Del Mar Sediment Management Study

March 22, 2018

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Sediment Management Plan

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  - Vulnerability Assessment identified risks with sea-level rise
    - Beach erosion → coastal flooding
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  - Companion document to Adaptation Plan and LCP Amendment

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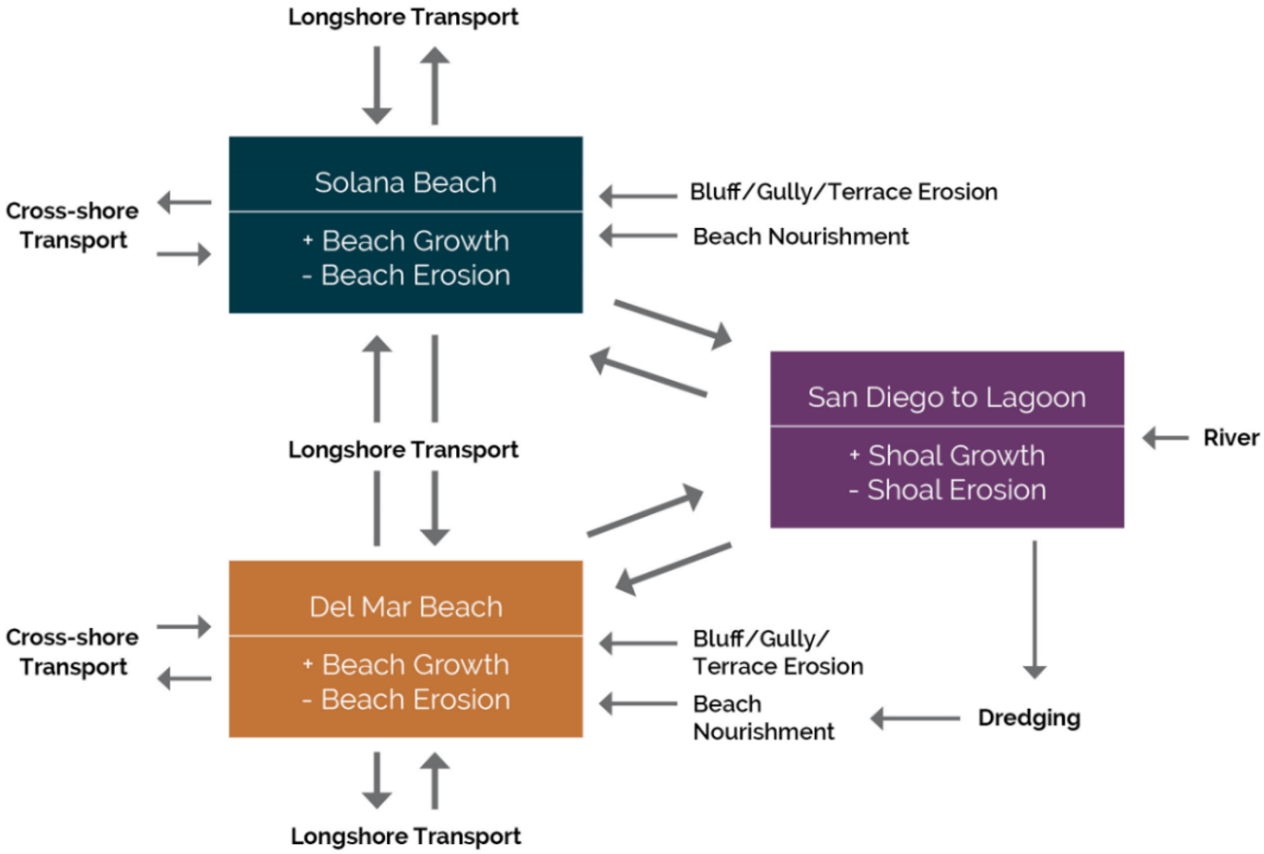
  - Companion document to Adaptation Plan and LCP Amendment
- How was the plan developed?
  - Gathered data to develop long-term sediment budget
    - Developed existing conditions budget
    - Considered how each process will change with sea-level rise
  - →Developed Channel Dredging Plan
  - →Developed Beach Nourishment Plan
  - →Developed planning-level cost estimates with assumptions

What is a Sediment Budget?

Coastal management tool to understand balance between sediment added and removed from a coastal system



Sediment Budget "Boxes" to Understand Current Processes

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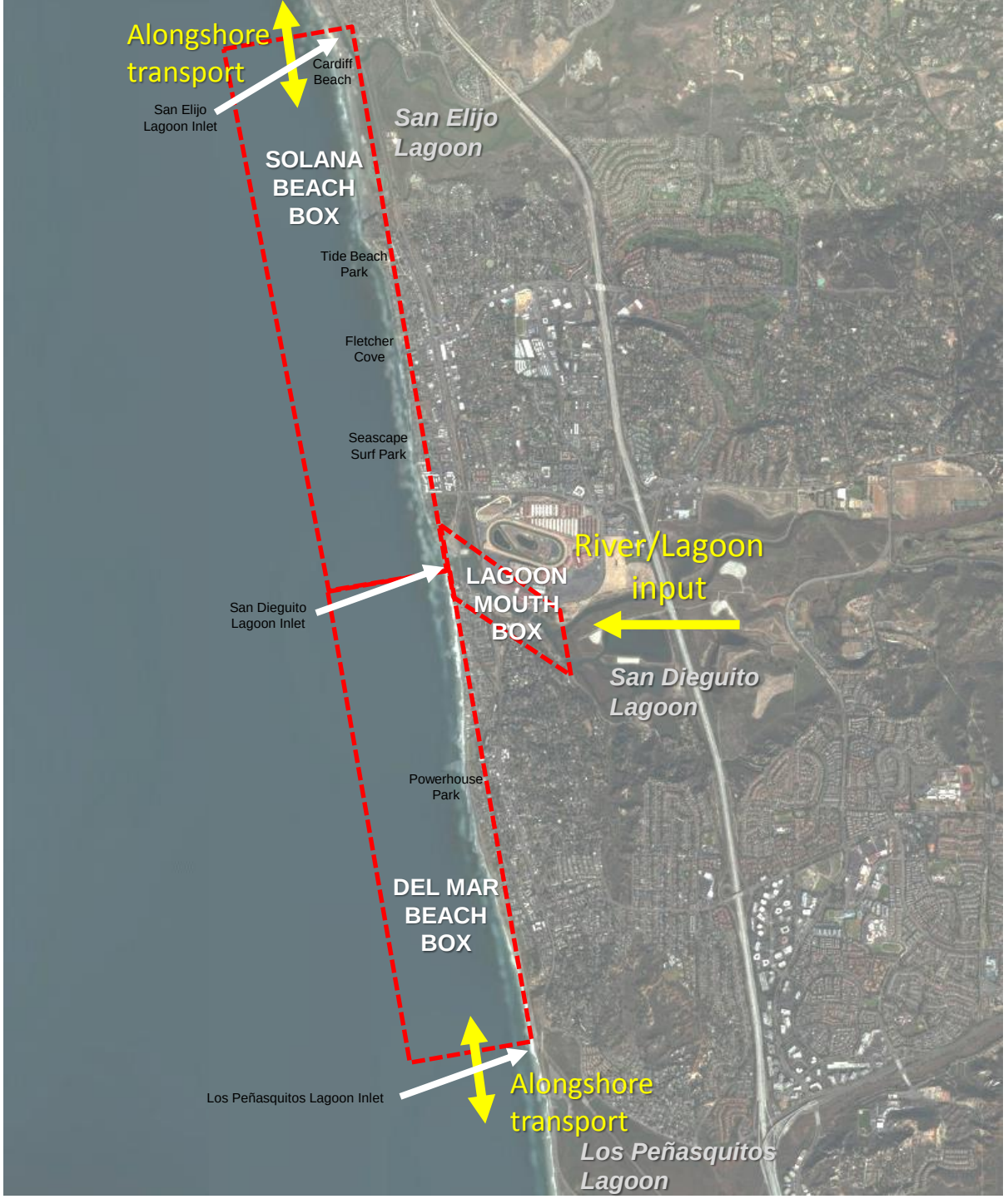

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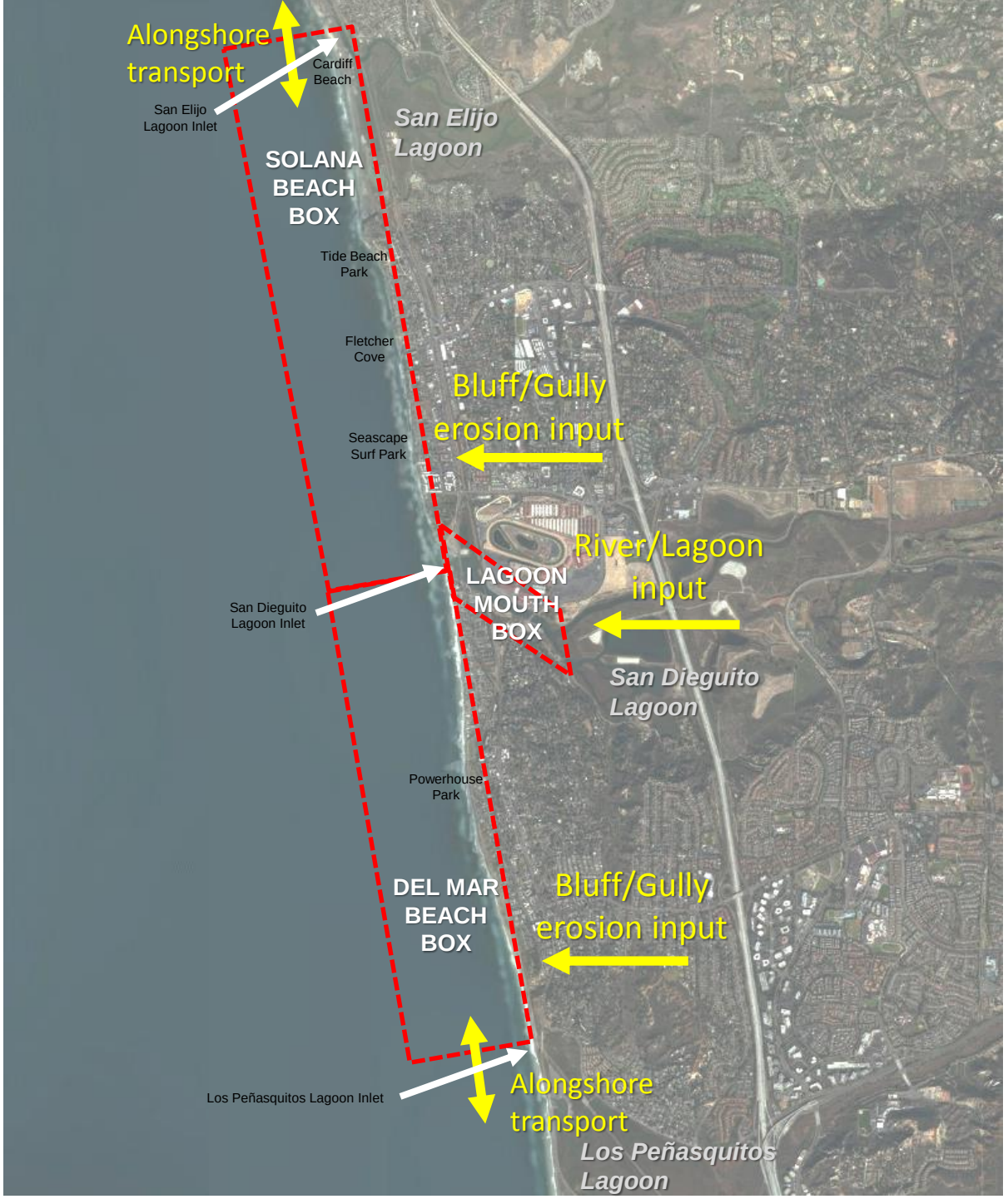

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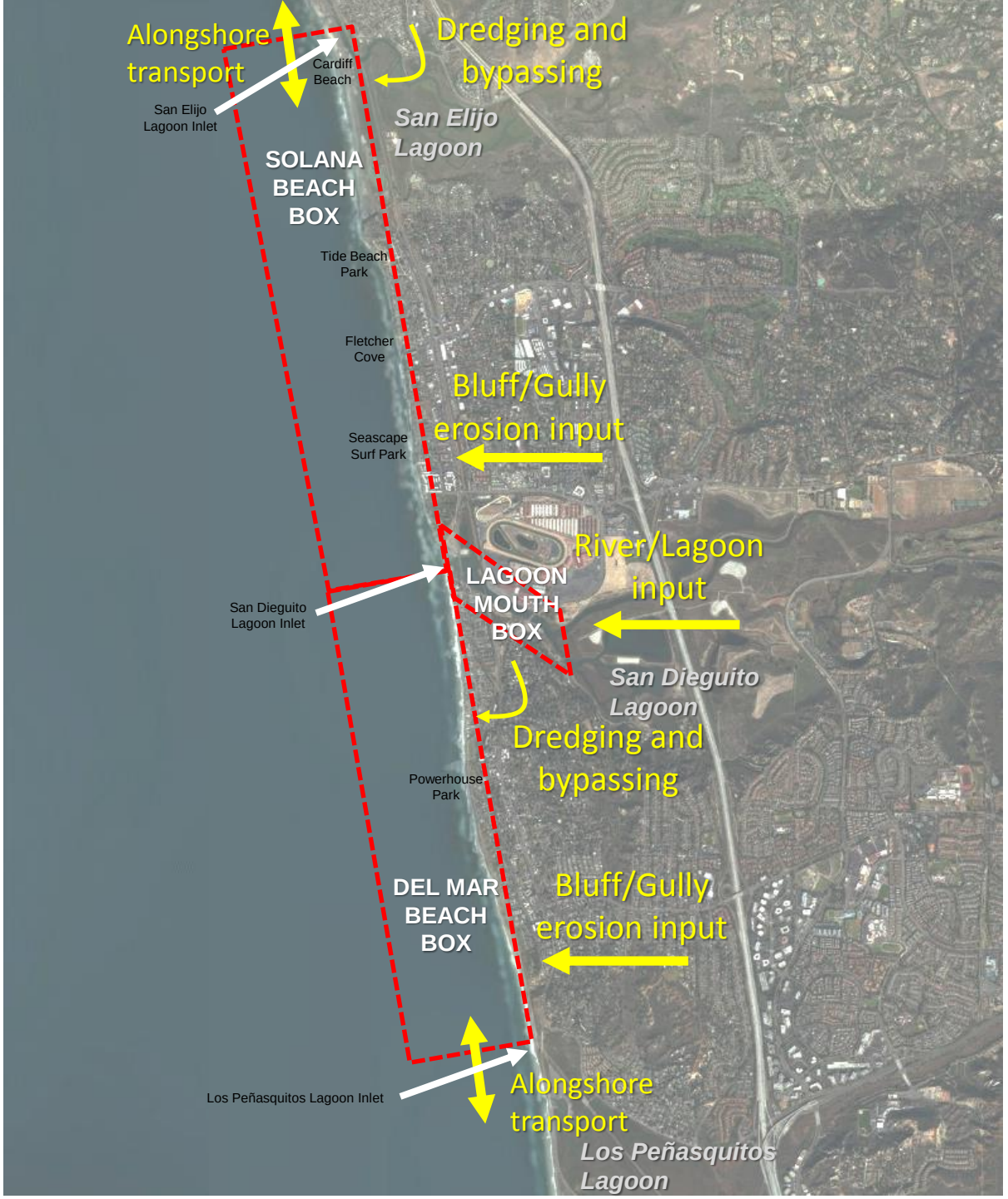

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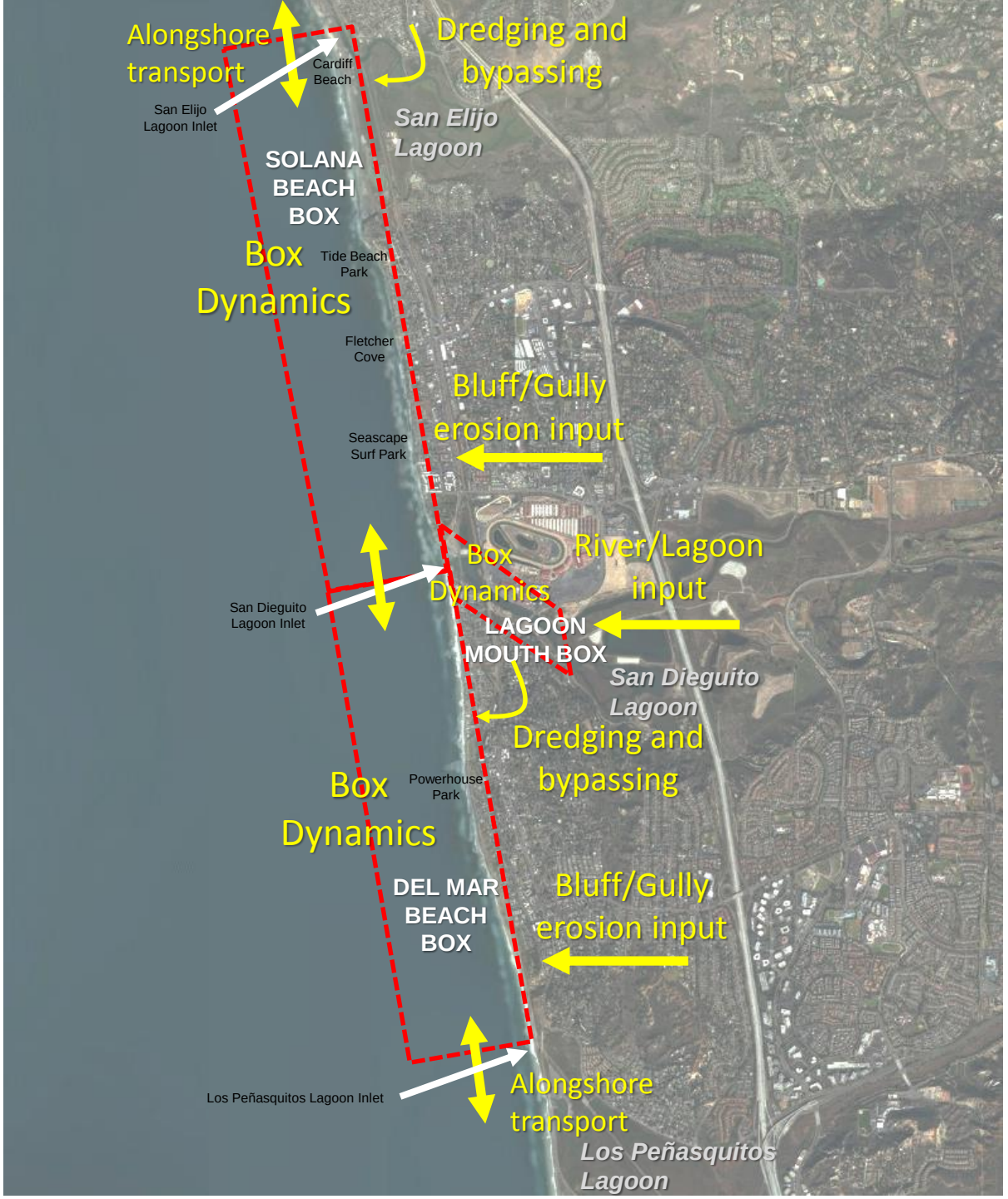

Longshore Transport

- Many studies analyzing longshore transport in the region
  - Marine Advisers 1960
  - Hales 1978
  - Inman and Jenkins 1983
  - Tekmarine Inc 1987
  - Moffatt and Nichol 1990
  - USACE 1991
  - Inman and Masters 1991
  - Coastal Environments 2001
  - Patsch and Griggs 2006
- ESA also modeled transport rates near Del Mar
- Results vary, because longshore transport is variable
- Typically, transport is to north in the summer, to the south in the winter
- Generally, results show net transport to the south

Beach Nourishment

- Sand bypassing from lagoons
  - About 21,900 cy/yr from San Elijo
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- Regional Beach Sand Project (RBSP) through SANDAG

	RBSP I, 2001		RBSP II, 2012	
Location	Volume (cy)	Grain Size (mm)	Volume (cy)	Grain Size (mm)
Moonlight Beach	105,000	0.34 – 0.62	92,000	0.48
Cardiff Beach	101,000	0.34	89,000	0.57
Fletcher Cove	146,000	0.14	142,000	0.55
Del Mar	183,000	0.14	n/a	n/a
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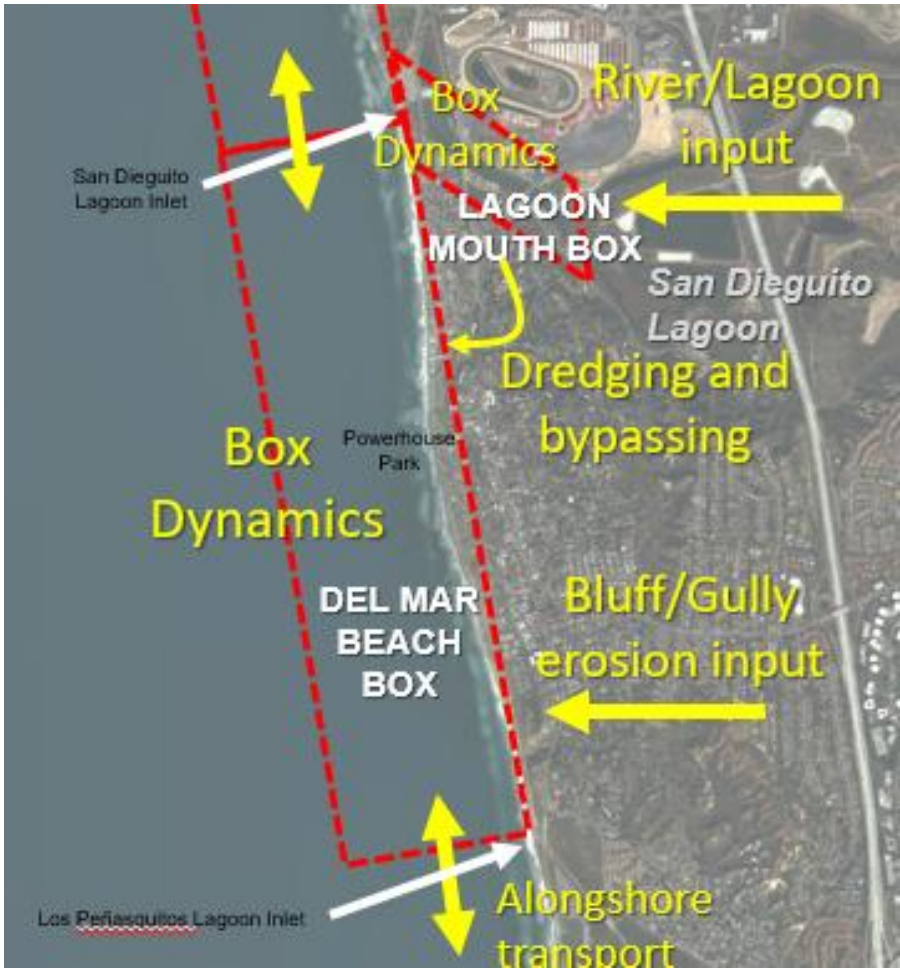
- Opportunistic sand placement

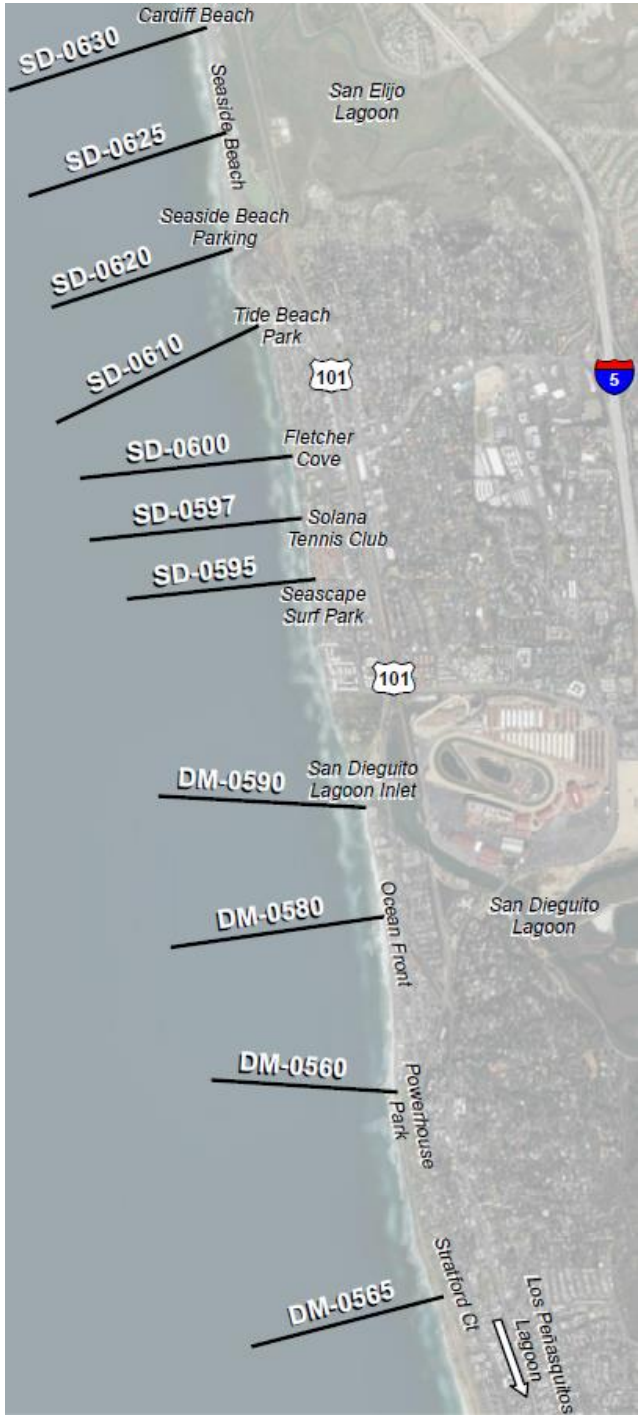
Beach Dynamics- the Beach "Box"

- Alongshore transport into box
- Dredging and bypassing
- Bluff/gully erosion
- Beach dynamics
  - Shoreline change
  - Beach transect volume change
- Influence of lagoon (lagoon box)



SANDAG Beach Transects

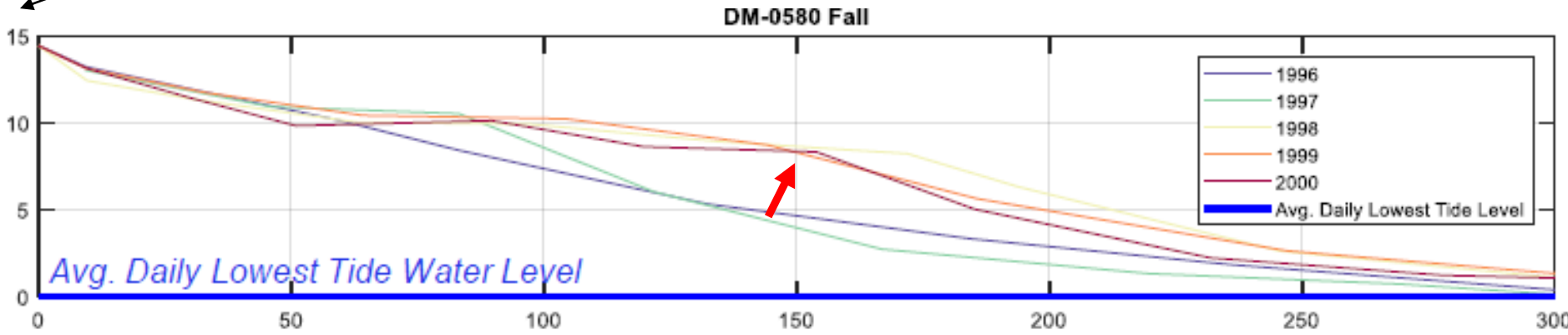
- Fall and spring surveys
- 1997 to present
- 7 transects between San Elijo & San Dieguito
- 4 transects between San Dieguito & Los Peñasquitos



SANDAG Beach Transects

- In 1997, US Navy Homeporting project added 170,000 cy of sand

Feet Above Average Daily Lowest Tide Water Level (e.g., ft MLLW)

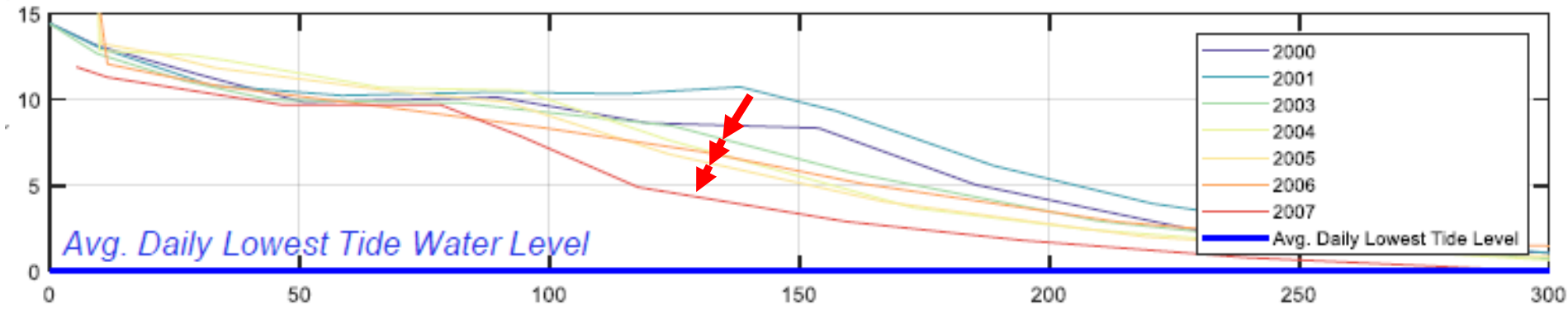


Distance in feet from Seawall

SANDAG Beach Transects

- RBSP I (2001) eroded away in the following years

Feet Above Average Daily Lowest Tide Water Level (e.g., ft MLLW)

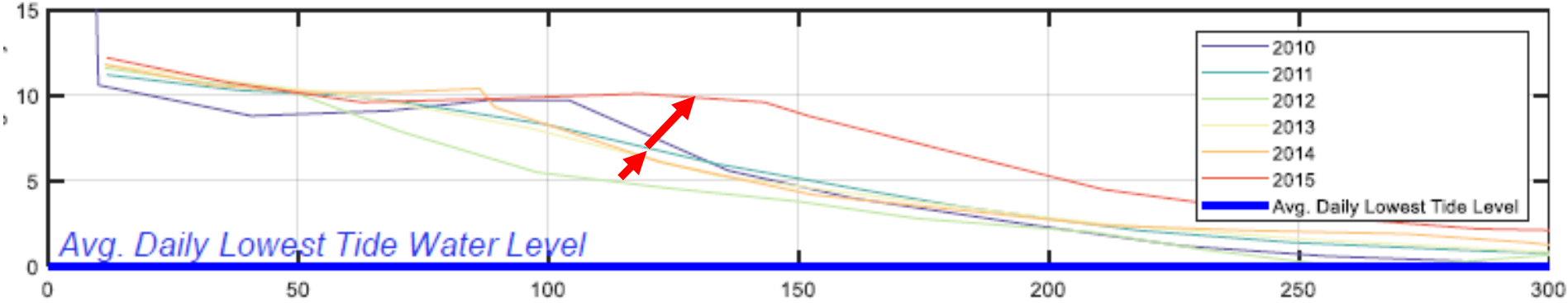


Distance in feet from Seawall

SANDAG Beach Transects

- RBSP II (2012) transported to 25th St by 2015

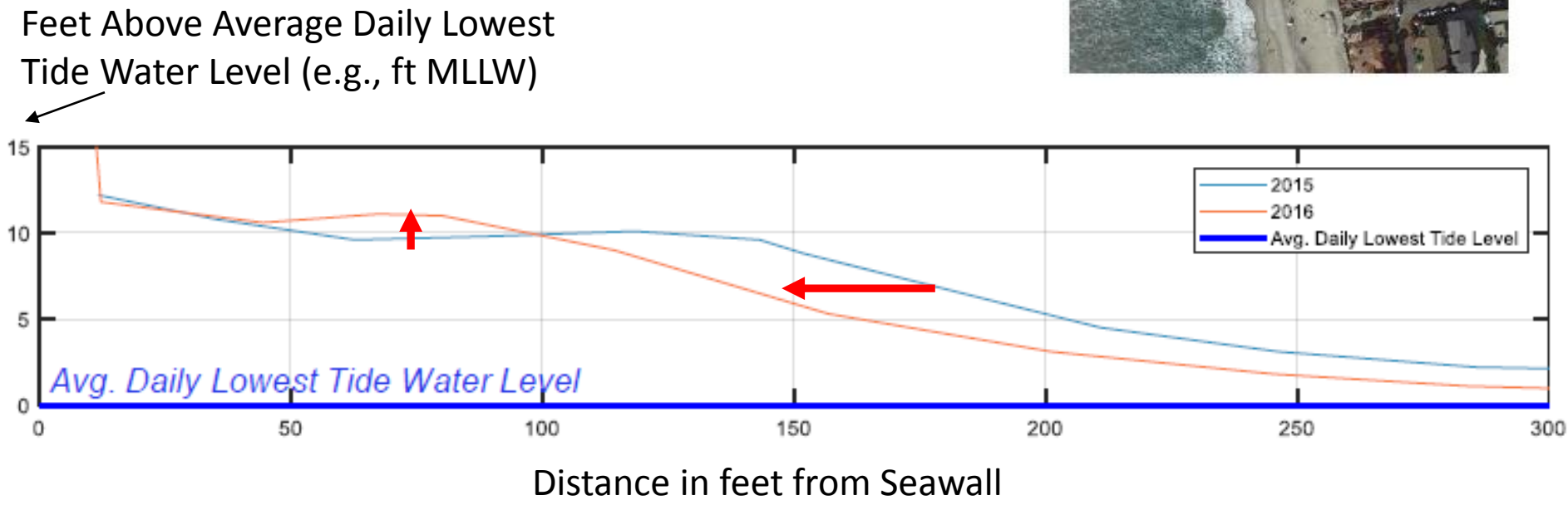
Feet Above Average Daily Lowest Tide Water Level (e.g., ft MLLW)



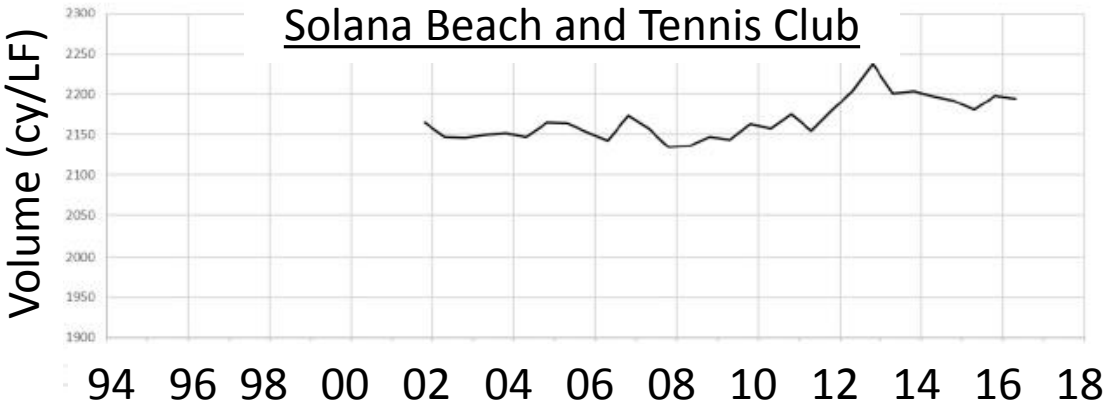
Distance in feet from Seawall

SANDAG Beach Transects

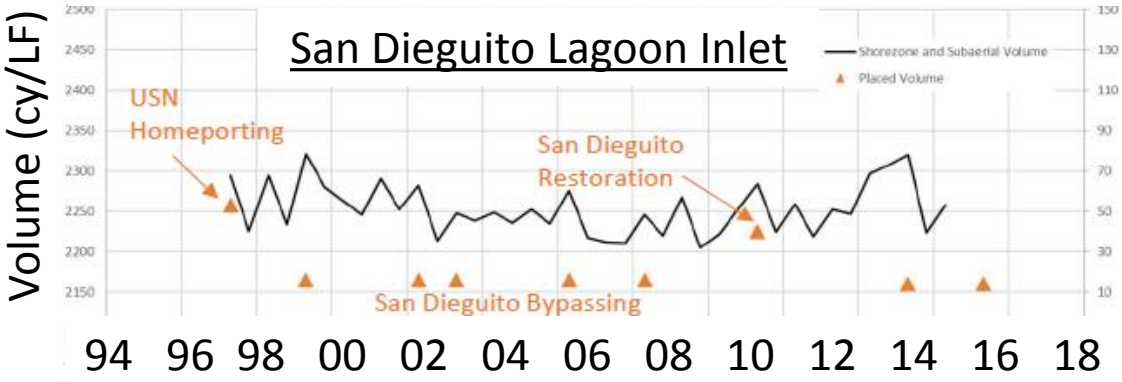
- Before and after 2015-2016 El Niño



Solana Beach and Tennis Club

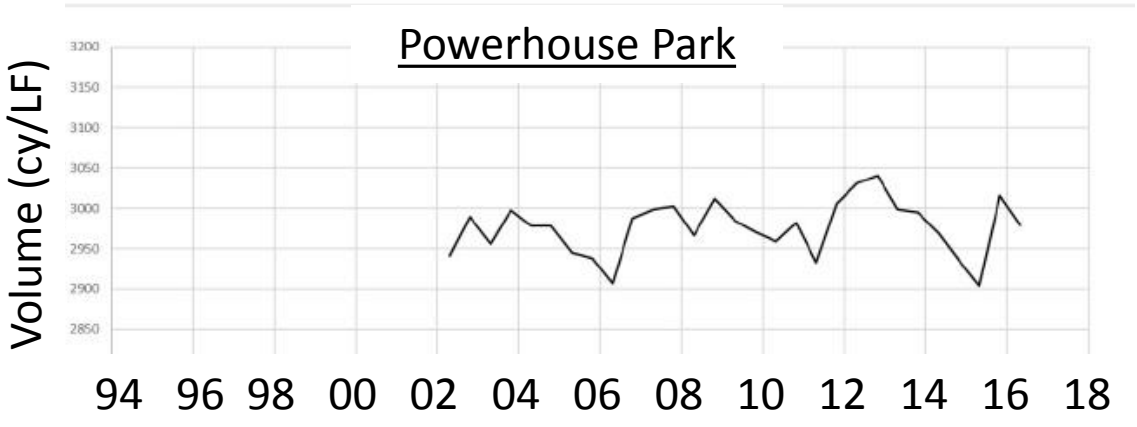


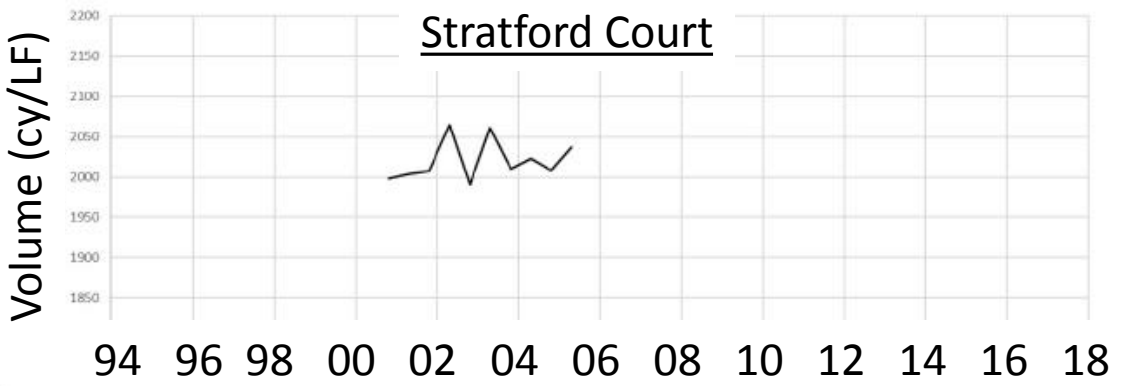
San Dieguito Lagoon Inlet



25th Street


Cardiff Beach
SD-0630
Seaside Beach
San Elijo Lagoon
SD-0625
Seaside Beach Parking
SD-0620
Tide Beach Park
SD-0610
101
5
SD-0600
Fletcher Cove
SD-0597
Solana Tennis Club
SD-0595
Seascape Surf Park
101
DM-0590
San Dieguito Lagoon Inlet
DM-0580
Ocean Front
San Dieguito Lagoon
DM-0560
Powerhouse Park
Stratford Ct
DM-0565
Los Penasquitos Lagoon


Powerhouse Park
Volume (cy/LF)
3200
3150
3100
3050
3000
2950
2900
2850
94 96 98 00 02 04 06 08 10 12 14 16 18


Stratford Court
Volume (cy/LF)
2200
2150
2100
2050
2000
1950
1900
1850
94 96 98 00 02 04 06 08 10 12 14 16 18

Existing Conditions Beach Dynamics - Findings

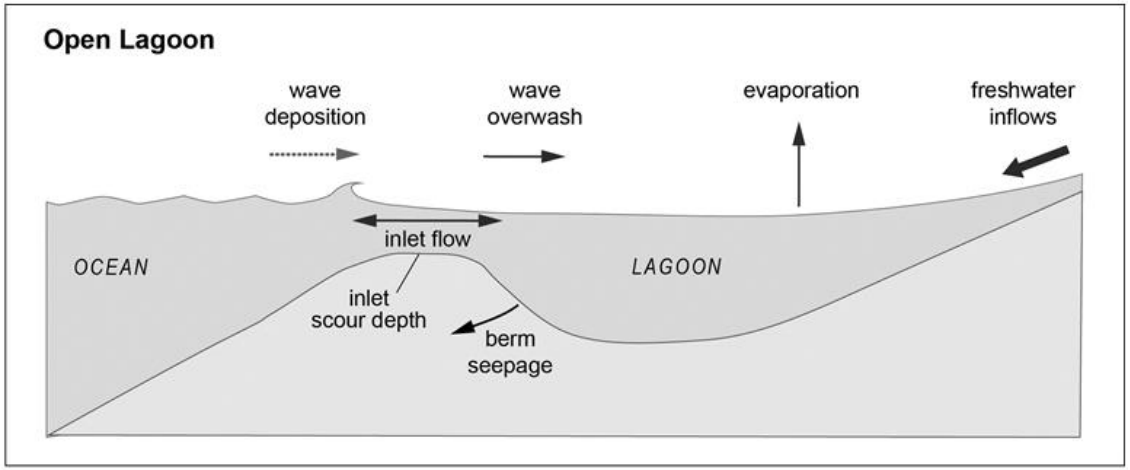
- During 2002-2012 time period Del Mar Beach eroded, even with bypassing from San Dieguito Lagoon
  - Losing 7,900 cy/yr from beach
  - Already nourishing with 9,500 cy/yr from San Dieguito dredging/ bypassing
  - Beach needs 17,400 cy/yr to remain stable

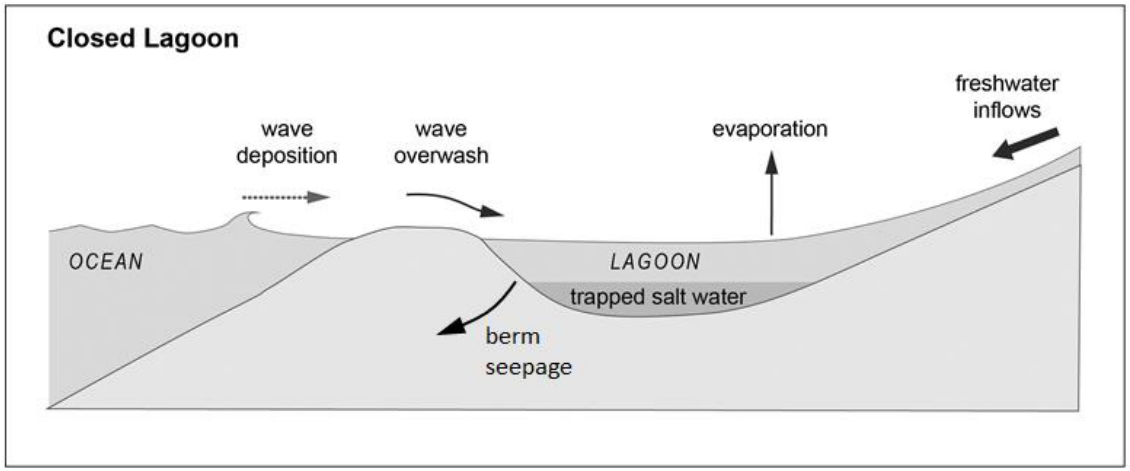
Lagoon Dynamics- the Lagoon "Box"

- River/lagoon input
- Dredging and bypassing
- Lagoon mouth dynamics
  - Quantified Conceptual Model (QCM)

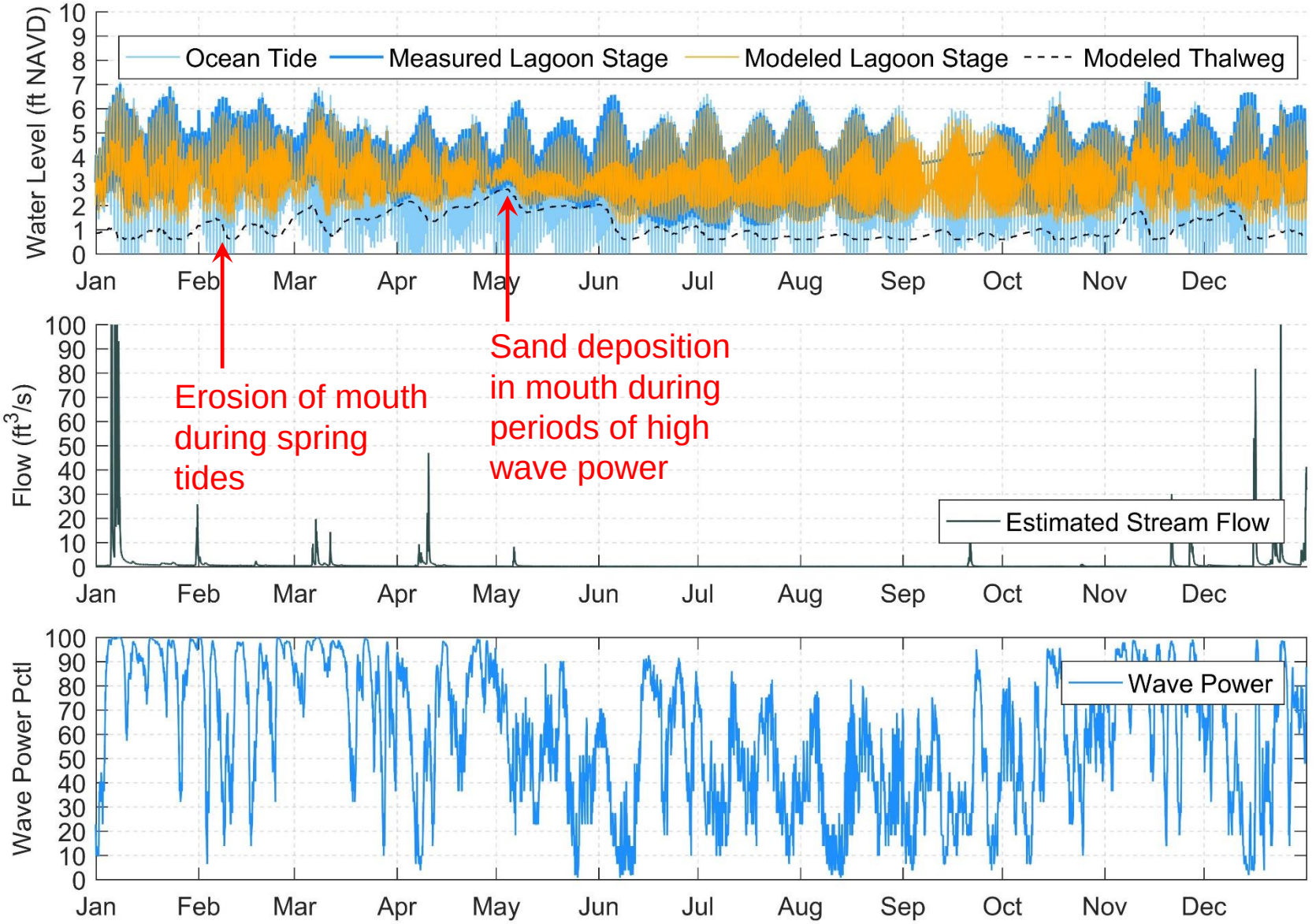
Quantified Conceptual Model (QCM)

Coastal Forcing **Inlet/Beach Morphology** **Lagoon Hydrology**





Existing Conditions (2016) Model Output



Existing Conditions Lagoon Dynamics

- Waves bring sand into mouth
  - Builds flood shoal
  - Raises elevation of bottom of channel (or thalweg)
- Tides move sand out of mouth and limit shoal
  - More water moving causes scouring of mouth
- Dredging creates a hole, which fills rapidly at first, and then flattens out

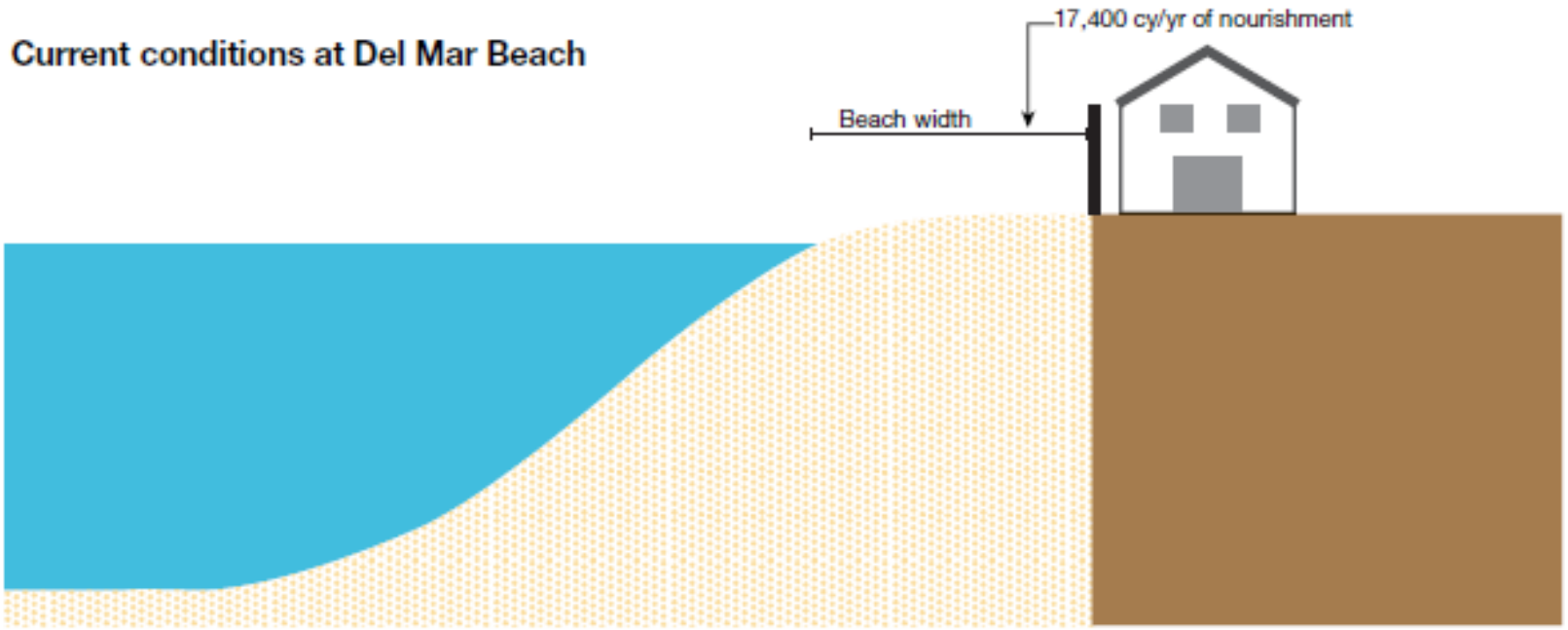
Future Conditions

- Looked at how each input and output would change with higher ocean water levels
- Helps project how beach and inlet mouth conditions may change

Future Longshore Transport

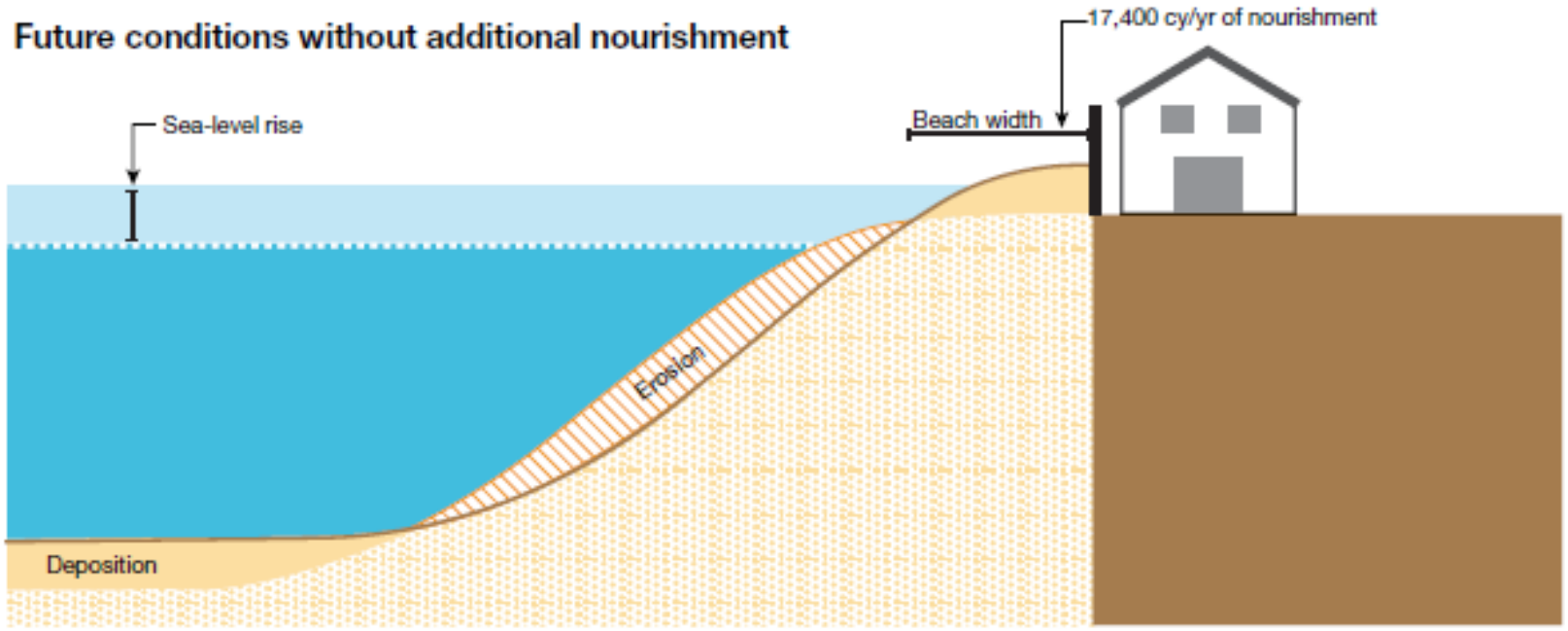
- Existing longshore transport is highly variable and will be in the future too
- Considerations for transport in the future:
  - Increased storminess could increase transport rates
  - Erosion of beaches to the north and south could mean there is less or no sand to transport, lowering transport rates

Future Beach Dynamics



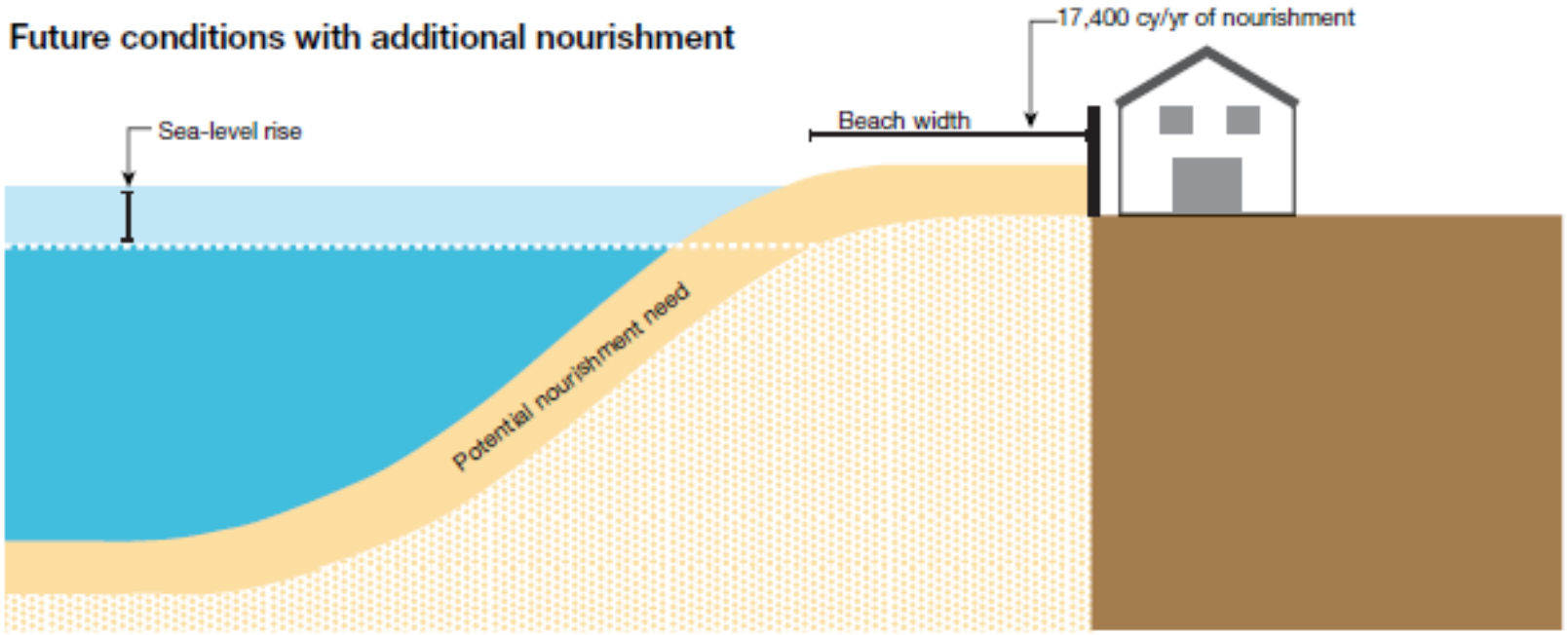
- Existing beach profile

Beach Dynamics with Sea-Level Rise



- Profile shifts up and in with sea-level rise (Bruun rule)

Beach Dynamics with Sea-Level Rise



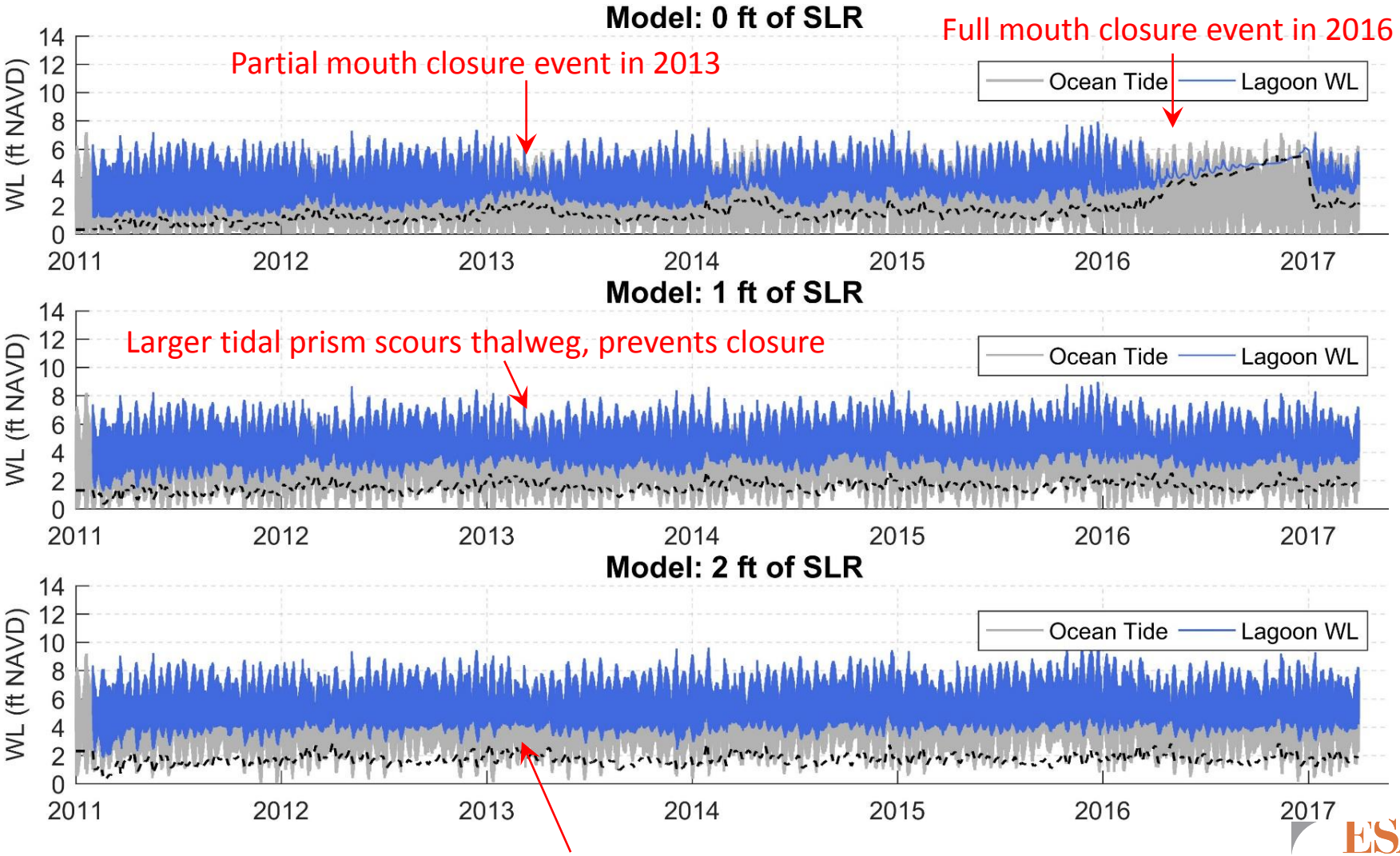
- Nourishment needs to raise entire profile to keep pace with sea-level rise

Beach Nourishment - Findings

- From existing conditions, need 17,400 cy/yr to maintain beach width for entire Del Mar under current conditions
- With future sea-level rise, additional nourishment need:

	1 ft of SLR	2 ft of SLR	5.5 ft of SLR
Current need	17,400 cy/yr	17,400 cy/yr	17,400 cy/yr
Additional need with SLR	34,000 – 35,600 cy/yr	50,900 – 53,200 cy/yr	76,400 – 80,200 cy/yr
Total nourishment	51,400 – 53,000 cy/yr	68,300 – 70,600 cy/yr	93,800 – 97,600 cy/yr

Lagoon Mouth Dynamics with Sea-Level Rise



Lagoon Dynamics with Sea-Level Rise- Findings

- Mouth may stay open without dredging
- Bed level predicted to increase with sea-level rise as assumed for Vulnerability Assessment
- Adaptation, for example mouth dredging, would be needed to reduce projected increase in flood risk as identified in Adaptation Plan
  - Mouth dredging volume would need to increase in order to maintain existing level of flood risk
  - Increased dredging volume is small compared to volume needed for beach nourishment

Sediment Budget Findings, compared to RBSP

	RBSP I	RBSP II	Average
	2001	2012	~Every 11 years
Del Mar	183,000	-	n/a
Solana Beach	146,000	142,000	144,000
Cardiff Beach	101,000	89,000	95,000
Oceanside Littoral Cell	1,833,000	1,082,000	1,457,500
Total for SANDAG RSBP	2,104,000	1,532,000	1,818,000

	Current	1 ft of SLR	2 ft of SLR	5.5 ft of SLR
Nourishment needed every 11 years	191,400 cy	374,000 – 391,000 cy	559,000 – 585,000 cy	840,000 – 882,000 cy

ESA

Conclusions & Recommendations

- Current San Dieguito Lagoon mouth dredging program not expected to maintain walkable beach with sea-level rise
- To keep up with sea-level rise, would need to place ~1M cy of sand every ~10 yrs (at 5 ft of sea-level rise)
  - Cost $21m - $22M per nourishment event
  - Feasibility uncertain at higher sea-level rise amounts (e.g., > 2 - 3ft)
    - Estimates assume neighboring cities nourish at a similar scale, otherwise sand would be lost to neighbors
    - Sand retention structures would be needed if neighbors don't nourish at same level to make nourishment effective
    - At this scale, might not be feasible due to availability of and competition for sand sources
  - Would still require higher sea walls

Conclusions & Recommendations

- Coordinated regional sediment management with beach targets is recommended
  - Sand placed directly on beach has better potential to maintain walkable beach than relying on up-coast nourishment
  - Consider participating in future SANDAG program with some optimization for Del Mar beaches
- There are approaches for strategic placements (timing, grain size, etc.) that could improve effectiveness
- Sand placement may have some negative impacts
  - Beach ecology, sand mining impacts, increase lagoon mouth deposition and maintenance
- Sand retention structures could increase effectiveness
  - Artificial reefs are recommend for consideration as a potential multi-benefit approach and potential effectiveness in trapping sand due to high rates of both north and south transport

Channel Dredging Plan

- Existing Conditions
  - Possible sand deposition upstream of railroad → Data gap
  - More monitoring needed to understand deposition
- Near-term Recommendations
  - Monitor channel deposition upstream of railroad
  - Evaluate flood risks
  - Increasing mouth dredging could reduce sand depositing further in
  - Dredging upstream of railroad as needed, but more difficult, costly
- Long-term Recommendations
  - Increased deposition likely with up to 2 ft of sea-level rise
  - → Increased flood risk
  - Frequent downstream dredging (below railroad) will become less effective and dredging upstream of railroad regularly may be infeasible
  - Likely that other adaptation measures will become necessary

Beach Nourishment Plan

- Near-term Recommendations
  - 17,400 CY/yr needed for Del Mar beaches under current conditions (more than currently receiving)
  - Place sand strategically (wave forecasting, etc.)
  - Increase frequency of SCE dredging (permit allows as frequently as every 8 months)
  - Monitoring- review SANDAG data regularly
  - Other current/future projects in the area

Beach Nourishment Plan

- Long-term Recommendations
  - Lagoon dredging alone not sufficient to maintain beach
  - Larger-scale placements, similar to RBSP I and II needed
  - Regional coordination recommended
  - Sand retention structures such as offshore reefs
  - Sand supply/sources
    - Offshore (like RBSP I and II)
    - Opportunistic nourishment- City could set up Sand Compatibility and Opportunistic Use Program
    - Lake Hodges reservoir

Questions?