



# **Flood Mapping and Sea Level Rise**

## **City of Petaluma**

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Zone 2A Briefing  
August 14, 2025



# Discussion Topics

- New Flood Modeling
  - Rain/Storm
  - Sea Level Rise
- FEMA Mapping updates
- Combined Storm and SLR Maps
- General Plan Framework for Flood Resiliency
- Upcoming Floodplain Management Initiatives







**Where does flood water come from?**







**Water comes down the land, creeks and river from rain**





**Water also comes up the River from the Bay**





# 3 Flood Types to Consider



## King Tide

The highest tides of the year

Happen every year

Tide gauges



## Rainfall

Rain falling on the city and watershed, trying to move down river

1% chance of happening every year

Flood models



## Storm Surge

Extreme high water in the river due to atmospheric events, separate from rain

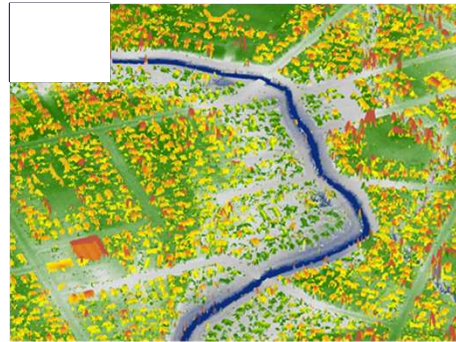
1% chance of happening every year

Tide gauges

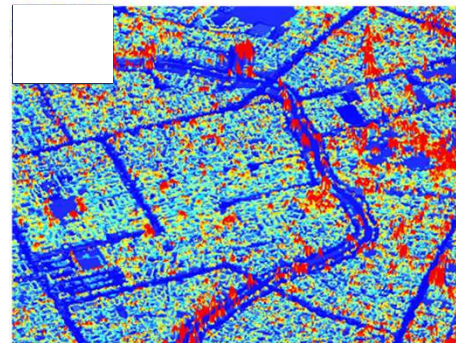


# Petaluma Flood Modeling

- Petaluma's HEC-RAS 2D model considers 4 main factors
  - 1: The shape of the land and creeks
  - 2: Rainfall amount and location
  - 3: Amount and speed of run off
  - 4: Height of the River/Bay
- 1% Annual Flood Risk = 1% chance every year = 100 year flood
  - Common standard for Flood Planning

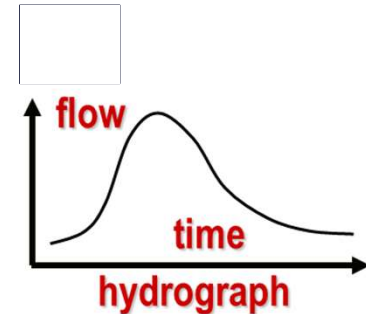


elevation model



surface roughness model

Niwa.co.nz



flood depths & extent



# PETALUMA FLOOD MODELING

Includes Climate Change Impacts, Uses Petaluma Specific Data

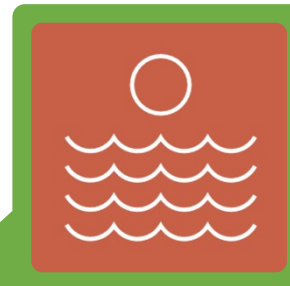
## SEA LEVEL RISE

Based on current science



## MEAN HIGHER HIGH TIDE

The average of the highest tides each year as provided by NOAA.



## HYDROLOGY and HYDRAULICS

Ground Surface Terrain, Field Surveys, Land Uses, Vegetation levels



## RAIN

Custom rain study specific to Petaluma in 2023. Considered how much rain is reasonable, where it falls in the watershed heaviest, and how quickly it falls.

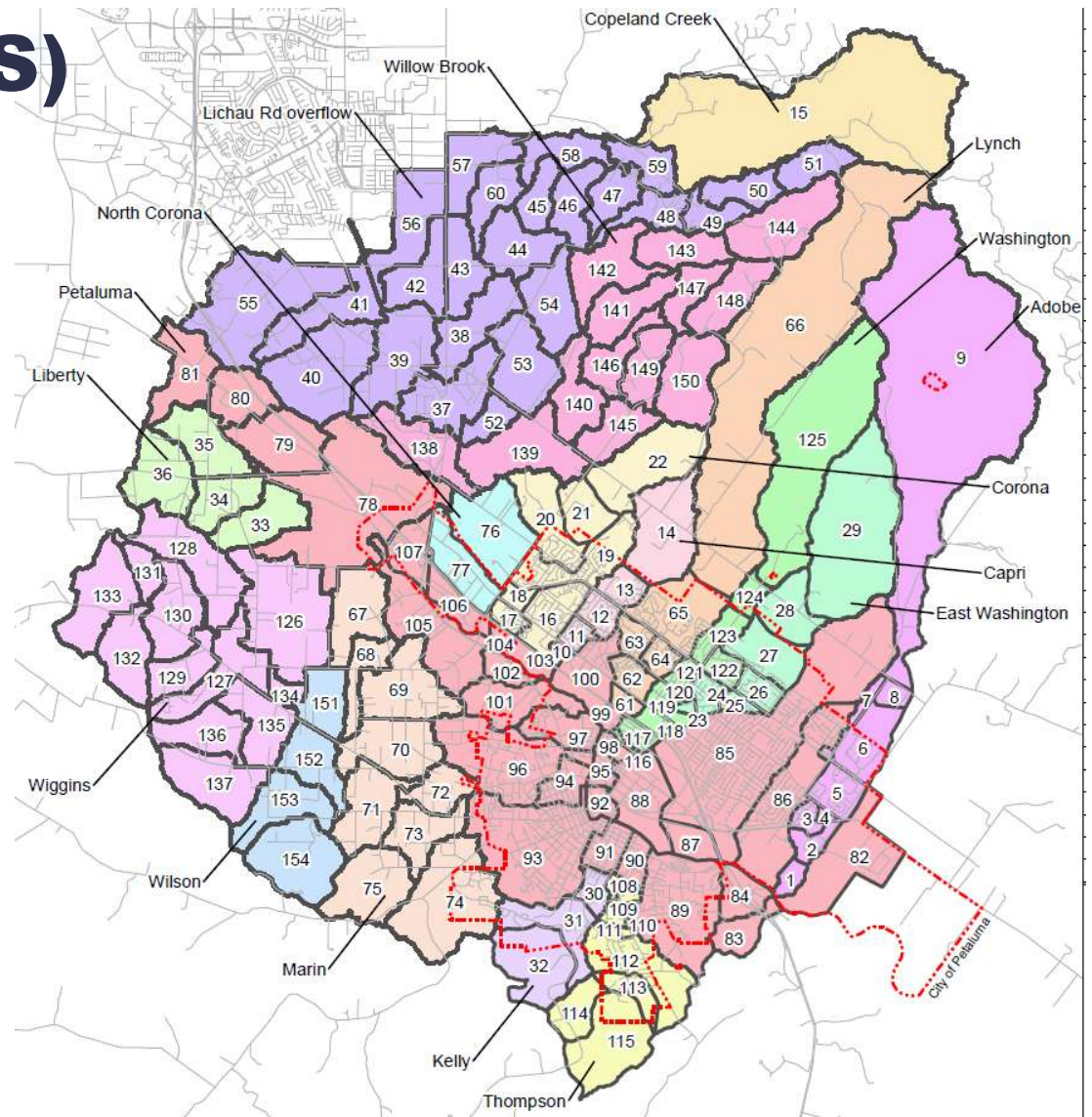


**FLOOD  
MODEL**



# Hydrology (HEC-HMS)

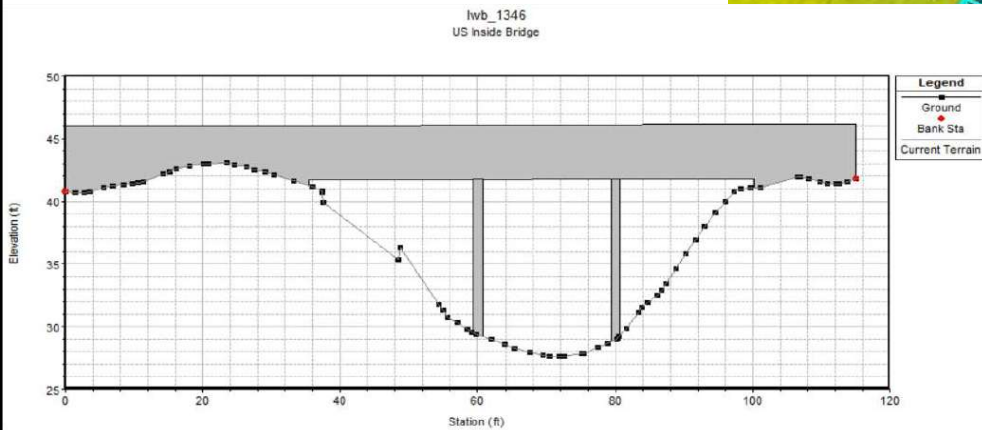
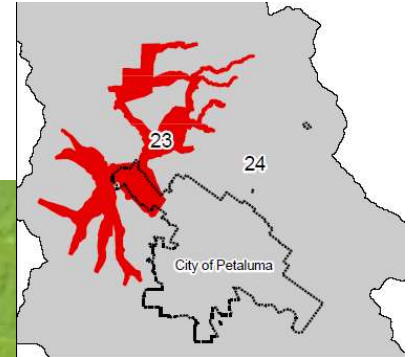
- This is the Petaluma River watershed
- Flow estimated in each drainage area
- 154 subbasins





# Hydraulics (HEC-RAS 2D)

- Ground elevation data
- Structures
- Roughness (streets vs. vegetation)

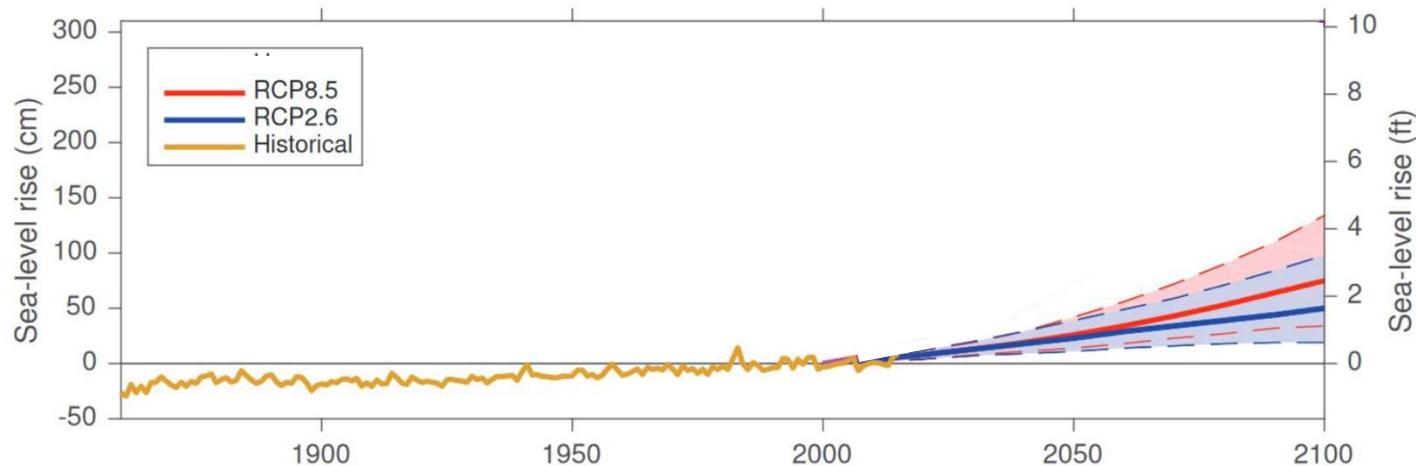




# Source for SLR Predictions

- California Ocean Protection Council Guidance (OPC2018)
  - Used by numerous state and local agencies and counties/cities
  - Provides ranges of SLR, and how likely they are to happen in future decades
  - Recommends which predictions are appropriate for different planning efforts
  - Recommends assuming continued High Emissions (RCP)


(b) Relative sea level in San Francisco, California




# Sea Level Rise (SLR) Selections

- Mid-Century
  - Roughly 2050
  - Very low probability SLR
  - 0.5% chance
  - **1.9 feet**
- Short planning horizon, so the worst case was selected

Mid Century SLR		
Likelihood	Elevation	PETGP Definition
0.5%	1.9'	Very Low Probability
5%	1.4'	
17%	1.1'	Low Probability
50%	0.9'	
83%	0.6'	



A vertical red double-headed arrow labeled "Likely Range" spans the elevation values from 0.6' to 1.9'.



An orange arrow points from the text "Very low probability SLR" in the list to the 0.5% likelihood row in the table.



# Sea Level Rise (SLR) Selections

- End-of-Century

- Roughly 2100
- Low probability SLR
- 17% chance
- **3.4 feet**

- Longer planning horizon gives us more time to prepare
- Appropriate for most planning efforts

End of Century SLR		
Likelihood	Elevation	PETGP Definition
0.5%	6.9'	Very Low Probability
5%	4.4'	
17%	3.4'	Low Probability
50%	2.5'	
83%	1.6'	
96%	1.0'	

Likely Range

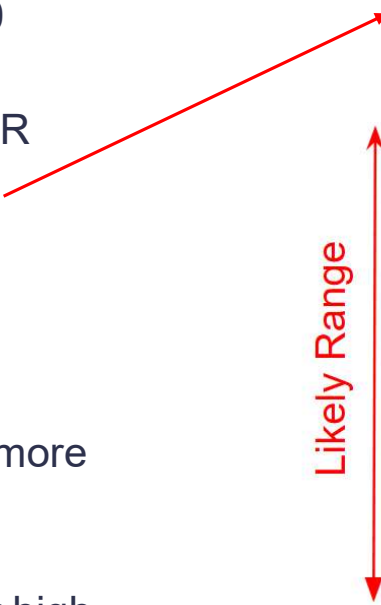


# Sea Level Rise (SLR) Selections

- End-of-Century
  - Roughly 2100
  - Very Low probability SLR
  - 0.5% chance
  - **6.9 feet**
- Longer planning horizon gives us more time to prepare
- Appropriate for isolated critical or high risk infrastructure and uses

End of Century SLR		
Likelihood	Elevation	PETGP Definition
0.5%	6.9'	Very Low Probability
5%	4.4'	
17%	3.4'	Low Probability
50%	2.5'	
83%	1.6'	
96%	1.0'	

Likely Range



The diagram features a blue vertical bar representing the 'Likely Range' of sea level rise, spanning from 1.0' to 6.9'. A red double-headed arrow labeled 'Likely Range' is positioned to the left of this bar. A red arrow points from the '0.5% chance' bullet point in the list to the 0.5% likelihood row in the table. Another red arrow points from the '6.9 feet' bullet point to the 6.9' elevation in the table.



# Using SLR in flood analysis

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- The maps most relevant for long term planning are 1.9 ft. of SLR in Mid-Century and 3.4 ft. in the End-of-Century.
  - It is straightforward to explore how SLR affects King Tide and Storm Surge flooding
  - Considering how SLR affects Rainfall flooding requires our new model
  - 6.9' ft. scenario is relevant only to a few critical uses



# King Tide and Storm Surge

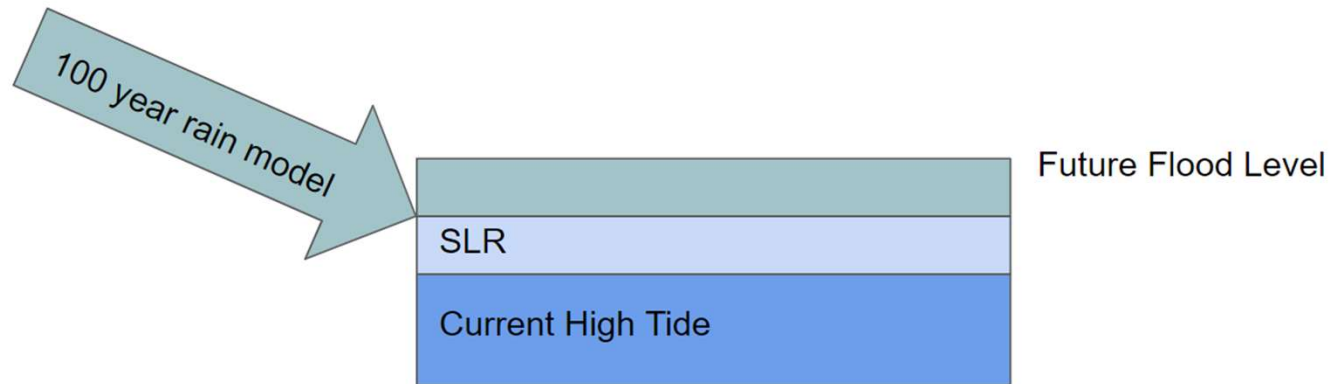
- Current King Tide and Storm Surge patterns are layered on top of Sea Level Rise to predict what will flood in the future





# SLR effects on Rainfall flooding

- Considering how SLR impacts rainfall flooding requires updated rain model
  - Model Method
    - 1: Add SLR amount to current MHHW tide level
    - 2: Run the rain flood model, now with rainfall needing to "fight" the higher river elevation
    - 3: Model results may show extra flooded areas

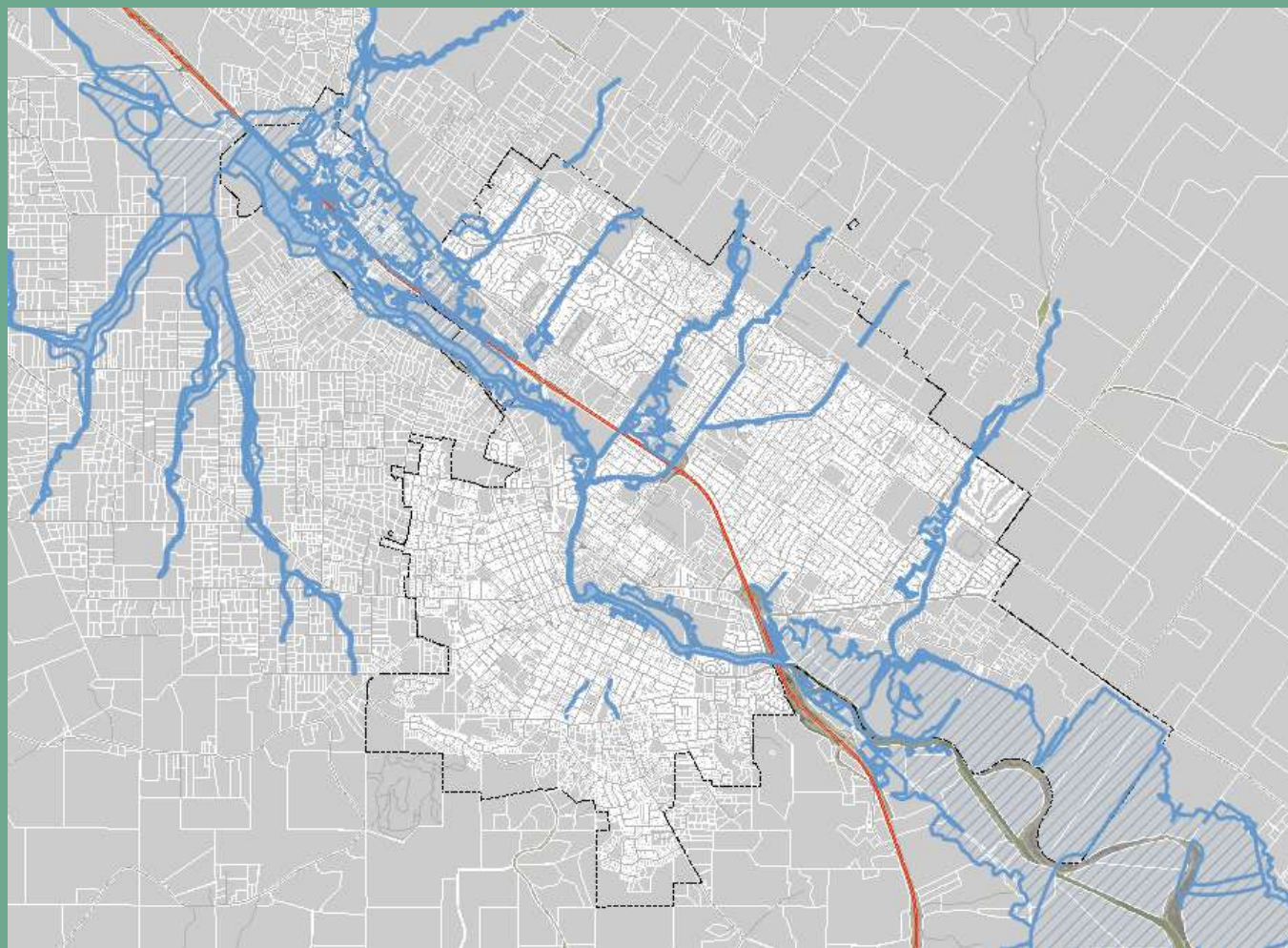


# What did we model?

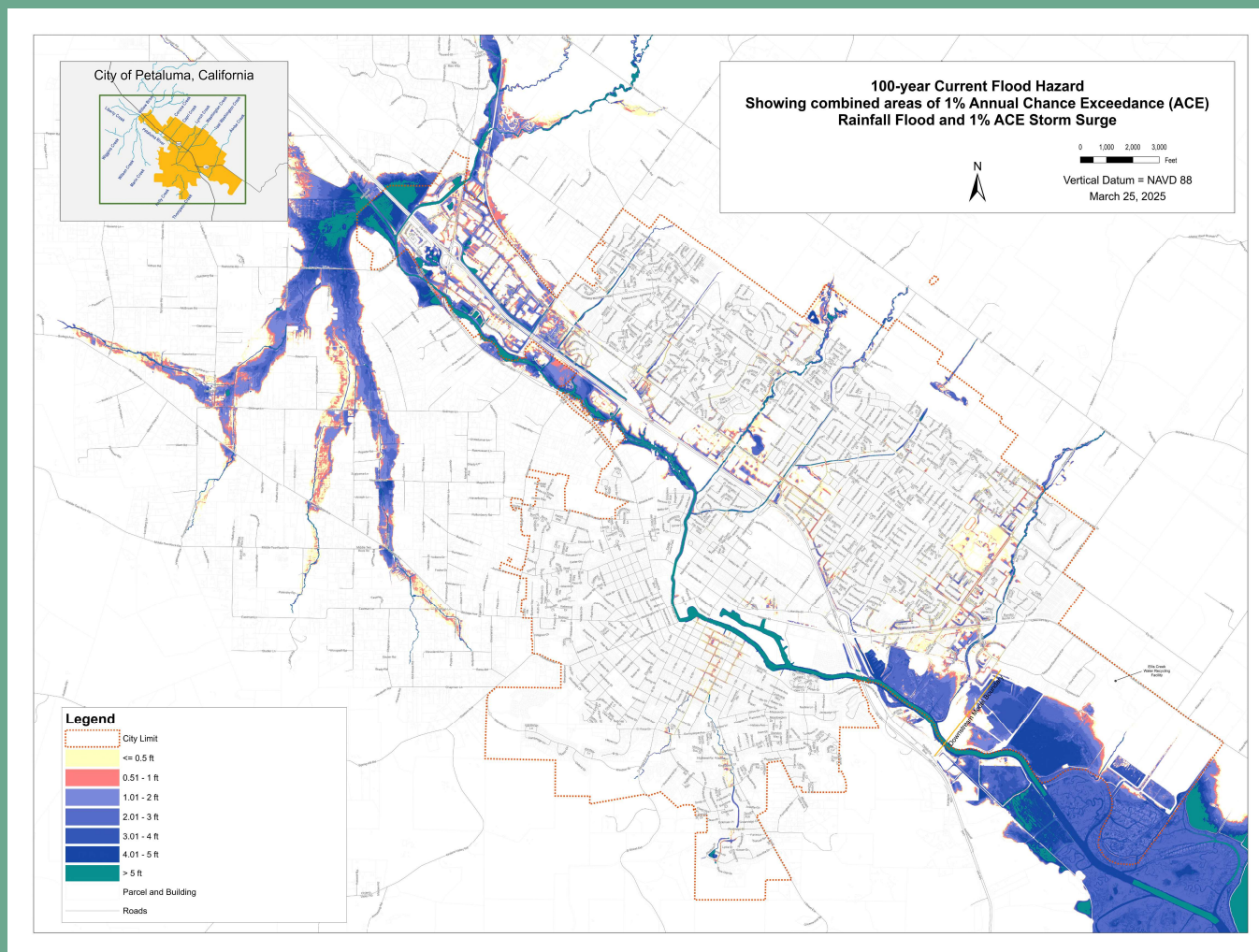
- What are flood risks at mid-century (around 2050), if we look at
  - Rain and storm surge (Map 1)
  - King tides (Map 2)
- What are flood risks at the end of the century (around 2100), if we look at
  - Rain and storm surge (Map 3)
  - King tides (Map 4)
- What could the *very low probability* flood risks at the end of the century
  - Rain and storm surge (Map 5)
  - King tides (Map 6)



**Current  
FEMA 100  
Yr (1%  
Chance)  
Floodplain**

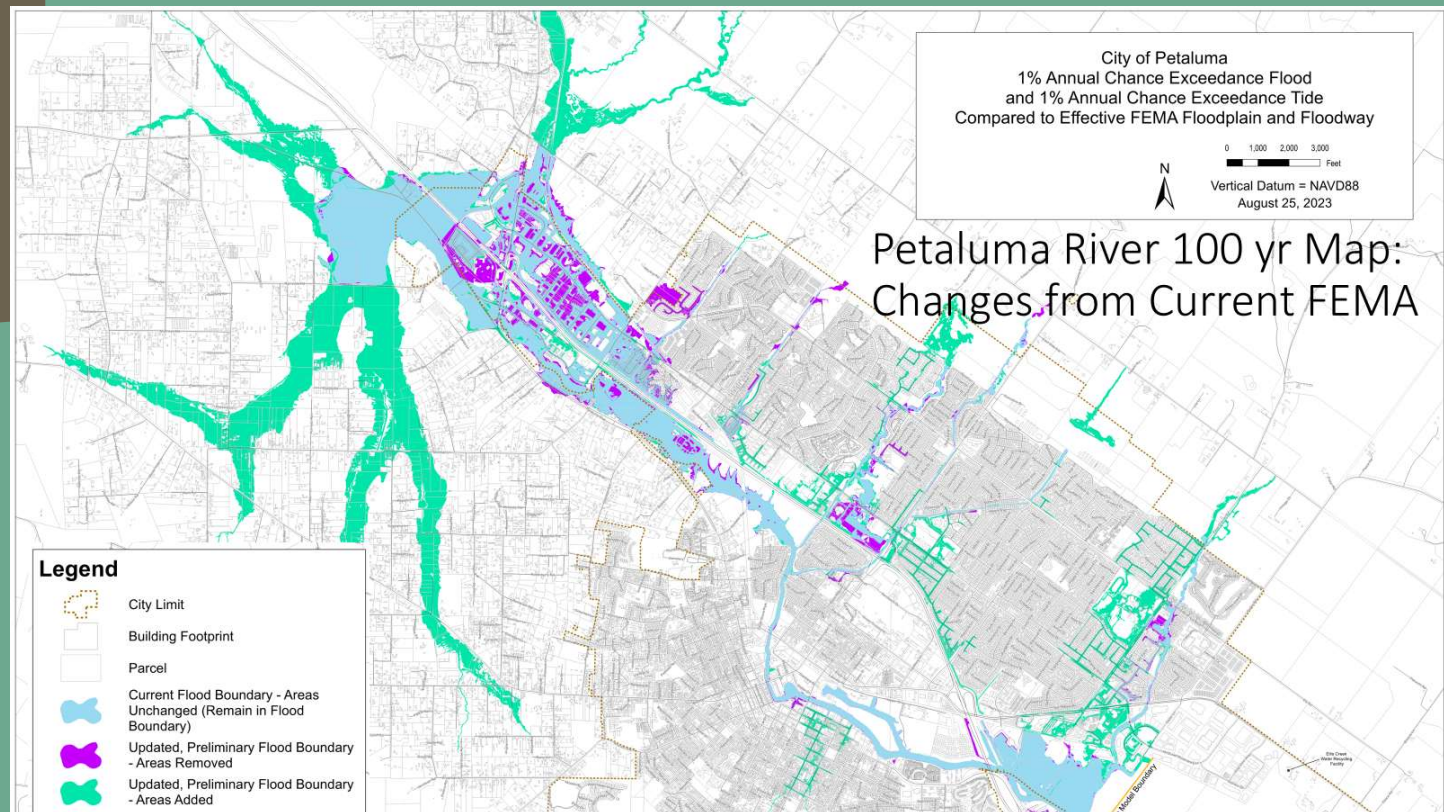



# Proposed FEMA 100 Yr (1% Chance) Floodplain





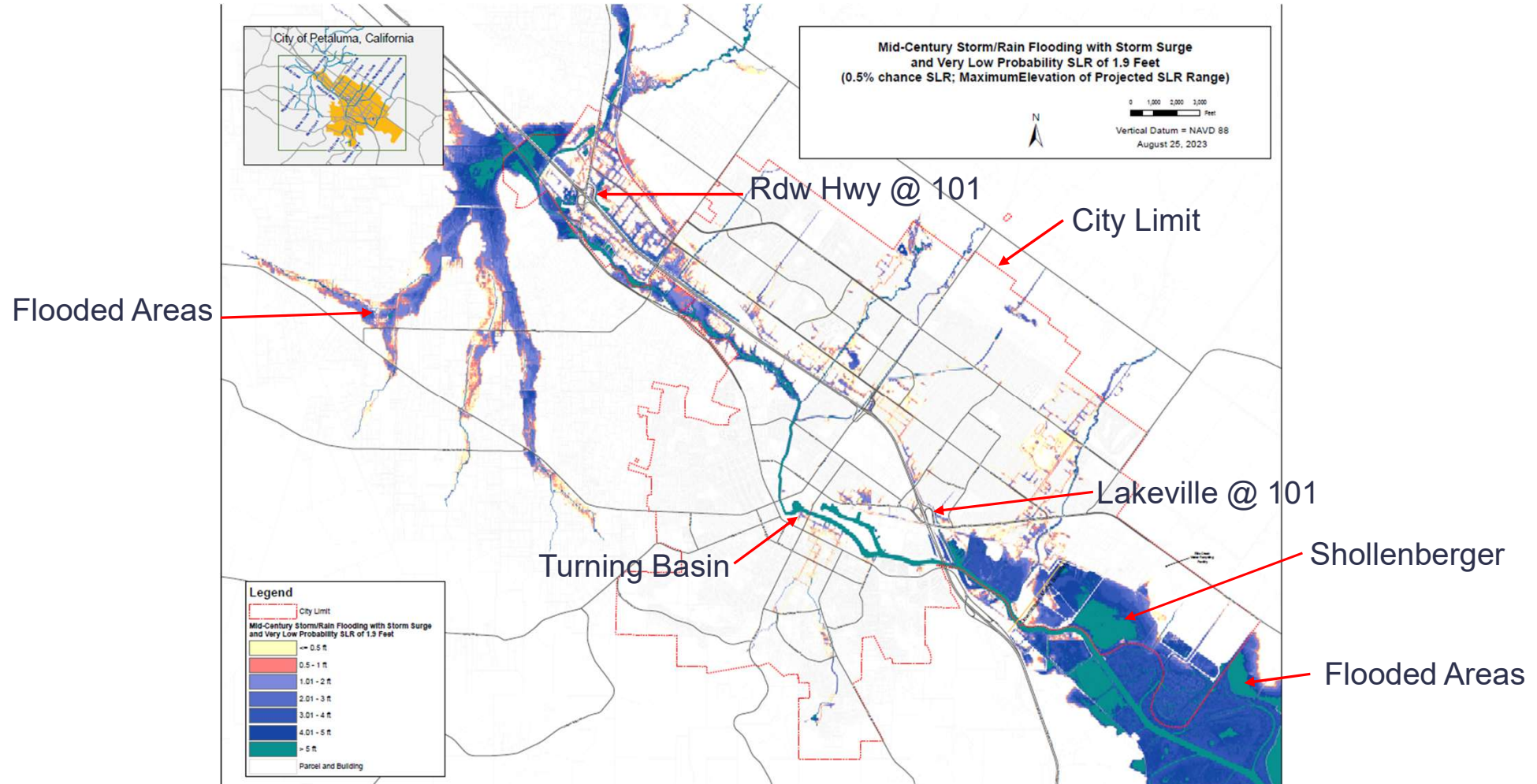
# CHANGES in Proposed FEMA 100 Yr (1% Chance) Floodplain



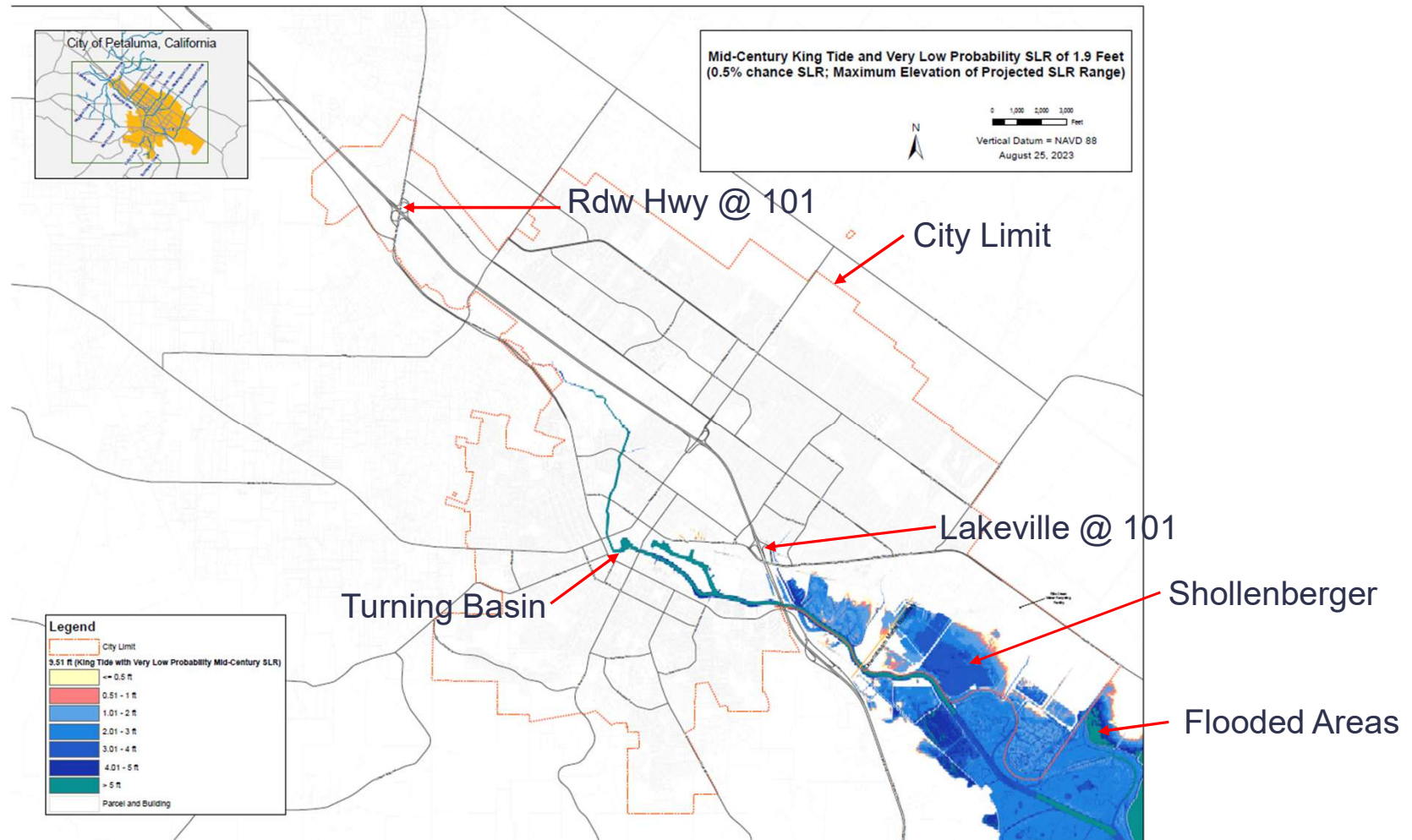
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- The City has begun the process to update our flood maps with FEMA
  - FEMA model and maps (100 yr, 500 yr and Floodway) are currently in FEMA review
  - Community Engagement program will kick off in 2026
    - Smaller neighborhood/community meetings organized by tributary creeks
    - Extensive Educational Outreach campaign for both updated FEMA flood mapping and Sea Level Rise maps
  - 1-2 year timeline to completion



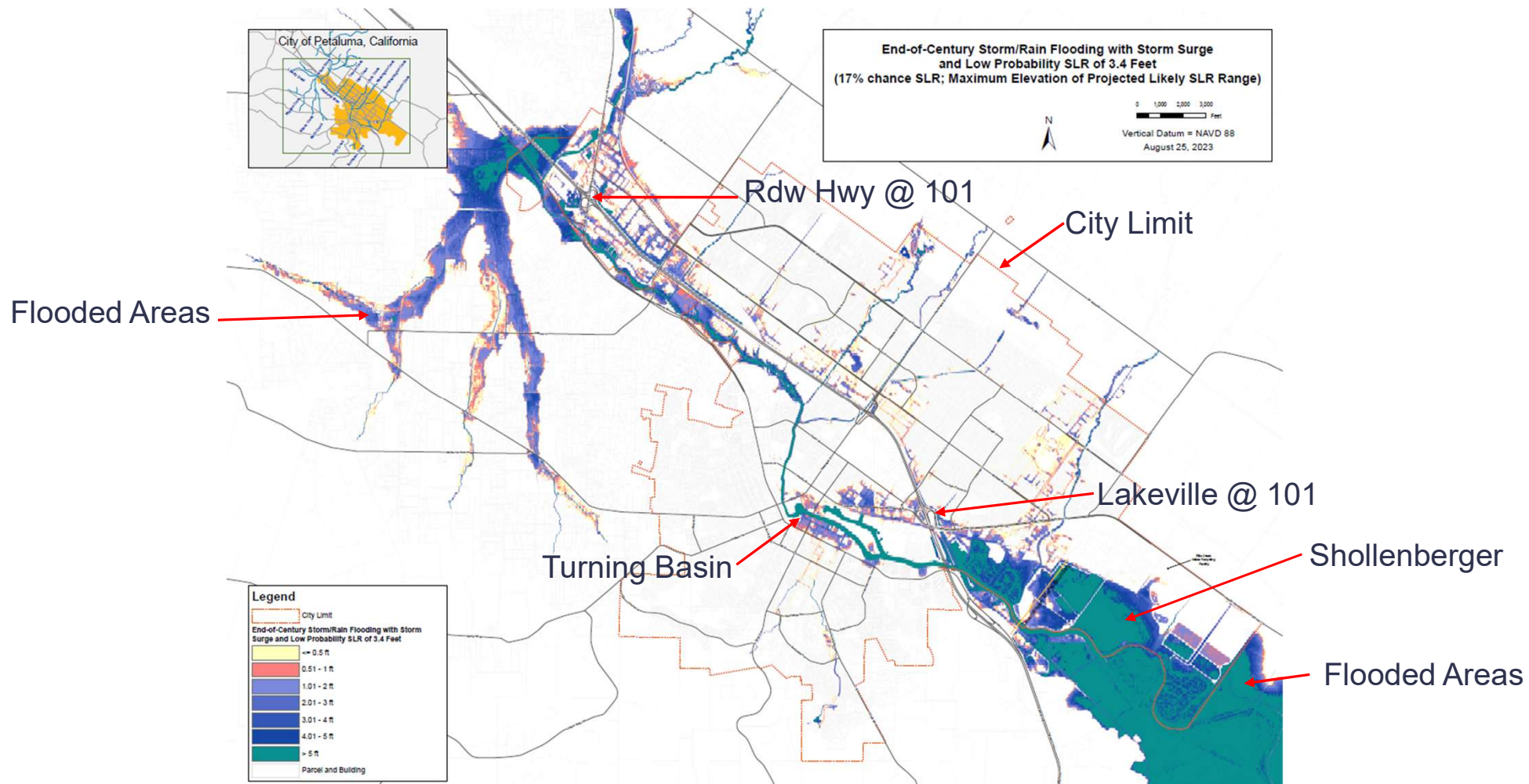
# Mid-Century SLR (1.9 feet), Rain and Storm Surge



# Mid-Century SLR (1.9 feet), King Tide

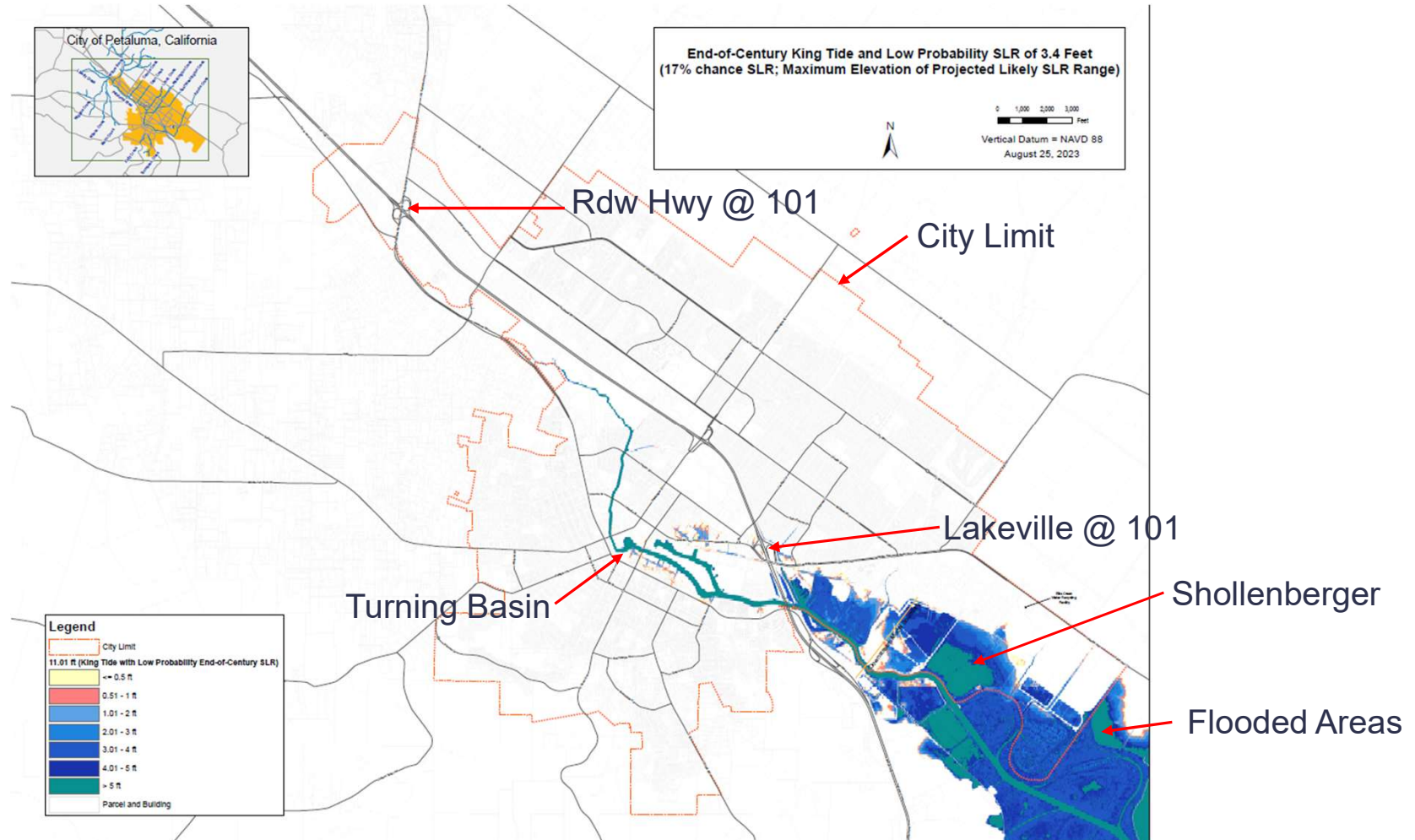


# End-of-Century SLR (3.4 feet), Rain and Storm Surge

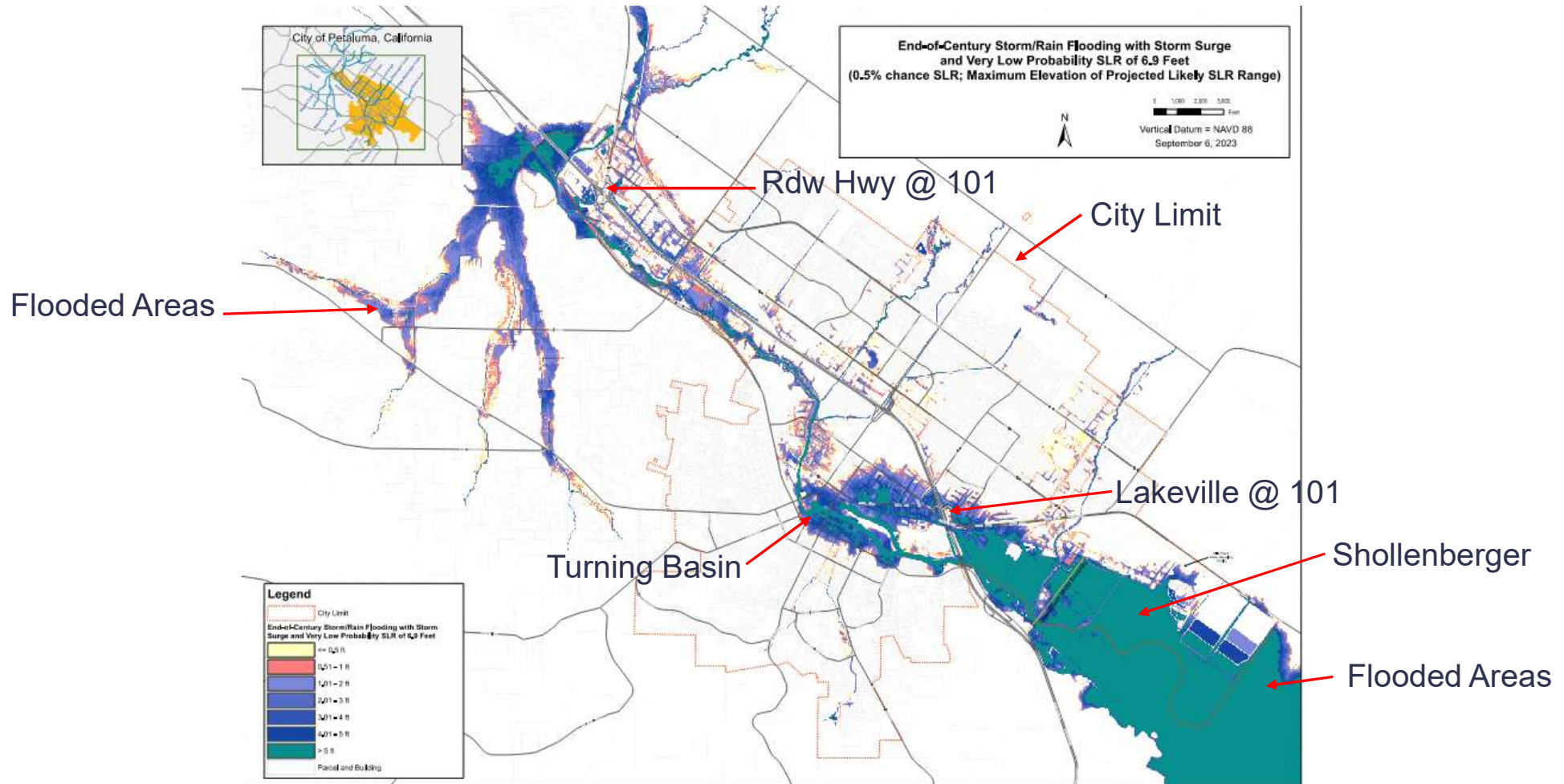




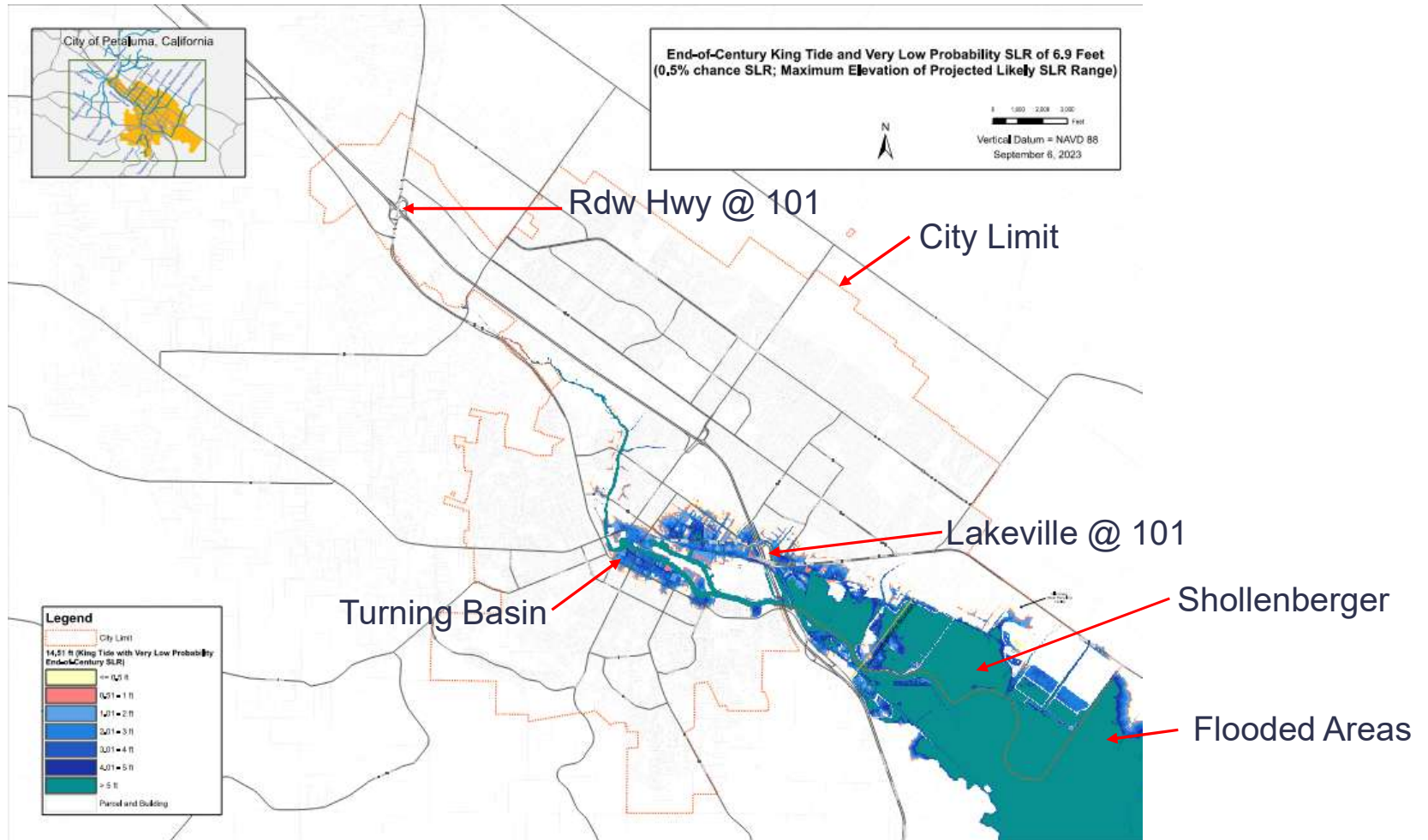
# End-of-Century SLR (3.4 feet), King Tide



# End-of-Century SLR (6.9 feet), Rain and Storm Surge



# End-of-Century SLR (6.9 feet), King Tide



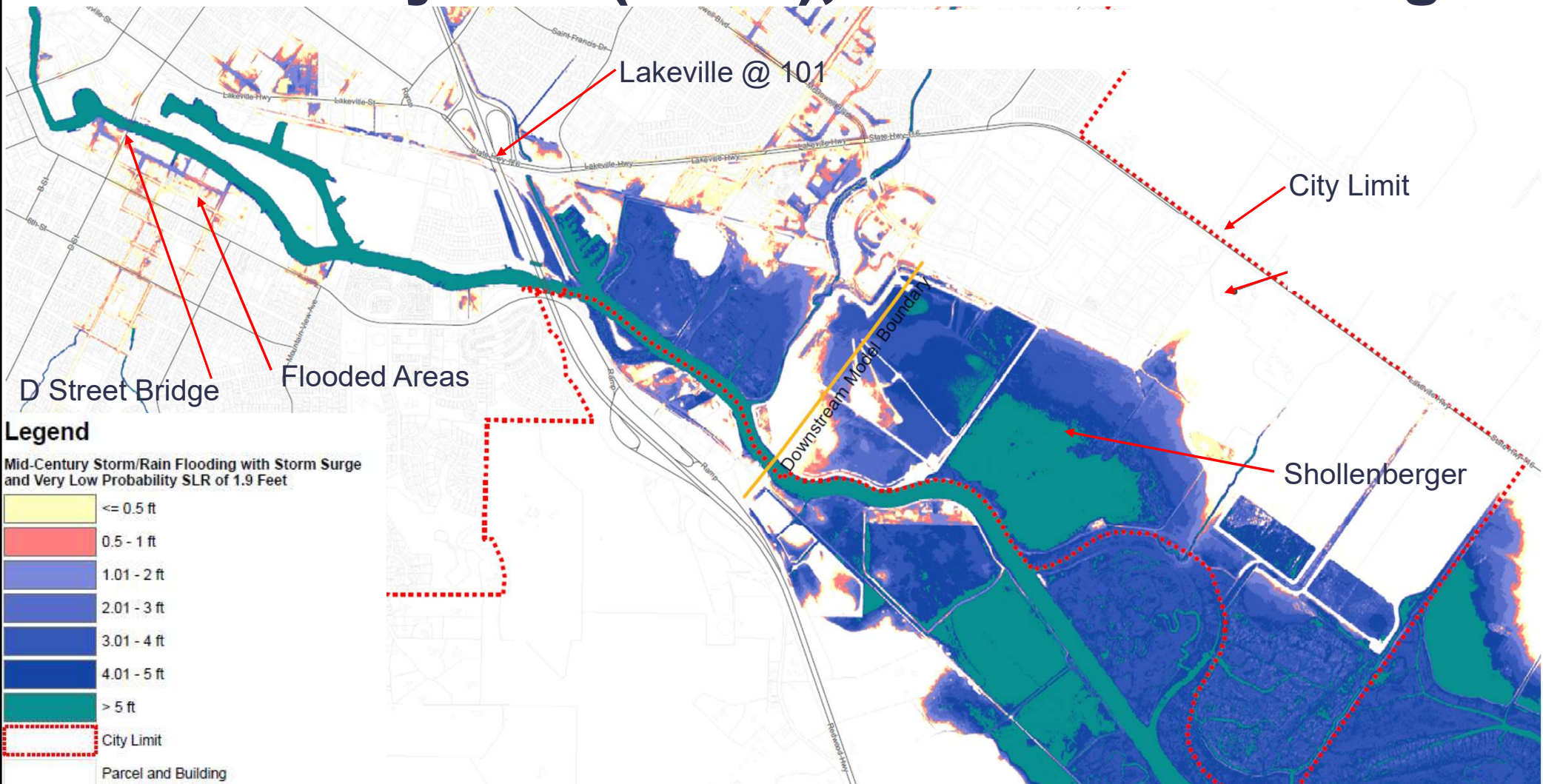


# Where can SLR affect the City in the Future

Let's zoom in to the same maps

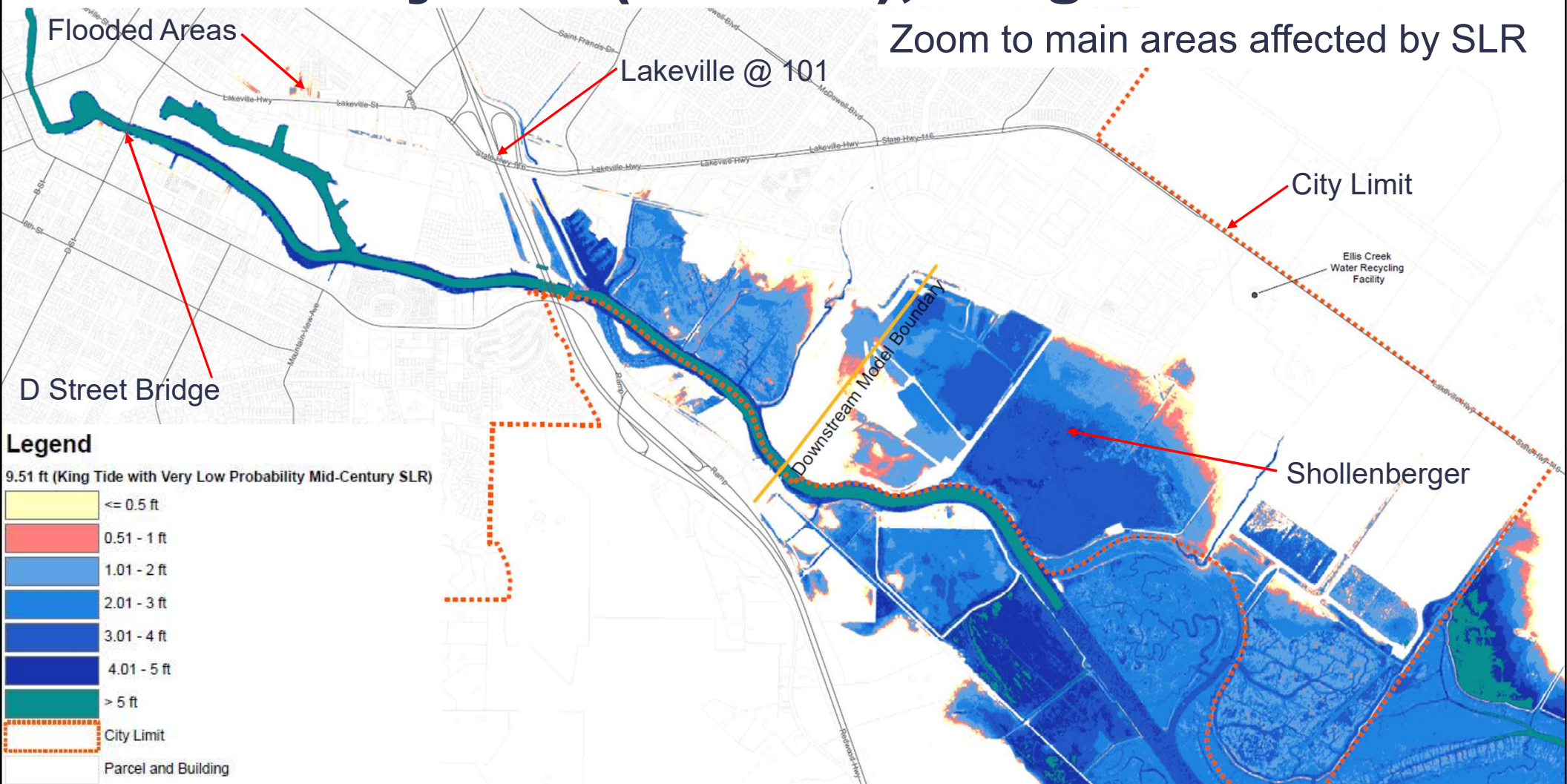


# Mid-Century SLR (1.9 ft), Rain + Storm Surge



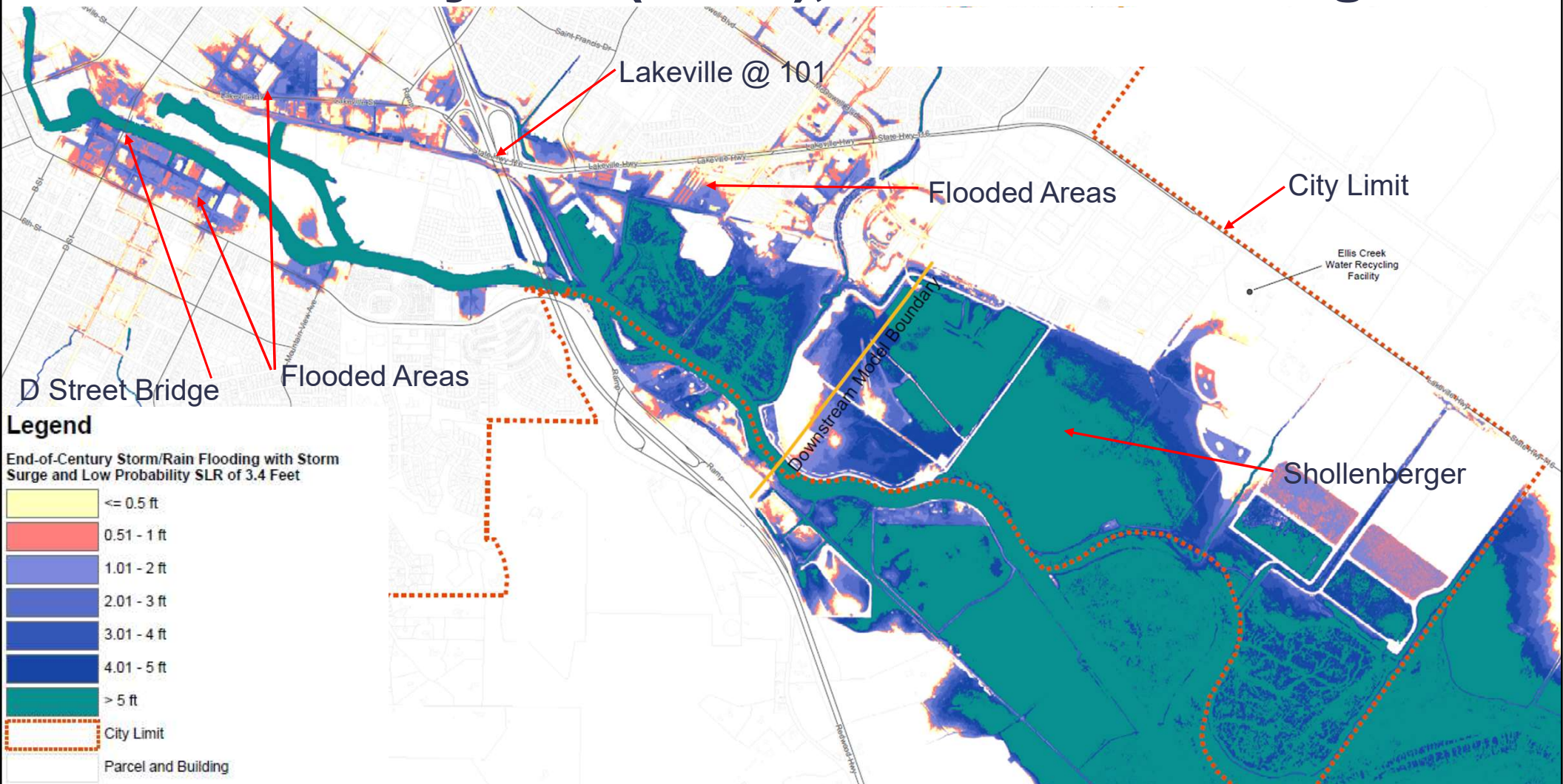


# Mid-Century SLR (1.9 feet), King Tide



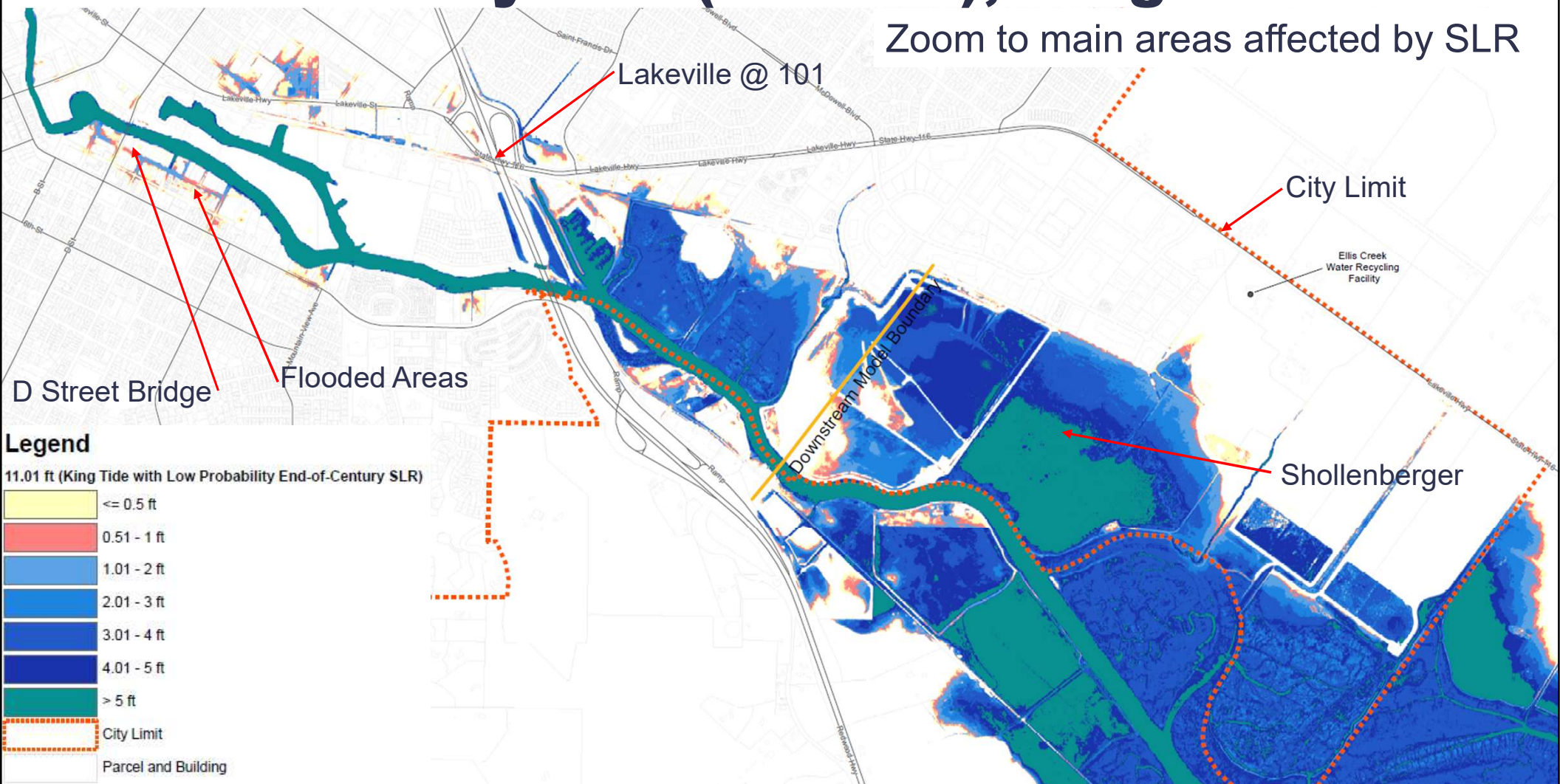


# End-of-Century SLR (3.4 ft), Rain + Storm Surge



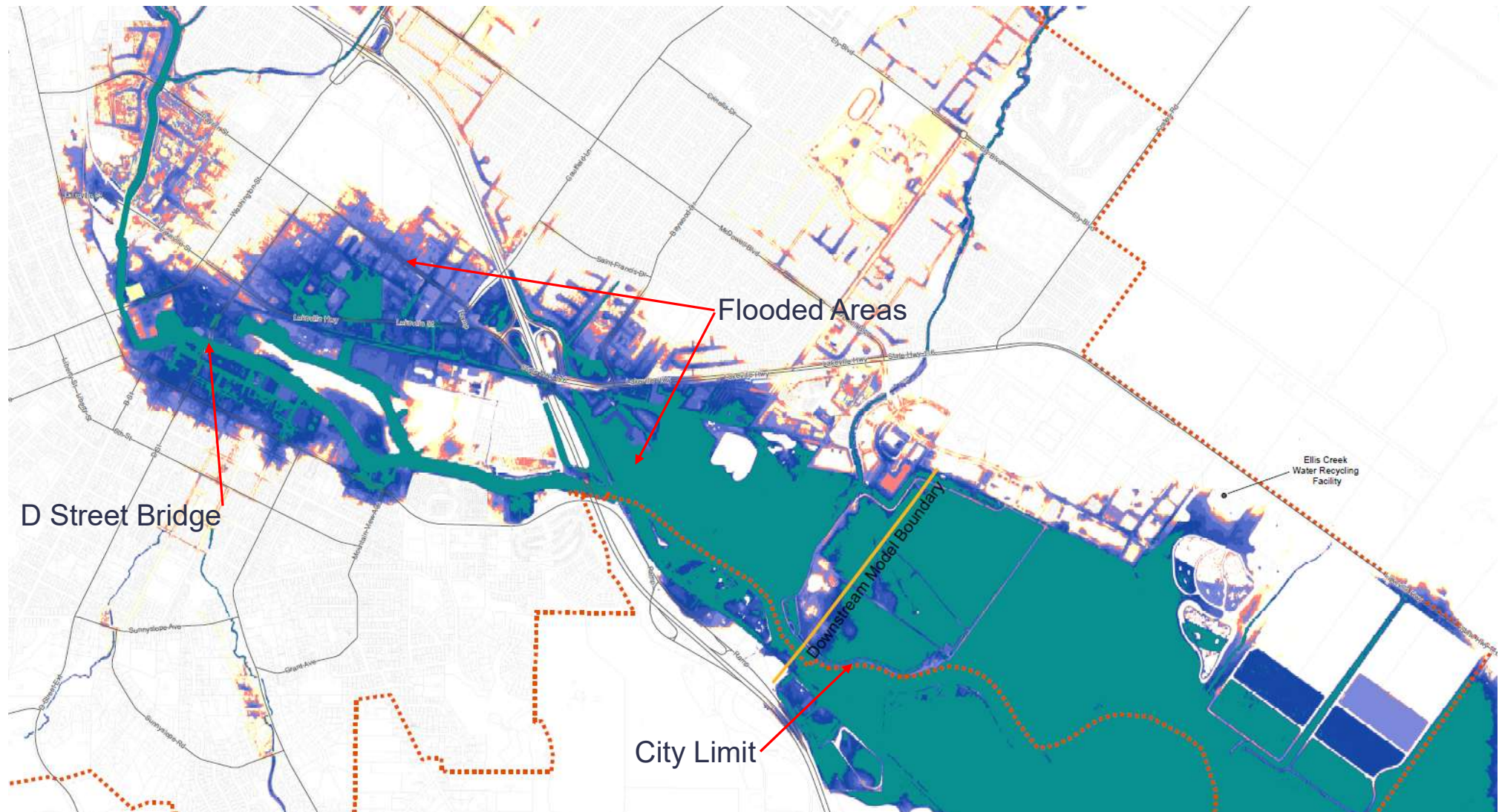
# End-of-Century SLR (3.4 feet), King Tide

Zoom to main areas affected by SLR



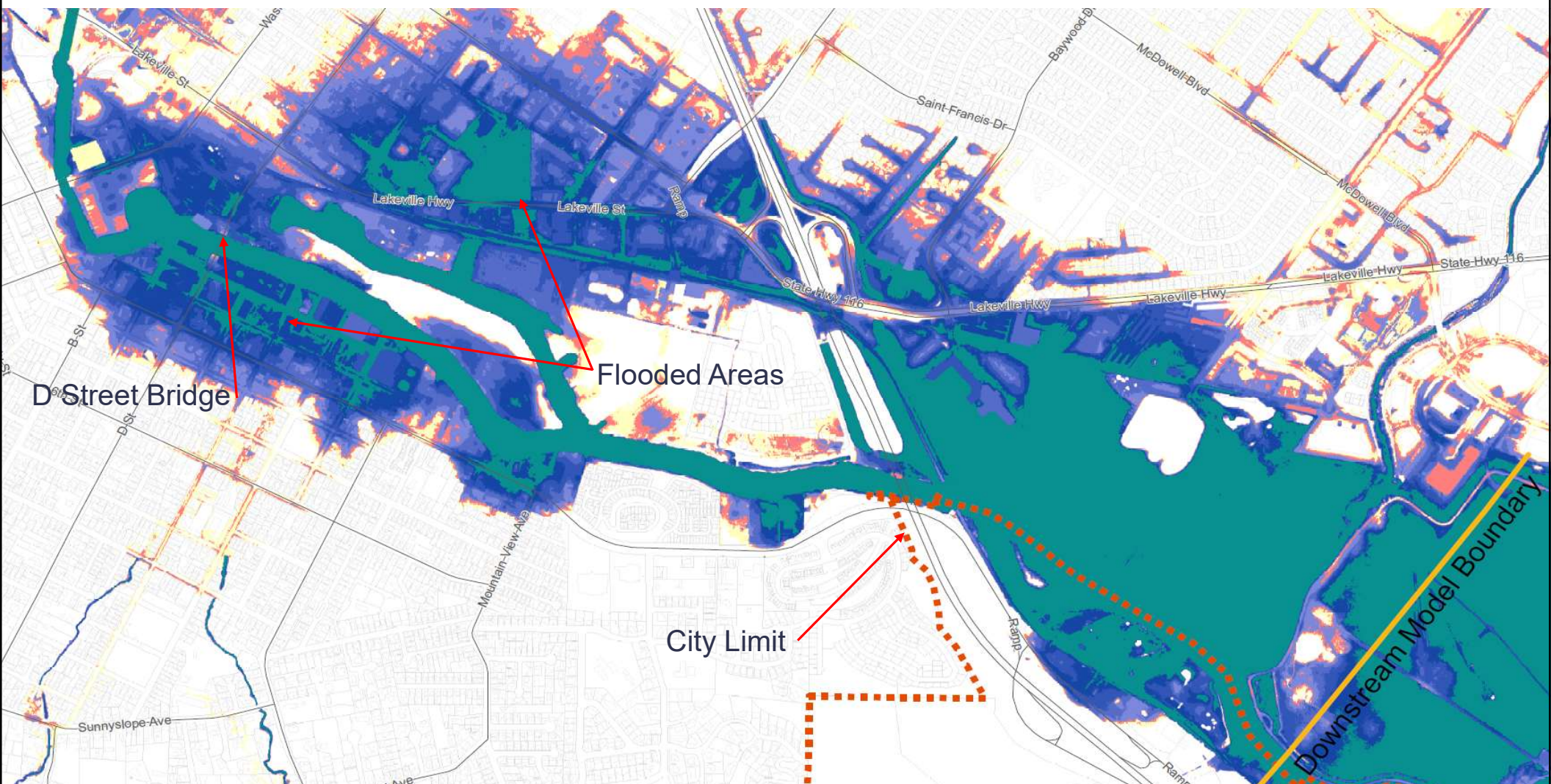


# Very Low Probability, End of Century SLR (6.9'), Storm Surge



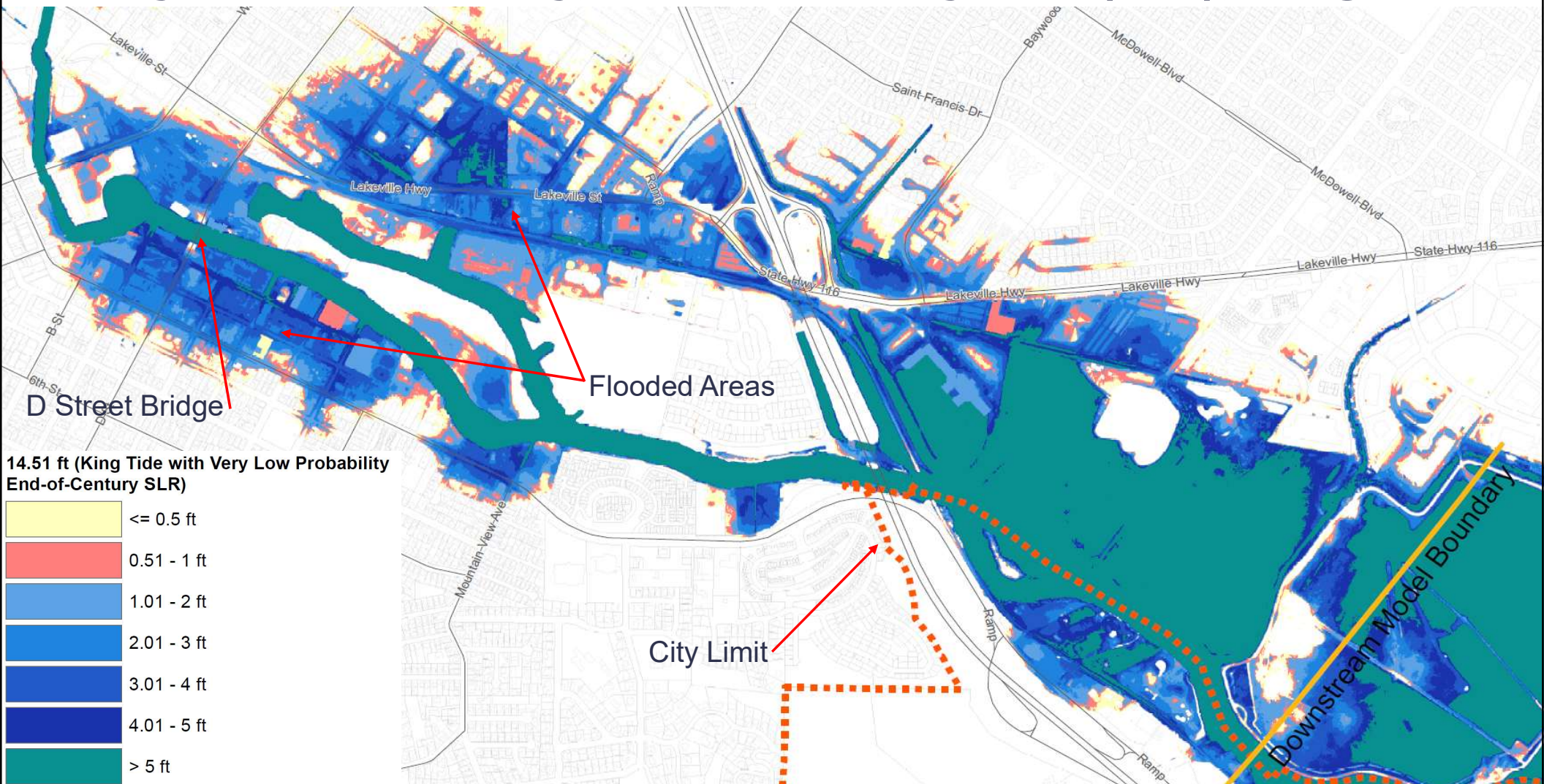


# Very Low Probability, End of Century SLR (6.9'), Storm Surge



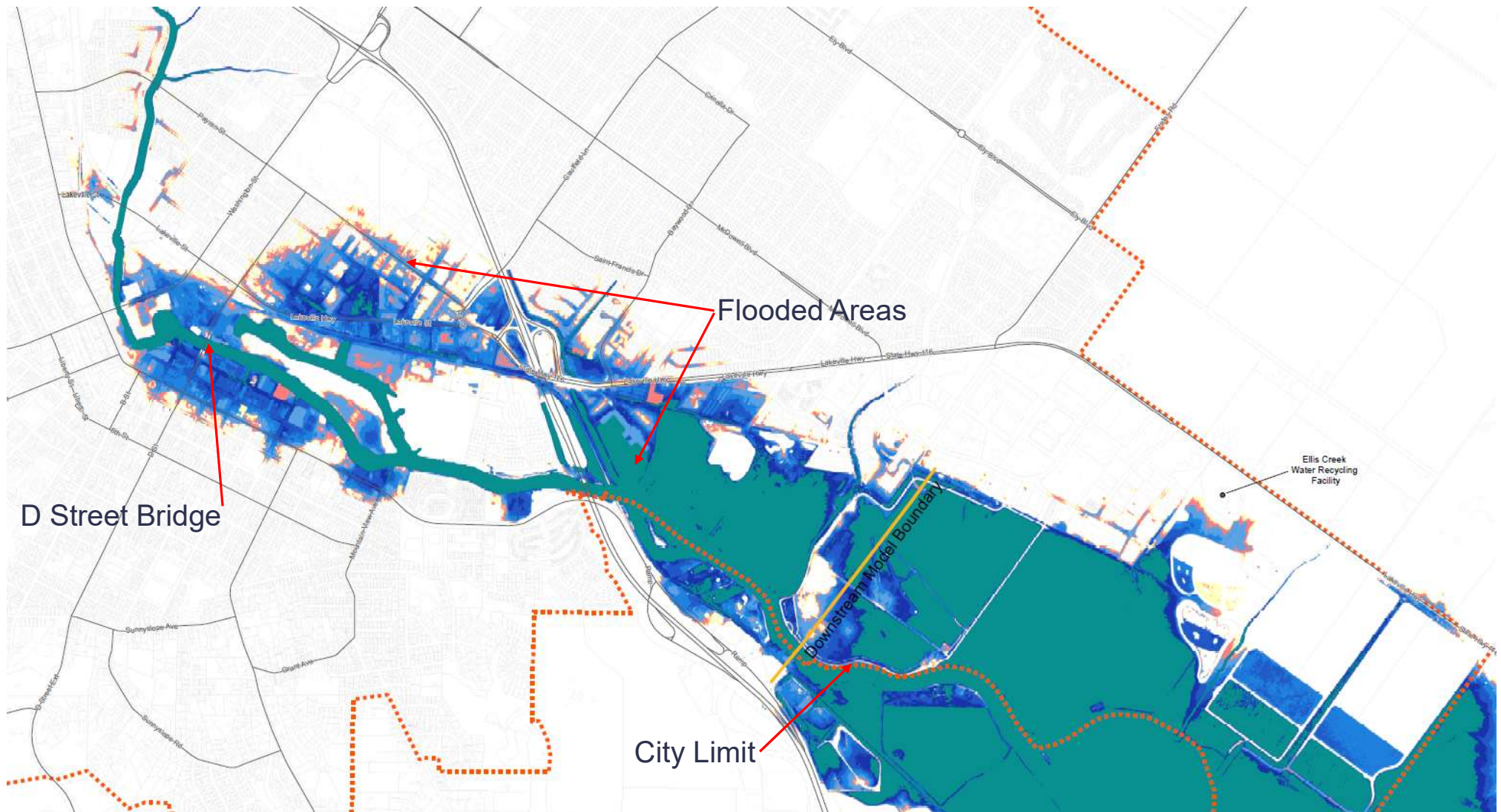


# Very Low Probability, End-of-Century SLR (6.9'), King Tide





# Very Low Probability, End of Century SLR (6.9'), King Tide





# Draft Flood Resiliency Framework

General Plan Frameworks set

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## Planning for the Future

New flood data and maps guide the **General Plan Update** with predictions of potential future floods



# General Plan Update

## Proposed Flood Resiliency Framework

Goal FR-1: Safe from the current flood

**Policy Areas**  
FR-1.1: Model and map current floods

**Policy Areas**  
FR-1.2 & FR-1.3: Use current 100 year and 500 year floods to guide construction standards

Goal FR-2: Understand the future flood

**Policy Area**  
FR-2.1: Model climate flood projections with the best science

**Policy Area**  
FR-2.2: Develop and adopt Climate Flood Hazard Maps

Goal FR-3: Flood Adaptation Master Plan

**Policy Area**  
FR-3.1: Design detailed adaptation plans for different parts of the City

**Policy Area**  
FR-3.2: Evaluate changing demographics of flood impacts

Goal FR-4: Prepared for flood recovery

**Policy Area**  
FR-4.1: Plan post-flood recovery standards and equity goals

Goal FR-5: Future looking plans and regulations

**Policy Area**  
FR-5.1: Reduce climate flood vulnerability with land-use planning and regulatory standards

Goal FR-6: Safe against rising floods

**Policy Area FR-6.1:** Build resilient Capital Improvements

**Policy Area FR-6.2:** Build multi-benefit nature based flood protection

**Policy Area FR-6.3:** Develop sustainable funding

**Policy Area FR-7.1:** Expand public education of climate flood risk

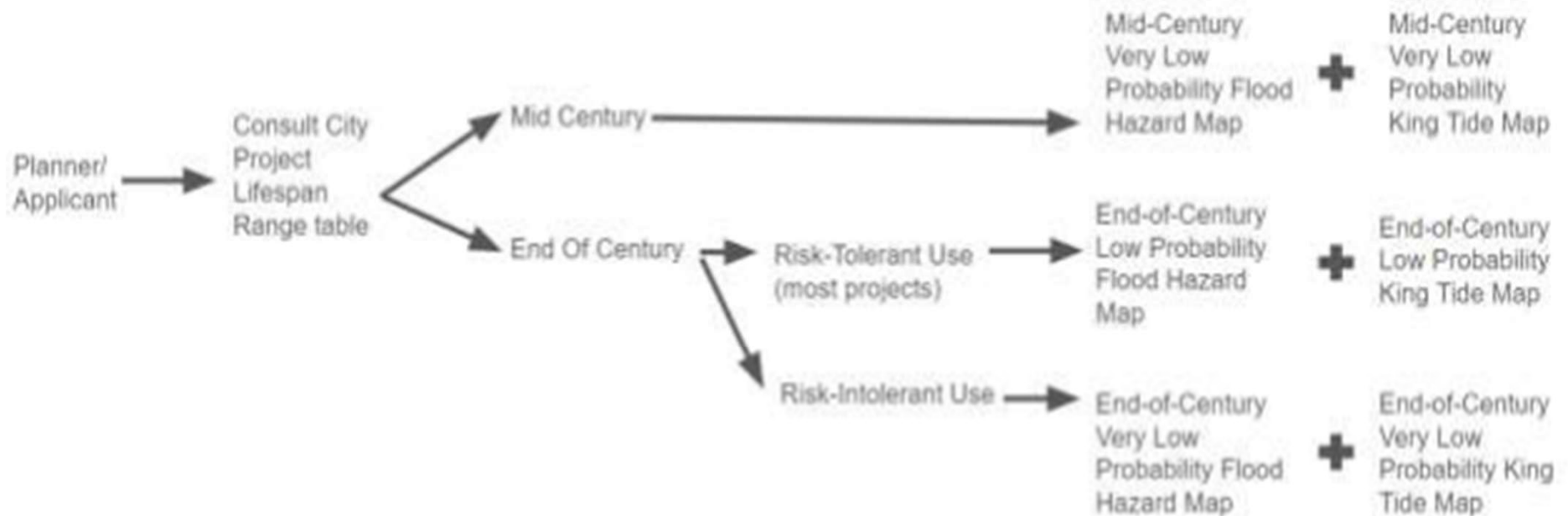
**Policy Area FR-7.2:** Build regional partnerships

**Policy Areaa FR-7.3 and FR-7.4:** Encourage development and community to protectively adapt

Goal FR-7: Empower stakeholders

## General Plan Update Proposed Flood Resiliency Framework

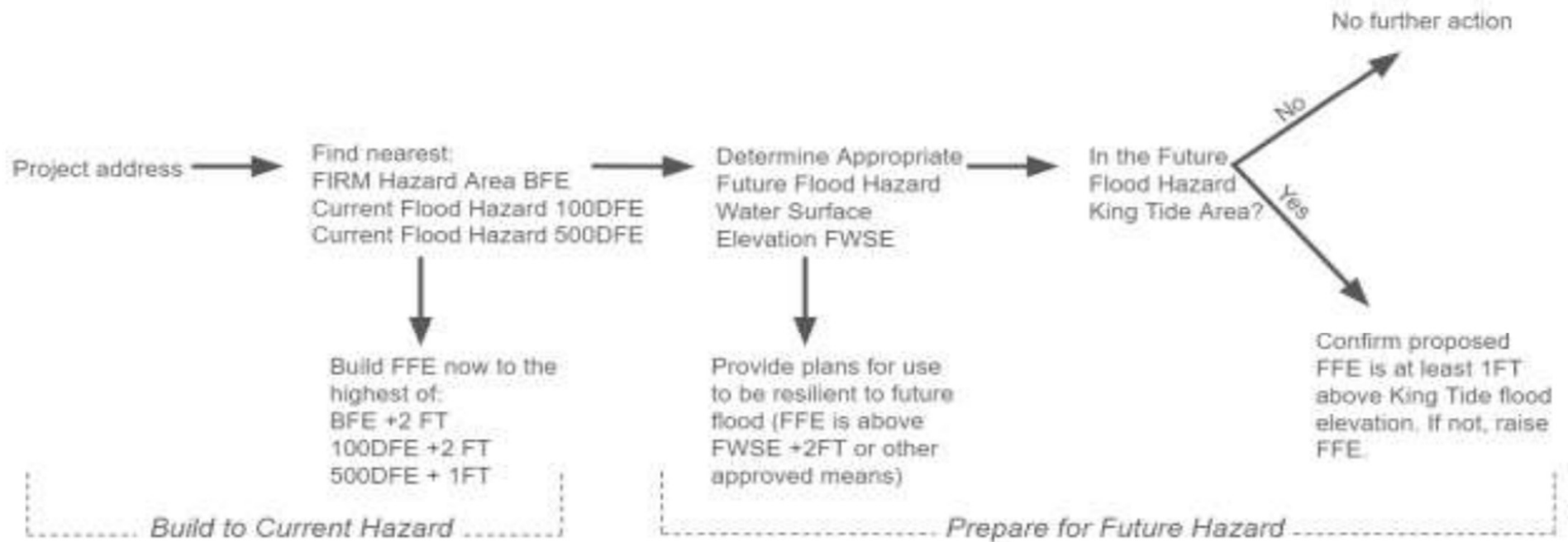
**Figure 2: Selection Process of Appropriate Future Flood Hazard Maps**





## General Plan Update Proposed Flood Resiliency Framework

**Figure 11: A summary of the steps a project applicant or planner would use to determine the flood resilience building standards applicable to their project**



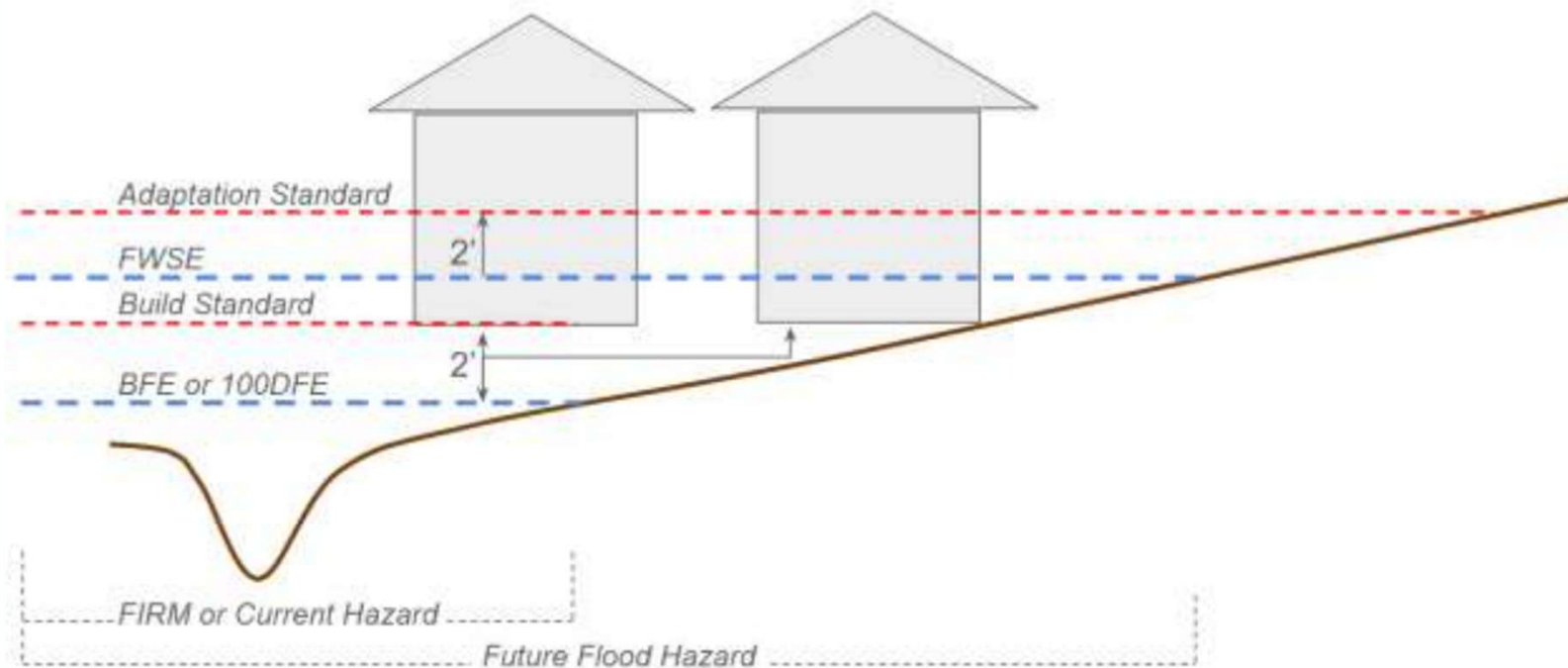
## General Plan Update Proposed Flood Resiliency Framework

Proposed Flood Resilience Standards Summary			
Map	Requirement	Impacted by King Tides	Not Impacted by King Tides
<b>Mid-Century Very Low Probability Flood Hazard Map</b>  (Applicable to any short-lived uses)	<b>Required Finished Floor Elevation</b>	2' above FIRM BFE and 100DFE, and 1' above 500DFE	
	<b>Adaptability Standard</b>	FFE 2' above Hazard Map FWSE, or other means	
<b>End-of-Century Low Probability Flood Hazard Map</b>  Applicable to any Risk-Tolerant uses (retail, residential, etc.)	<b>Required Finished Floor Elevation</b>	2' above FIRM BFE and 100DFE, and 1' above 500DFE and King Tide KWSE	2' above FIRM BFE and 100DFE, and 1' above 500DFE
	<b>Adaptability Standard</b>	FFE 2' above Hazard Map FWSE, or other means	
<b>End-of-Century Very Low Probability Flood Hazard Map</b>  Applicable to any Risk-Intolerant uses (hospital, emergency shelter, etc.)	<b>Required Finished Floor Elevation</b>	2' above FIRM BFE and 100DFE, and 1' above 500DFE and King Tide KWSE	2' above FIRM BFE and 100DFE, and 1' above 500DFE
	<b>Adaptability Standard</b>	FFE 2' above Hazard Map FWSE, or other means	



## General Plan Update Proposed Flood Resiliency Framework

**Figure 12: Demonstrating how projects that are within a future flood hazard map but are outside the FIRM or Current 100-Year Flood Hazard Map will reference the nearest BFE or 100DFE to set their FFE standard, see FR-5, General Plan Standards**



# Floodplain Management in Petaluma

- Updated models will inform General Plan policies and zoning ordinance.
- Critical information for flood management projects.
- Improve current Class 6 standing in the FEMA NFIP Community Rating System (CRS)
  - Utilize higher regulatory standards
  - Enhance natural flood management & maintenance solutions
  - Identify priority parcels for mitigation





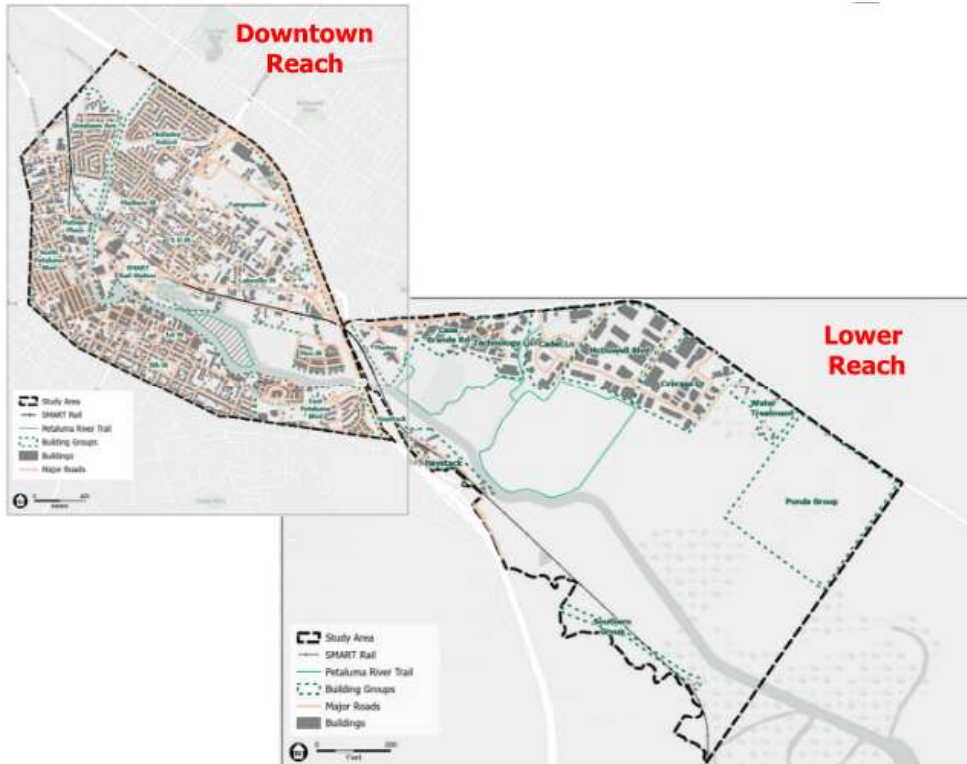
# Next Steps in Petaluma Floodplain Management



## Active Partnerships for SLR Planning

North Bay Water Reuse Authority  
(NBWRA): Draft Petaluma SLR  
Adaptation Vision and Strategies

Sonoma County – Joint/Regional  
OPC Grant Application for Flood  
Adaptation & Data Gap Analysis



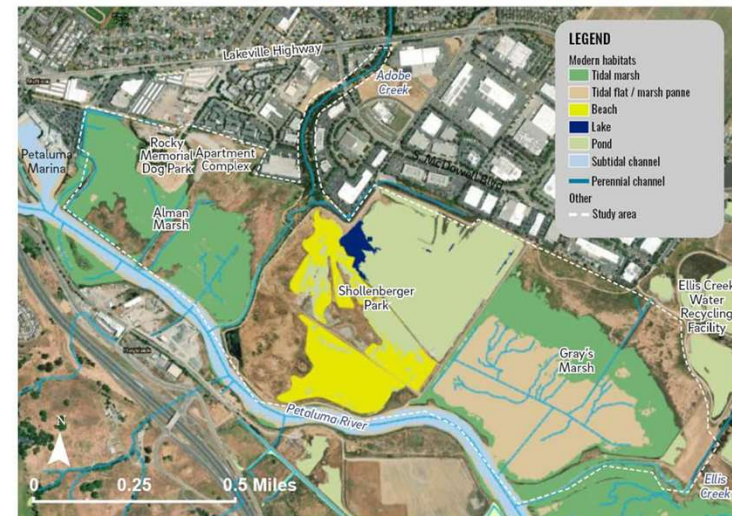
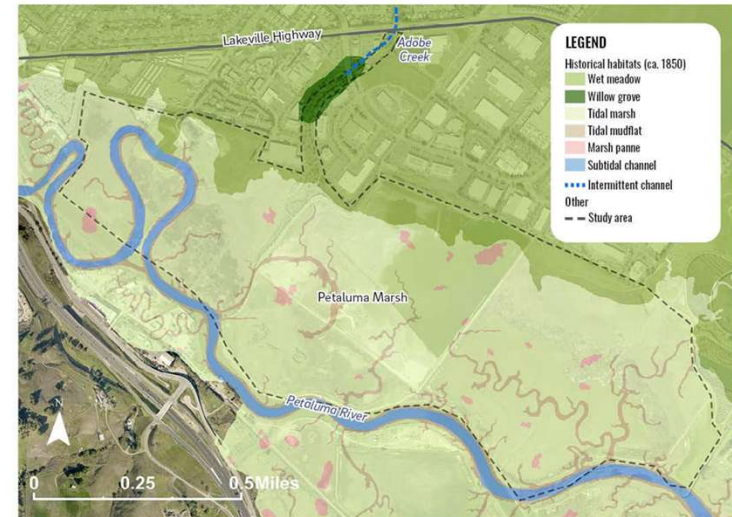
# Next Steps in Petaluma Floodplain Management



## Active Partnerships for SLR Planning

SFEI San Francisco Estuary  
Institute - Sediment Solutions

Adobe Creek Baylands –  
Restoring Sediment Pathways





# Partnering with USACE WRDA Restoration Study @ Shollenberger, Alman, and Gray's Marsh



- Environmental restoration feasibility study of the Petaluma marsh area,
- Continuing off SFEI's Lower Adobe Creek Visioning work.
- Study options for beneficial reuse + multi-benefit project to reconnect Alman Marsh, Shollenberger, and Grays Marsh
- Restore tidal marshlands and offer SLR protection in this area.

# Next Steps in Petaluma Floodplain Management



## Update SLR Maps OPC 2024 & FEMA FIRM Approvals

Currently reviewing and developing SLR map updates for consistency with newly released OPC Guidance ; complete FEMA process for new FIRMS



## Flood Adaptation Master Plan

Funding through OPC, will integrate findings from both grants into a comprehensive, long-term strategy for flood mitigation.



## CRS Rating improvement

Implementing higher standards to improve CRS to Class 5

Further reduce flood insurance costs to residents in floodplain



# Questions

*August 14, 2025*

