CHAPTER 9

Beach Erosion and Flooding Adaptation

This chapter includes a range of adaptation measures to address vulnerabilities from beach erosion and flooding in North Beach (north from 15th street to the San Dieguito river mouth). The beach level community in the City of Del Mar comprises a century-old beach front neighborhood with approximately 600 properties in a densely populated area, a major U.S. coastal route (101), and railroad tracks supporting both commuter and interstate freight traffic. Its 596 residential households have an average household income of $102,664 and average property value of $3,585,615 (USPS Carrier Route data, Nov. 2017). The area is heavily populated with high concentrations of multi-family zoning and 5-foot building setbacks. It serves visitors with direct public beach access at each street from 15th to 29th. Permanent lifeguard towers with public restrooms at 17th St, 20th St, & 25th St are supplemented with temporary towers during busy tourist seasons. This region has unique neighborhood features, topographies, and vulnerabilities. It is already subject to both coastal and river flooding. The homes and structures throughout the area benefit from resident sea-walls along almost the entire beachfront. Permitting for some adaptation measures lies within the jurisdiction of federal, state or City entities, as summarized in Section 9.3.

Vulnerability assessment:

- Public access along the beach (horizontal access) will be lost due to beach erosion with 1 to 2 feet of sea-level rise.
- Beach erosion and coastal storms will threaten sea wall integrity and increase flooding and storm damage.
- Low-lying roads and properties in North Beach will be highly vulnerable to coastal and river flooding, including the blocks between Ocean Front and Camino Del Mar/Coast Blvd and the blocks directly east of Camino Del Mar/Coast Blvd.
- The present low to moderate vulnerability to coastal flooding and wave damage will become a high vulnerability with 1 to 2 feet of sea-level rise, for low-lying roads and properties in North Beach, including the City's 17th St Beach Safety Center.

Beach adaptation options:

- Beach and dune nourishment
- Sand retention
- Raise/improve sea walls and revetments
- Elevate structures
- Relocate public infrastructure

Beach adaptation monitoring:

- Beach width
- Flooding and storm damage frequency

9.1 Beach adaptation options

9.1.1 Adaptation option: beach and dune nourishment

Widening North Beach would reduce the risk of flooding and erosion of property along the beach. However, the width of the beach will diminish with time and sea-level rise, requiring an ongoing cycle of “re- nourishment” to maintain beach width. As sea-level rises, the frequency of required nourishment is likely to increase, because, in addition to widening the beach to offset erosion, additional sand will be needed to raise the elevation of the beach up to the increased sea level. For all these reasons, beach nourishment should be considered in conjunction with sand retention measures (Section 9.1.2).

The dominant direction of sand transport along the Del Mar coast is from north to south. Beach nourishment could therefore contribute to closure of the Los Peñasquitos Lagoon inlet to the south, and could also affect the San Dieguito Lagoon inlet to the north (during south swells that transport sand from south to north). With sea-level rise, increased sediment supply may be a net benefit to the extent that it mitigates rapid shoreline and ecological changes. The Coastal Hazards, Vulnerability and Risk Assessment indicates beach nourishment will be effective up to 1 ft of sea-level rise. Thus, the Adaptation Plan prioritizes beach nourishment as the primary and immediate strategy for Del Mar’s North Beach area. Table 9.1.1 summarizes benefits and constraints of beach and dune nourishment.

Table 9.1.1
Beach and dune nourishment benefits and constraints summary

Benefits	Constraints
• Preserves beach • "Living shoreline" provides beach and dune habitat • Reduces flood and erosion risks	• Limited sand sources • Less effective over time with increasing sea-level rise • Transportation of sediment to receiver sites • Beach use and ecology impacts

Placement of sand typically provides a temporary benefit until the sand erodes and migrates away from the placement area. It is therefore important to consider the fate of the sand and implications of deposition in other areas. In general, increased sand supply is considered beneficial to most beach areas, but can be problematic at lagoon inlets and storm drain outlets. Sand deposition on rocky substrate may adversely affect habitat and recreation. The dominant direction of sand transport along the Del Mar coast is from north to south. Beach nourishment could therefore contribute to closure of the Los Peñasquitos Lagoon inlet to the south, and could also affect the San Dieguito Lagoon inlet to the north (during south swells that transport sand from south to north). However, with sea-level rise, increased sediment supply may be considered a net benefit in terms of mitigating rapid shoreline and ecological changes.

9.1.2. Adaptation option: sand retention

Sand retention measures include structures that prevent sand transport away from the beach and encourage sand deposition on the beach. Types of structures include the following:

- **Groins**: These structures serve to maintain a wider beach but have the potential to diminish horizontal access along the beach. Constructing rock groins and other rock structures on the beach or in the ocean typically requires habitat mitigation (e.g., restoration of comparable habitat in another location) and could alter the character of Del Mar's natural shoreline. New groin designs may become available in the future, so this option should be evaluated over time.
- **Breakwaters**: These structures maximize wave reduction and sand retention but can disrupt and alter wave patterns and interfere with surfing resources, which may negatively impact Del Mar. Current permitting and mitigation requirements ,and the degree of potential negative impacts, may restrict use of breakwaters as an adaptation measure. New breakwater designs may become available in the future, so this option should be evaluated over time.
- **Artificial reefs**: These structures create rocky reef habitat and have potential to enhance surfing resources; however, using artificial reefs to retain sand and enhance surfing is still in the experimental phase of development. They have been investigated, constructed, and tested in various locations including Orange County. Successful reef installation remains a work in progress to date. New reef designs may become available in the future to ensure that reef implementation will provide the intended benefits, so this option should be evaluated over time.
- **Artificial headlands**: These structures are intended to protect against localized erosion while allowing flanking regions to erode naturally. Their design, placement and use is still in the experimental phase of development. This option should be evaluated over time.

Table 9.1.2 summarizes benefits and constraints of sand retention measures.

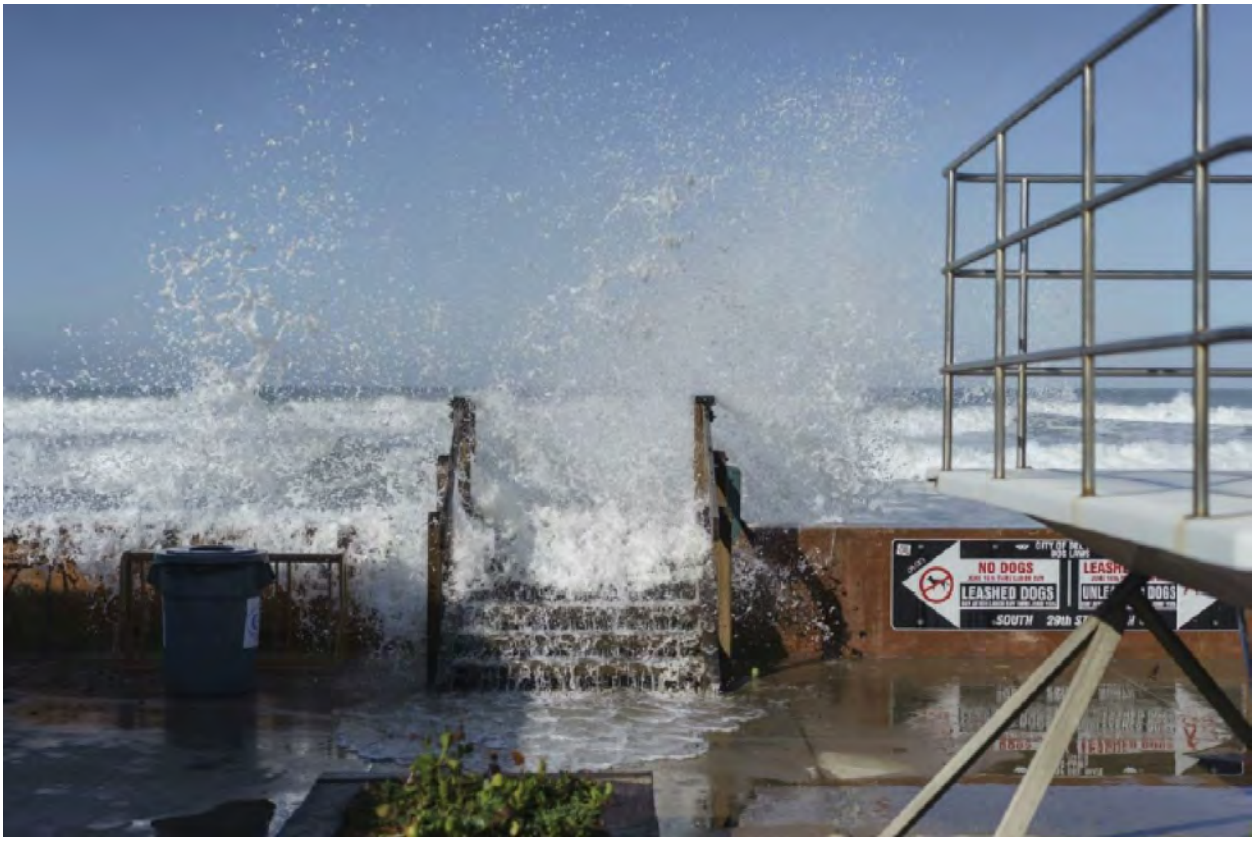
Table 9.1.2
Sand retention measures benefits and constraints summary

Type of sand retention structure	Benefits	Constraints
All	Retain sand	Require mitigation
Groins	Maintains wider beach	Affects horizontal access along beach
Breakwater	Maximizes wave reduction and sand retention	Destroys surfing resources
Artificial reefs	Creates rocky reef habitat Potential to enhance surfing resources	Experimental / limited experience
Artificial headlands	Protects discrete frontage while leaving intervening regions to erode naturally	Experimental / limited experience

9.1.3 Adaptation option: improve sea walls and revetments

The existing sea walls and rock (i.e., rip rap) revetments along North Beach provide flood and erosion protection for beachfront properties during typical storms and seasonal erosion. During severe storms, which can be coupled with severe seasonal erosion of the beach, waves can overtop the sea walls and revetments as in March 2016 (Figure 9.1) and cause damage as in the 1983 El Nino storm event (Figure 9.2). Improving North Beach sea walls and revetments provides an adaptation measure to offset the increase in flood risk with sea-level rise. This could be accomplished by adding a new section of sea wall or rock to the top of the existing walls/revetments; however, doing so may require significant modifications or a rebuilding of the existing walls/revetments. While beach access points along the City's beaches from 15th Street north to the lagoon can be currently protected with seasonal berms, it may be important to consider sea wall protection for these locations.

Figure 9.1
Overtopping in Del Mar on March 8, 2016



While sea walls and revetments provide protection to the existing property slopes, these structures can contribute to erosion and accelerate beach loss when the beach width narrows and wave run-up frequently reaches the structure. As the beach narrows and sea-level rises, wave run-up and overtopping of the sea wall structures will also increase as the waves begin to break near or on the structures, and will require more frequent maintenance or reconstruction.

With ongoing beach erosion and sea-level rise and without any other mitigating measures, fixing the shoreline location in one place with a sea wall or revetment will eventually lead to the loss of the beach seaward of the structure.

Sea wall and revetment construction is regulated by the CA Coastal Act and Del Mar LCP. The Coastal Act and LCP allow for construction and maintenance of sea walls or revetments when necessary to protect existing structures or public beaches in danger from erosion, when designed to eliminate or mitigate adverse impacts on the local shoreline sand supply. New development may not rely upon protective devices (e.g., sea walls and revetments) that would substantially alter natural landforms. Table 9.1.2 summarizes benefits and constraints of raising/improving sea walls and revetments.

Figure 9.2
Coastal Damage Following 1983 Storm

Table 9.1.3
Raise/improve sea walls and revetments benefits and constraints summary

Benefits	Constraints
• 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 • In Del Mar, provides protection for properties throughout North Beach	• Potential for loss of beach with sea-level rise and without other measures • Potentially accelerates beach erosion with sea-level rise • May require more frequent maintenance or reconstruction with sea-level rise • Level of protection provided decreases with loss of beach

9.1.4. Adaptation option: elevate structures

The ground floor elevation of homes and buildings or infrastructure such as roads can be raised to above sea-level rise flood levels (e.g., the 100-year flood level plus an allowance for sea-level rise) to reduce the risk of flooding with sea-level rise. Raising structures can include raising vulnerable buildings on pile foundations; ~~so that the beach can move landward with sea-level rise without necessarily requiring armoring (e.g., a sea wall or revetment). Raising structures allows for some limited migration and persistence of a fronting beach in the near term. Without additional measures such as beach and dune nourishment, the shoreline will migrate past homes and potentially damage roads, infrastructure and even the homes if the pilings are undermined. There may also be challenges with height restrictions and other codes. In contrast to maintaining sea walls or revetments, this option allows for the flexibility to retain structures while maintaining the beach.~~ however, there may be challenges with building height restriction, earthquake code compliance and other building codes. Further, while raising oceanfront structures could have potential to allow for some limited migration and persistence of a fronting beach, if it were done without accompanying beach and dune nourishment, shoreline migration would likely damage roads, infrastructure, and the many lower lying properties east of the shoreline.

Raising existing homes may not be feasible from an engineering and cost perspective, but is more feasible for new construction. However, this is likely an “all or nothing” plan, where the ocean ebb and flow and resulting shoreline migration would need to be enabled under all structures in the beach zone. If some structures are raised on pilings and others are not, the structures that are not raised are likely to be even more impacted and compromised by the lack of impediments to the ebb and flow of the ocean and migrating shoreline.

Building design and construction can be modified so that the second floor is above the target flood level and contains all flood-sensitive features, while the first (ground level) floor is used for parking and/or storage and is designed to be durable and resilient to flood damage. While this type of design is feasible for new construction, it may be unfeasible from a cost and engineering perspective as a retrofit to existing structures.

Raising roads can be accomplished by placing fill to rebuild roads at higher elevations. Utilities, that are vulnerable to flooding, erosion, or increased ground water levels with sea-level rise, such as sewer pipelines and storm drains, which are often buried along roads, can also be raised. Other options for raising roads and utilities may include replacing at-grade roads with pile-supported causeways. Table 9.1.4 summarizes the benefits and constraints of raising structures.

Table 9.1.4
Raising structures benefits and constraints summary

Benefits	Constraints
• ~~Maintains beach and allows for limited landward migration of beach~~ Protects vulnerable structures.	• Beach erosion and flooding continues to migrate inland, requiring additional adaptation

9.1.5 Adaptation option: relocate public infrastructure

Relocating roads and utilities is an adaptation measure that allows the shoreline to move inland, thereby maintaining the beach with sea-level rise. The City can consider relocation of public buildings, utilities and other infrastructure as the risk to public structures increases with sea-level rise. Proactively, the City could consider options for facilitating structure removal where there is a public benefit, such as removing structures to restore beach areas or parks that are resilient to flooding.

9.2 Beach adaptation monitoring

Criteria to be monitored for beach adaptation include changes in risk or chance of extreme coastal flooding and storm damage, and approximate beach widths. Projected flood and damage risks and beach widths with sea-level rise and without adaptation are based on the Coastal Hazards, Vulnerability, and Risk Assessment (ESA 2016). With greater than 1 ft of sea-level rise, winter/spring beach widths are anticipated to be great enough to eliminate a walkable beach and its storm protection, and the risk of flooding and damage are anticipated to exceed an acceptable level. Therefore, thresholds for initiating consideration and planning of beach adaptations are any of the following:

- Risk of sea wall failure.
- Flood and damage risk approaching a moderate level (5% annual chance of extreme flooding and damage)
- Average or successive winter beach widths approaching 25 ft
- Average or successive summer beach widths approaching 80 ft

Once adaptation measures are implemented to increase beach widths and/or reduce flood/damage risks, then the flood risk would be estimated for the adapted condition assuming future sea-level rise. Increasing flood/damage risks and decreasing beach widths would then continue to be monitored and compared against the beach width thresholds above. Table 9.2.1 shows projected beach widths with increasing chance of extreme flooding/damage.

Table 9.2.1
Projected beach width with increasing chance of extreme flooding/damage

Annual chance of extreme flooding/damage (1983 event)	1%	5%	15%	50%	100%
Summer/fall beach width	120 ft	80 ft	34 ft	0 ft	0 ft
Winter/spring beach width	65 ft	25 ft	0 ft	0 ft	0 ft

Other beach adaptation criteria may be considered or added through further refinement, application, and re-evaluation of the Adaptation Plan, which could include the following:

- Beach elevation at the toe of the sea walls and revetments to serve as an indication of the exposure of the structure to wave action.
- Risk of sea wall failure.

As the beach narrows with sea-level rise, the beach and dunes could be nourished to improve beach access, aesthetics and habitat function, as well as limit future damages in areas that are eroded during storm events. Even so, it must be noted that with enough sea-level rise (e.g., 3 ft, corresponding to 50% chance of extreme flooding), the shoreline adaptation measures that would be required to maintain existing structures would be insufficient. The ground floor elevation of beachfront and adjacent homes and buildings could instead be raised. Table 9.2.2 presents the Beach Adaptation monitoring criteria and adaptation measures and anticipated beach width ranges for which each measure would be effective. Table 9.2.3 provides lead times to begin advance planning before adaptation measures could be in place to limit risk.

Table 9.2.2
Beach erosion monitoring criteria to consider adaptation options

Criteria & Thresholds	**Summer beach width**	**120 ft**	**80 ft**	**35 ft**	**0 ft**
	Winter beach width	**65 ft**	**25 ft**	**0 ft**	**0 ft**
	Annual risk of extreme flooding (without adaptation)	**5%**	**15%**	**50%**	**100%**
Adaptation Options	**Protect (soft measures)**	Beach and dune nourishment			
	Protect (hard measures)		Raise and improve sea walls		
	Protect (hard measures)			Sand retention strategies	
	Accommodate		Elevate structures		
	Retreat		Relocate public infrastructure		

Table 9.2.3
Lead times for planning beach erosion adaptation options

Risk	Actions	Lead Times	Adaptation Options
Beach	**Protect**	**5-10 years**	Beach and dune nourishment
erosion	**Protect**	**10-15 years**	Raise and improve sea walls
	Protect	**15-20 years**	Sand retention strategies
	Accommodate	**5-10 years**	Elevate structures
	Retreat	**15-20 years**	Relocate public infrastructure

9.3 Beach adaptation coastal permitting

The Coastal Development Permit review and approval for beach adaptation measures may be processed by the City of Del Mar through the LCP and/or by the California Coastal Commission, pursuant to the California Coastal Act, as well as the US or California Fish and Wildlife Service, the US Army Corps of Engineers, and California Regional Water Quality Control Boards. Table 6.3 summarizes. In general, adaptation measures that involve construction or disturbance above the Mean High Water (MHW) line are within the City's LCP jurisdiction, while adaptation measures taken below MHW is within the California Coastal Commission's jurisdiction. Table 9.3 summarizes the likely coastal permitting mechanisms relevant to developing the LCP amendment for beach adaptation measures. For measures that would be permitted through the California Coastal Commission rather than the LCP Amendment, policies developed by the City within the LCP Amendment that support particular adaptation measures may be considered by the California Coastal Commission in their review process. However, the Coastal Act would remain the standard of review for measures within the CCC's retained jurisdiction. The likely coastal permitting mechanisms for beach adaptation measures are summarized in Table 9.3 for the purpose of informing the development of the LCP Amendment as a next step. Other approvals and permits would also be required and would need to be addressed separately.

Table 9.3
Summary of likely California Coastal Act approval and permitting process for beach erosion adaptation measures

Adaptation Measure	LCP Jurisdiction	CCC Jurisdiction	Note
Beach and dune nourishment	✔	✔	• LCP review for above water portion • CCC Coastal Development Permit required for below water portion
Sand retention measures	✔	✔	• Contingent on CCC approval and funding • Likely to require mitigation
Raised/improved sea walls and revetments	✔		• LCP redevelopment policies and regulations • Coastal Act limitations may apply
Elevate structures	✔		• LCP redevelopment policies and regulations
Relocate public infrastructure	✔		• LCP policies