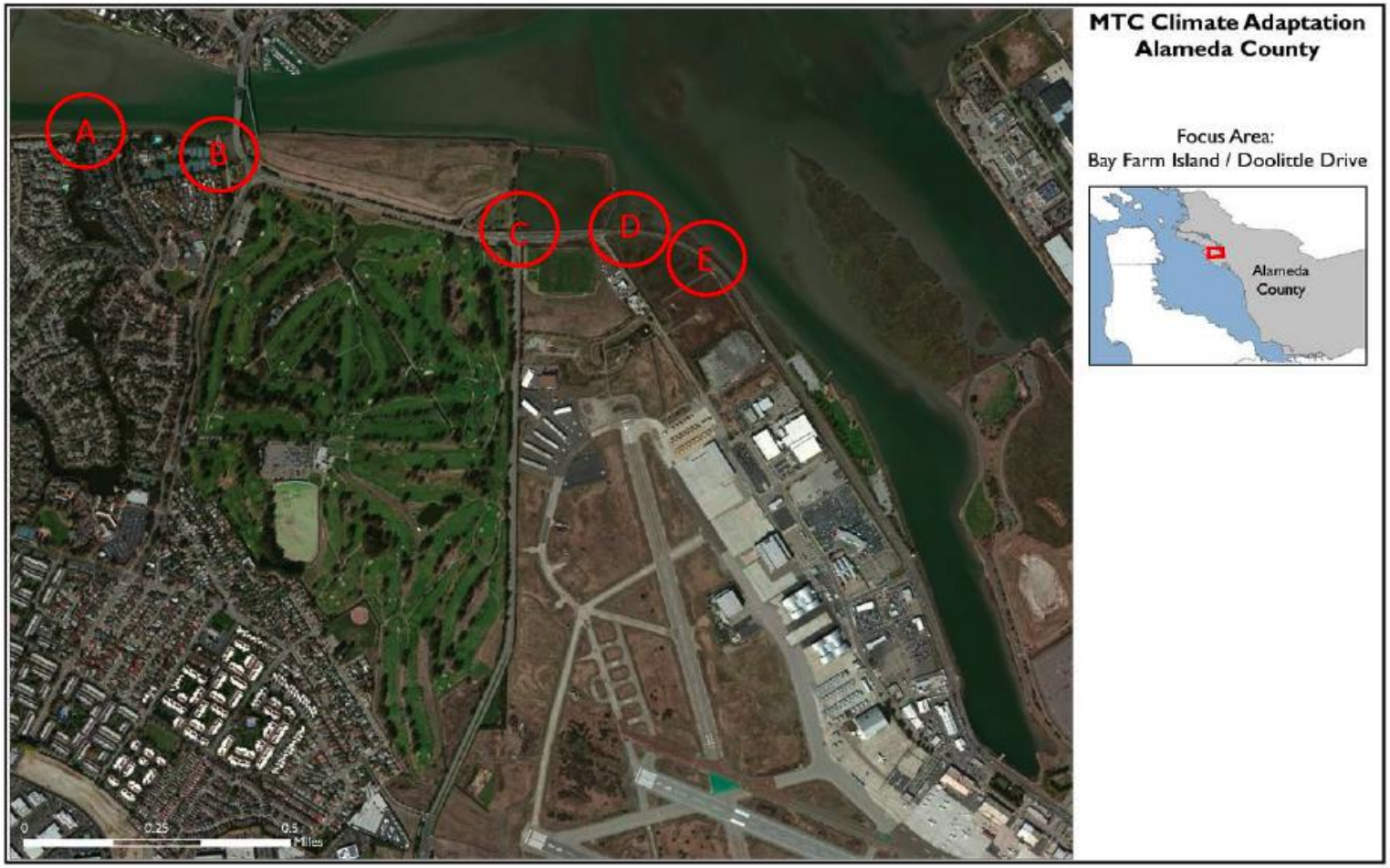
Flooding with only 12 inches of sea level rise???

Annual King Tides are about 12 inches higher than the daily high tide, yet flooding does not occur. What is going on?

Maps were ground-truthed

Example:
ART Alameda

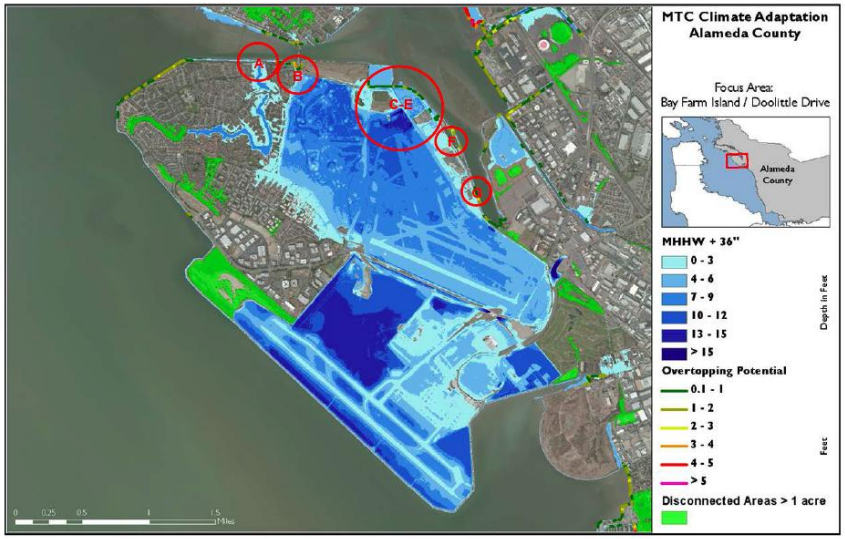
Locations identified by the shoreline delineation and the overtopping potential analysis as low spots were field-verified to make sure they truly were problem areas



Maps were refined based on ground-truthing

Example: ART Alameda

Flooding could occur with 36 inches of sea level rise



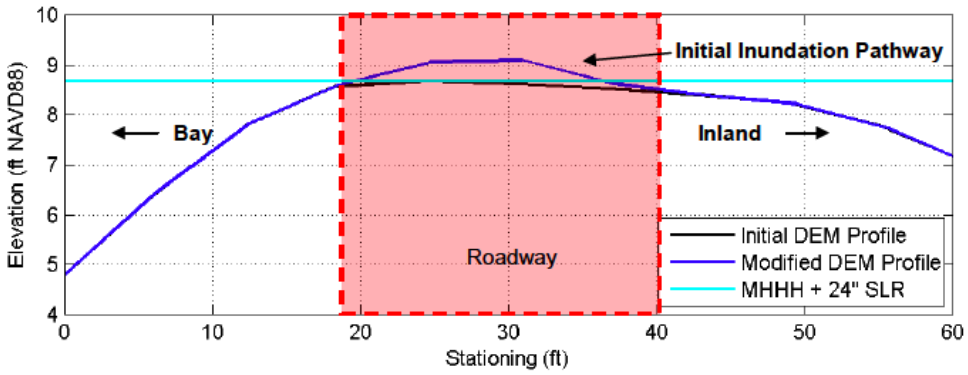


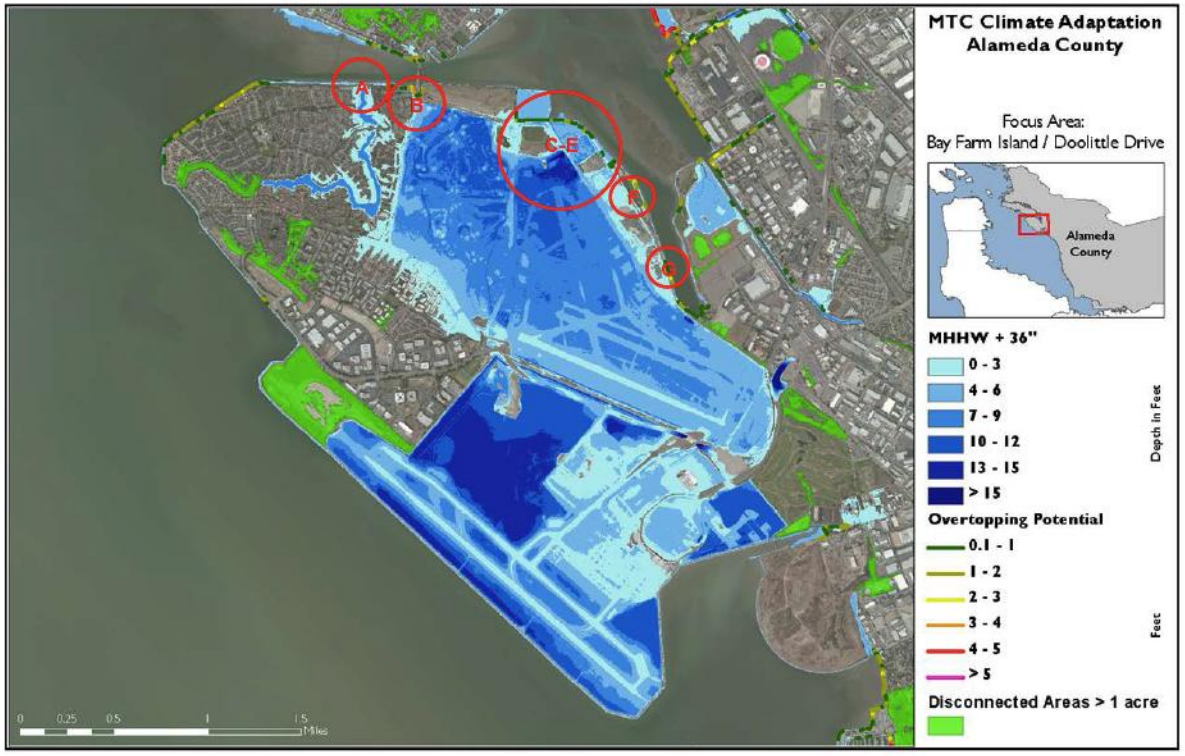
Figure 8. Roadway Cross Section of Intersection at Doolittle Drive and Harbor Bay Parkway

Figure 10. LiDAR Elevations at Site D

Refined maps were used to ID early actions

Example: ART Alameda

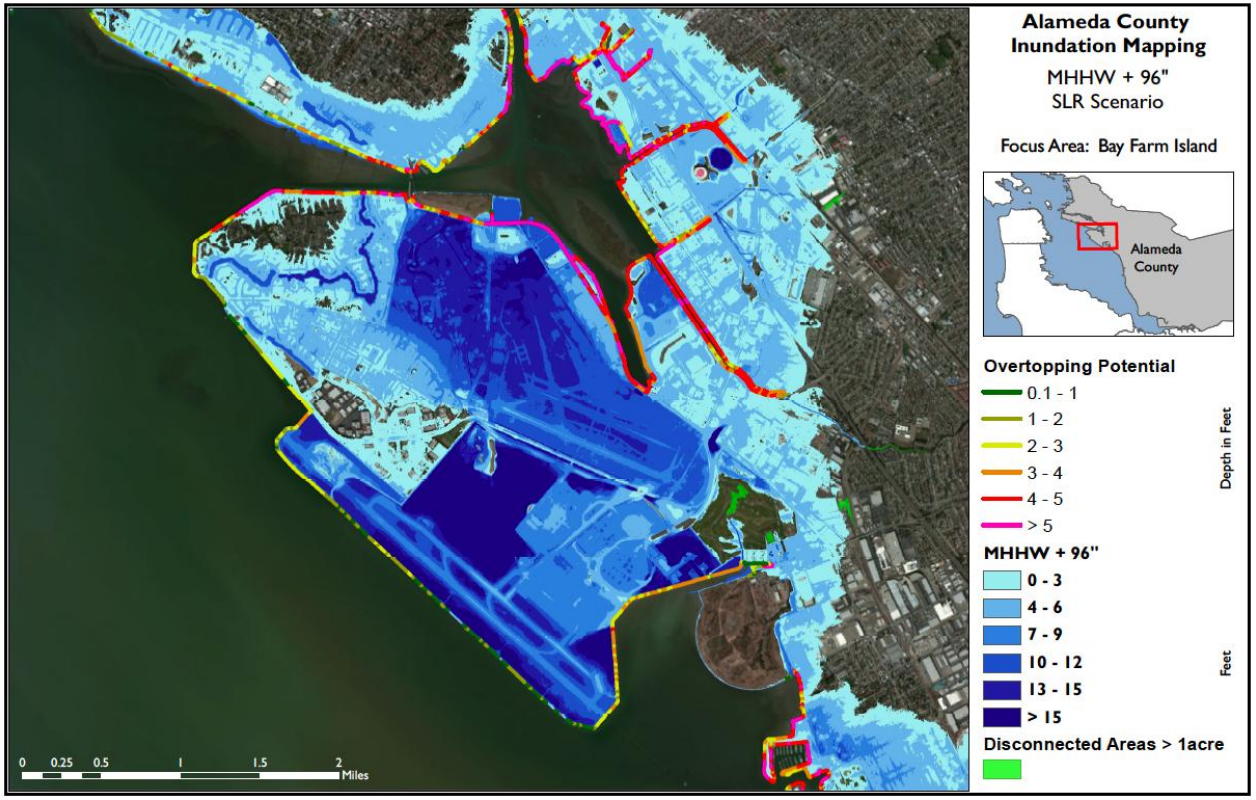
- Raise tide gate structure
- Raise and strengthen seawall or construct a living levee
- Elevate low sections of roadway and improve shoreline habitat elements



Refined maps supported future collaboration

Example: ART Alameda

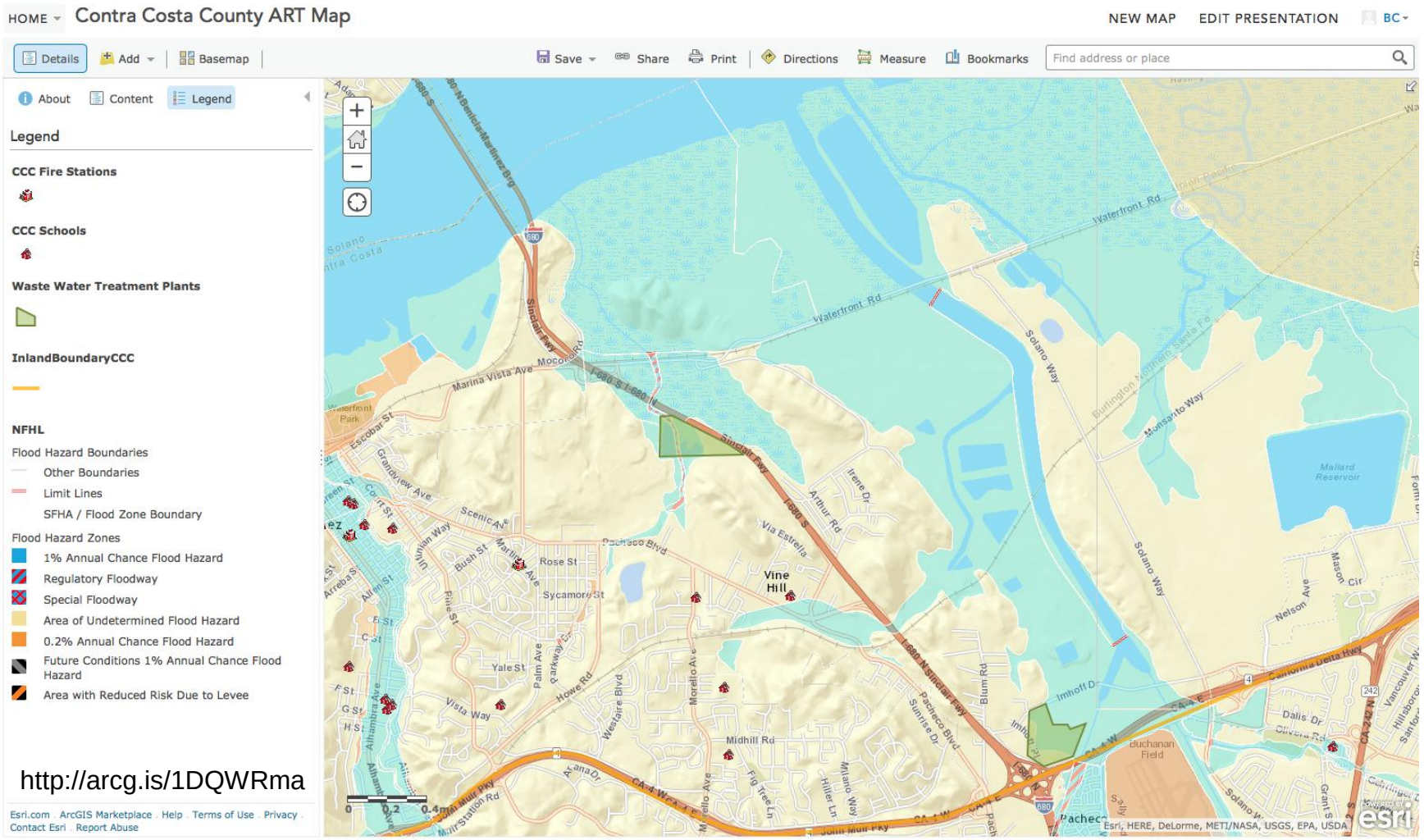
Localized solutions will buy time, however eventually there will need to be broader, system-wide solutions to prevent flooding of the airport and Bay Farm Island community



Adapting to Rising Tides Oakland/Alameda Resilience Study (www.adaptingtorisingtides.org)

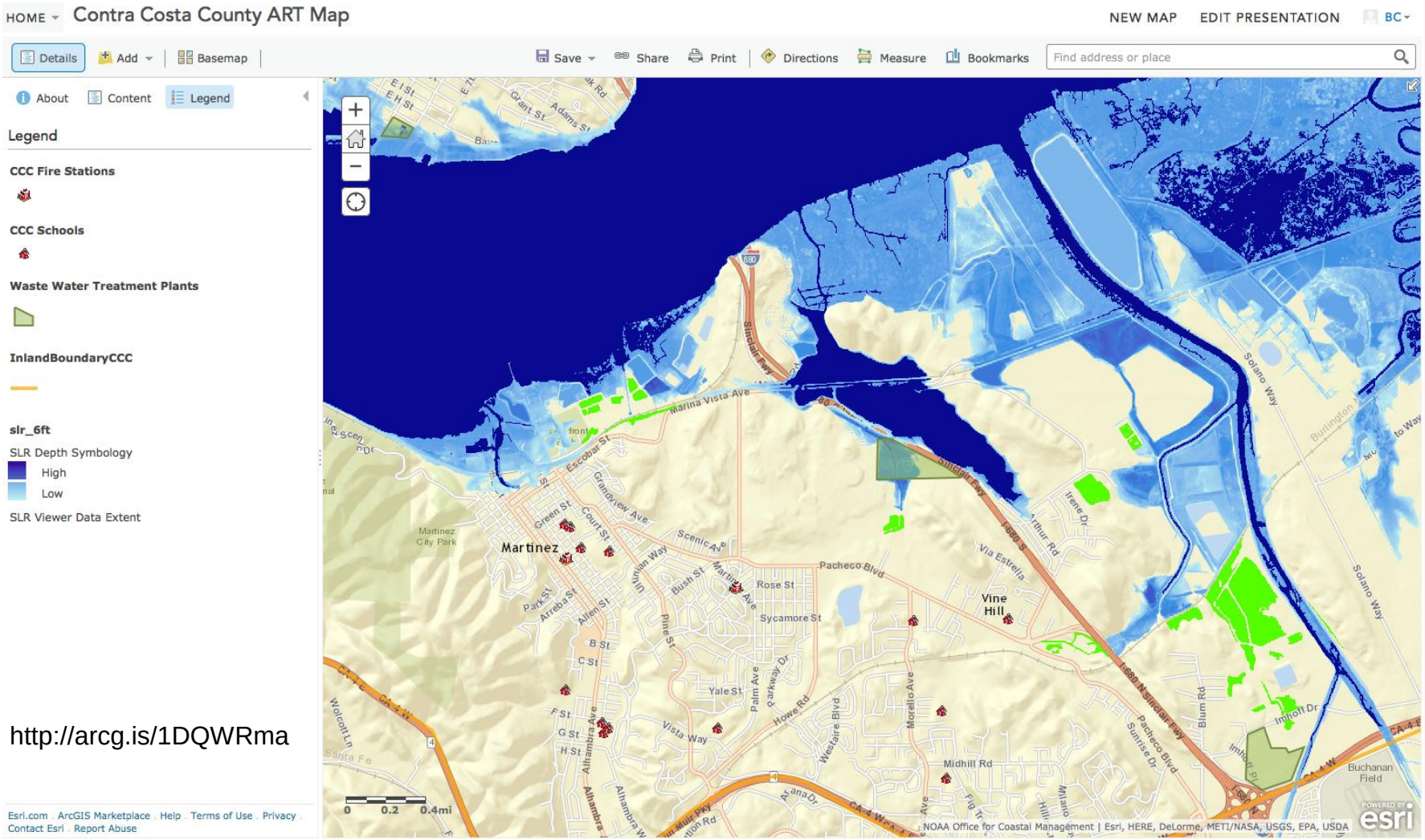
Regionally available flood maps

Current flooding: FEMA Flood Insurance Rate Maps (FIRMs)



Regionally available flood maps

Future flooding: NOAA SLR viewer



http://arcg.is/1DQWRma

One Map = Many Futures

The “total water level” approach unlocks the NOAA SLR maps because one map = many futures

Sea Level Rise	MHHW (≈ daily high tide)	Total water level above today’s daily high tide, MHHW (inches NAVD88), by tide recurrence interval						
		1-yr (≈ King Tide)	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr (1% annual chance)
+0	0	12	19	23	27	32	36	41
+6	6	18	25	29	33	38	42	47
+12	12	24	31	35	39	44	48	53
+18	18	30	37	41	45	50	54	59
+24	24	36	43	47	51	56	60	65
+30	30	42	49	53	57	62	66	71
+36	36	48	55	59	63	68	72	77
+42	42	54	61	65	69	74	78	83
+48	48	60	67	71	75	80	84	89
+54	54	66	73	77	81	86	90	95
+60	60	72	79	83	87	92	96	101

One Map = Many Futures

NOAA SLR Viewer 4 feet

Permanent Inundation

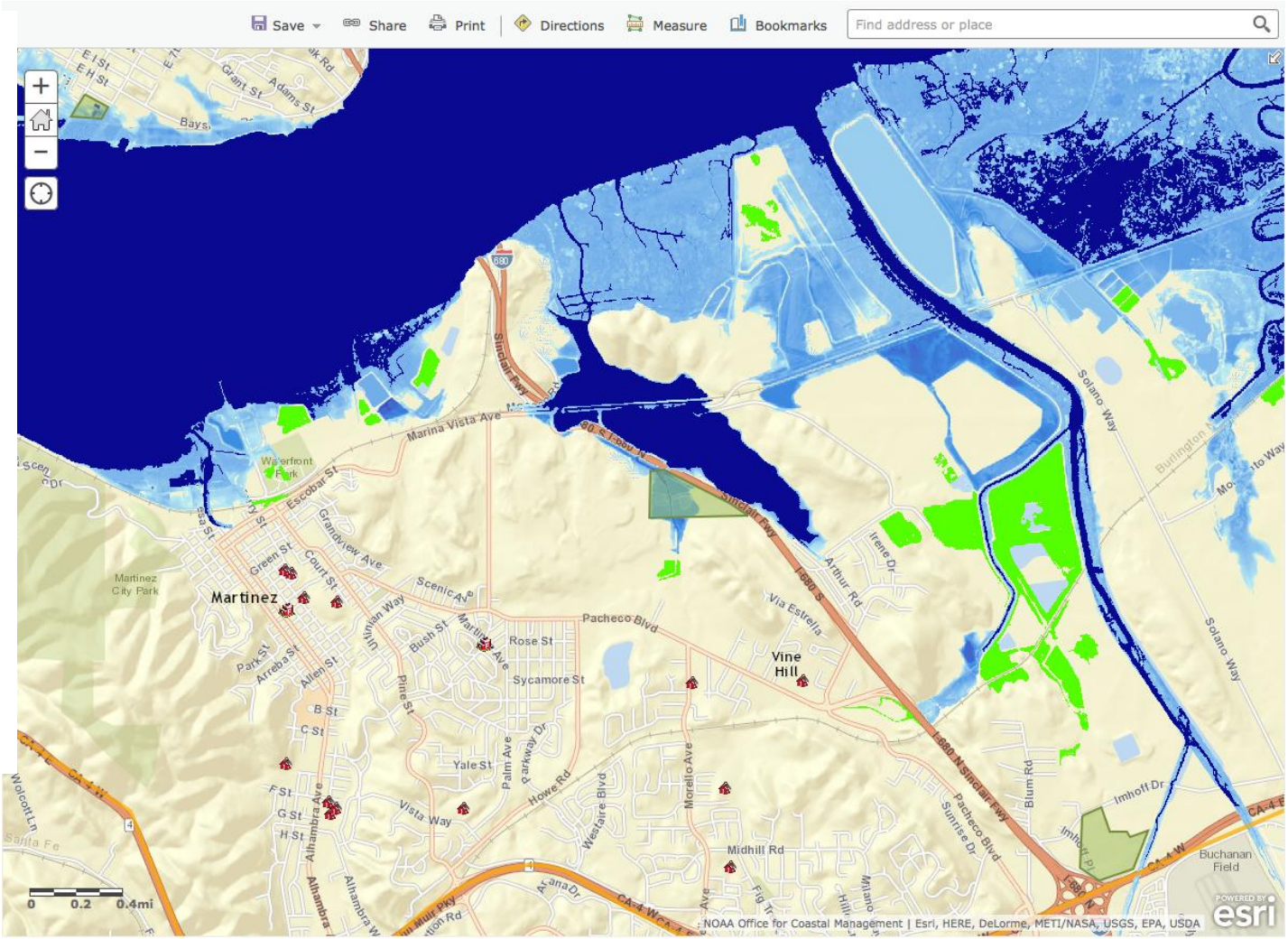
High tide with 48” SLR

Temporary Flooding

1-year tide with 36” SLR

25-year tide with 12” SLR

100-year tide with 6” SLR



Example Exposure Results

Three Land Uses Types	Number of Parcels Exposed		
	Commercial	Industrial	Residential
Current and future (50-year flood with 3 ft SLR) flooding	61	178	791
Current 100-year flood only (FEMA FIRM)	194	127	726
Total	*255*	*305*	*1517*

Three Networks	Miles Exposed		
	Bay Trail	Rail	Pipelines
Current and future (50-year flood with 3 ft SLR) flooding	15	37	50
Current 100-year flood only (FEMA FIRM)	18	16	63
Total	*33*	*53*	*113*