

ARCCA Learning Session

Cost-Benefit Analysis for Sea Level Rise Adaptation Scenarios



Wednesday, March 21st | 1:00 – 2:00 PM PST

Learning Session Agenda

- Webinar Logistics
- Brief overview of ARCCA
- Featured Presentation
- Participant Q&A
- Closing remarks

About ARCCA

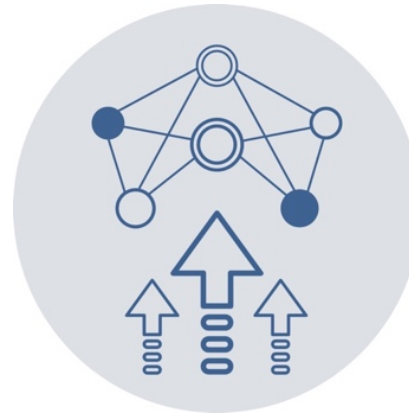
A network of leading regional collaboratives from across California that work together to advance adaptation statewide and increase local capacity to build community resilience.



Peer-to-Peer Network



Knowledge Exchange

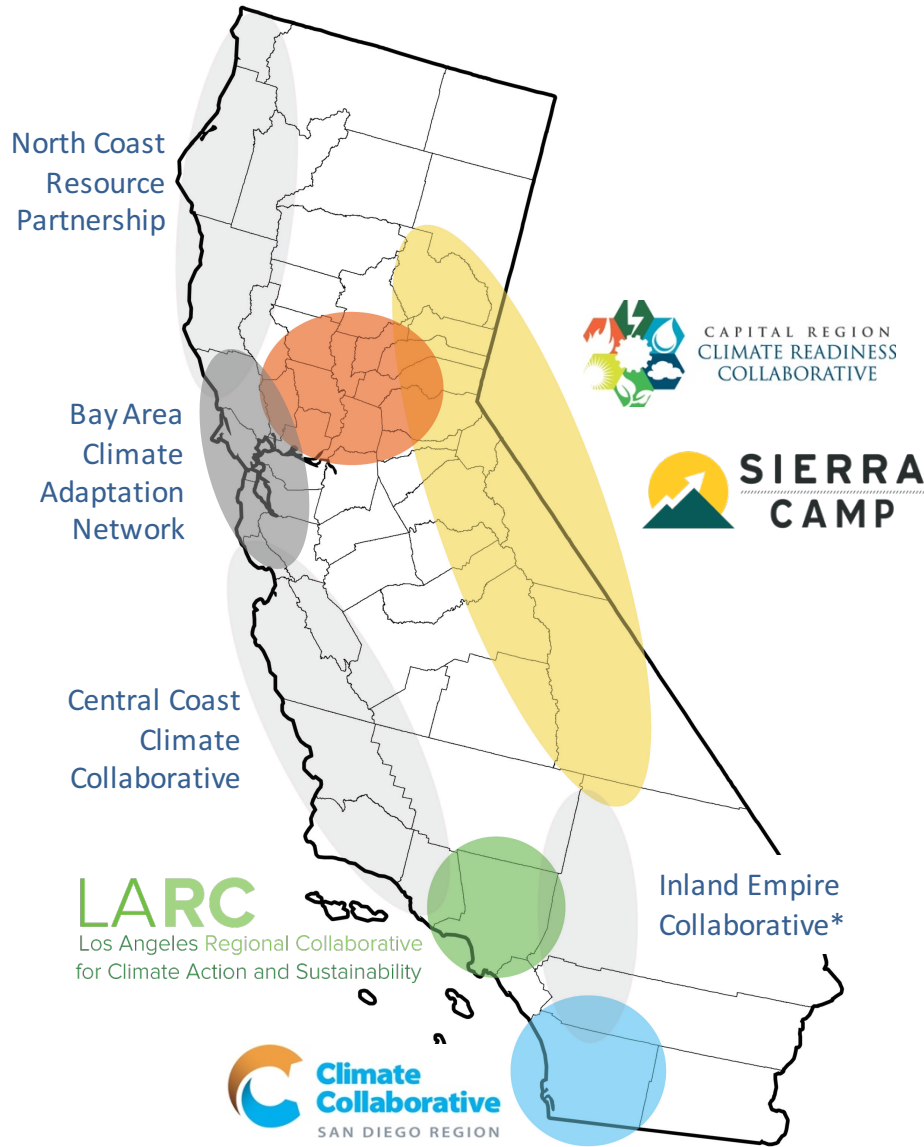


Emerging Collaboratives



State Engagement

ARCCA Members



Coordinator



Local Government Commission
Leaders for Livable Communities

State Liaison



Affiliates



Four Twenty Seven
Climate Solutions



Point Blue
Conservation Science



The California State University
OFFICE OF THE CHANCELLOR

GEORGETOWN
CLIMATE CENTER

CADMUS

Presenters



Laura Engeman

Program Manager

Center for Climate Change Impacts & Adaptation
Scripps Institution of Oceanography



Amanda Lee

Principal Planner/Long Range Planning Manager
Planning and Community Development
City of Del Mar



Resilient Coastlines Project of Greater San Diego:

*Connecting local governments,
regional science and communities*

Laura Engeman
March 20, 2018





26 Members

11 Cities

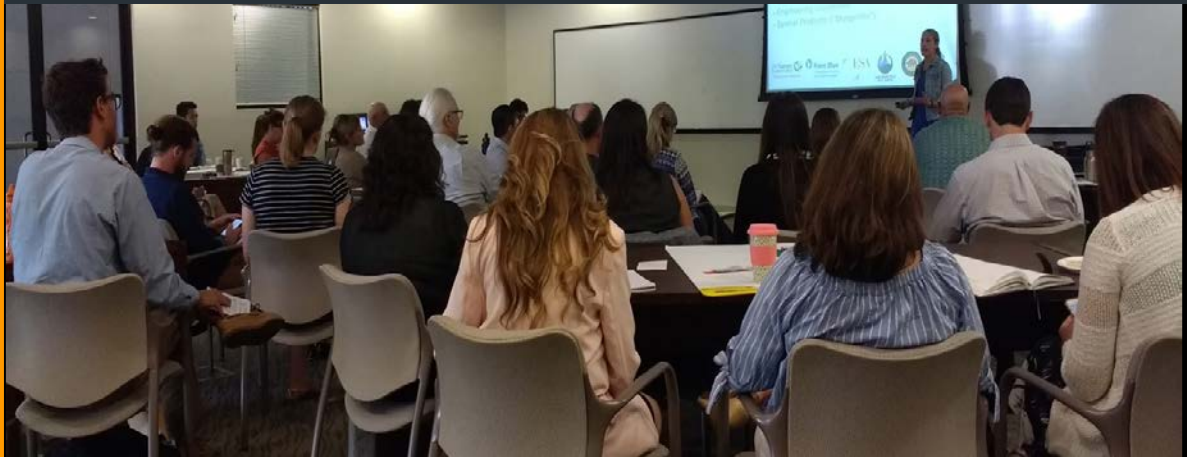
5 Regional Agencies

4 Universities

4 Non-Profits

San Diego Gas & Electric

The San Diego Foundation





NOAA Award

\$689,500

NOAA Regional
Coastal Resilience
Grant Program

Directly support
community-based
coastal hazard
planning





14+ Coastal Resilience Projects Across San Diego County

Coastal Resilience Activities Occurring in San Diego County



Sea Level Rise and Coastal Resilience Efforts

Airport

Carlsbad

Del Mar

Encinitas

Imperial Beach

Navy

Oceanside

San Diego Bay

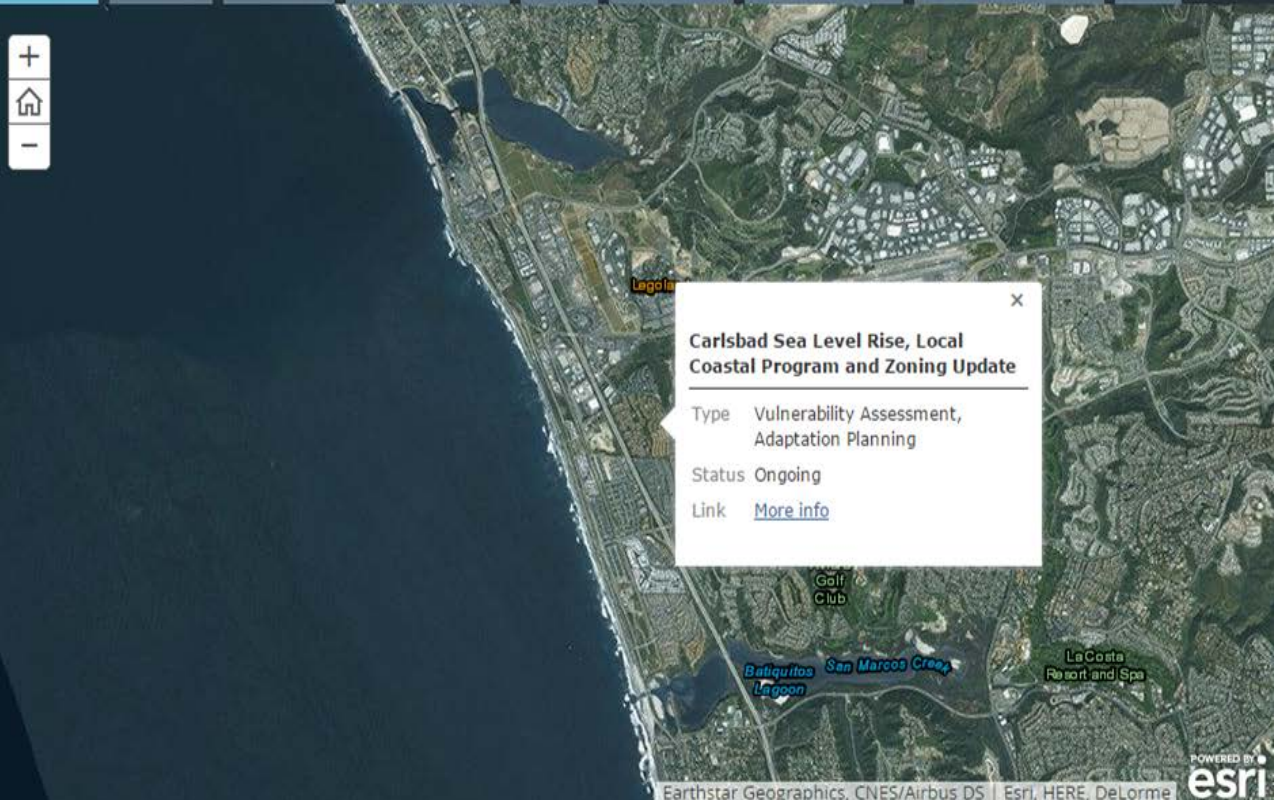
San Diego County



City of Carlsbad Sea Level Rise, Local Coastal Program and Zoning Update



The city of [Carlsbad's Vulnerability Assessment](#) presents a Carlsbad-specific sea level rise analysis to support and update the city's Local Coastal Program and Zoning Ordinance. The assessment evaluates the degree to which important community assets are susceptible to, and unable to, accommodate adverse effects of projected sea level rise. The assessment identifies the assets that are likely to be impacted and the causes and components of each asset's vulnerability.



Carlsbad Sea Level Rise, Local Coastal Program and Zoning Update

Type Vulnerability Assessment, Adaptation Planning

Status Ongoing

Link [More info](#)



Regional Work Group

- State / Navy Engagement
- Local Science
- Regional Consistency & Coordination
- Regional Needs & Opportunities



Comparing Sea Level Rise Adaptation Strategies in San Diego: An Application of the NOAA Cost-Benefit Framework



The Approach: A Comparative Study

of Benefits – PV of Co

$$+ B_s + \frac{\left(\frac{B_r + B_p + B_s}{(1+i)^2}\right)(1 - \frac{1}{1+i})}{1 - \frac{1}{1+i}}$$

$$+ \frac{\left(\frac{C_m}{(1+i)^2}\right)(1 - \frac{1}{1+i})}{1 - \frac{1}{1+i}}$$

Final Report

What Will Adaptation Cost? An Economic Framework for Coastal Community Infrastructure

June 2013

Eastern Research Group, Inc.

Written under contract for the
National Oceanic and Atmospheric Administration (NOAA)
Coastal Services Center

NOAA Coastal Services Center
(843) 740-1200
www.csc.noaa.gov



NOAA Coastal Services Center
LINKING PEOPLE, INFORMATION, AND TECHNOLOGY

The Approach: A Comparative Study

1. Understand Your Baseline Risk

Task 1: Select Appropriate Local Sea Level Rise Scenarios

Task 2: Develop High Water-Level Event Scenarios

Task 3: Assess Exposed Infrastructure for Your No-Action Scenario

2. Assess What You Can Do Differently

Task 1: Select Adaptation Strategies to Form Action Scenarios

Task 2: Re-Assess Exposed Infrastructure for Each Action Scenario

3. Calculate Costs and Benefits

Task 1: Identify Impacts

Task 2: Monetize Impacts

Task 3: Estimate Costs of Implementing Adaptation Strategies

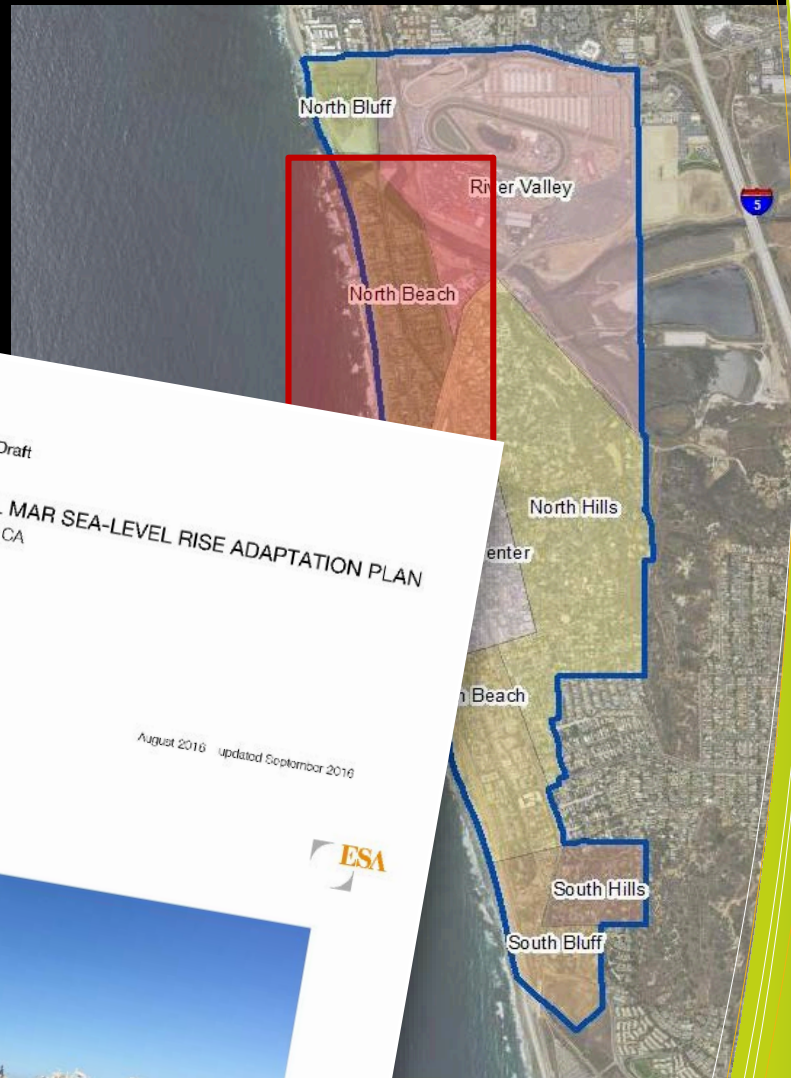
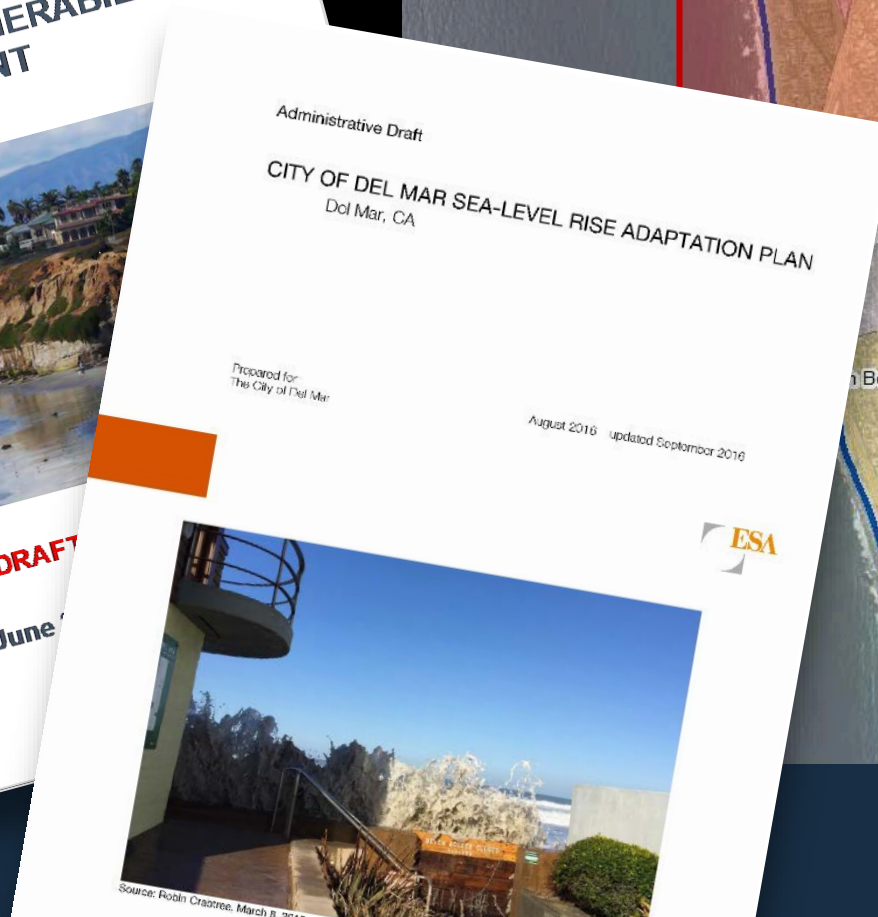
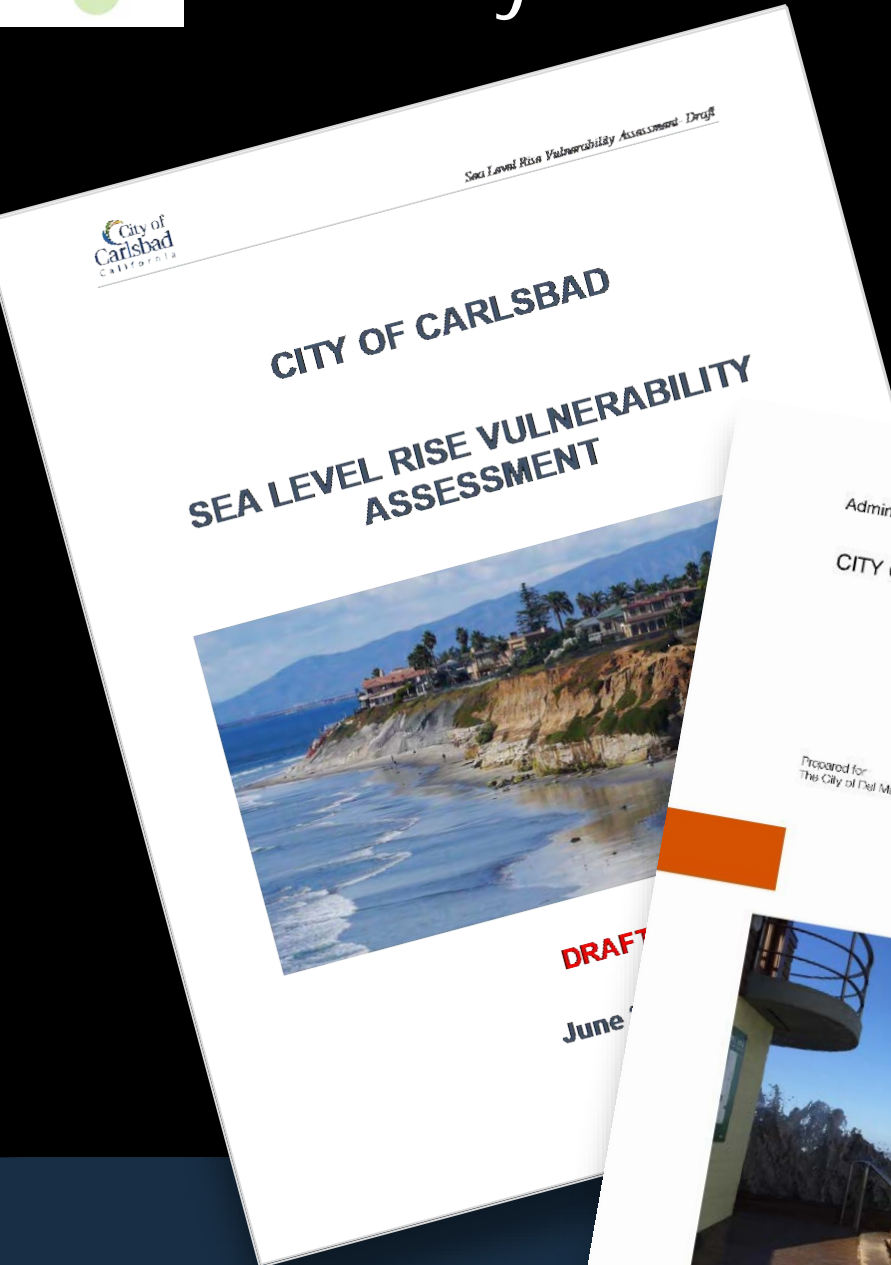
4. Make a Decision

Task 1: Calculate Total Benefits of Each Action Scenario

Task 2: Compile Capital and Maintenance Costs

Task 3: Assess Each Action Scenario

Study Areas – Del Mar & Carlsbad



Adaptation Strategies



Beach Sand Nourishment



Seawalls & Revetments



Groins



Elevate Structure

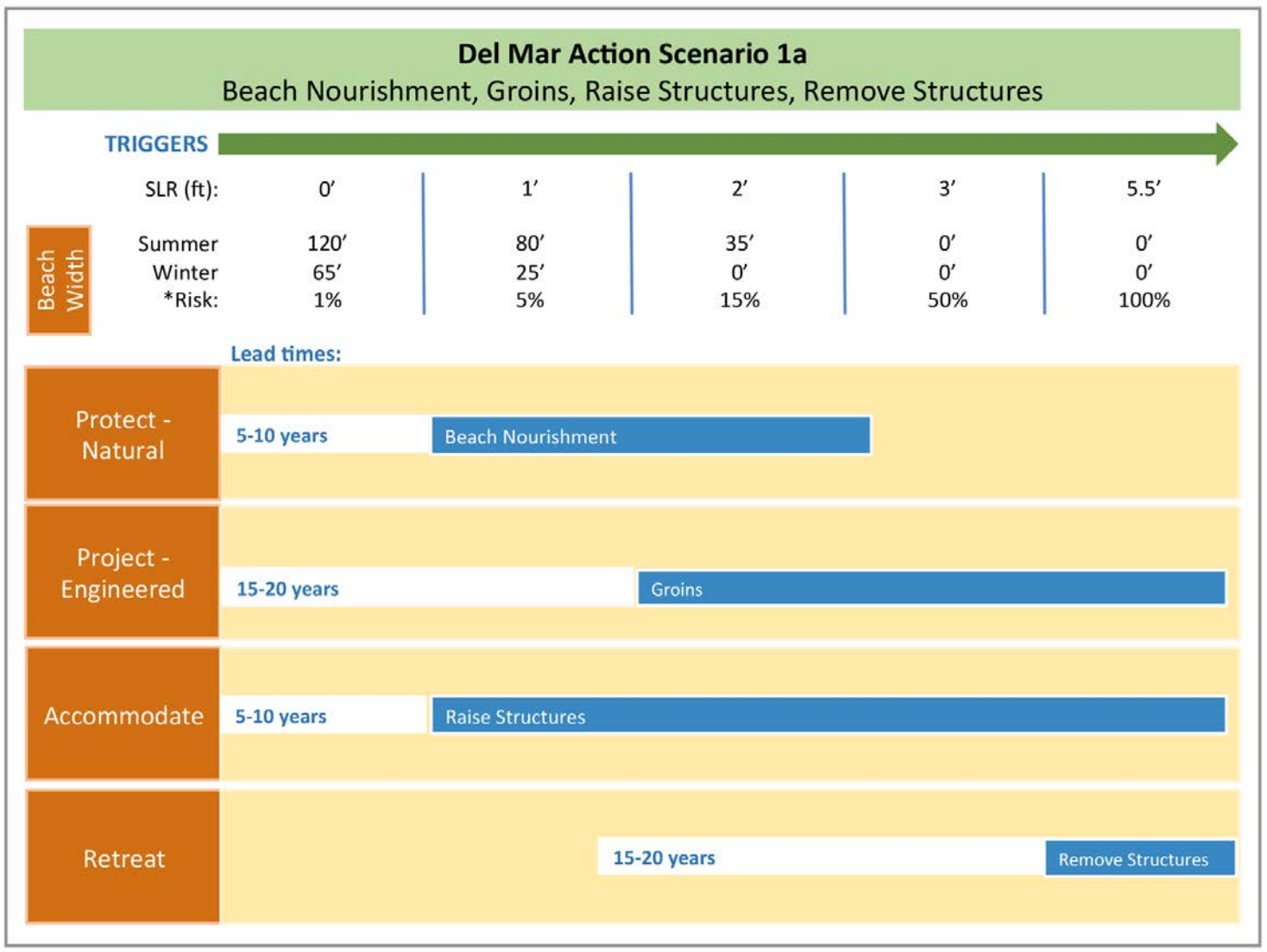


Remove Structure



Action Scenarios

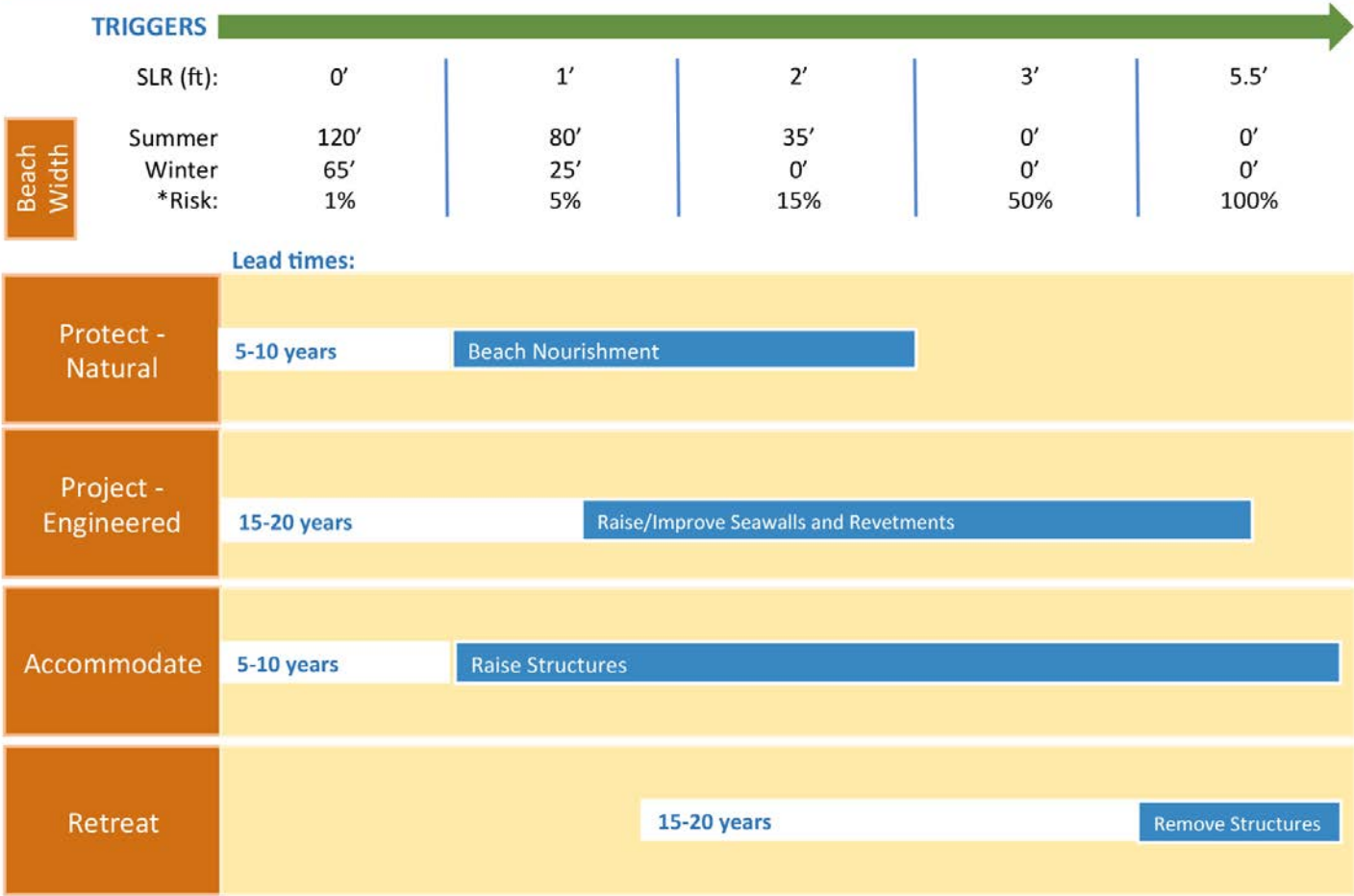
Del Mar Action Scenarios



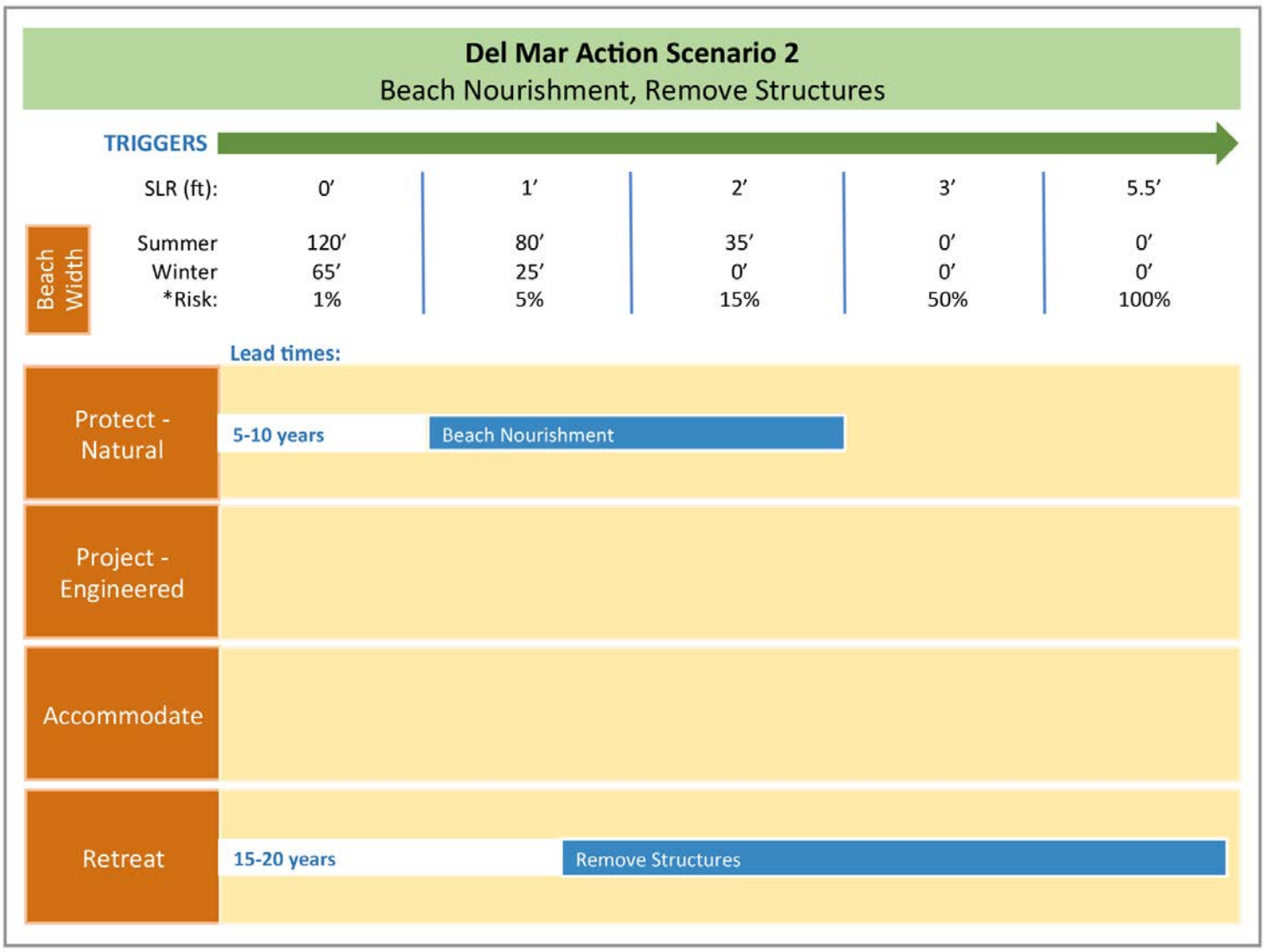
Del Mar Action Scenarios

Del Mar Action Scenario 1b

Beach Nourishment, Seawalls/Revetments, Raise Structures, Remove Structures



Del Mar Action Scenarios



Cost-Benefit Model

1. Monetized NO ACTION SCENARIO: baseline risk primary and secondary impacts, which represent the maximum damages prevented
2. Monetized LOSSES IN SCENARIOS: negative impacts resulting from action scenarios (i.e. property tax revenues)
3. Costs of adaptation strategies
4. Benefits of each action scenario
5. Capital and maintenance costs

The Model: Benefits

Primary Impacts

- City property and structures
- City public infrastructure
- City transportation infrastructure
- Residential property (structure and tax revenue)
- Commercial and industrial property (structure and tax revenue)
- Beaches

Secondary Impacts

- Loss of beach tourism revenue to businesses
- Loss of beach tourism city tax revenue due to chronic inundation
- City cleanup for flooding events
- Emergency response and/or traffic control for flooding events

Net Benefits & Benefit-Cost Ratios

Nourish, groin,
elevate, remove

Nourish, armor
elevate, remove

Nourish, remove

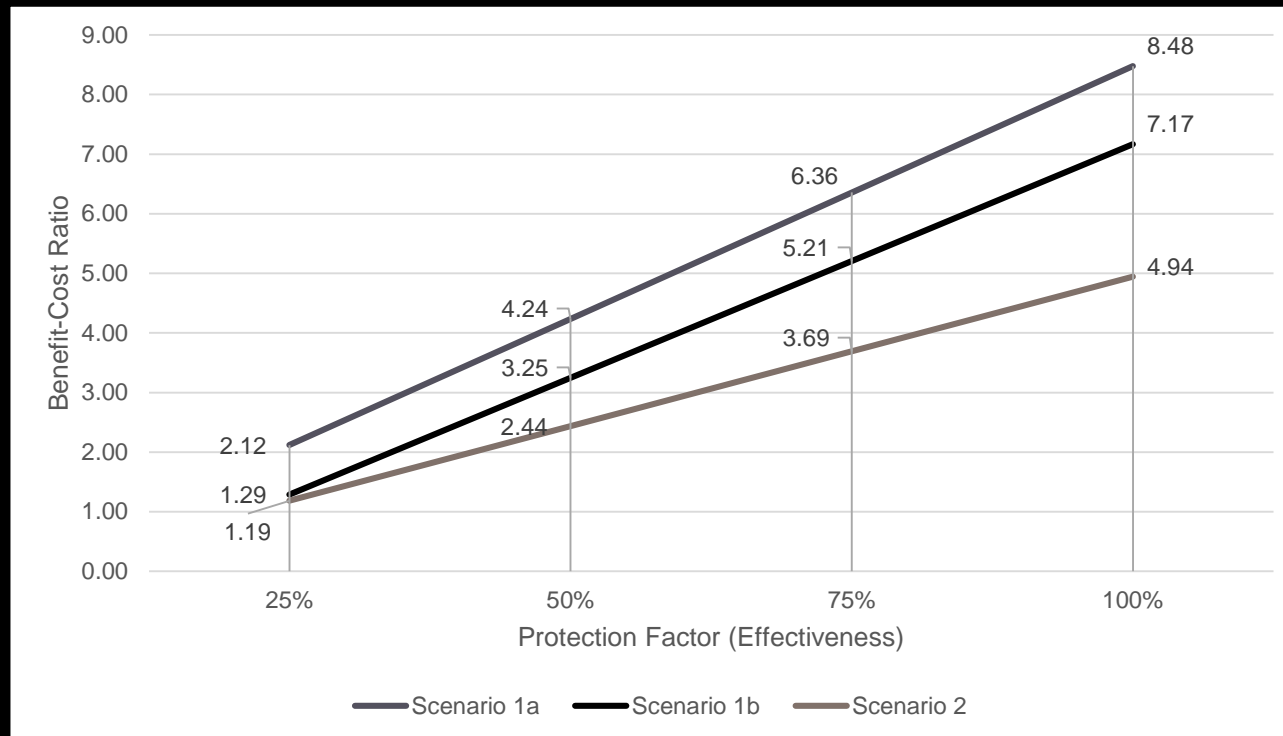
	NPV of Total Benefits (\$million)	NPV of Total Costs (\$million)	Net Benefits (\$million)	Benefit-to- Cost Ratio
Scenario 1a	\$2,470.2	\$335.4	\$2,134.8	7.36
Scenario 1b	\$2,228.2	\$363.2	\$1,865.0	6.14
Scenario 2	\$2,432.2	\$567.3	\$1,864.8	4.29

**** KEY MESSAGES**

- Not just comparing Strategy A to Strategy B
- Ratio reflects benefits of all strategies to NO Action
- These are NET PRESENT VALUES

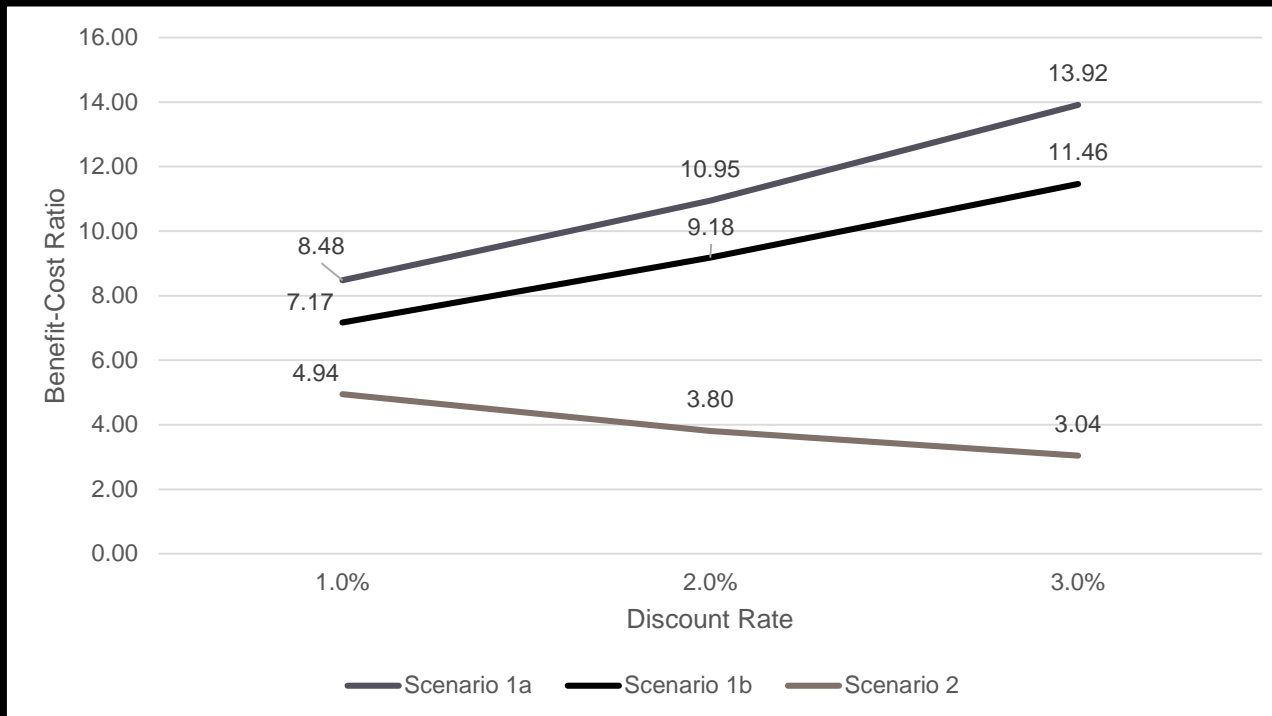
Sensitivity Analysis

Varied Effectiveness Assumption



Sensitivity Analysis

Varied Discount Rates



Lessons Learned

1. The NOAA Framework: Adaptable, but assumes strategies applied in a linear fashion, not overlapping
2. Project and site-specific information is necessary to provide more detailed cost estimates.
3. Different methods for evaluating impacts: FEMA HAZUS = Broad, but high value in investing in GIS and parcel level information for more precise info
4. The value of “ground-truthing” and on-the-ground site inspection – Don’t depend on Desktop tools!
5. The value of collaboration with appropriate agencies



Climate Collaborative

SAN DIEGO REGION

info@sdclimatecollaborative.org

Or Dani Boudreau dboudreau@trnerr.org

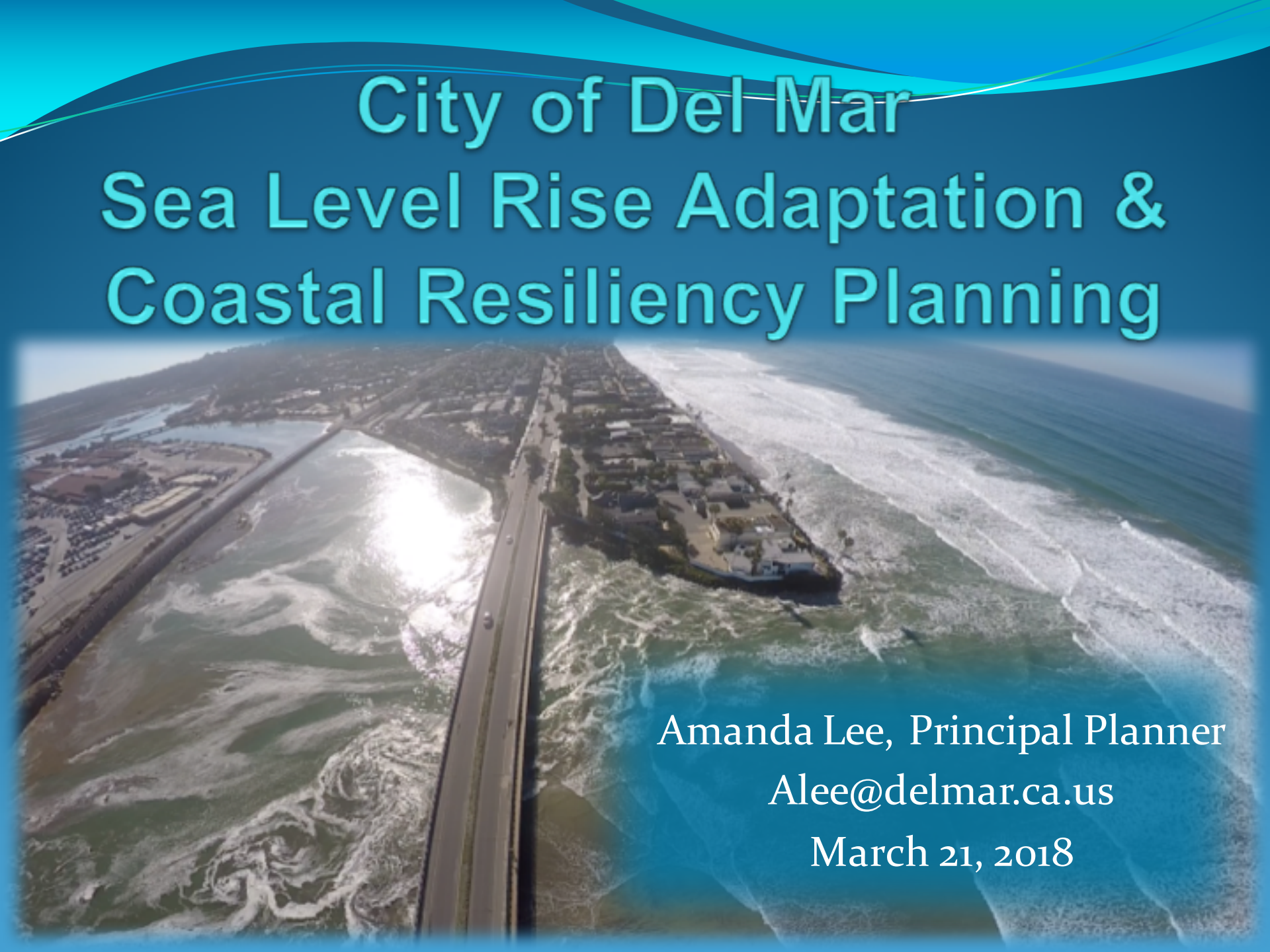
Laura Engeman – lengeman@ucsd.edu

www.resilientcoastlines.org

www.resilientcoastlines.org/leadership

City of Del Mar

Sea Level Rise Adaptation & Coastal Resiliency Planning

An aerial photograph of a coastal highway, likely the San Diego State Route 56, running parallel to the ocean. The highway is a multi-lane road with a median. To the right of the highway is a sandy beach with waves breaking. The ocean is a deep blue, and the sky is clear. The image is used as a background for the presentation slide.

Amanda Lee, Principal Planner
Alee@delmar.ca.us
March 21, 2018

Del Mar, California

- Small beach city in San Diego County
- Less than 2 square miles; ~4,200 people
- Millions of visitors annually
- Walkable beach end-to-end
- San Dieguito Lagoon
- State Fairgrounds/Racetrack
- Beach-level neighborhood (North Beach)
- Development atop coastal bluffs



Photos: Kenneth & Gabrielle Adelman; californiacoastline.org



Adaptation Planning- In Process

- Phased, long-term approach & strong technical basis
- Range of options/flexibility to address local hazards



Background

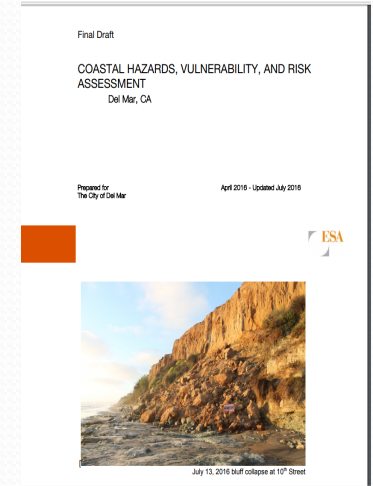


- **City awarded two State Grants 2014/2016 (\$311,220)**
 - Technical reports and to amend Local Coastal Program
 - Environmental Science Associates- technical consultant
- **Established Technical Advisory Committee**
 - Public forum for recommendations to City Council
 - Robust outreach- over 20 public meetings since July 2015
- **Prepared local Vulnerability & Risk Assessment (2016)**
 - Del Mar is vulnerable along ocean interface & Lagoon

What are City's Vulnerabilities?

Projections through year 2100 (5.5 ft of SLR):

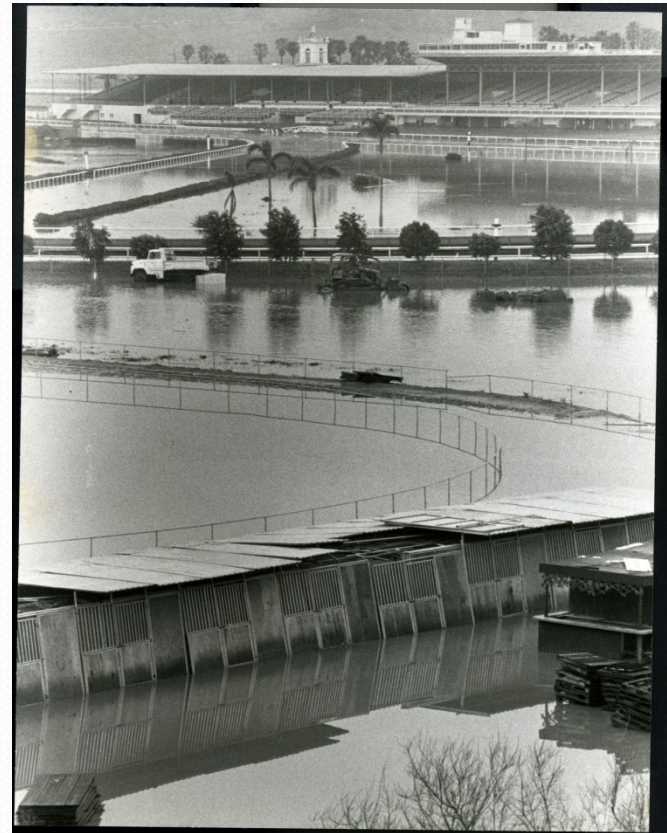
- Narrowing of beach
- Erosion of coastal bluffs
- Increased flooding frequency/damage
- Conversion & loss of Lagoon habitat
- Flooded roads, storm drains, utilities
- Service impacts: fire, public works, sewer, beach access



Extreme Floods like Del Mar-1980



Coast Blvd (1980)



Fairgrounds (1980)

Followed up with Adaptation Plan

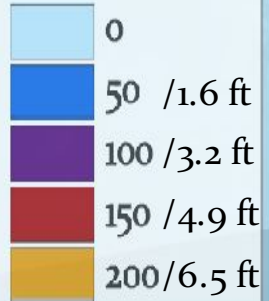
- Resiliency planning for future of Del Mar
- To help property owners (public/private) prepare for projected flooding, erosion, and rising tides
- Align options with community goals & values



Why is Planning Needed?

- To help prepare and mitigate/avoid the worst effects
 - Protect people from risk of harm
 - Help owners plan/protect development per Coastal Act
- Maintain community's desired high quality of life
 - Protect valued assets: beaches, parks, bluffs, Lagoon
- Ensure future of Del Mar will be viable
 - Maintain public infrastructure and essential services

**100-year storm
flood extent**
SLR scenario (cm)



**Worst Case Scenario
(without adaptation)**



Strong Technical/Scientific Basis

- **Best available science-** National Research Council (2012)
- **Coastal Commission Guidance** (2015)
- **Local Vulnerability and Risk Assessment-**(2016)
- **Cost Benefit & Legal Risk Analyses** (2017)
 - Nexus Planning & Research- Cost Benefit Analysis
 - Environmental Law Institute- Legal Risk Analysis

Cost to City of “No Action”

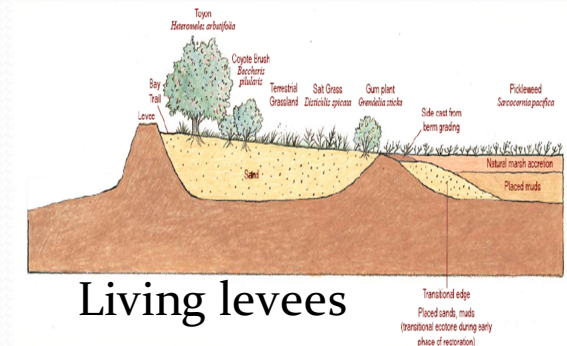
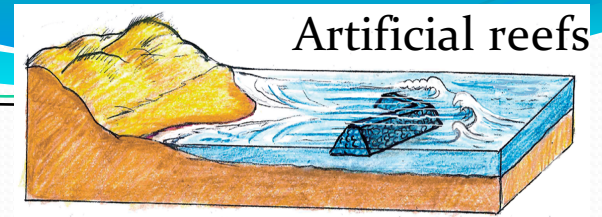
- Risk of harm to individuals (flood/erosion hazards)
- Risk of damage to public assets and infrastructure
- Risk of damage to private property/reduced tax base
- Risk of legal challenges over public trust lands
- Risk of penalties for default on commitment to grant funds
- Risk of reduced municipal bond rating

Nexus Research Study Findings

- Highest Cost to the City of Del Mar:
 - No action
- Next Highest Cost:
 - Planned retreat of North Beach neighborhood
- Highest Return on Investment:
 - Combination of beach nourishment and sand retention

Del Mar AP Strategies

- Beach nourishment
- Sand retention: reefs, groins, breakwater
- Dune restoration
- River channel dredging
- Living levees along river banks
- Elevate/improve sea walls per BPI
- Flood proof, elevate, setback structures
- Relocate highly vulnerable facilities & public infrastructure (essential services)
- Accommodate wetland habitat migration
- Min setbacks from erosion/flood hazards



Sediment Management Plan

Volumes of sand needed- 5 ft SLR

- 900,000 cubic yards/10-11 yrs

Sand nourishment cost estimate

- \$20-25 per cubic yard
- \$9 million every 10 yrs near term
- \$20 million/ 10 yrs long term

Report also includes:

- **River channel dredging plan**



Wetland Habitat Migration Plan

- **Addresses migration/ loss of Lagoon habitat**
 - SLAMM model: Sea level rise affecting marshes
 - Identifies habitat changes & conservation strategies
- **Wetlands have carbon sequestration benefits**
 - Atmospheric CO₂ is held in biomass and soils
 - Degree of benefit changes when habitat type converts
 - Implications for City's greenhouse gas accounting

Challenges of Adaptation

- **Evolving and uncertain nature of climate science**
- **Change in conditions must be monitored**
 - Beach width (sandy beach)
 - Bluff edge (bluff edge to development)
 - Frequency/extent of flood damage (repetitive loss)
- **All options have extensive costs (no perfect solution)**
 - Untested area of law; limited examples
 - Lack of long term funding source
- **Planned retreat was the most controversial issue**

Rationale for No Planned Retreat in Del Mar's North Beach

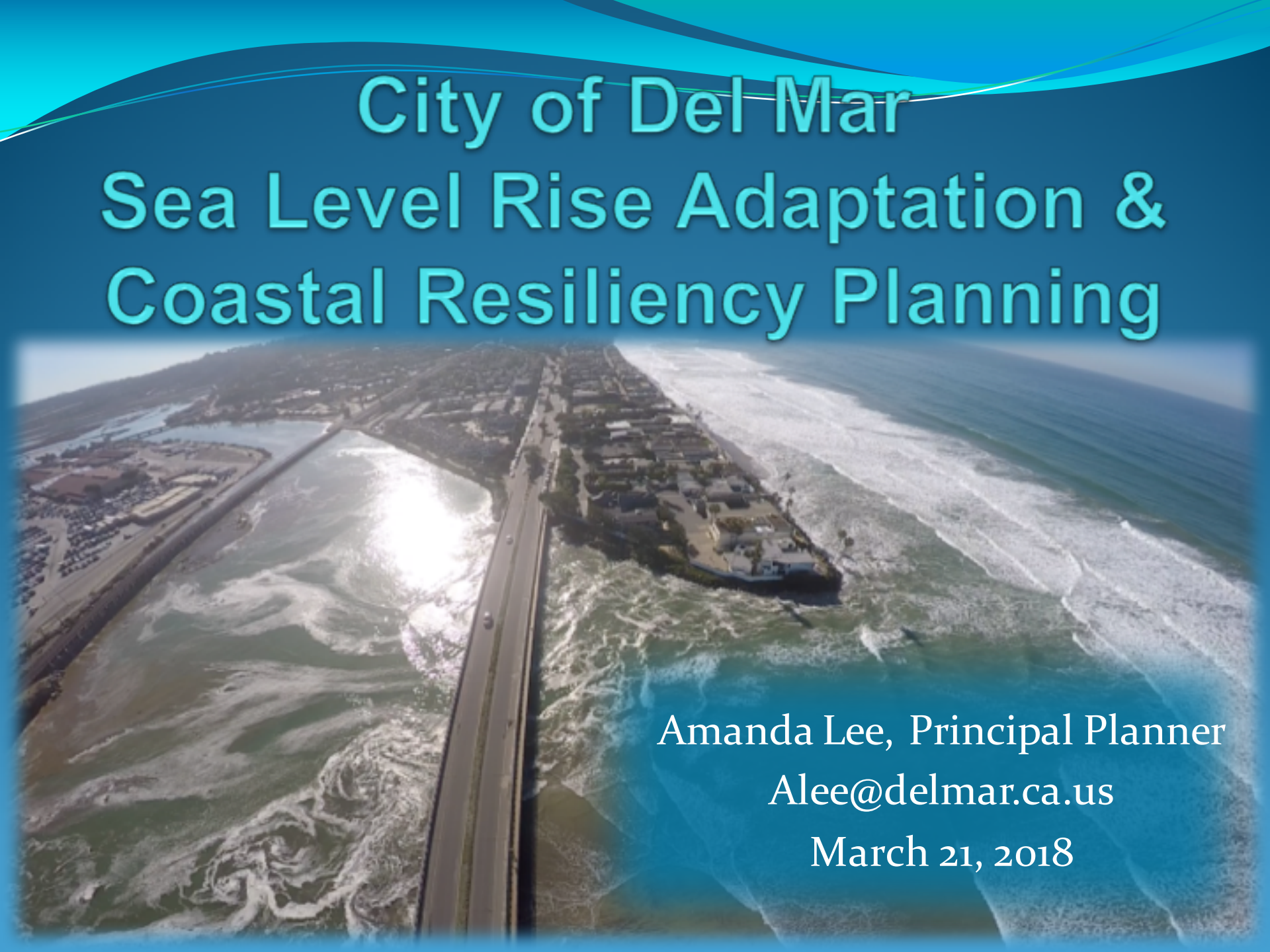
- Conflict w/ Community Plan- century old neighborhood
- Conflict with 1988 voter initiative and certified LCP protections for public beach and property owners
- No confidence retreat can achieve quality beach and access
- High land value makes public acquisition cost prohibitive
- Alternative locations not available for those displaced
- High threat of legal risk if retreat is planned now

Del Mar's Adaptation Plan

- **Follows State guidance and Coastal Act requirements**
- **Uses best available science- strong technical basis**
- **Addresses identified local vulnerabilities and risks**
- **Process involved robust public outreach**
- **Plan includes wide range of adaptation options**
- **Explains how City approach best meets goals & priorities**

City of Del Mar

Sea Level Rise Adaptation & Coastal Resiliency Planning

An aerial photograph of a coastal area. A multi-lane highway runs vertically through the center of the image. To the left of the highway is a body of water, possibly a lagoon or bay, with some land and buildings visible. To the right of the highway is a sandy beach and the ocean. Waves are breaking on the shore. The sky is blue with some clouds.

Amanda Lee, Principal Planner
Alee@delmar.ca.us
March 21, 2018

Thank You!

- Resilient Coastlines Project of Greater San Diego
 - resilientcoastlines.org
- Upcoming ARCCA Learning Sessions
 - Navigating Coastal Resilience Strategy Development (3/30)
 - Adaptation Clearinghouse Beta Testing (4/18)
 - Learn more at arccacalifornia.org/resources/learning-sessions
- New ARCCA Resources
 - 2018 Legislative Tracking: arccacalifornia.org/2018-legislative-tracking
 - Roadmap to Transportation Resilience: arccacalifornia.org/roadmap-to-resilience