City of Del Mar Local Coastal Plan (LCP) Amendment for Sea Level Rise and Coastal Flooding

6/22/17 Presentation to Sea Level Rise Stakeholder-Technical Advisory Committee (STAC)

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ESA

ESA is where solutions and service meet.

Overview

1. Comparison of:
   - Del Mar Costal Hazards, Vulnerability, and Risk Assessment (CHVRA) (ESA 2016)
   - CoSMoS 3.0 Phase 2 (USGS 2017)
   - FEMA Preliminary Flood Insurance Rate Maps (2017)
2. Overview of approach for:
   - Del Mar Sediment Management Plan
   - San Dieguito Lagoon Habitat Vulnerability Assessment

Del Mar CHVRA (ESA 2016)

Analyzed increase in hazards with sea-level rise (SLR):

- Beach erosion
- Coastal flooding
- Bluff erosion
- River flooding

Del Mar CHVRA (ESA 2016)

Comparison of CHVRA assessments:

- Beach erosion - CoSMoS
- Coastal flooding – CoSMoS, FEMA

Not comparing:

- Bluff erosion – used CoSMoS
- River flooding
  - Used FEMA river flood extent as basis for CHVRA
  - Extreme river flooding not analyzed by CoSMoS

Beach Erosion Assessments

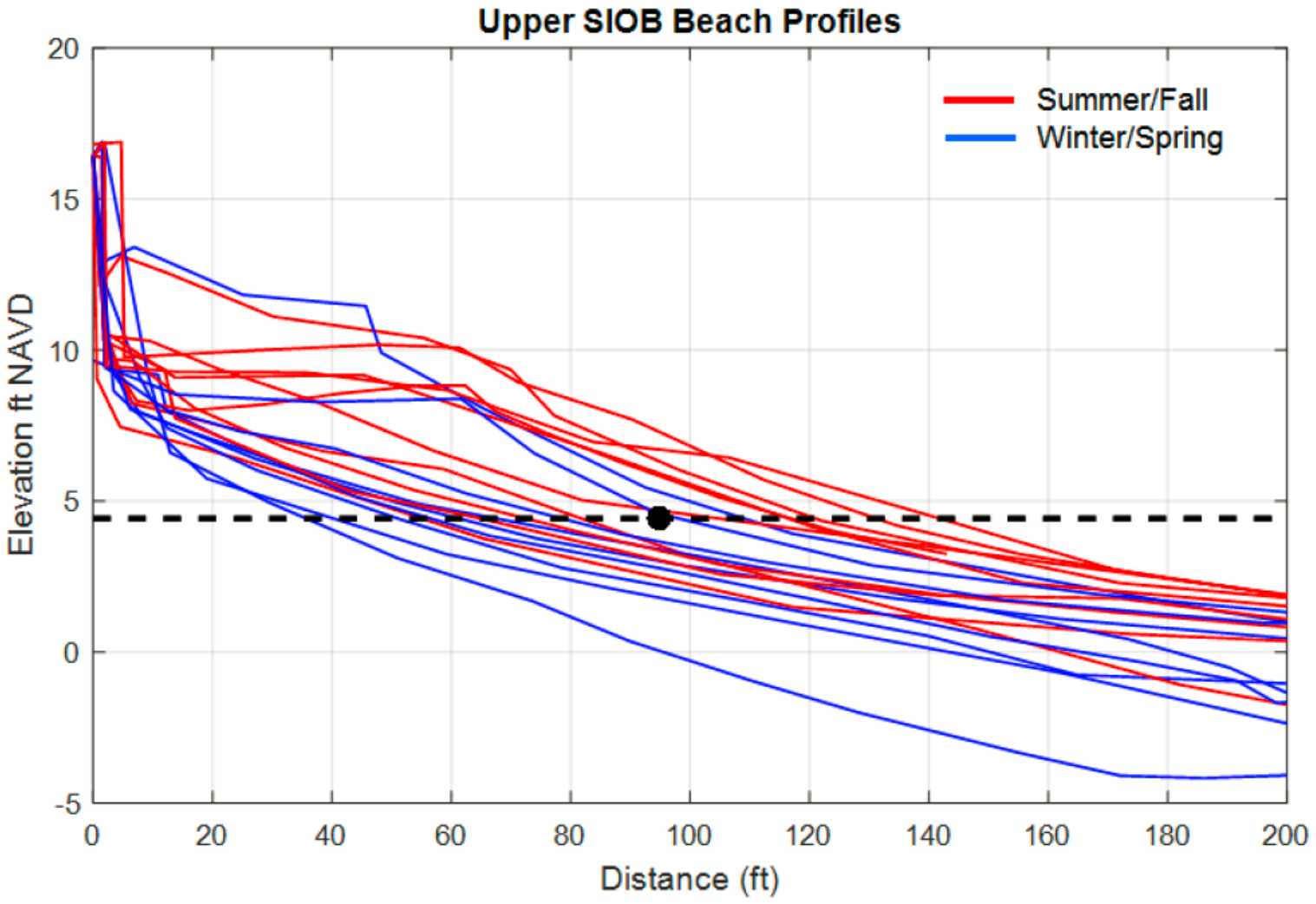
1. Del Mar CHVRA (ESA 2016)
   - Bruun Rule
   - Average beach width with winter/summer range
   - CA low, mid, high SLR scenarios (NRC 2012)
2. CoSMoS 3.0 Phase 2 shoreline projections (USGS 2017)
   - Process-based models including Bruun Rule term
   - Beach width on January 1 of each simulation year
   - NRC mid SLR scenario, 1 – 2 m and 5 m SLR at 2100
   - Management scenarios:
     - "Hold-the-line" and "No Hold-the-line"
     - "Nourishment" and "No Nourishment"
   - Model uncertainty and winter erosion uncertainty

Sea-Level Rise Scenarios

NRC (2012)

	2030	2050	2070	2100
Mid SLR	5 in	12 in	20 in (1.7 ft)	37 in (3.1 ft)
High SLR	12 in	24 in	38 in (3.2 ft)	66 in (5.5 ft)

Del Mar CHVRA Beach Erosion (ESA 2016)



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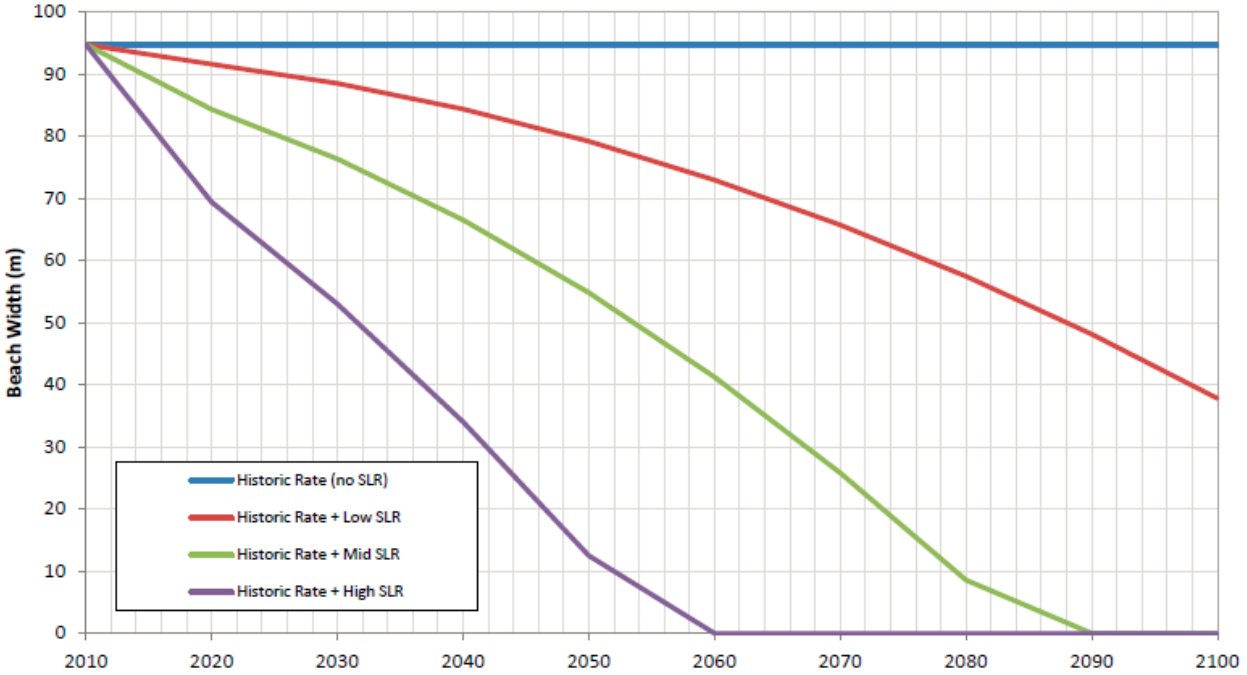
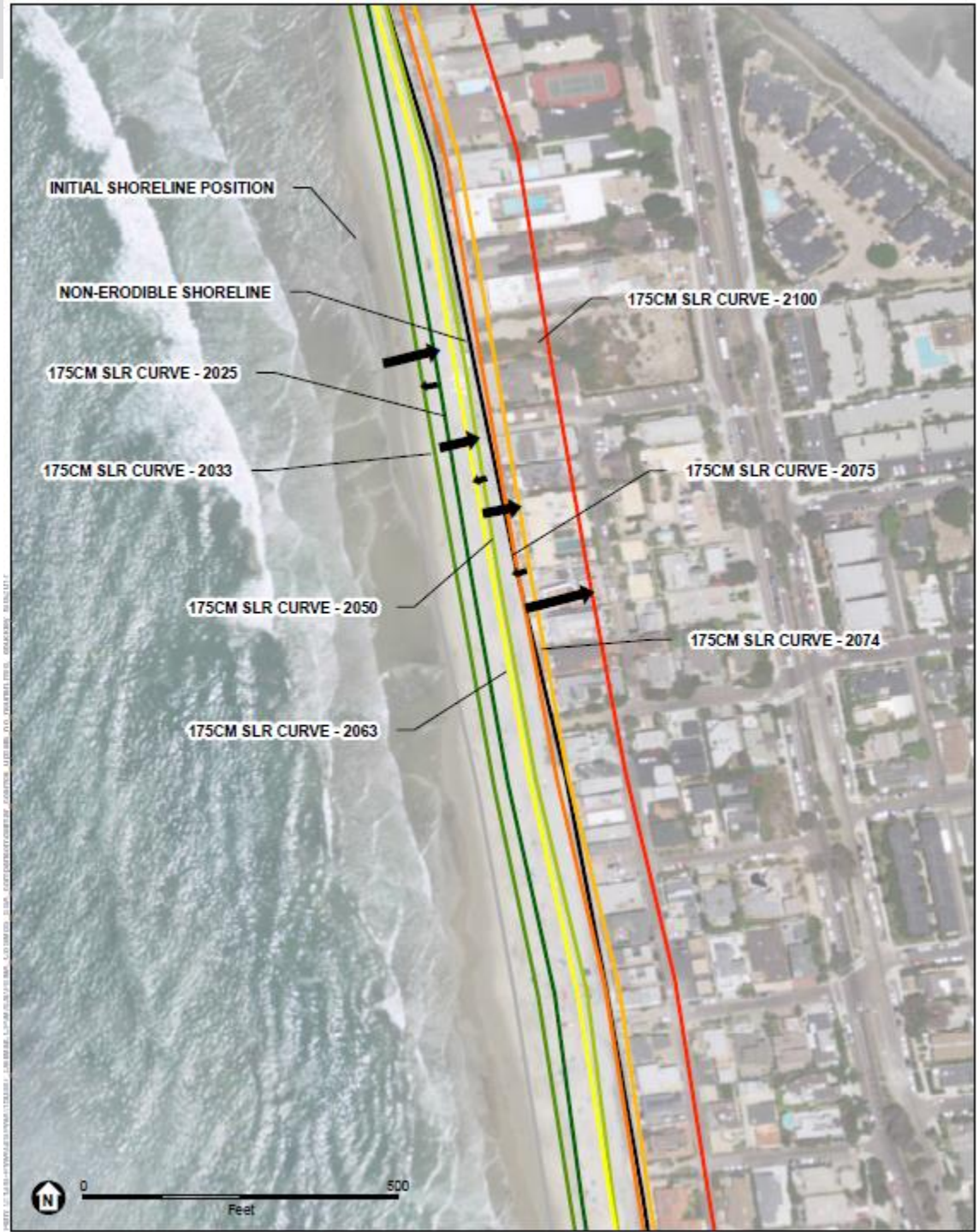


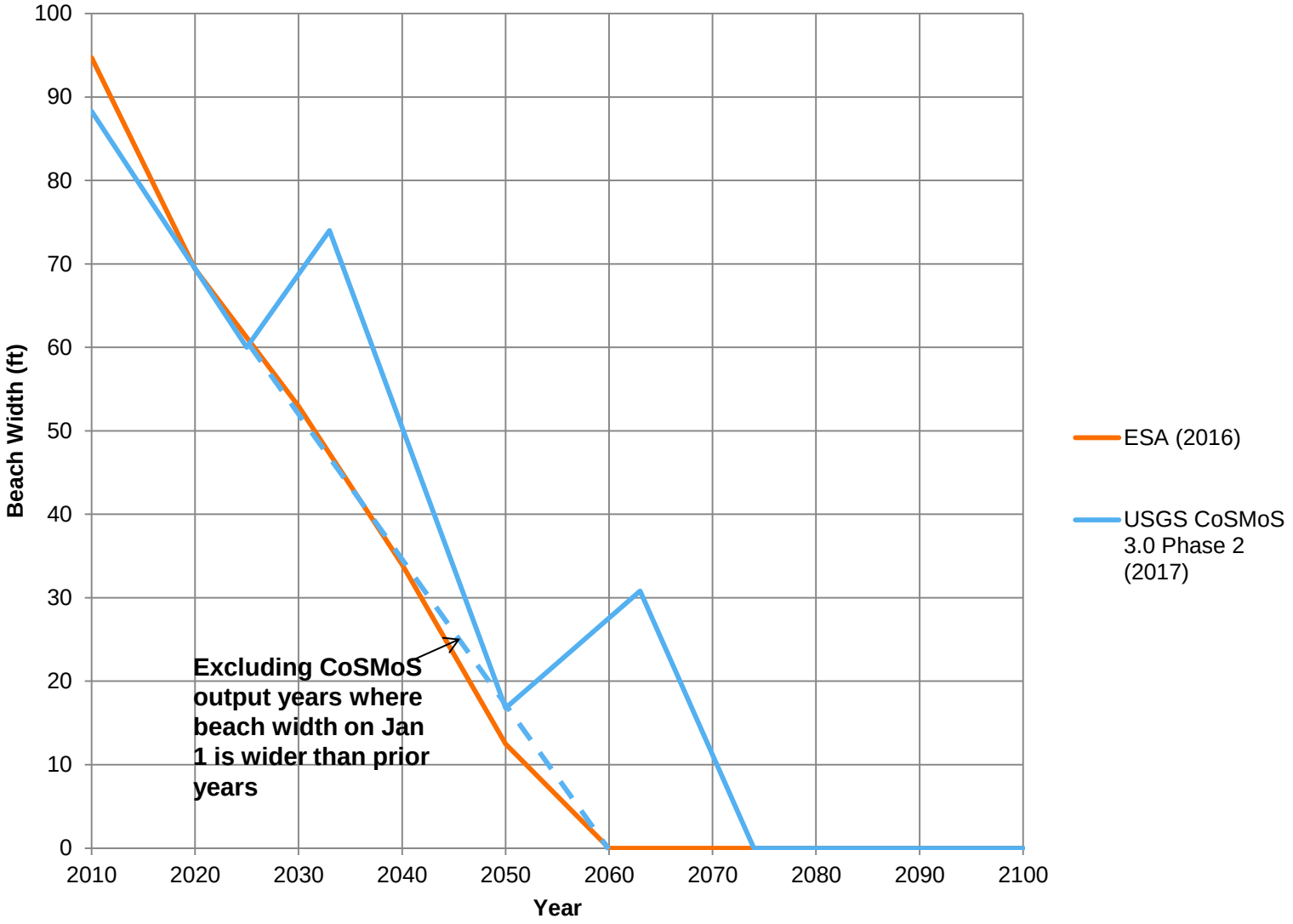
TABLE 4
BEACH WIDTHS OVER TIME WITH SLR

Beach Width (ft)	2010	2020	2030	2040	2050	2060	2070	2080	2090	2100
Historic Rate (no SLR)	95	95	95	95	95	95	95	95	95	95
Historic Rate + Low SLR	95	92	88	84	79	73	66	57	48	38
Historic Rate + Mid SLR	95	84	76	67	55	41	26	9	0	0
Historic Rate + High SLR	95	69	53	34	12	0	0	0	0	0

CoSMoS Beach Erosion (USGS 2017)



Comparison of CHVRA and CoSMoS



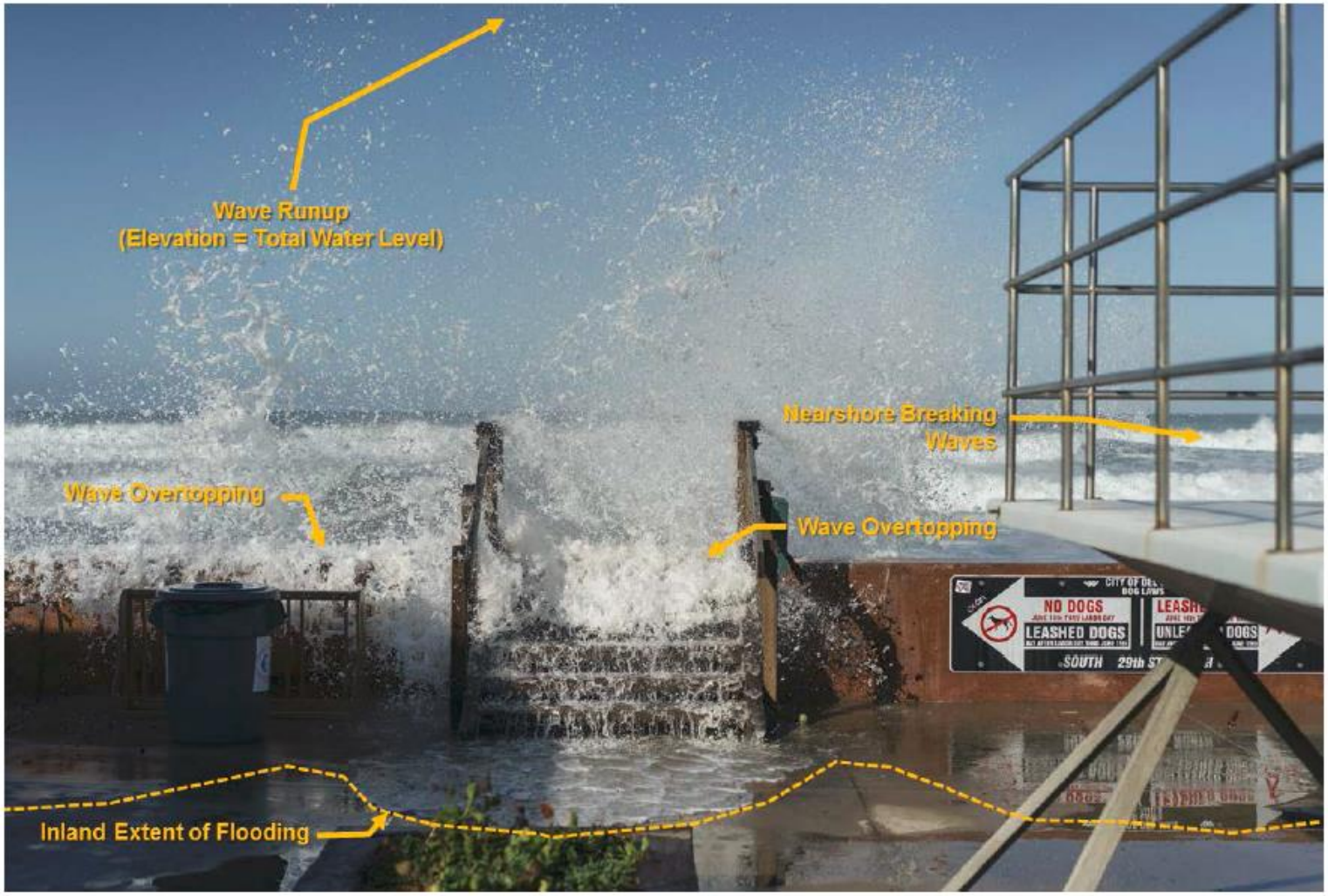
Beach Erosion Assessment

Conclusions of comparison:

- Del Mar CHVRA and CoSMoS agree because both are primarily based on the same approach (Bruun Rule)
- Del Mar SLR Adaptation Plan is based on beach width monitoring and triggers rather than projections

Coastal Flood Hazard Assessments

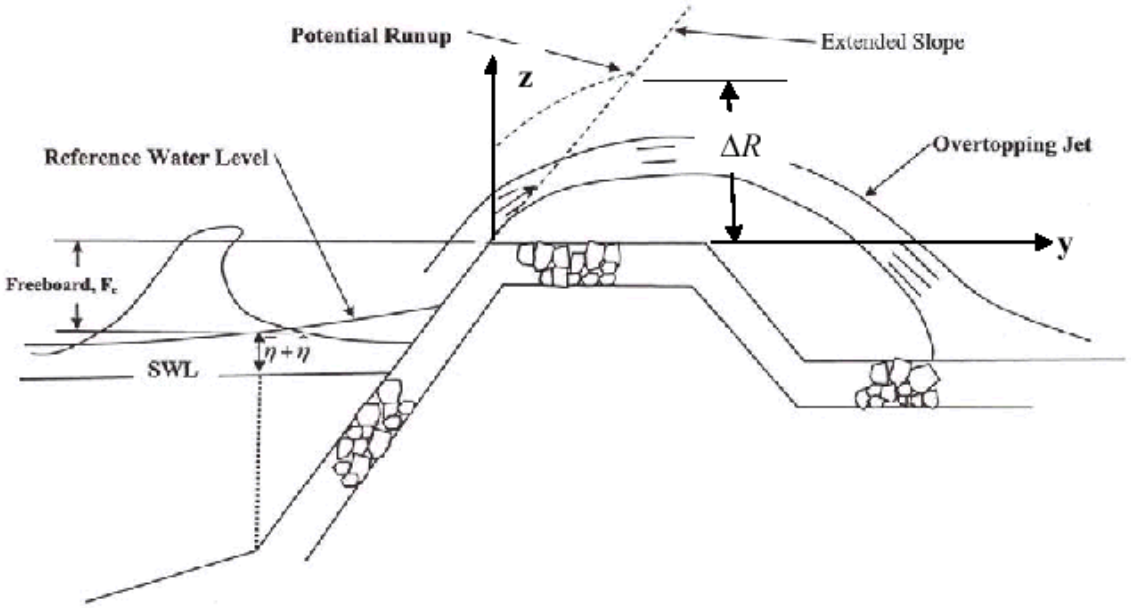
Terms



Coastal Flood Hazard Assessments

Terms

- Still water level (SWL)
- Wave Runup
- Wave setup
- Wave overtopping



Coastal Flood Hazard Assessments

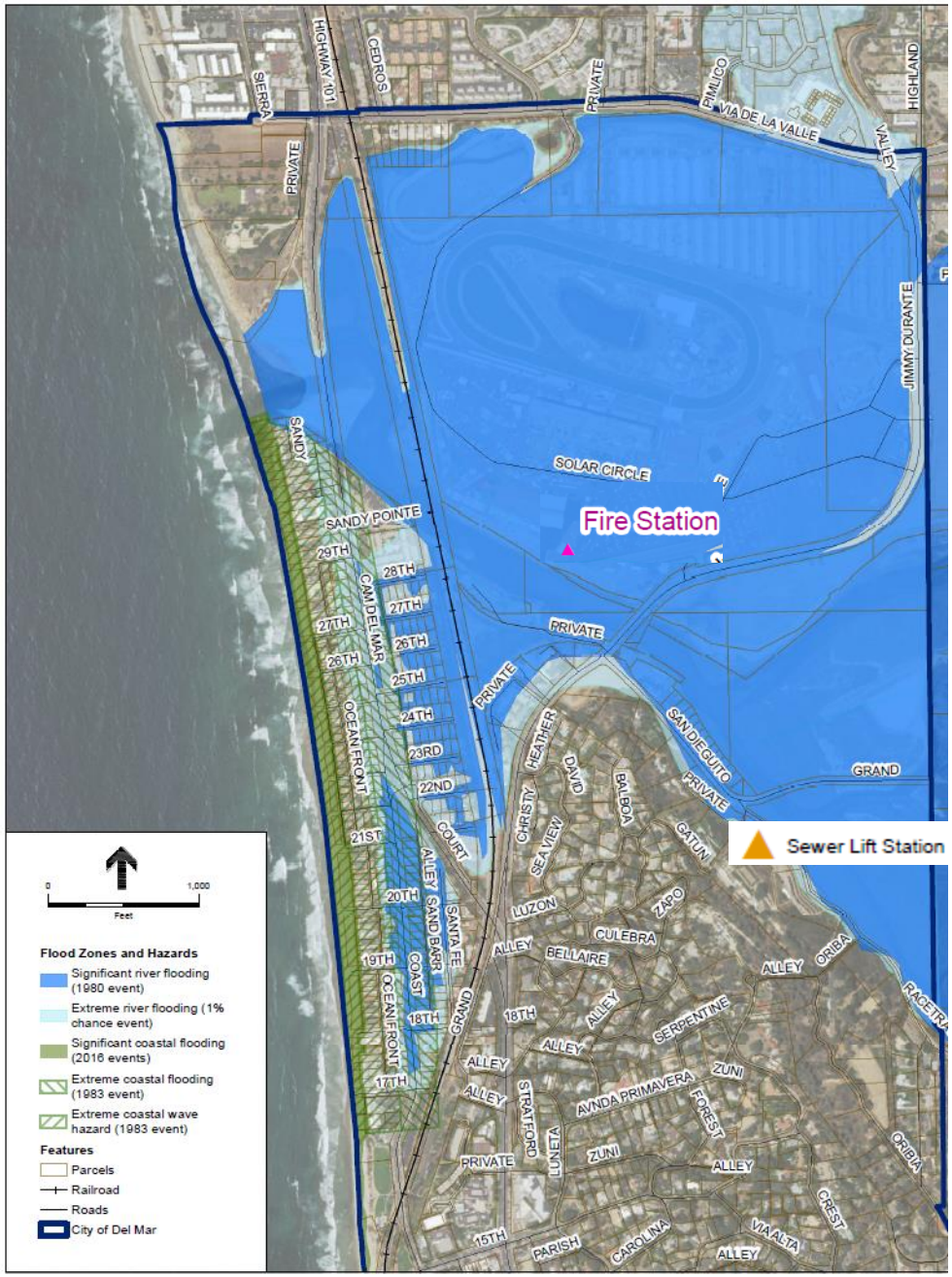
1. Del Mar CHVRA (ESA 2016)
   - Hazard zones created based on:
     - 1983 storm: “extreme coastal flooding”
     - 2016 events: “significant coastal flooding”
   - Projected increase in occurrence with SLR
2. CoSMoS 3.0 Phase 2 (USGS 2017)
   - 1%, 5%, 100% chance coastal storm with estimated coincident river discharge (e.g., 1% coastal storm with 5% river flood)
   - Mapped SWL + wave setup
   - Maximum wave runup point data
3. FEMA Flood Insurance Rate Map (FEMA 2017)
   - 1% chance coastal flood and 1% chance river flood
   - Map high wave velocity (VE) zones and inundation (A) zones

Del Mar CHVRA

		Flood Risk Annual Chance of Occurrence				
	SLR:	0’	1’	2’	3’	5.5’
Coastal Flooding	Signi-ficant (2016)	Mod 10%	High 50%	High 100%		
	Extreme (1983)	Low 1%	Mod 5%	Mod 15%	High 50%	High 100%
River Flooding	Signi-ficant (1980)	Low 4%	Mod 15%	Mod 25%	Mod 50%	High 100%
	Extreme (100-yr)	Low 1%	Mod 5%	Mod 6%	Mod 6%	Mod 20%

Accounts for:

- Beach erosion
- Change in extreme rainfall and River discharge



Del Mar CHVRA

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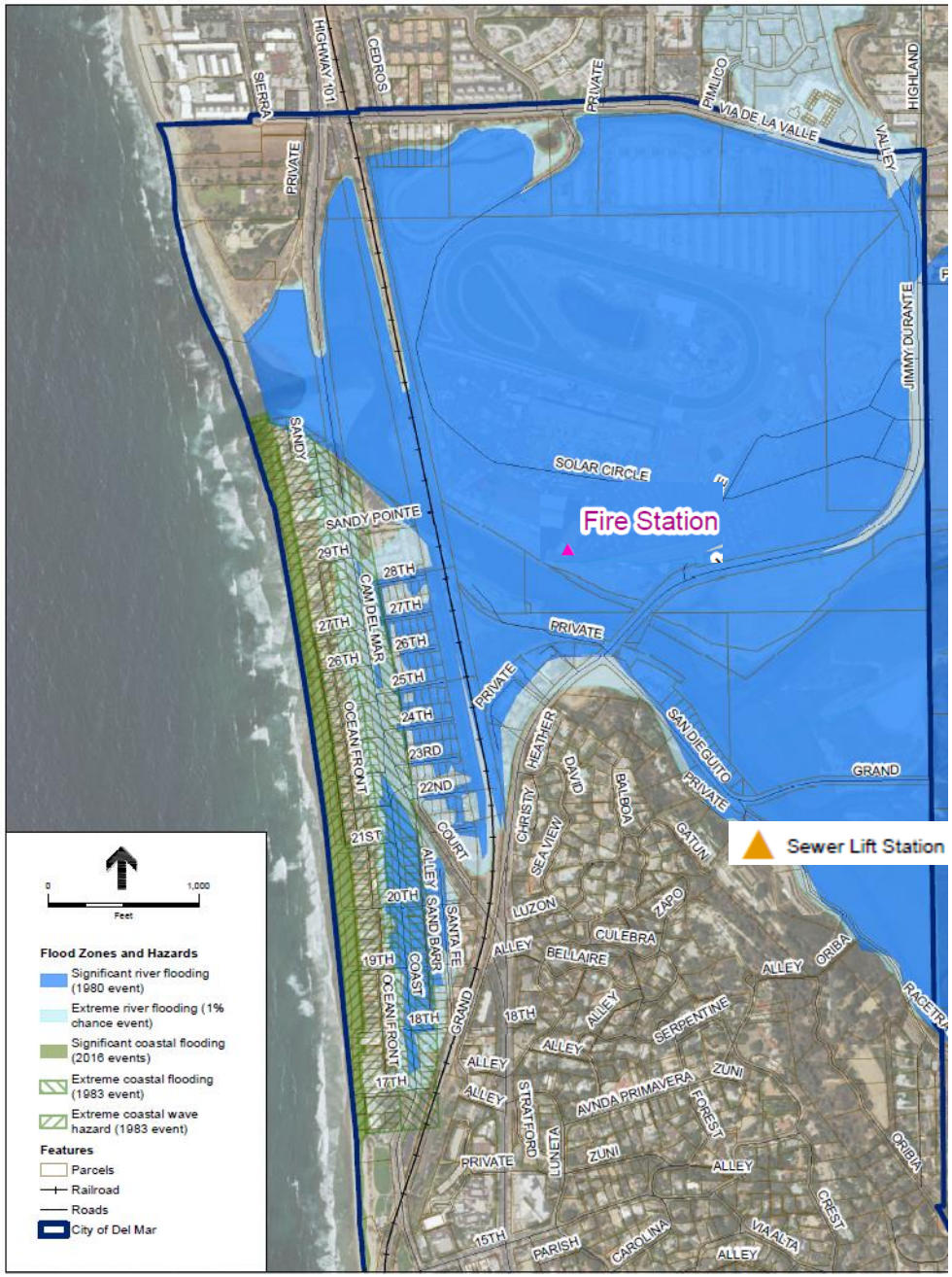
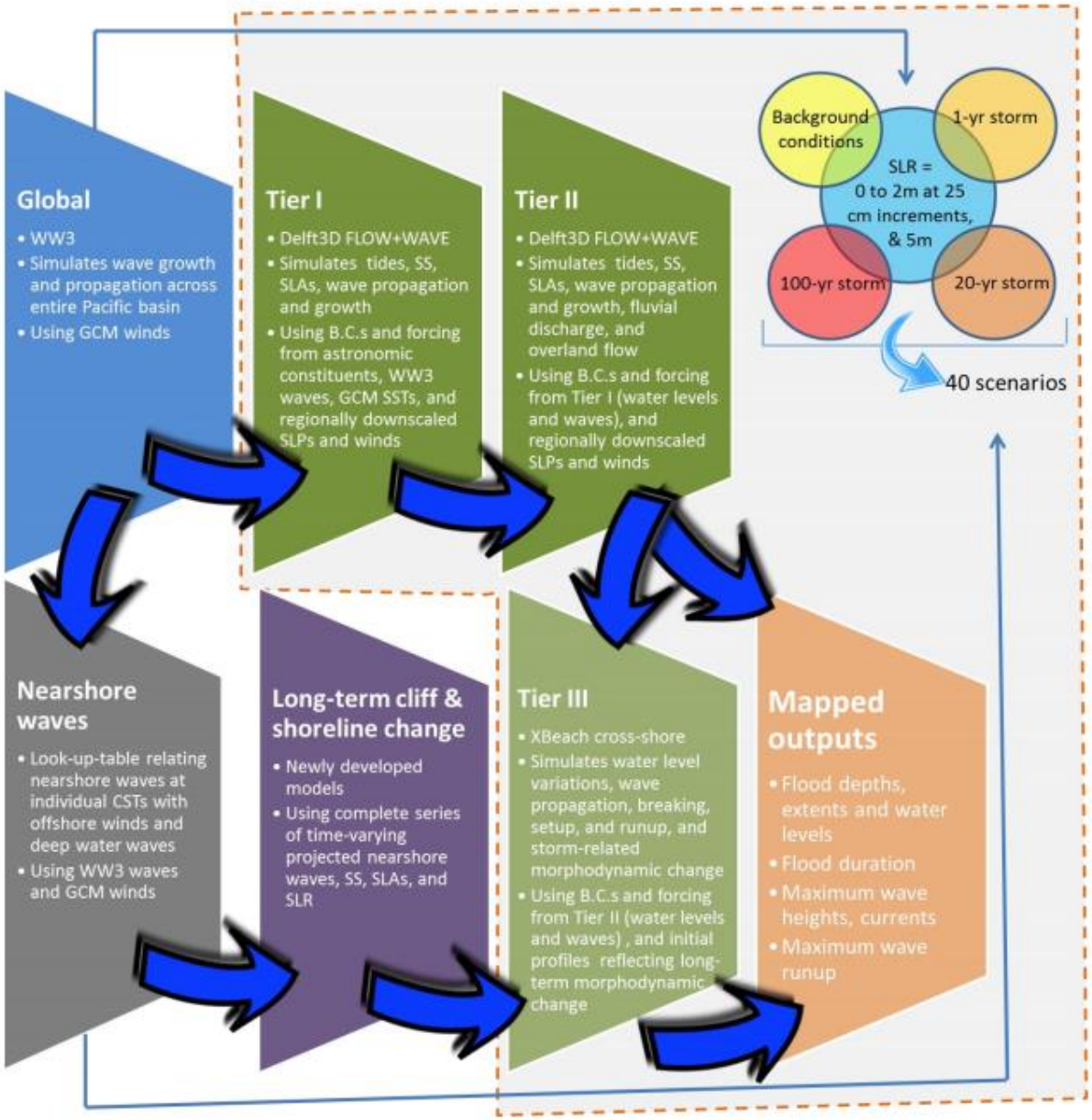
Accounts for:

- Beach erosion



CoSMoS Flood Hazard Methodology

- Global Climate model winds and waves
- Tier I large scale wave growth and propagation
- Tier II downscaled regional wave models using boundaries from Tier I.
- Tier III XBeach cross shore wave breaking, set up and runup

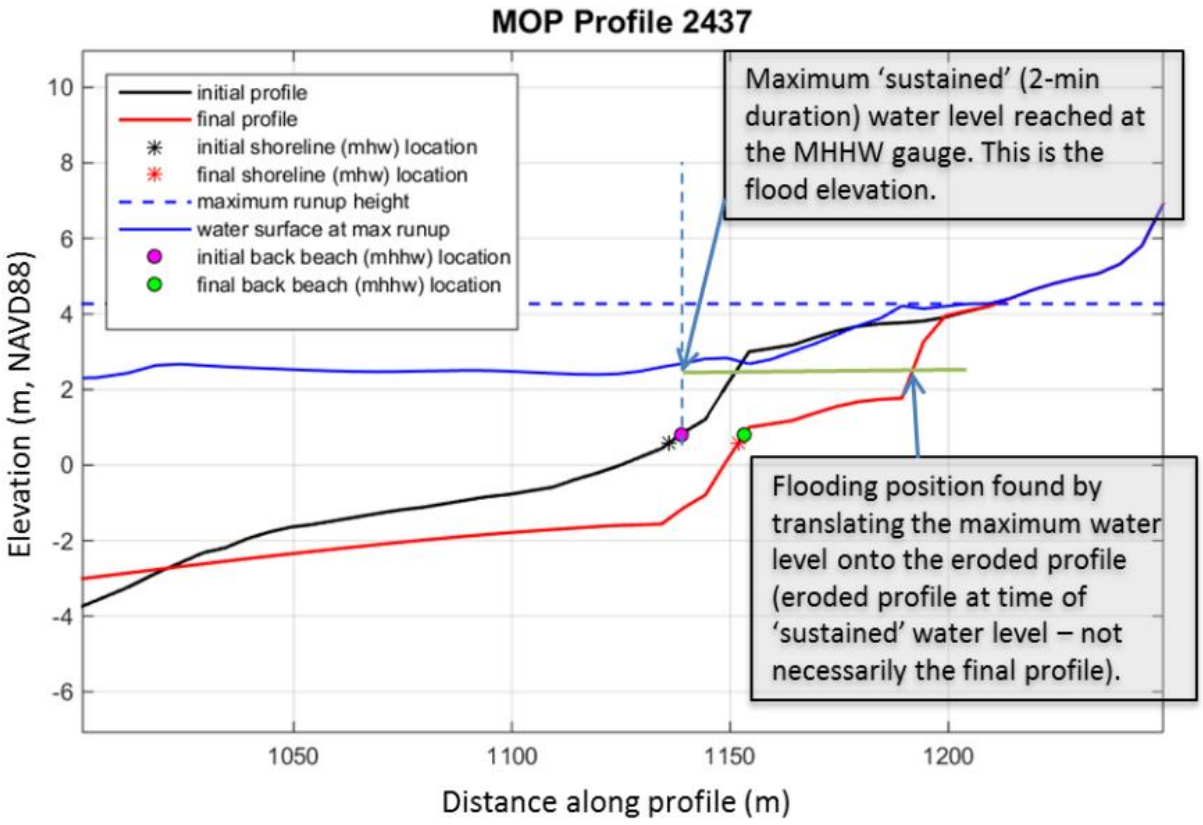


CoSMoS Flood Extent

- Mapped SWL + Wave Setup

(flood extent at 2-min sustained inundation)

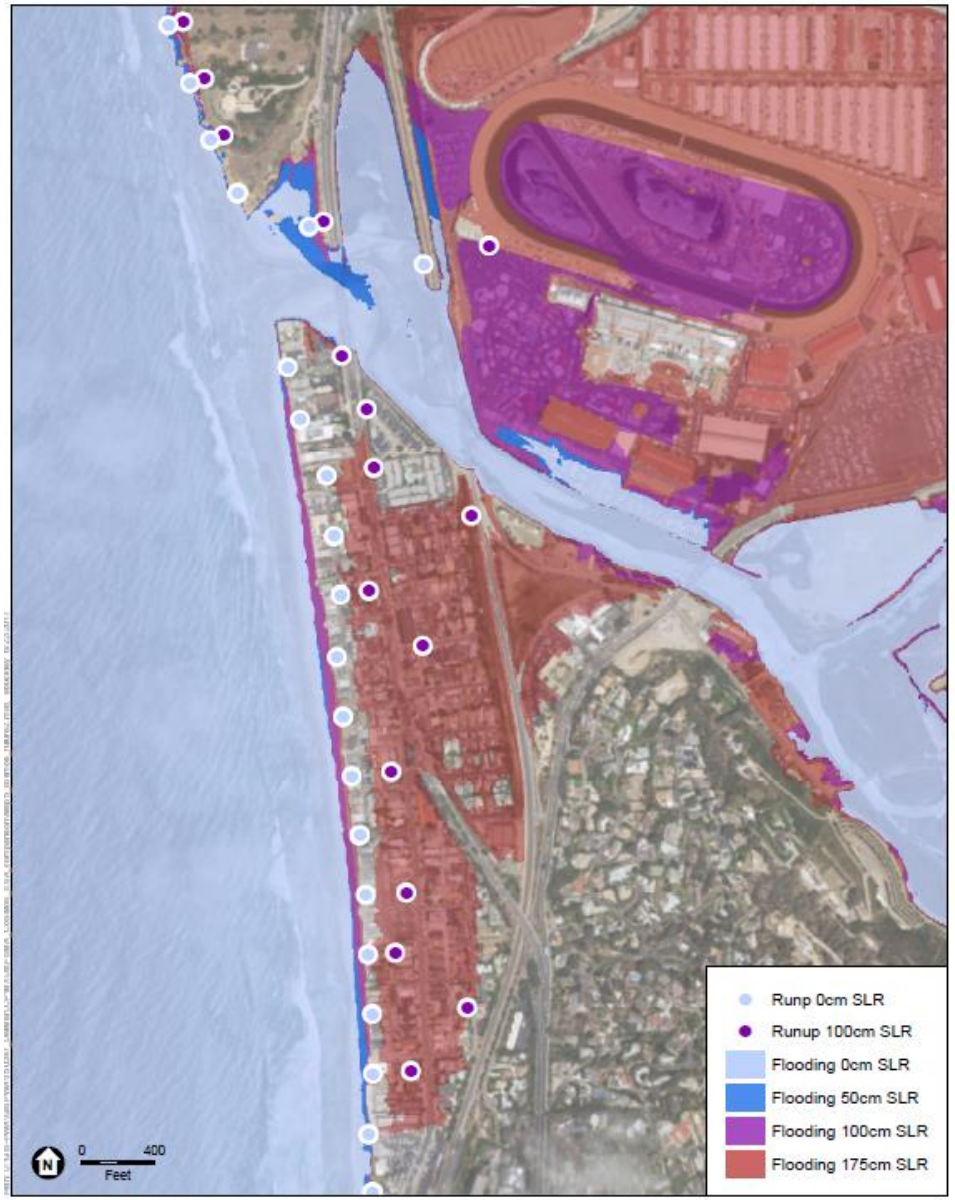
- Provided maximum wave runup point data



CoSMoS 100% Chance Storm

CoSMoS 100% chance (1-year) coastal flooding

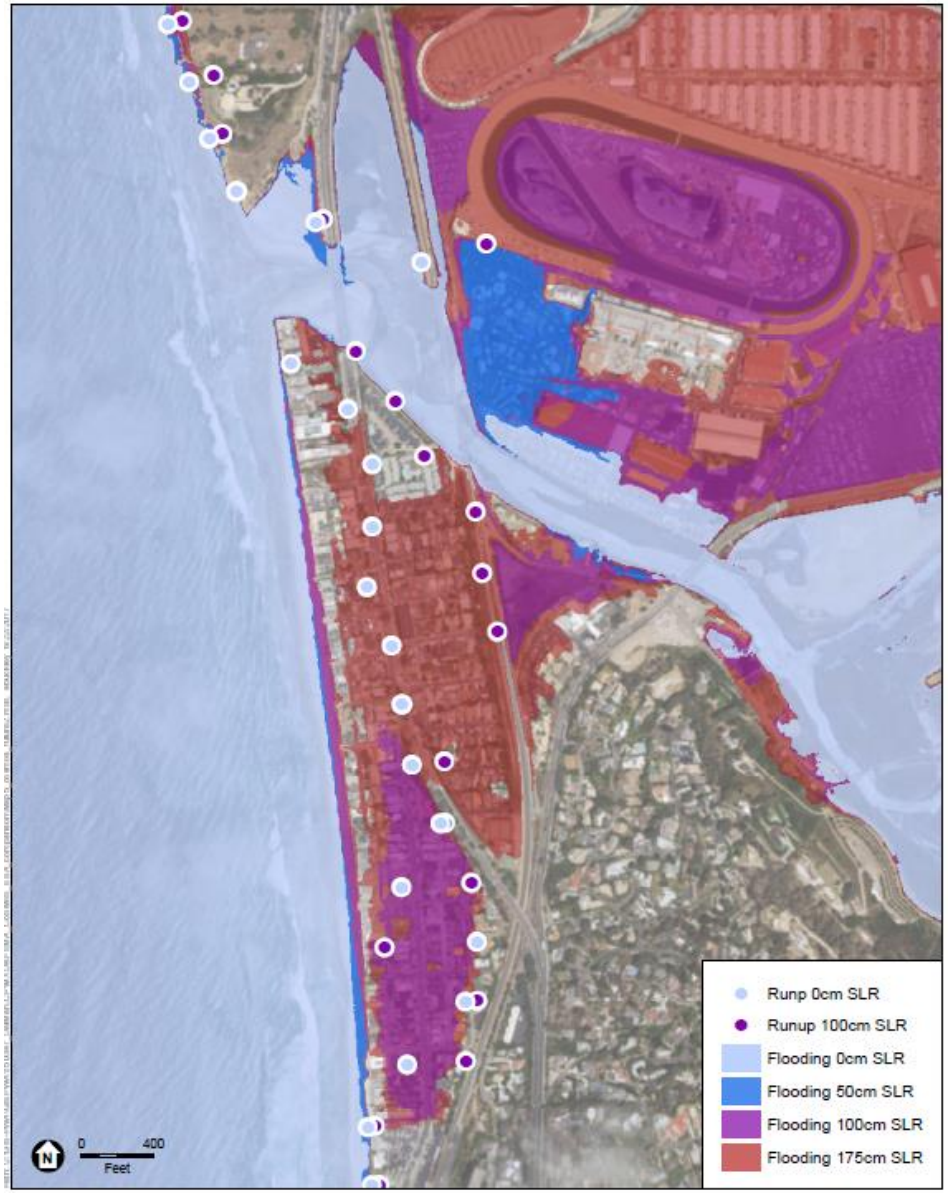
- Inundation extent (SWL + wave setup)
- Maximum wave runup location



CoSMoS 5% Chance Storm

CoSMoS 5% chance (20-year) coastal flooding

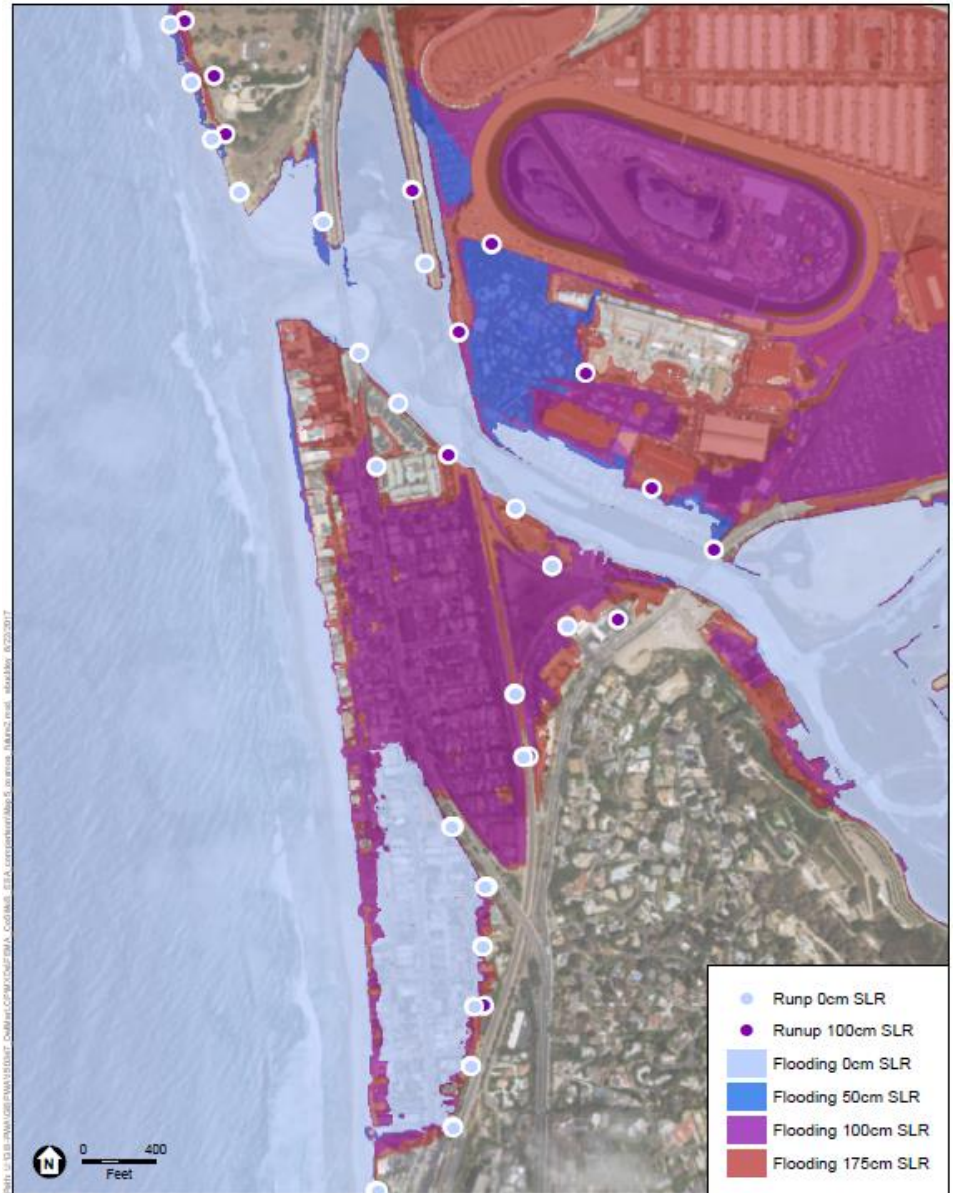
- Inundation extent (SWL + wave setup)
- Maximum wave runup location



CoSMoS 1% Chance Storm

CoSMoS 1% chance (100-year) coastal flooding

- Inundation extent (SWL + wave setup)
- Maximum wave runup location



Coastal Flood Event Comparison

	Del Mar CHVRA: 1983 storm	CoSMoS: 2 representative 1% (100-year) storms
SWL (ft NAVD)	6.9 ft	~7.1-7.3 ft NAVD
Storm surge (ft)	0.4 ft	0.6 - 0.8 ft
Predicted tide (ft NAVD)	6.6 ft NAVD	~ 6.5 ft NAVD
Wave height (ft)	24 ft	20 – 22 ft
Tp (s)	18 s	16 – 18 s
Annual chance of occurrence	Less than 1%	1%

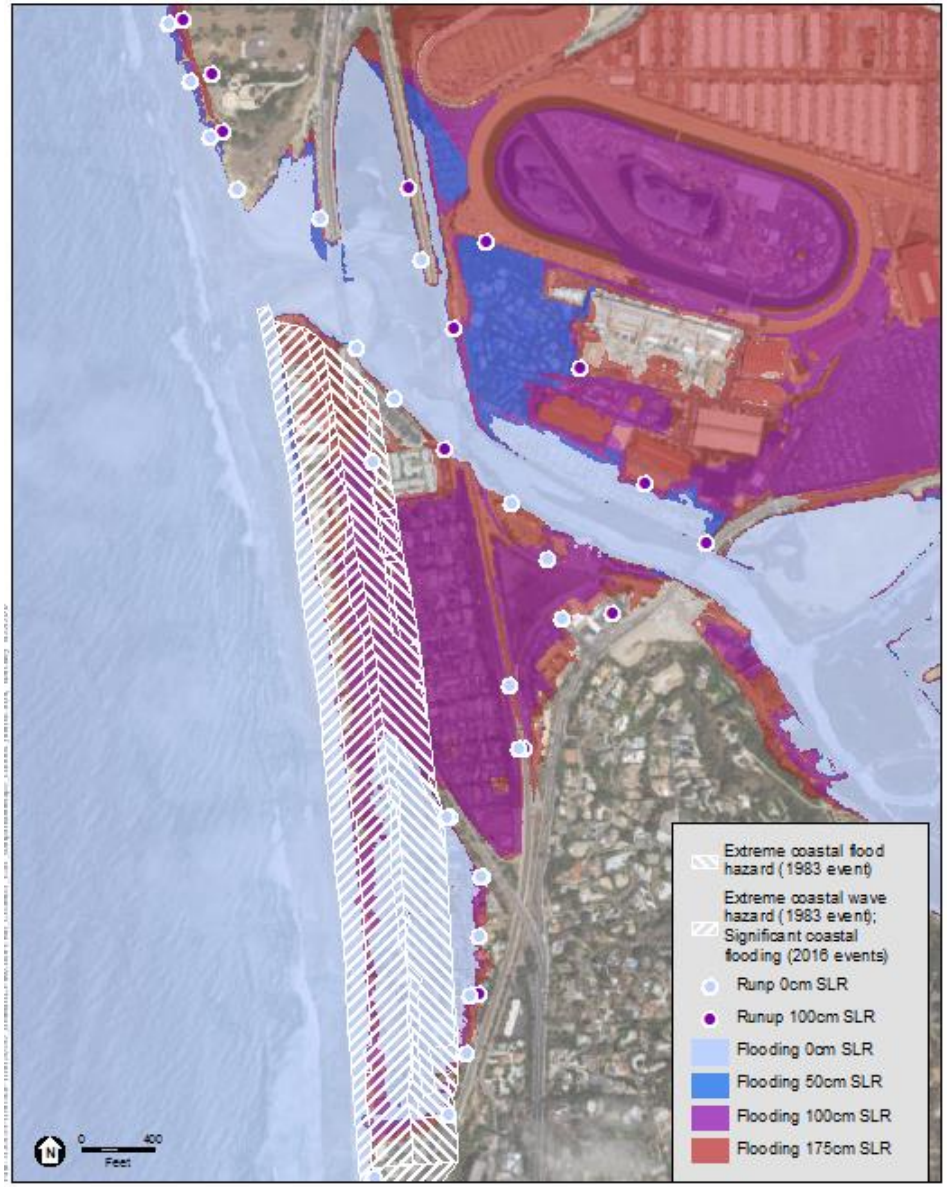
Del Mar CHVRA – CoSMoS Comparison

Del Mar CHVRA

- Extreme coastal flooding (1983 storm)
  - Wave hazard
  - Flood hazard

CoSMoS 1% chance (100-year) coastal flooding

- Inundation extent (SWL + wave setup)
- Maximum wave runup location



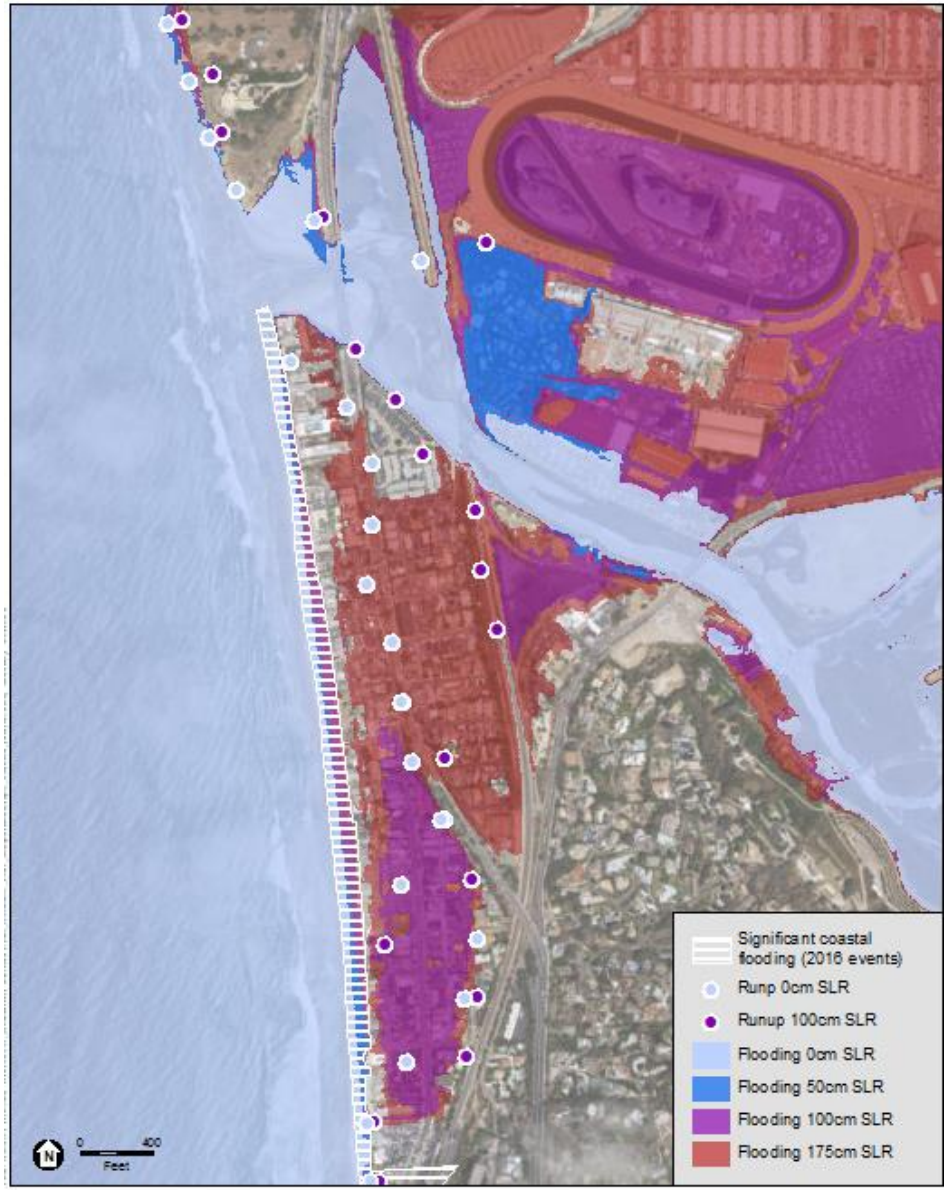
Del Mar CHVRA – CoSMoS Comparison

Del Mar CHVRA

- Significant coastal flooding (2016 events)
  - Wave hazard
  - Flood hazard

CoSMoS 5% chance (20-year) coastal flooding

- Inundation extent (SWL + wave setup)
- Maximum wave runup location



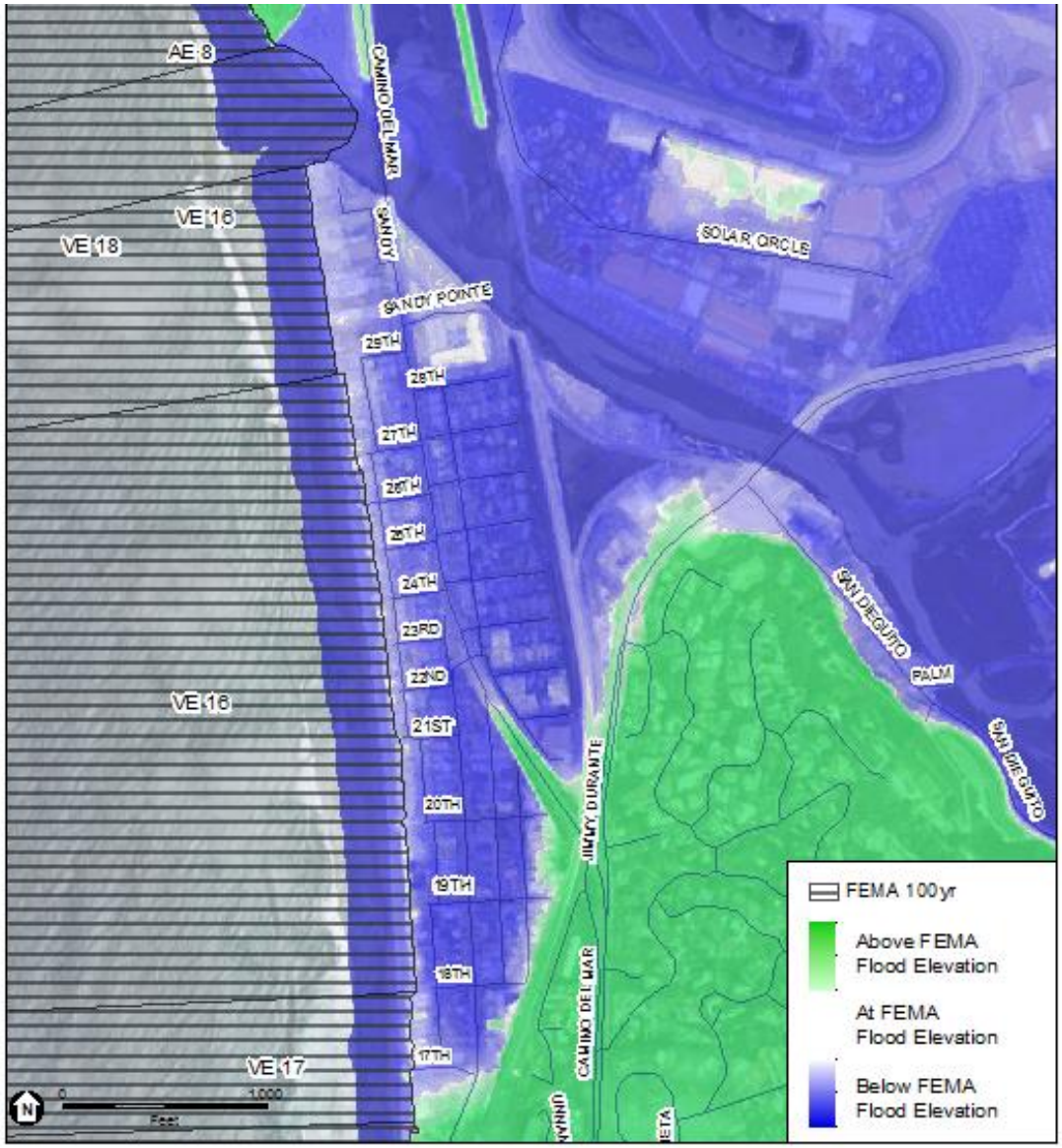
FEMA Flood Zones

Preliminary FIS
2/3/2017

1% chance and
0.2% chance flood
extent

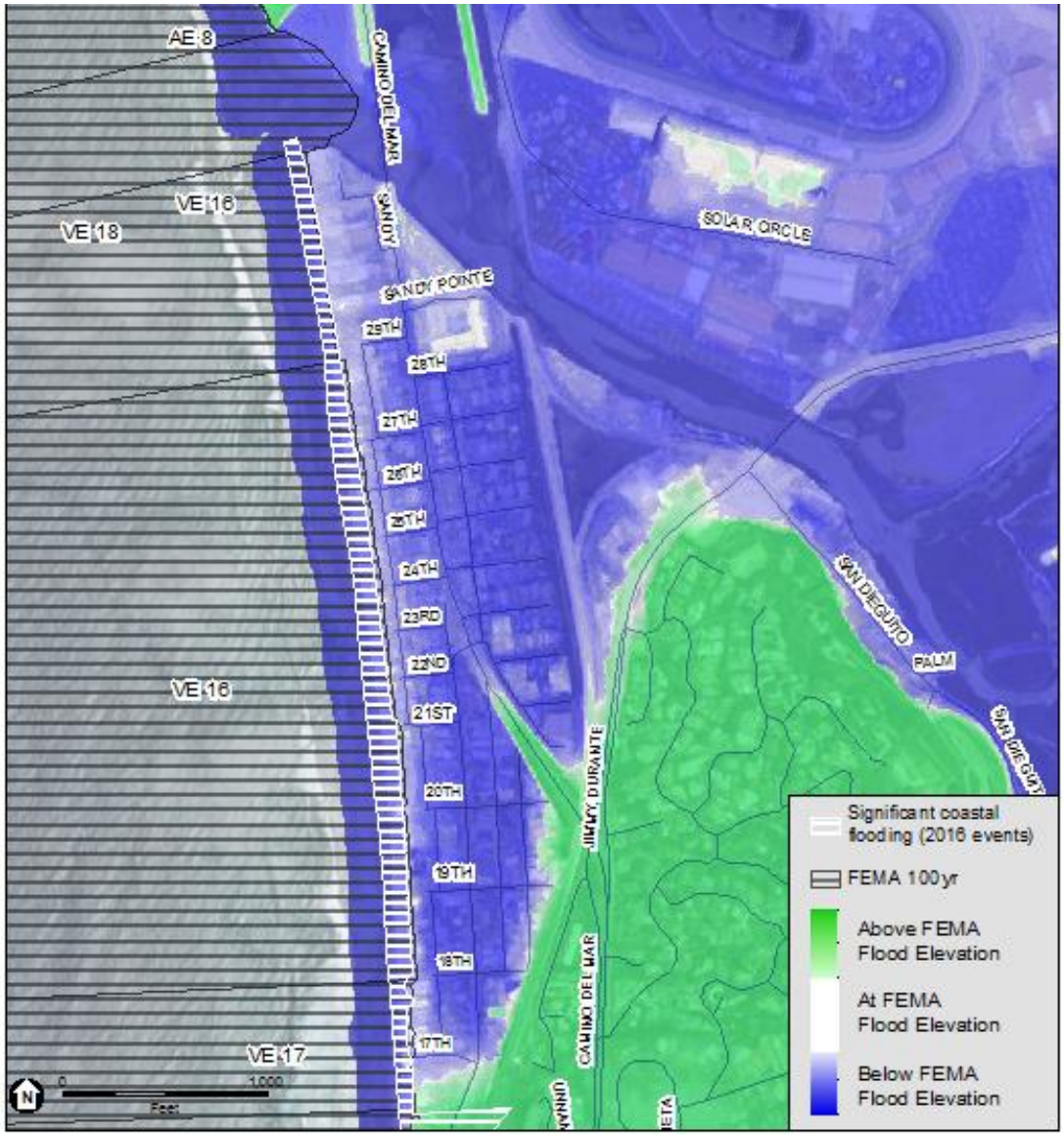
Del Mar CHVRA – FEMA Comparison

Topography relative to FEMA 1% chance flood elevation



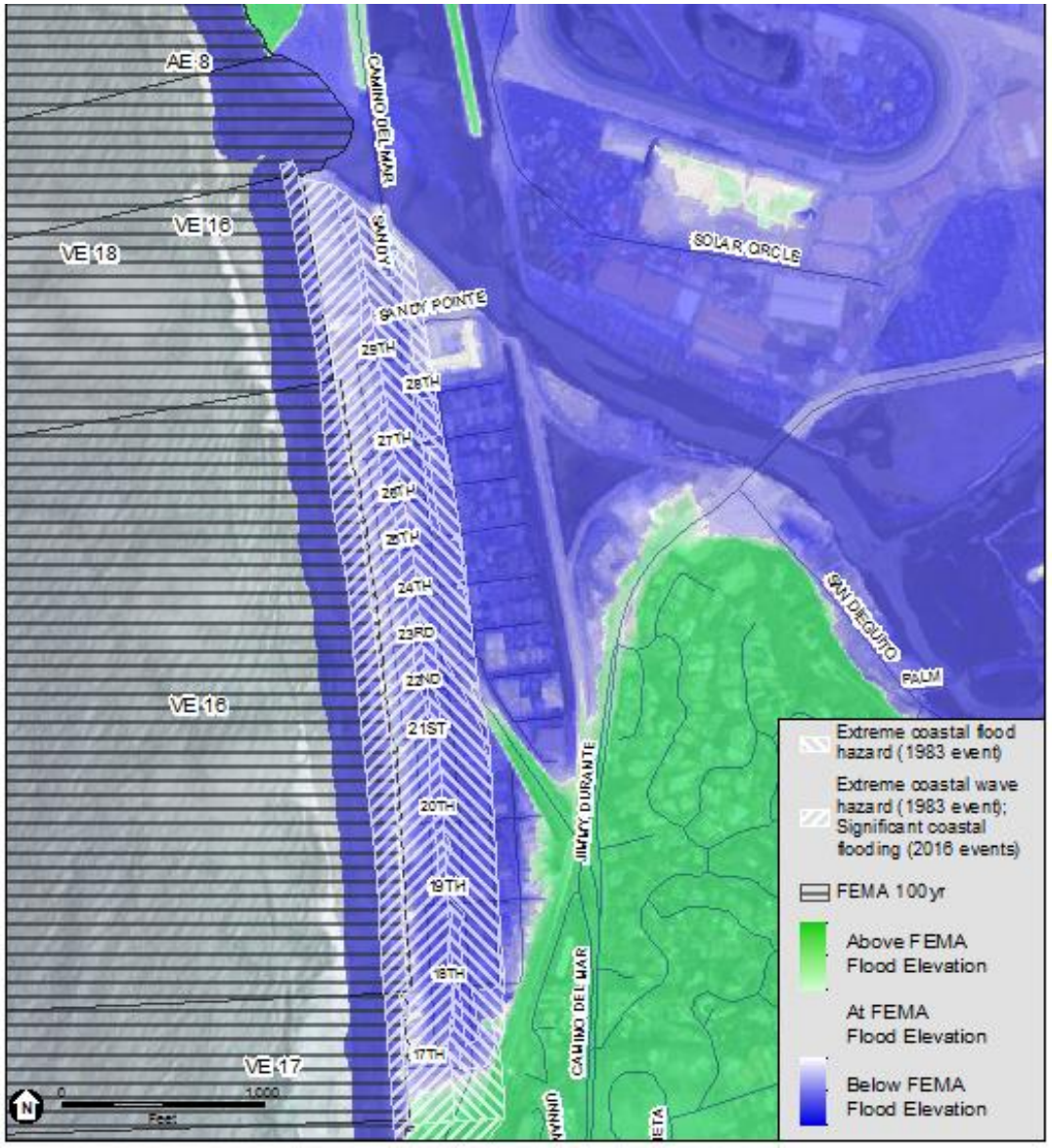
Del Mar CHVRA – FEMA Comparison

Comparison of
- FEMA 1% chance
- Del Mar CHVRA
  - Significant Coastal Flood Hazard (10%)



Del Mar CHVRA – FEMA Comparison

Comparison of
- FEMA 1% chance
- Del Mar CHVRA
  - Significant Coastal Flood Hazard (10%)
  - Extreme coastal event (<1% chance)
    - Wave hazard
    - Flood hazard



Del Mar CHVRA – FEMA Comparison

Comparison of
- FEMA 1% chance
- Del Mar CHVRA
  - Significant Coastal Flood Hazard (10%)
  - Extreme coastal event (<1% chance)
    - Wave hazard
    - Flood hazard
- CoSMoS
  - Maximum wave runup for 1% chance coastal storm, no SLR