Coastal Sediment Management

Beachfront

Beach Nourishment

Placement of imported sand to widen a beach

Dune Nourishment

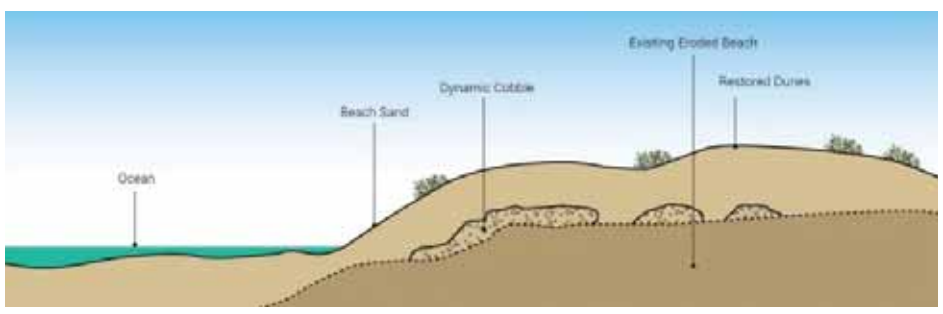
Placement of sand, grading, and planting to form "living" back beach dunes

Sand Bypassing

Placement of sand, removed from the harbor or lagoon inlets, on down shore beaches

Sand bypassing concept illustration

Cross-section illustration of beach nourishment, dune restoration, and cobble placement



Coastal Sediment Management Considerations

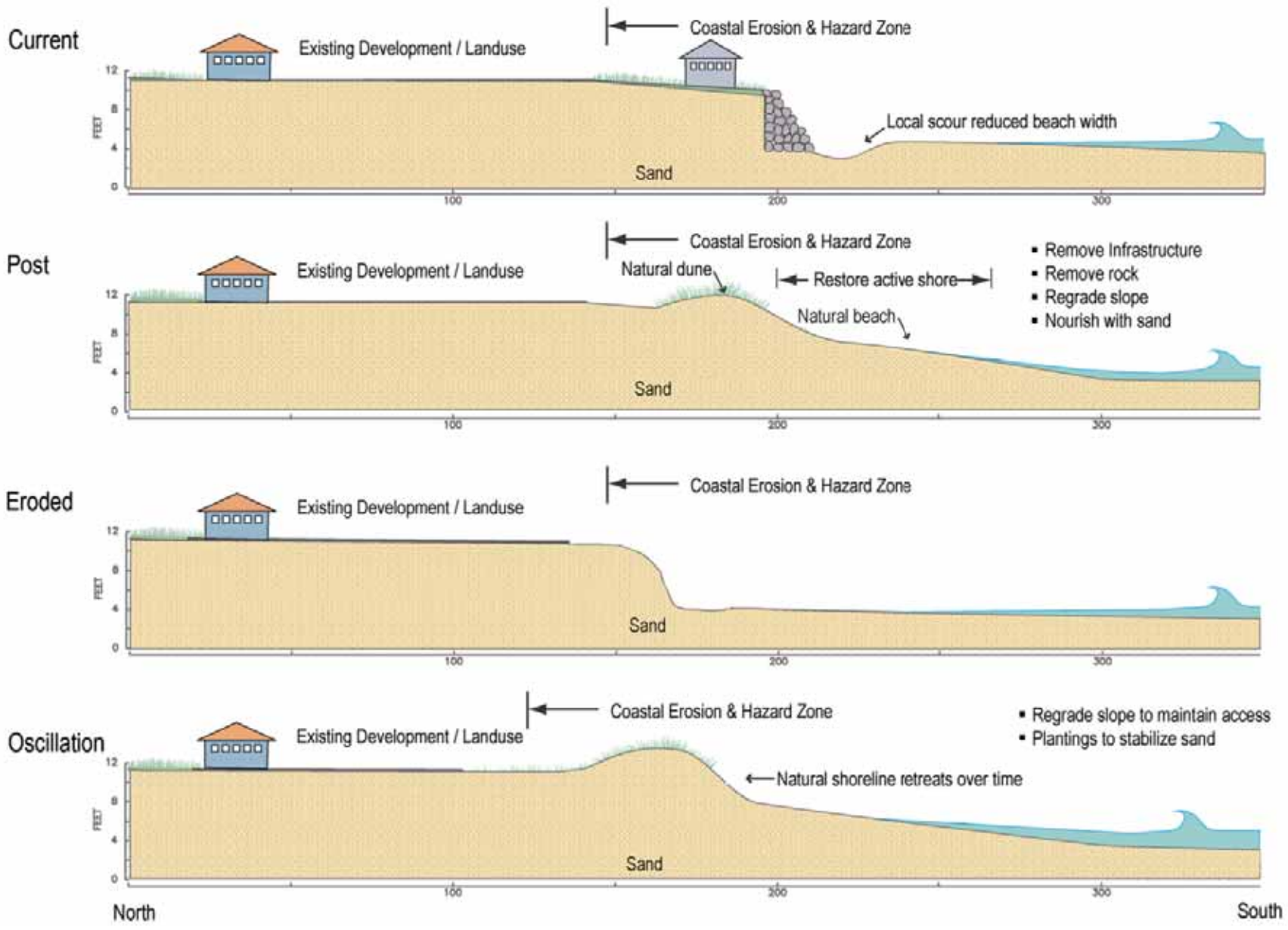
CONSIDERATION	SCORING	BENEFITS	CONSTRAINTS
COST	$$$	• Regional funding sources are available	• Transportation of sand/cobble from sources to nourishment sites • Limited sand sources and increased competition for sand over time • Material dredged from the harbor must be evaluated for suitability for beach placement
ENVIRONMENT	Minor	• Preserves beach • "Living shoreline" provides beach habitat	• Ecological impacts from pumping sand and bulldozing into place • Nourishment sand can be transported down coast and contribute to closure of lagoon mouths
FLOOD PROTECTION	Short-term	• Reduces flood risks and wave impacts in the short-term	• Less effective over time with increasing sea-level rise. Likely only effective up to 2-3 ft of sea-level rise. • Sand will likely erode quickly along segments of the coast that presently have no beach • Less effective without sand retention structures
TIMELINE TO IMPLEMENT		• Already being implemented in Oceanside	• Regulated by the California Coastal Act and Oceanside Local Coastal Program

Managed Retreat

Beachfront, Coastal Watersheds, and Small Craft Harbor

Managed Retreat

As conditions warrant, relocating and/or reducing the footprint of structures and supportive infrastructure in a planned fashion as sea levels rise to allow the shoreline to move inland, thereby maintaining the beach.



Managed Retreat Considerations

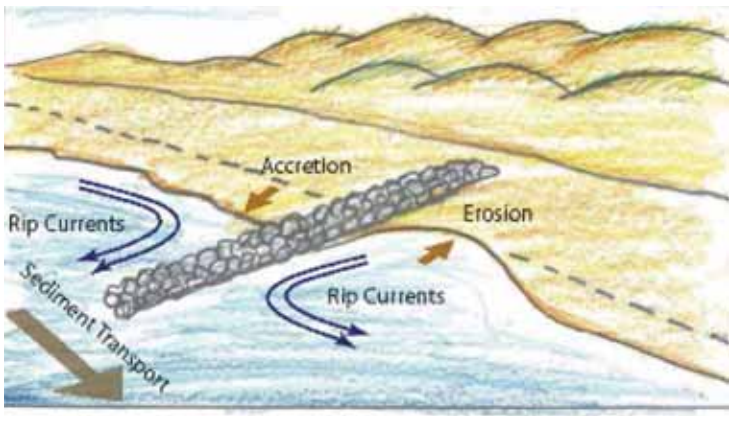
CONSIDERATION	SCORING	BENEFITS	CONSTRAINTS
COST	$$$$	• Avoids repeated costs for repair of storm and flooding damage	• High costs due to high property values
ENVIRONMENT	Benefit	• Reduces the likelihood of damaged material entering the ocean and creating hazards elsewhere • Allows for beach preservation and restoration and associated ecological and recreational resources	
FLOOD PROTECTION	Long-term	• Removes at-risk development	
TIMELINE TO IMPLEMENT	🕒🕒🕒	• Would be sustainable in the long-term	• Private property rights considerations • Would require significant redevelopment of infrastructure

Sand Retention Structures

Beachfront

Groins or Artificial Headlands

Hardened structures extending perpendicular to the beach to trap sand from drifting downcoast; can be buried and planted to appear more natural



Offshore Reefs

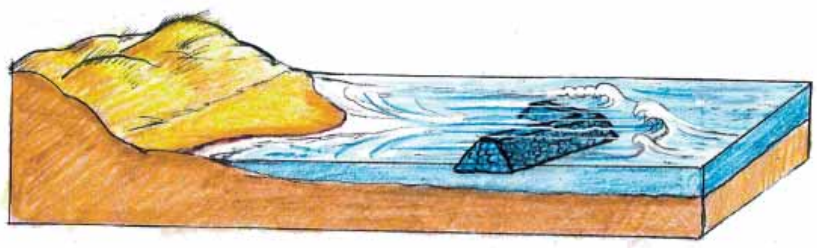
Rock or other material structures located underwater and offshore that encourage sand retention behind the reef, provide rocky reef habitat, and can enhance surfing resources

Example of oyster reef structures

Source: Orange County Coastkeeper

Breakwaters

Offshore structures constructed parallel to the beach to reduce wave action and slow sand drifting downcoast



Cross-section of offshore reef providing wave break

Source: www.marinas.com

The Oceanside Harbor breakwater protects the harbor behind it

Sand Retention Structure Considerations

CONSIDERATION	SCORING	BENEFITS	CONSTRAINTS
COST	$$		• In-water work is more expensive
ENVIRONMENT	Major	• Maintains a wider beach • Can improve surfing resources (reefs) • Provides rocky reef habitat (reefs)	• Requires habitat mitigation (groins and breakwaters) • Can destroy surfing resources (breakwaters) • Impacts horizontal access along the beach (groins) • Can induce/accelerate erosion down coast of structures
FLOOD PROTECTION	Short-term	• Reduces flood and erosion risks by retaining sand and maintaining a wider beach • Reduces wave impacts (breakwaters and reefs)	• Less effective over time with increasing sea-level rise • Provides little flood protection during high water events (groins and reefs)
TIMELINE TO IMPLEMENT	🕒🕒🕒		• Requires substantial planning and permitting • Regulated by the California Coastal Act and Oceanside Local Coastal Program

Raise/Reinforce the Pier

Beachfront

Raise the Pier

Reconstructing the pier by raising the deck and structural support members to accommodate higher sea levels and wave events

Raise the Pier Considerations

CONSIDERATION	SCORING	BENEFITS	CONSTRAINTS
COST	$$$	• Reduces maintenance and repair costs, reduces the likelihood of pier closures, which can impact local businesses	• Elevating the pier could be costly for the City • Reconstruction may need to occur more than once as sea levels continue to rise
ENVIRONMENT	Minor	• Extends recreational benefits	• Could change visual character • Ecological impacts from reconstruction
FLOOD PROTECTION	Long-term	• Removes structures on pier from flood elevations	• Structure will continue to experience damage from storm events, which will likely increase in intensity and frequency in the future
TIMELINE TO IMPLEMENT			• Regulated by the California Coastal Act and Oceanside Local Coastal Program • Raising structures would involve work in the water and on the beach

Levees with Wetland Restoration

Coastal Watersheds

Levees

Engineered earth embankment placed parallel to the course of a river or creek to reduce flood risk. Could be set back from the waterway to create wetland habitat.

Levee Cross-section with Public Access

Levees with Wetland Restoration Considerations

CONSIDERATION	SCORING	BENEFITS	CONSTRAINTS
COST	$$$		• Would require substantial fill material which would increase costs
ENVIRONMENT	Major	• Can provide some wetland habitat along slope	• Requires a large right-of-way, which could have major ecological impacts during construction
FLOOD PROTECTION	Mid-Term	• Reduces flooding	• Less effective over time with increasing sea-level rise with increasing sea levels
TIMELINE TO IMPLEMENT			• Requires substantial planning and permitting • Regulated by the California Coastal Act and Oceanside Local Coastal Program • San Luis Rey river is regulated by the US Army Corps of Engineers

Shoreline Protection Devices

Beachfront, Coastal Watersheds, and Small Craft Harbor

Sea Walls or Flood Walls

Vertical walls designed to provide flood and erosion protection for beachfront or river/creek front properties

Revetments

Rock or rip rap structures designed to provide flood and erosion protection for beachfront properties. Typically constructed on a slope to absorb wave energy.

Walls and revetments can be overtopped during storm events

The existing sea wall along The Strand

An existing rock revetment along The Strand

Rock revetments in the harbor protect inland properties

Shoreline Protection Device Considerations

CONSIDERATION	SCORING	BENEFITS	CONSTRAINTS
COST	$$	• Commonly-used engineering solution	• May require more frequent maintenance or reconstruction with sea-level rise
ENVIRONMENT	Major		• Accelerates beach erosion, since waves reflect off the structures and carry sand off the shore • Impedes public access • Degrades scenic qualities of coastal area • “Holding the line” with walls will result in loss of the beach over time with sea-level rise
FLOOD PROTECTION	Short-term	• Protects property and reduces flood and erosion risks for the design lifespan and conditions • “Holds the line” and buys time to implement other adaptation measures, like raising infrastructure or managed retreat	• Less effective over time with increasing sea levels
TIMELINE TO IMPLEMENT		• Properties with existing shoreline protection devices can seek permits for repair and maintenance	• Regulated by the California Coastal Act and Oceanside Local Coastal Program

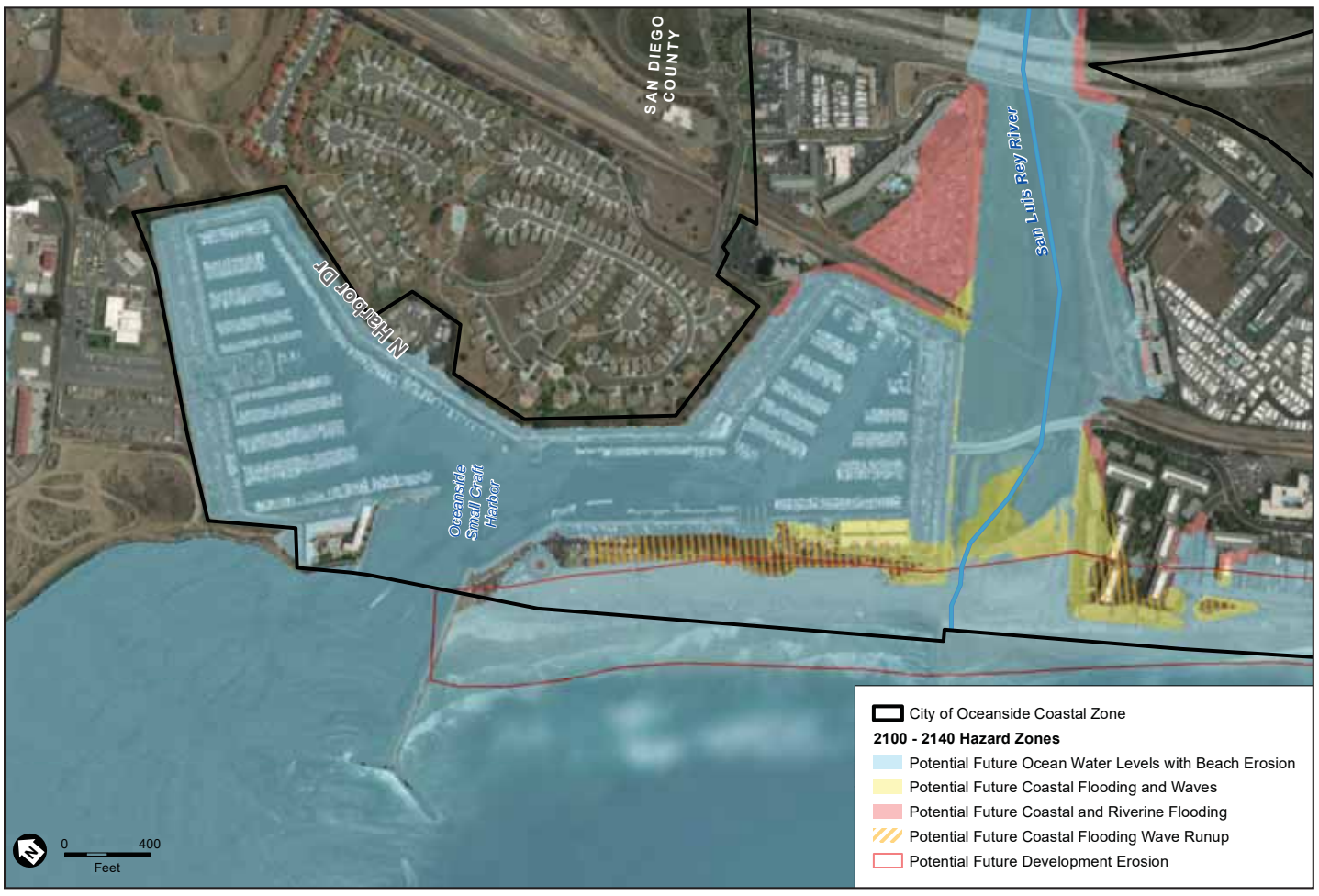
Abandon the Harbor

Small Craft Harbor

Harbor Relocation

In the future, the harbor can be abandoned or relocated to a different location, and if the Camp Pendleton Boat Basin was also abandoned, the area could be restored to provide coastal habitat

Source: www.marinas.com



Abandon the Harbor Considerations

CONSIDERATION	SCORING	BENEFITS	CONSTRAINTS
COST	$$$$	• Avoids repeated costs for repair of storm and flooding damage	• Relocating the harbor to a different location would be costly
ENVIRONMENT	Benefit	• Could restore natural sand transport from the north • Could provide coastal habitat	
FLOOD PROTECTION	Long-term	• Removes at-risk development • Restored natural transport could help preserve beaches down coast	
TIMELINE TO IMPLEMENT	🕒🕒🕒	• Would be sustainable in the long-term	• Regulated by the California Coastal Act and Oceanside Local Coastal Program • Would require extensive coordination with Camp Pendleton

Elevate Structures and/or Property Grade

Beachfront, Coastal Watersheds, and Small Craft Harbor

Elevate Structures

Raising buildings, roads, and utilities on pile foundations or pile supported causeways

Building Design/Construction

Designing first floors to be durable and resilient to flooding (e.g., for parking), while the second floor is above flood levels and contains all flood-sensitive features

Raise Property Grades

Placing fill to raise building and road foundations to higher elevations

Buildings have been raised on pile foundations in Stinson Beach, California

Source: Copyright 2002-2016 Kenneth & Gabrielle Adelman, California Coastal Records project, www.californiacoastline.org

Elevating Structures Considerations

CONSIDERATION	SCORING	BENEFITS	CONSTRAINTS
COST	$$$		• Elevating existing structures can be costly for the City and property owners
ENVIRONMENT	Benefit	• Elevating structures maintains beach and allows for limited landward migration of beach	• Could change visual character • Could impact views
FLOOD PROTECTION	Mid-term	• Removes structures from flood elevations	• Beach erosion and flooding will continue to migrate inland, requiring additional adaptation • Must be implemented district-wide across neighborhoods or else raising some structures could cause increased flooding of other structures
TIMELINE TO IMPLEMENT		• Raising structures would not involve work in the water or on the beach	• Need sufficient local guidance to navigate design and permitting requirements

Raise the Breakwater

Small Craft Harbor

Raise the Breakwater

Rebuilding the breakwater to a higher elevation or adding a new section of sea wall or rock to the top of the existing structure to offset the increase in flood levels with sea-level rise

A sea wall could be added to the Oceanside Harbor breakwater

Source: http://www.mr-ideahamster.com/howto/kayak/kayakvocabulary4jake.htm

Raise the Breakwater Considerations

CONSIDERATION	SCORING	BENEFITS	CONSTRAINTS
COST	$$$	• Could reduce costly damage to the harbor	• In-water work is more costly
ENVIRONMENT	Major		• An expanded breakwater footprint would have ecological impacts • Could change visual character
FLOOD PROTECTION	Short-term	• Reduces wave impacts	• Less effective over time with increasing sea levels • Structure will continue to experience damage from storm events, which will likely increase in intensity and frequency in the future
TIMELINE TO IMPLEMENT			• Regulated by the California Coastal Act and Oceanside Local Coastal Program

Raise the Marina Facilities

Small Craft Harbor

Raise Docks and Floating Infrastructure

Reconstruction of docks and other floating infrastructure with longer guide piles and support piles to float higher with higher water levels

Elevate Structures

Raising buildings, roads, and utilities on pile foundations or pile supported causeways

Raising Property Grades

Placing fill to raise inland building and road foundations to higher elevations

Guide piles allow docks and other floating infrastructure to move up and down with changing water levels. They are typically stiff enough to keep infrastructure in place but flexible enough to absorb heavy wave action.

Source: Harbor Technologies, www.harbortech.us/guide-piles

Raise the Marina Facilities Considerations

CONSIDERATION	SCORING	BENEFITS	CONSTRAINTS
COST	$$$		• Elevating existing structures can be costly
ENVIRONMENT	Minor	• Extends recreational benefits	• Short-term impacts during construction • Could change visual character • Raising structures would involve work in the water or on the beach
FLOOD PROTECTION	Mid-term	• Removes structures from flood elevations • Increases marinas facilities' resiliency to storm events	• Less effective over time with increasing sea levels
TIMELINE TO IMPLEMENT			• Regulated by the California Coastal Act and Oceanside Local Coastal Program

River and Creek Channel Management

Coastal Watersheds

Channel Sediment Management

Dredging certain areas along the channel to expand flood capacity

Creek Mouth Management

Managing the connections between the creeks and the ocean, possibly through dredging or changed operation of water control structures (e.g., Buena Vista lagoon weir)

The weir at Buena Vista lagoon

Source: Scripps Institute of Oceanography

The mouth of the Los Peñasquitos Lagoon in San Diego is regularly dredged to maintain an open tidal connection with the ocean.

River and Creek Channel Considerations

CONSIDERATION	SCORING	BENEFITS	CONSTRAINTS
COST	$$		• Requires increased management • Off-site disposal of dredged material can be costly
ENVIRONMENT	Minor	• Dredged material could be used for beach nourishment or other sediment-starved areas as part of a sediment management plan	• Ecological impacts of dredging or management
FLOOD PROTECTION	Mid-term	• Increases flood flow capacity	
TIMELINE TO IMPLEMENT		• Dredging San Luis Rey River is a USACE project that has already been authorized by Congress	• Regulated by California Coastal Act and Oceanside Local Coastal Program

Guiding Principles for Adaptation Planning

Community Values

What physical features and activities do we want to preserve and enhance?

- Beach and ocean
- Public amenities (e.g. pier, harbor, restrooms)
- Scenic resources
- Natural habitat (e.g., coastal watersheds)
- Commercial goods and services (e.g., restaurants, boutique retail)
- Arts and entertainment
- Community events
- Public parking

What considerations should guide our assessment of adaptation options?

- Coastal access
- Public safety
- Visual quality/community character
- Natural resources
- Private property rights
- Economic development
- Fiscal health
- Legal exposure/indemnity
- Flexibility

Guiding Principles for Adaptation Planning

Coastal Commission Guidance

What must we assume regarding the extent of sea level rise?

Use science to guide decisions

- Local conditions
- Scenario planning
- Precautionary approach

What resources must we consider and prioritize in our assessment of adaptation options?

Maximize protection of public access, recreation, and sensitive resources

- Natural shoreline values and processes
- Public trust lands
- Mitigation of unavoidable impacts

Minimize vulnerabilities through planning and development standards

- New development
- Social and economic needs of the community
- Assumption of risk

Maximize agency coordination and public participation

- Regional, state, and federal agencies
- Regional vulnerability assessment and planning
- Public participation