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DRAFT

SEA LEVEL RISE VULNERABILITY ASSESSMENT

Pacifica, CA

Prepared for
The City of Pacifica

January 2018



Near-king tides and high surf at Beach Boulevard on November 30, 2017 (J. Jackson)

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1. INTRODUCTION

1.1. Background

The City of Pacifica is updating its Local Coastal Program, a planning document that regulates development in the City's Coastal Zone and establishes a long-range vision for the community. The California Coastal Act, passed in 1976, provides for coastal jurisdictions to adopt a Local Coastal Program (LCP) to ensure local implementation of Coastal Act priorities. The City adopted its current LCP in 1980 and is currently preparing a Local Coastal Plan (LCP) update to address sea level rise (SLR) and its effects on coastal erosion and flooding. Environmental Science Associates (ESA) performed this Vulnerability Assessment to address existing conditions and future vulnerability of the City of Pacifica and its social, economic and physical coastal resources to projected sea level rise, coastal flooding and erosion. The findings of this Assessment will enable ESA to assist the City with development of adaptation strategies to prepare for future impacts. Ultimately, the City, with assistance from ESA, will develop policy language for incorporation into the City's LCP Update.

ESA's coastal hazard analysis and vulnerability assessment is a planning-level assessment for the purposes of informing the development of an Adaptation Plan and LCP policies in the next phases of the LCP update preparation process. This assessment therefore relies on reasonable assumptions and engineering judgement to simplify the analysis where needed and utilizes available coastal hazard mapping products that are discussed in Section 1.2 and Section 2.

Please note that this document incorporates the Existing Conditions Report deliverable detailed on ESA's work plan for the sea level rise assessment and adaption planning effort, removing the need for a separate Existing Conditions Report to be prepared.

1.2. Past Studies on Coastal Flooding and Erosion

To conduct the Vulnerability Assessment, ESA relied on readily available data sources. The following studies examined coastal flooding and erosion impacts in Pacifica. The hazard maps and associated data produced from these studies are utilized in this Vulnerability Assessment (described in Section 2.2).

Sea Change San Mateo County

This Sea Change San Mateo County study established and executed a risk-informed methodology to assess SLR vulnerability and flood risk in San Mateo County (SMC 2017). The assessment used data from all three sources mentioned below for evaluating the vulnerability of the County and its assets to coastal hazards. One goal of this study is to remain consistent with the County-wide study. ESA used the same hazard data sources for the Vulnerability Assessment, which are described below.

Our Coast Our Future (OCOF)

Our Coast Our Future (Ballard et al. 2016) is a collaborative project that provides online maps and tools to help users understand, visualize and anticipate vulnerabilities to sea level rise (SLR) and storms. The project maps 40 different SLR and storm scenarios that were developed by the United States Geological Survey (USGS) using

their Coastal Storm Modeling System¹ (CoSMoS). The hazard maps are hosted in an interactive web environment that includes layers for flooding extent, depth, duration, wave heights, current velocity, as well as various infrastructure and ecology layers. ESA used various OCOF hazard mapping products to evaluate existing and future coastal flooding hazards due to SLR and storm flooding for this Vulnerability Assessment. Details on the SLR scenarios and descriptions of each type of coastal hazard are discussed in Section 3.1.

Pacific Institute Study

In 2009, Philip William and Associates, Ltd. (PWA, now ESA) was funded by the Ocean Protection Council to provide the technical hazards analysis supporting the Pacific Institute report on the “Impacts of Sea Level Rise to the California Coast” (PWA 2009; Pacific Institute 2009). In the course of this work, PWA projected future coastal flooding hazards for the entire state based on a review of existing Federal Emergency Management Agency (FEMA) hazard maps and projected future coastal erosion hazard areas for the northern and central California coastline, ending at Santa Barbara. These hazard areas were used in the Pacific Institute study, which evaluated potential socio-economic impacts of SLR. In order to maintain consistency with the Sea Change SMC study, ESA used the coastal erosion hazard maps in this Vulnerability Assessment to identify potential impacts to Pacifica.

Coastal Regional Sediment Management Plan, San Francisco Littoral Cell (Draft)

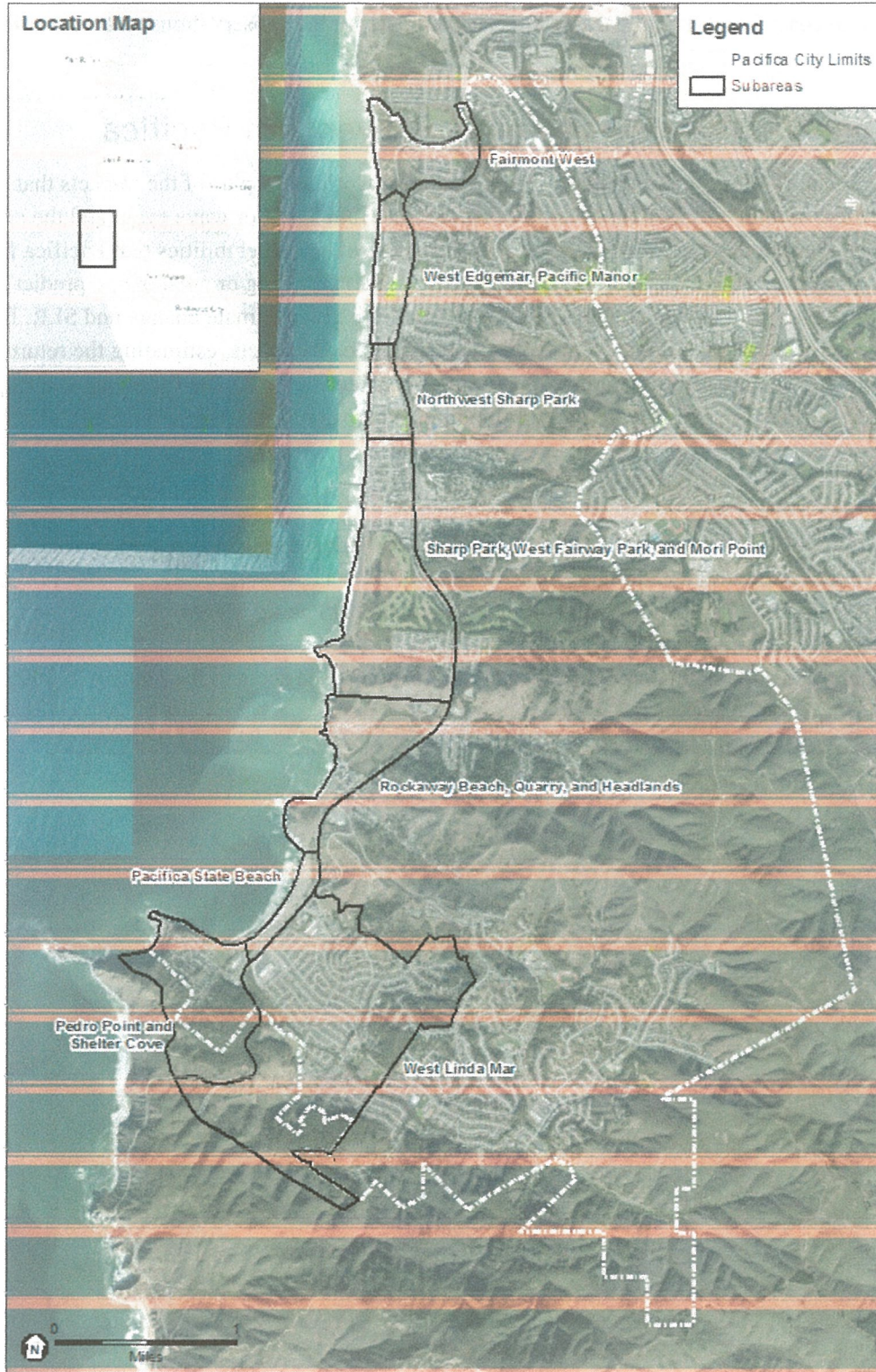
A Coastal Regional Sediment Management Plan (CRSMP) is a guidance and policy document that discusses how Regional Sediment Management (RSM) can be applied in a rapid, cost-effective, and resource-protective manner. ESA (2015) completed a Draft CRSMP for a segment of the San Francisco Littoral Cell along the San Francisco and San Mateo Counties Pacific coastline for the Coastal Sediment Management Workgroup (CSMW). The CSMW was a taskforce, co-chaired by the U.S. Army Corps of Engineers and the California Natural Resources Agency, and focused on the adverse impacts of coastal erosion on coastal habitats. Along with other federal, state and local/regional entities, the CSMW worked to implement RSM to augment or restore natural processes. The Draft CRSMP is a source of information for Pacifica’s LCP Update, specifically the vulnerability and adaptation components, and the existing data base of assets and erosion hazard maps. The erosion hazard maps were produced by ESA using updated methodology originally developed for the Pacific Institute Study and include accelerated erosion in response to SLR, projections of future beach widths, and modifications for a range of potential adaptation alternatives including allow erosion (do nothing), beach nourishment, beach nourishment with reef, armor, and hybrid approaches. These erosion hazard maps will be used to assess the implications of different shoreline management options in the upcoming Adaptation Plan task of this project.

1.3. Existing Conditions

This document is focused on vulnerabilities of property and built assets in Pacifica that are exposed to coastal flooding and erosion now or may be exposed in the future due to projected sea-level rise. Existing land use, policy and zoning are not covered in this document. Existing natural resources will be expanded upon in the Final Vulnerability Assessment.

¹ Information on OCOF can be found at: <http://data.pointblue.org/apps/ocof/cms/>

The Pacifica coastal community consists of nearly 40,000 residents and has six miles of beaches and bluffs along the Pacific Ocean. Built and natural resources along Pacifica’s coastline are currently vulnerable to coastal flooding and erosion. Vulnerabilities, and subsequently adaptation planning, are being evaluated for Pacifica’s coastal sub-areas as defined in the draft LCP (with slight modifications by ESA). Following the organization of the Vulnerability Assessment (Section 3), existing conditions for each sub-area in Pacifica are discussed below, from north to south. Pacifica’s sub-areas are shown in Figure 1. Sub-area descriptions include the existing exposure to coastal and riverine hazards considering FEMA hazard maps, physical characterization of the backshore, description of coastal protective devices (flooding and erosion) and general description of natural and built assets.



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SOURCE: City of Pacifica, San Mateo County

Figure 1
Pacifica Sub-areas

Existing exposure to coastal and fluvial hazards are based on past studies, observations and current FEMA flood insurance rate maps.

Observed coastal flooding and erosion events in Pacifica

Observations of coastal flooding and erosion events provide real world examples of the impacts that can be sustained by Pacifica, both in terms of the severity of a particular rain storm or wave event and the actual damages to infrastructure, property and other assets. One way to characterize the vulnerabilities that Pacifica faces with projected SLR is to estimate the return period² of observed events of flooding or erosion and predict how the frequency of these events (and damages) may increase in the future given climate change and SLR. For example, this is accomplished by choosing a flood event that is representative of impacts, estimating the return period for the event, and predicting future return periods at given times considering SLR. The following events provide examples of Pacifica’s existing exposure to coastal flooding and erosion:

- Winter 1983: Large swell and precipitation
- El Nino 1997-1998: Large swell
- January 11, 2001: Wave event and overtopping at Sharp Park seawall and erosion damages to Beach Blvd seawall (photographs shown in Figure 2)
- Winter 2009-2010: Large swell and resulting bluff erosion at Pacific Manor
- January 21, 2016: Large swell (photographs in Figure 3)
- Others identified and documented by City staff (for example see account for January 2, 2006 in Figure 4)



SOURCE: B. Battalio

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Figure 2
Observed flooding and erosion along Beach Blvd on January 11, 2001

² Return Period is an estimate of the time between individual events (e.g. precipitation or wave event) of a given severity.

Sub-Area Descriptions

Each Pacifica sub-area (shown in Figure 1) is discussed below. Existing conditions maps were created for each sub-area (Appendix A). Each map shows stormwater and wastewater infrastructure, coastal armoring structures, existing FEMA flood hazard zones, and the latest available (2016) mean higher high tide shoreline. ESA reviewed current FEMA maps (shown in Appendix A) to assess existing flooding risk in Pacifica. FEMA flood hazard maps, which are used for the National Flood Insurance Program, present coastal and fluvial flood hazards. FEMA recently released updated coastal flood hazard maps for San Mateo County (effective 8/2/2017) according to the 2005 Pacific Coast Guidelines (FEMA 2005a). The latest FEMA National Flood Hazard Layer is hosted online via an ArcGIS webmap³. In the following sub-area descriptions, we will refer to existing coastal hazards using the following FEMA terms:

- BFE – Base Flood Elevation, the elevation of surface water resulting from a flood that has a 1% chance of equaling or exceeding that level in any given year.
- VE zone – The flood insurance rate zone that corresponds to the 100-year coastal floodplains that have additional hazards associated with storm waves.

In this report, elevations of FEMA flood zones and the Pacifica are referenced to the North American Vertical Datum of 1988 (NAVD), the vertical control datum established for vertical control surveying in the USA. For reference, mean sea level in Pacifica is approximately 3.2 ft NAVD, mean high tide is approximately 5.3 ft NAVD. Conditions of the coastline are generally described in terms of the following areas: the beach (sand or gravel); the backshore (dunes or bluffs that rise behind the beach); the bluff top; and inland areas.

Fairmont West



SOURCE: Adelman & Adelman 2013

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Figure 5
Fairmont West Sub-area
CA Coastal Records Photos

The Fairmont West sub-area includes 0.6 miles of shoreline at the northern most portion of the City of Pacifica that includes open space west of and residential development east of Palmetto Ave and Westline drive (Figure 5, Appendix A-1). Land use includes residential (single and multi-family), parks, and open space. The most seaward

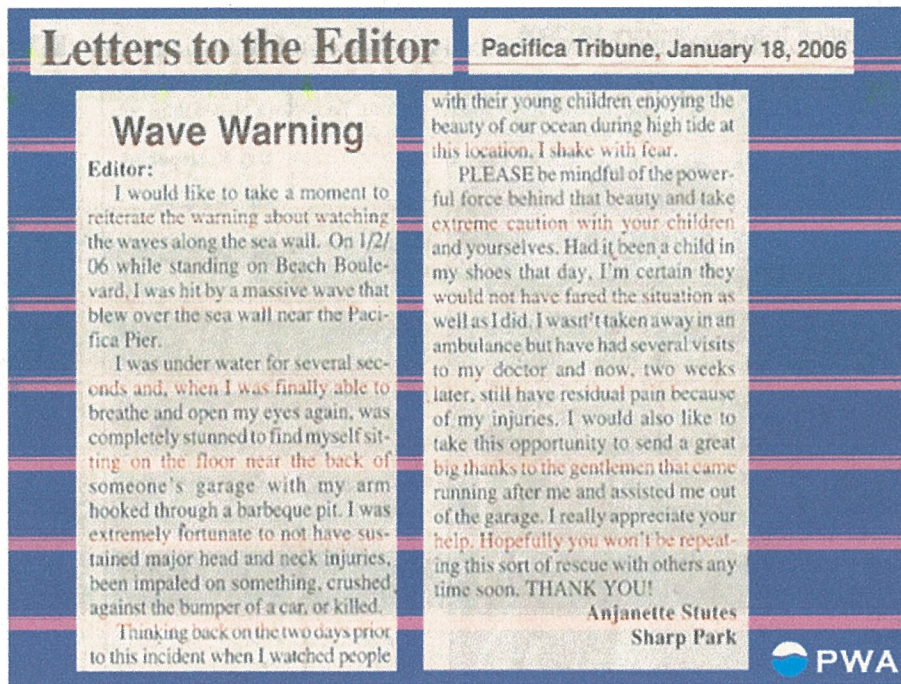
³ <http://fema.maps.arcgis.com/home/webmap/viewer.html?webmap=cbe088e7c8704464aa0fc34eb99e7f30>



SOURCE: B. Battalio

Pacifica LCP 170663

Figure 3
Observed flooding and erosion events at Pacifica on January 22, 2016



SOURCE: Pacifica Tribune

Pacifica LCP 170663

Figure 4
Reported wave overtopping at Pacifica on Jan 2, 2006

assets in this sub-area are the north end of Palmetto Avenue and Westline Drive which are beyond 300 feet from the current bluff edge, and the Dollaradio station (100 Palmetto Avenue). The shoreline is comprised of mixed sand and gravel that can give way to exposed rocky shores depending on the season. The backshore is mostly characterized with undeveloped tall coastal bluffs (140-180 feet). Bluff erosion has recently exposed concrete piles and cap seaward of the Dollaradio station. A rock revetment was constructed along the bluff toe in front of Dollaradio in 2010. As of December 19, 2017, the beach is relatively high in this sub-area and only the top of the revetment is exposed, but this is believed by ESA to be a temporary condition associated with the dynamic beach environment. Due to the tall bluff, assets in this sub-area are not currently at risk to coastal flooding but are projected to be exposed to coastal erosion. FEMA coastal base flood elevations (BFEs) in this sub-area range from 27 to 28 feet NAVD, which is well below (lower) than the bluff tops.



SOURCE: J. Jackson, 20 Dec 2017

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Figure 6
Dollaradio Station with rock at toe and Piles at top of bluff (Left)
Drainage pipes and terrestrial erosion of bluff south of Dollar Radio (Right)

West Edgemar and Pacific Manor



SOURCE: Adelman & Adelman 2013

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Figure 7
West Edgemar and Pacific Manor Sub-area
CA Coastal Records Photos

This West Edgemar and Pacific Manor sub-area includes all land west of Highway 1, south of Dollaradio Station and including the San Francisco RV Resort (Figure 7, Appendix A-2). Land uses include single and multi-family residential, commercial (including Manor Plaza), auto services, office, vacant, and other public or community uses. The sub-area includes 0.8 miles of coastline that consists of rip rap and a few short (100-400

West Edgemar and Pacific Manor



SOURCE: Adelman & Adelman 2013

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Figure 7
West Edgemar and Pacific Manor Sub-area
CA Coastal Records Photos

This West Edgemar and Pacific Manor sub-area includes all land west of Highway 1, south of Dollaradio Station to and including the San Francisco RV Resort (Figure 7, Appendix A-2). Land uses include single and multi-family residential, commercial (including Manor Plaza), auto services, office, vacant, and other public or community uses. The sub-area includes 0.8 miles of coastline that consists of rip rap and a few short (100-400

feet) stretches of sandy beach. The backshore is characterized by tall bluffs (60-120 feet) with development on or near the edge of bluff. Approximately 80 percent of the backshore is currently armored in this sub-area, which highlights the erosion hazards posed to bluff top property and infrastructure. For example, the bluffs fronting the OceanAire Apartments (formerly called “Lands End Apartments”; 100 and 101 Esplanade Avenue) have eroded up to 90 feet in the last decade, prompting the construction of a concrete seawall at the bluff toe and re-sculpting and restoration of the bluff face and access path. This seawall has since failed due to erosion above and behind the structure which caused portions of the wall to collapse (Figure 8). Erosion continues beyond the structure at both ends, and the area is currently under construction with large rocks placed on the beach.



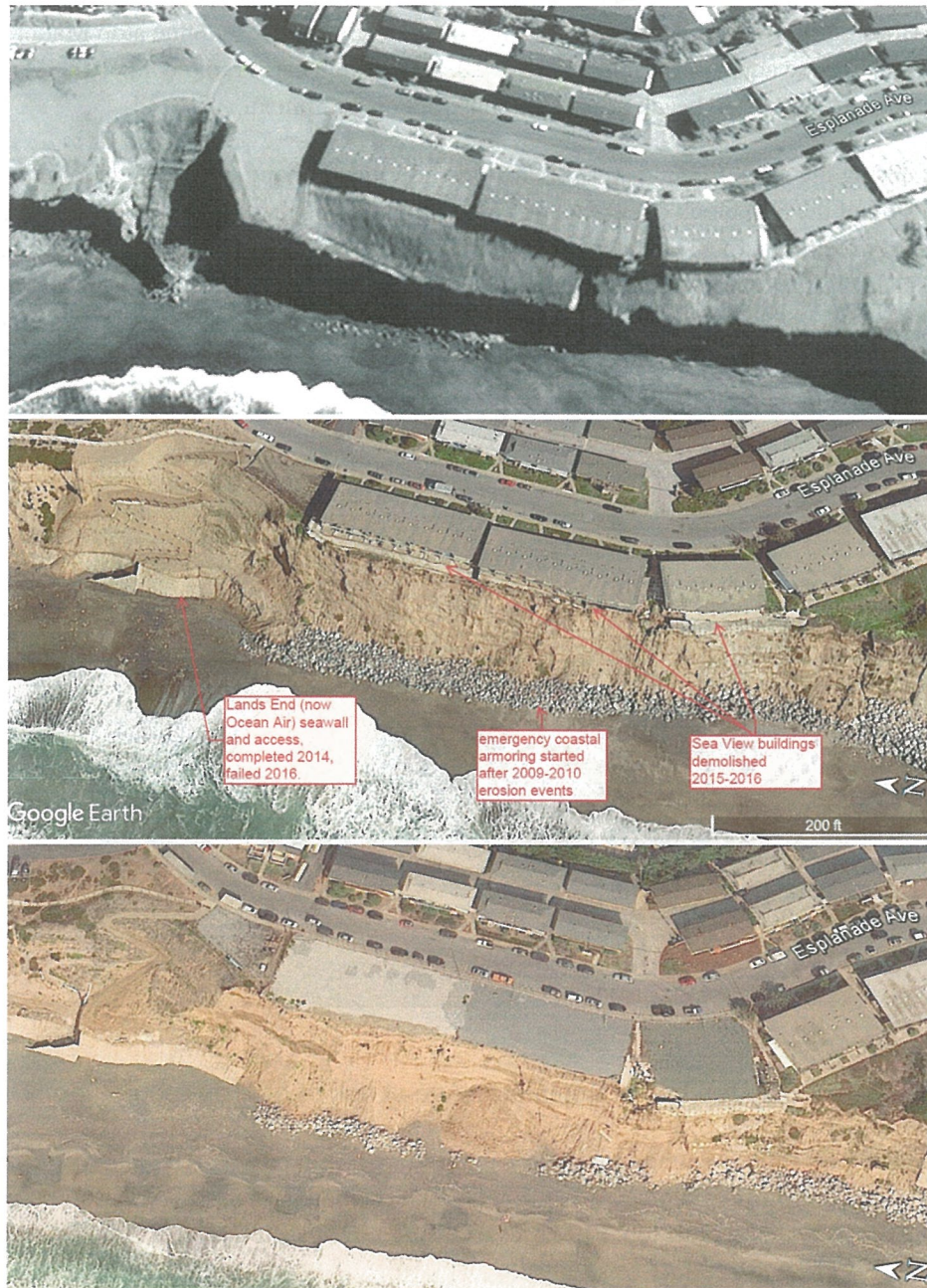
SOURCE: J Jackson, Dec 20, 2017

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Figure 8

Failure of seawall caused by erosion behind structure and partial collapse

Immediately south, erosion of the bluff face has led to the removal of three multi-unit apartment buildings on Esplanade Avenue since 2015 (310, 320, 330 Esplanade Avenue) despite the presence of a rock revetment at the bluff toe. Existing coastal structures were upgraded since 2015 and expanded in the last to cover the entire bluff face at The Bluffs apartments (380 Esplanade Avenue). Erosion in northern Pacifica 2009-2016 led to a substantial expansion of coastal armoring as well as demolition of three apartment buildings and loss of public access to the beach. Figure 9 compares the progression and impacts of erosion along Esplanade Avenue in three aerial photographs taken in 2009, 2014, and 2016.



SOURCE: Google Earth

Pacifica LCP 170663

Figure 9
Erosion of bluffs in Pacifica at Sea View buildings
February 2009 (top), February 2014 (middle), November 2016 (bottom)

Just south of The Bluffs, undeveloped land along the 400 block of Esplanade Avenue atop Manor beach provides a buffer to Esplanade Avenue and sewer facilities. In 2010, an armored earth ramp connecting Esplanade Avenue to Manor beach was built to provide beach access for construction equipment.

Further south and during the 1998 El Nino storms, erosion undermined many of the single family residences along the western side of the 500 block of Esplanade Avenue, and all but two were demolished (528 and 532 Esplanade Avenue). A rock revetment was constructed under an emergency permit, and the City converted the property to open space with and bluff top trail. Erosion of the bluff has continued, and is now encroaching on the bluff-top trail (Figure 10). The last two remaining homes along the western side of the 500 block of Esplanade Avenue were acquired by the City of Pacifica and are presently being demolished. The City of Pacifica is placing rock to armor the base of the bluff from erosion.



SOURCE: B. Battalio, Dec 20, 2017

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Figure 10
Bluff top trail at Esplanade Ave at risk of erosion (photograph Dec 20 2017)

The San Francisco RV Resort (700 Palmetto Avenue) armored their property with a rock revetment in 2016/2017, under an emergency permit. Bluff erosion caused the closure of the San Francisco RV Resort public access trail, which traverses the property at the bluff top. FEMA coastal BFEs in this sub-area are 24 to 28 feet NAVD, compared to bluff edges of 70 to 120 feet.



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SOURCE: San Mateo County 2017

Figure 11
Bluff toe armoring and erosion at Esplanade blufftop apartments (top)
Bluff toe and face armoring at The Bluffs apartments (bottom)

Northwest Sharp Park



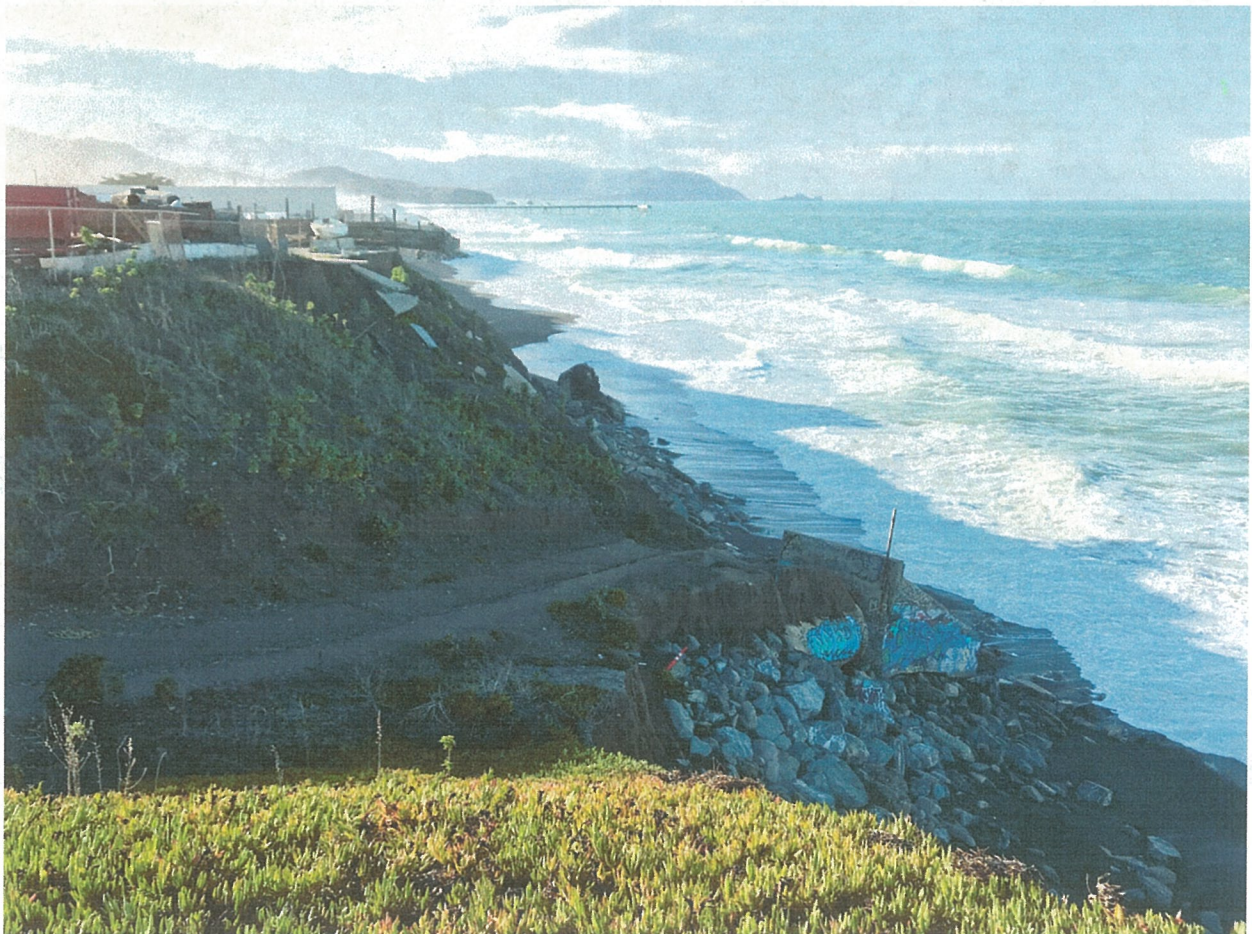
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SOURCE: Adelman & Adelman 2013

Figure 12
Northwest Sharp Park Sub-area
CA Coastal Records Photos

The Northwest Sharp Park sub-area includes land west of Highway 1 and between the SF RV Resort and Bella Vista Ave (Figure 12, Appendix A-3). Land uses include residential, industrial, commercial, school, mobile homes, office, auto services and mixed use. This sub-area is the northern portion of the West Sharp Park sub-area defined in the draft LCP. For this study, the West Sharp Park sub-area from the LCP was divided along the parcel boundaries between Shoreview Avenue and Paloma Avenue for two reasons. First, the backshore armoring infrastructure changes at this location from private to public. North of the divide, private homes are armored by rock revetments and gunnite covering the bluff face. South of the divide, a public walkway and Beach Boulevard runs along the bluff top which is protected by a seawall and fronting rock revetment. Secondly, flooding at the Sharp Park Golf Course (SPGC) affects residences directly north of the course. ESA and the City recognize this direct linkage and that any shoreline management strategies taken for SPGC will have implications for the neighborhood north of and adjacent to the golf course. Thus, the southern portion of West Sharp Park sub-area was combined with the Sharp Park sub-area in order to more clearly discuss existing conditions, evaluate vulnerability and develop adaptation strategies that account for this flooding linkage. The Sharp Park sub-area is discussed in the following section.

Northwest Sharp Park sub-area includes approximately 2,800 feet of shoreline from the south end of the San Francisco RV Resort to the north end of the Beach Boulevard seawall. The shoreline is almost entirely covered with rock or rubble; the beach is currently very narrow at the north end and disappears in front of the armored homes along Shoreview Avenue. Bluff top land use includes industrial, commercial, and residential uses. One of the residential uses includes The Cottages at Seaside (previously known as the Pacific Skies Estates mobile home park). The backshore is about 90 percent armored in this sub-area, owing to gaps in rubble along the northern bluffs. A damaged stormwater outfall is located at the north end of this sub-area (Figure 13). Along these areas of industrial use, scattered rubble and landfill material resulting from erosion of the bluff is present along the bluff toe. A rock revetment was built since 2010 along the private property situated in Industrial North Palmetto. The coastal armor at The Cottages at Seaside consists of rock, concrete piles and gunnite. Various rock revetments and gunnite cover the bluff along the Shoreview Avenue residences. New rock was observed on December 19, 2017 in and around the bluff notch at the south end of Shoreview Avenue. The new rock was placed in front of homes and the City stormwater outfall. The FEMA BFE in this sub-area is 32 feet NAVD, compared to bluff elevations of 34 to 68 feet NAVD.



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SOURCE: J. Jackson 20 Dec 2017

Figure 13
 Damaged stormwater outfall in foreground, landfill and eroded rubble on narrow beach beyond

Sharp Park, West Fairway Park and Mori Point



SOURCE: Adelman & Adelman 2013

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Figure 14
Sharp Park, West Fairway Park and Mori Point Sub-area
CA Coastal Records Photos



Pacifica LCP 170663

SOURCE: Adelman & Adelman 2013

Figure 15
 Sharp Park, West Fairway Park and Mori Point Sub-area
 CA Coastal Records Photos

The Sharp Park, West Fairway Park and Mori Point sub-area (Figure 14 and Figure 15, Appendix A-4) includes land west of Highway 1 and contains the Palmetto Ave business district, Beach Boulevard Promenade, Fishing Pier, multiple City-owned parcels and landmarks, the Sharp Park Golf Course, West Sharp Park and West Fairway Park neighborhoods and Mori Point. Land use is diverse in this sub-area and includes residential, commercial, auto services, office, mixed use, industrial, church, public and community uses, parks, some vacant/undeveloped parcels and beach.

The draft LCP defined the “Sharp Park Golf Course, West Fairway Park and Mori Point” sub-area containing the named areas with the northern boundary along Clarendon Rd and Lakeside Ave, while the draft LCP sub-area “West Sharp Park” continues north and contains the business district and neighborhoods that can be affected by flooding at Sharp Park Golf Course (SPGC). In order to represent the flooding connectivity of the lower Sharp Park neighborhood with the SPGC, the “West Sharp Park” sub-area was split in two (as described for Northwest Sharp Park above). The southern portion of the “West Sharp Park” sub-area was added to the “Sharp Park Golf Course, West Fairway Park and Mori Point” sub-area to create a hybrid sub-area for this study so that any adaptation alternatives that address hazards along the SPGC would also be assessed for the effects the alternatives may have on the community north of the SPGC.

The shoreline in this sub-area is comprised of rip rap at the north end along the Beach Boulevard seawall, coarse grained sand from the pier to Mori Point, and exposed wave-cut platforms in bedrock around Mori Point. At the north end of this sub-area, the backshore consists of the Beach Boulevard seawall and fronting rock revetment that extend south of the Pacifica Pier and terminates north of Clarendon Avenue. The seawall elevation ranges from 25 to 31 feet NAVD north of the pier and 22 to 24 feet NAVD south of the pier. The seawall protects the pedestrian walkway, road and residential properties from its northern terminus to Montecito Avenue. South of Montecito Avenue there is open space and parking between the seawall/walkway and development that includes City owned and private parcels. The beach is mostly absent along the northern Beach Boulevard seawall, and emerges south of the Pacifica Fishing Pier and widens with distance south. Multiple stormwater outfalls exist south of the pier.

Current coastal hazards along the Beach Boulevard seawall include erosion, wave run-up and overtopping (as seen in Figure 2 and Figure 3 and reported in Figure 4). While the updated FEMA maps depict limited wave overtopping of the seawall, overtopping has been observed to reach as far as the residences landward of Beach Boulevard. A portion of the seawall north of the pier was recently repaired after storm damage in 2016. Beyond the south end of the seawall, the City currently manages a sand berm to limit wave run-up and overtopping at the end of Clarendon Ave. The City also has a portable pump station deployed along Clarendon Rd to pump stormwater from swales out Clarendon Road and over the beach berm to the ocean (Figure 16).



SOURCE: B. Battalio

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Figure 16
Portable stormwater pump station at Clarendon Road and Lakeside Avenue
(1/9/2018)

South of Clarendon, the backshore consists of an earthen berm levee that spans south to the headlands of Mori Point (Figure 14 and Figure 15). The levee was built in the 1980s to protect the Sharp Park Golf Course. The fronting beach is approximately 200 feet wide with sparse vegetation along the back of beach. Approximately 1,150 feet of the northern portion of the levee are covered with rock, while the southern approximately 250 feet are armored by a revetment where the drainage outfall is located. The levee elevation ranges from 28 to 31 feet NAVD and is managed the City of San Francisco. The CA Coastal Commission recently approved Coastal Development Permit 2-17-0702 that authorized these after the fact amendments to the berm levee. Behind the levee sits Sharp Park Golf Course and Laguna Salada, which drains a 1,200-acre watershed. A pump station is used to manage the water level in Laguna Salada. The pumping is restricted to maintain minimum water levels in

order to protect habitat in Laguna Salada. Flooding of the golf course and adjacent public and private property can result (ESA PWA et al 2011).

Rockaway Beach, Quarry and Headlands



SOURCE: Adelman & Adelman 2013

Pacifica LCP 170663

Figure 17
Rockaway Beach, Quarry and Headlands Sub-area
CA Coastal Records Photos

This sub-area includes the vacant quarry site, Rockaway Beach, and Rockaway Headlands (Figure 17, Appendix A-5). Land use includes hotels, mixed use, commercial, residential, office, public and community use, and beach. There are a few city-owned parcels in Rockaway Beach as well as the Calera Creek open space and land which houses the Calera Creek Water Recycling Plant located at the northeast end of the quarry site. The creek drains to the north end of Rockaway Beach; the 100-year floodplain is contained within the existing riparian corridor. South of the creek mouth, the backshore is armored with rock revetment and ranges from 20 to 22 feet NAVD with hotels and a restaurant situated 40 to 80 feet from the revetment. Of the 1,800 feet of shoreline at Rockaway Beach, 1,000 feet are backed by armoring structures that protect these commercial/hotel structures, parking, Rockaway Beach Avenue, promenade and pedestrian trail. South of the armored development, a small creek daylights from under the highway and flows onto the wider public beach which has parking and restrooms located at the landward side of the low terrace. There are two beach access points in this sub-area: one at the parking lot just south of Calera Creek mouth, and the other at Rockaway Beach.



SOURCE: J. Jackson 30 Nov 2017

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Figure 18
Wave overtopping south at Sea Breeze Hotel parking lot (top)
and at Rockaway Beach Ave and promenade (bottom)

The backshore of Rockaway Beach ranges from 21 to 24 feet NAVD and is exposed to coastal flooding via wave run-up and overtopping of the backshore (Figure 18). The FEMA VE-zone coastal BFEs along the backshore of

Rockaway Beach are generally 24 feet NAVD at the north and south ends of the beach and 32 feet NAVD within the parking lot in front of the Sea Breeze motel (100 Rockaway Beach Avenue). The BFE is 49 feet NAVD seaward of the revetment protecting Sea Breeze motel. It is not clear why this VE-zone steps down so dramatically landward of the rock revetment. The FEMA maps show overtopping of the backshore. In January of 2017, severe wave overtopping broke through the windows and damaged the building interior of Moonraker Restaurant (105 Rockaway Beach Avenue), shown bottom right photo of Figure 18 above. The Headlands (Figure 17), south of Rockaway Beach, is an undeveloped promontory that separates Rockaway Beach from Pacifica State Beach further south and is crossed by a scenic trail. Along these high bluffs, the FEMA BFEs are around 20 to 24 feet NAVD.

Pacifica Sate Beach



Pacifica LCP 170663

SOURCE: Adelman & Adelman 2013

Figure 19
Pacifica State Beach Sub-Area
CA Coastal Records Photos

This sub-area spans from the northeast end of Pacifica State Beach to the mouth of San Pedro Creek and includes land west of Highway 1 North (Figure 19, Appendix A-6). Land use is mostly beach, with public use at both parking lots and commercial use at the Taco Bell (5200 Coast Highway). The beach is currently 100 to 250 feet wide. The backshore is mostly comprised of low vegetated dunes habitat in the middle and north portions, while a

low seawall fronts the northern pump station and parking lot at the southwest end of the sub-area. The backshore in this sub-area is approximately 15 percent armored.

FEMA coastal BFEs in this sub-area range from 17 feet NAVD at San Pedro Creek mouth to 20 feet NAVD at the north end of the beach. The beach, scenic trail, restaurant and north pump station are within the existing 100-year FEMA V-zone (high velocity zone). Current City management indicates that Pacifica State Beach is a valuable asset to the local community and visitors alike.

The condition of the northern beach shows what is possible when applying a managed retreat strategy for shoreline adaptation. A managed retreat project was implemented by the City of Pacifica in 2005⁴. The project removed built assets and fill that encroached onto the State Beach managed by the City of Pacifica. The project was funded primarily by the State of California from a variety of sources, and was coordinated by the San Pedro Creek enhancement project supported by the US Army Corps of Engineers.

West Linda Mar



SOURCE: Adelman & Adelman 2013

Pacifica LCP 170663

Figure 20
West Linda Mar Sub-area
CA Coastal Records Photos

The West Linda Mar sub-area (Figure 20, Appendix A-7) is landward of Pacifica State Beach and reaches as far inland as the Linda Mar Blvd Fire Station and Oddstad City Park (1053 Crespi Drive). This study focuses primarily on the area west of Peralta Road as it is the most vulnerable to flooding. Land use in the area includes residential, commercial, industrial, public use, school, auto services, and hotel. The area includes the Pacifica Community Center and City-owned parcels, the Linda Mar Shopping Center and Crespi Center (580 Crespi Drive). The sub-area is not included within the coastal zone as defined in the City's LCP, but is included in this study because future conditions may further expose the neighborhood and commercial areas to flooding from both fluvial and coastal sources.

⁴ Kershner, J. (2010). Restoration and Managed Retreat of Pacifica State Beach [Case study on a project of ESA PWA]. Product of EcoAdapt's State of Adaptation Program. Retrieved from CAKE: <http://www.cakex.org/case-studies/restoration-and-managed-retreat-pacifi...> (Last updated December 2010) <http://www.cakex.org/case-studies/restoration-and-managed-retreat-pacifica-state-beach> Last visited December 2016.

The sub-area does not currently experience direct coastal flooding, but it is low-lying and subject to local rainfall ponding as well as flooding from San Pedro Creek (Appendix A-7). The Linda Mar Shopping Center and auto services, Crespi Center, Pacifica Community Center (including the skate park and wet weather equalization basin (under construction)) and portions of the neighborhood are within the 100-year floodplain of San Pedro Creek. While not directly connected to the coastal flood source, high ocean water levels (extreme tides, storm surge or sea level rise) that occur during a rainfall event could increase flooding extents in the area. The low area was historically a lagoon subsequently filled for agriculture and then housing (ESA PWA, RSM, 2015). Flood management is reportedly accomplished with a subdrain (buried drain that captures groundwater) that is pumped and discharged to the ocean, however records of the asset have not yet been located.

Pedro Point and Shelter Cove



SOURCE: Adelman & Adelman 2013

Pacifica LCP 170663

Figure 21
Pedro Point and Shelter Cove Sub-area
CA Coastal Records Photos

The Pedro Point and Shelter Cove sub-area is the southernmost in Pacifica (Figure 21, Appendix A-8), is comprised of residential, mixed use and vacant lands, office, mixed use and commercial use (including Pedro Point Shopping Center), as well as parks (most of which are south of Pedro Point outside of Pacifica City limits). The shoreline in this sub-area stretches west from San Pedro Creek out around Pedro Point and includes Shelter Cove. The backshore is low adjacent to the creek with a few homes built seaward of the former Ocean Shore Railroad berm, two of which have boat ramps into the ocean. These homes are within the 100-year coastal flood

zone and subject to wave run-up. Most of the homes have been fortified with timber sea walls. The coastal BFE in this area is 17 feet NAVD, while the beach home parcels are as low as 14 feet.

Behind the beach homes and berm are the Pedro Point shopping center and undeveloped Calson site (315 San Pedro Avenue) which is as low as 14 feet NAVD. Rainfall runoff that enters the Calson site flows through an open ditch and discharges through a flap gate near the mouth of San Pedro Creek. West of the beach homes, the previous railway berm and road to Shelter Cove rises up the bluff to over 50 feet NAVD. A 500-foot section of the road failed in 1983, rendering Shelter Cove inaccessible by motor vehicles. Upslope of the road, homes are built into the steep hillside.

The Shelter Cove community consists of a cluster of houses on a single parcel. The homes are fronted by a narrow beach and low dunes. Most of the homes are within the VE-zone of the 100-year coastal floodplain. A wooden seawall is built in front of the northernmost homes. Due to restricted vehicular access and limited utilities, the City considers Shelter Cove an at-risk community. The FEMA coastal BFE is 26 feet NAVD in the hazard zone encompassing most homes along the cove.

2. DATA COLLECTION

This study seeks to maintain consistency with the San Mateo County SeaChange Study (SMC 2017) while also following the latest state guidance on SLR for coastal planning and applying methods needed to conduct the adaptation plan. SLR scenarios were selected that reflect the County study while adhering to updated state guidance on SLR. Existing hazard data mapping products were reviewed and specific hazard maps were chosen from each data source that best represent the selected SLR scenarios. ESA relied on many of the same data sources used in the County work and added a number of additional local asset datasets that were available.

2.1. Sea Level Rise

Detailed information on past and current state guidance on SLR are discussed in a memorandum prepared for the City titled “Future Conditions Scenarios for Pacifica LCP Update” (ESA 2017a). The planning horizons and sea level rise scenarios selected for this study are discussed below.

Planning Horizons

The planning horizons proposed for this project are 2050 and 2100, selected to be consistent with SLR policy guidance documents. The SeaChange study did not consider timeframes for impacts from SLR, but it is necessary to develop adaptation alternatives and to determine the economic implications of each. The 2050 and 2100 planning horizons are recommended so that decisions about land use can be matched to the timeframe for project lifespans and to facilitate the identification of triggers for adaptation measures. These planning horizons (years) determine the amounts of SLR that are applied to assess vulnerability to coastal flooding hazards and the timeframes over which coastal erosion hazards and consequent impacts are evaluated.

Future Projections for Sea-level Rise

Amounts of SLR were selected for the study planning horizons (2050 and 2100) following updated State guidance (CalNRA & OPC 2017). For any given year (planning horizon), State guidance recommends analyzing a range of SLR projections:

Because future projections of sea-level rise along California's coastline are uncertain (due to uncertainty associated with modeling and the trajectory of global emissions), it is critical to consider a range of projections to understand the consequences of various decisions, determine the tolerance for risk associated with those decisions, and to inform adaptation strategies necessary to prepare for change in the face of uncertainty.

In general, decision makers may have a higher tolerance for risk (or lower risk aversion) when considering projects with a shorter lifespan, minimal consequences, flexibility to adapt, or low economic burden as a result of sea-level rise. However, for longer lasting projects with less adaptive capacity and medium to high consequences should sea-level rise be underestimated, we suggest that decision makers take the more precautionary, more risk-averse approach of using the medium-high sea-level rise projections across the range of emissions scenarios. We further recommend incorporating the extreme scenario in planning and adaptation strategies for projects that could result in threats to public health and safety, natural resources and critical infrastructure.

A total of six SLR amounts were selected, including existing conditions (2018: no SLR), to perform the Vulnerability Assessment and subsequent adaptation plan. The SLR amounts are selected from the state-recommended projections:

- Low SLR projection – for low risk aversion projects (17% chance SLR projection is met or exceeded)
- Medium-High SLR projection – for high risk aversion projects (0.5% or 1 in 200 chance that SLR projection is met or exceeded)
- Extreme SLR projection – for extreme risk aversion projects (probability n/a)

Values for 2100 were selected within the range of low and high emissions. Table 1 below presents the future SLR amounts based on the State-recommended projections. Background and additional information on SLR can be found in (ESA 2017).

Table 1
Proposed future Sea level rise (SLR) amounts for various scenarios with associated probability of occurrence (CaINRA & OPC 2017)

Year	Low (17% chance)	Med-High (0.5 % chance)	Extreme (n/a)
2050	1 ft	2 ft	-
2100	3 ft	6 ft	10* ft

* SLR of 6 ft at 2075 is applied in place of 10 ft at 2100 to assess flooding impacts under the extreme scenario. This is required because of the lack of erosion and flooding data for 10 ft of SLR.

2.2. Coastal Flooding and Erosion

For the draft vulnerability assessment, consistent with the County study, existing and future coastal flooding was evaluated using the OCOF hazard mapping products, while future coastal erosion was evaluated using the Pacific Institute (PI) erosion maps. We will also utilize the erosion layers produced for the Draft San Francisco Coastal Regional Sediment Management Plan (CRSMP) (ESA 2015) to enable the analysis of alternative adaptation options in the next task of this project. Table 2 presents the SLR amounts assumed for each hazard data source for comparison against the State-recommended values in the updated guidance document. Ranges shown for the data sources correspond to low and high SLR scenarios considered (PI and OCOF). Because this study is limited to the application of existing hazard data sources, SLR amounts assumed in these data sources do not exactly match the State-recommended SLR amounts, but are reasonably close given the uncertainty of SLR modeling and emissions scenarios.

Table 2
Comparison of SLR amounts assumed for guidance update and input data sources

Year	State-guidance SLR amount	PI erosion SLR amount	CRSMP erosion SLR amount	OCOF flood hazard SLR amount
2050	1 and 2 ft	1.4 and 1.5 ft	1.6 ft	0.8 and 1.6 ft
2100	3, 6 and 10* ft	3.3 and 4.6 ft	5 ft	3.3 and 5.7 ft

*We will analyze SLR of 6 ft at 2075 in place of 10 ft at 2100 to assess flooding impacts associated with this extreme SLR scenario. This is required because of the lack of erosion and flooding data for 10 ft of SLR.

The “PI erosion SLR amount” corresponds to SLR amounts assumed in the Pacific Institute study (PWA 2009). The “CRSMP erosion SLR amount” corresponds to the SLR amounts associated with the erosion hazard data that will be used to assess vulnerabilities for various adaptation alternatives. The “OCOF flood hazard SLR amount” corresponds to the amount of SLR assumed by OCOF data used to evaluate flooding impacts. Because the OCOF hazard data was developed for SLR increments of 25 cm, it is necessary to consider these slightly different SLR amounts in order to assess flooding impacts. In order to assess flooding impacts associated with the extreme SLR scenario of 10 feet at 2100, we apply the 6 feet OCOF flood hazards at 2075, which is when this SLR is reached under the extreme scenario.

Fluvial Flood Source

While CoSMoS flood mapping products do not include fluvial sources of flooding in Pacifica, it is important to consider these sources in the vulnerability assessment. Flooding from river sources is already a significant problem for two areas in Pacifica. San Pedro Creek is prone to flooding the Linda Mar neighborhood, as depicted in the FEMA flood hazard zone in Appendix A-4. Sanchez Creek drains into Laguna Salada, which can lead to flooding of the Sharp Park Golf Course and adjacent neighborhood. Higher sea levels will exacerbate flooding in the lower portions of these creeks. Detailed hydraulic modeling to determine the effects of SLR on fluvial systems is outside the scope of work, so a simplified approach was taken to evaluate fluvial flooding potential for these two creeks. ESA reviewed available studies and FEMA maps to determine the baseline flooding potential for a 100-year event within each creek.

As mentioned in Section 1.3, current FEMA maps for Sanchez Creek were created before the levee was constructed and are out of date. A study by Kamman Hydrology & Engineering (KHE 2009) established the peak 100-year flooding elevation within Laguna Salada to be 15 feet NAVD which assumed an initial water surface elevation of 6.8 feet NAVD (this elevation must be maintained for habitat function). To determine future peak flood levels with SLR, ESA first determined the volume corresponding to the peak flood level reached. For future conditions, the initial water surface was lifted with SLR and the 100-year peak volume was redistributed in the basin to determine the future peak flood levels. These updated existing and simplified future flood elevations were mapped within the Laguna Salada basin and added to the storm flooding layers from OCOF. For San Pedro Creek, which drains through Linda Mar, a similar approach was used. ESA determined the volume associated with the FEMA mapped ponded flooding, increased the flood level by raising the minimum terrain elevation with SLR and redistributed the ponded volume to determine the future flood levels. In both creek systems, the coastal flooding source becomes dominant with SLR greater than 3.3 feet.

2.3. Assets

Asset data was collected from a number of sources including the City of Pacifica, San Mateo County (SeaChange study), local utilities, Caltrans, CA Energy Commission, US Fish and Wildlife Service, SF Draft CRSMP and others. The City of Pacifica has assets in the following categories that are currently or may become vulnerable to flooding and erosion due to SLR.

Built Assets

- Residential buildings
- Hotels, Offices
- Commercial buildings
- Industrial facilities
- City-owned buildings
- Buildings with affordable rental units
- Schools and Churches
- Senior centers
- Mobile home parks
- Emergency shelter sites
- Fire stations
- Police station
- Communications towers
- Hazardous material sites
- Health care facilities
- Highway bridges
- Highways
- Levees and floodwalls
- Natural gas pipelines
- Shoreline protection devices
- Closed landfill
- Community Services
- Roads (local)
- Storm drains
- Stormwater pump stations
- Outfalls
- Transmission lines
- Underground chemical storage tanks
- Wastewater pump stations
- Wastewater treatment plant
- Water distribution pipelines

Natural Assets

- Beaches
- Streams
- Surfgrass habitat
- Steelhead habitat
- Red-legged frog habitat
- SF garter snake habitat
- Wetlands
- Marine (whale migration)

Access and Recreation

- Vertical access to shore
- Lateral access to shore
- Viewpoints
- Bluff top or promenade
- Fishing pier
- Parks
- Trails
- Surfing areas
- Golf course
- Parking, restrooms and other recreational facilities

Data were reviewed with City asset managers for completeness and accuracy at an asset inventory meeting on 11/28/2017. Surveys have been distributed to asset managers in the City for input on existing exposures and perceived vulnerability with SLR, as well as suggestions for adaptation to future coastal flooding and/or erosion impacts. Feedback from these surveys will be incorporated into the Final Vulnerability Assessment. More details on asset data collection can be found in a memo to the City: *Revised Asset Inventory Memo for Pacifica LCP Update* (ESA 2018).

Data Gaps

While a large amount of asset data has been collected for the City of Pacifica, there remains a number of important data gaps that shall be noted. The following data gaps are outstanding at the time of this draft report; ESA has listed potential workarounds to address these important assets in the study.

Drinking water – the NCCWD manages drinking water distribution for Pacifica, and is currently in the process of developing their GIS database. Therefore, drinking water distribution is not included in this draft assessment. ESA has requested paper or electronic maps of the distribution network in lieu of GIS data so that key infrastructure elements can at least be identified and included in discussions on vulnerability. Another surrogate for drinking water distribution is to use a map of fire hydrants and make assumptions on the type and location of pipe connecting them.

AT&T communications – AT&T provided electronic maps of their communications network, but not the underlying GIS data. We have not included these networks in the draft VA, and wish to obtain the GIS data. If these data are not obtained, we can include the network maps and discuss vulnerabilities qualitatively.

Natural gas and electricity – PG&E does not share data on their infrastructure network. If the City of Pacifica is unable to obtain these information, we must make assumptions and take a simplified approach to considering these assets. One potential workaround is to provide PG&E with shapefiles of the erosion and flooding hazard zones and ask them to tabulate or estimate the length of gas and electrical lines in each sub-area.

Public Access and Recreation – Additional information on public access is desired, such as vertical and lateral coastal access locations, viewpoints and blufftop or promenade areas. ESA has obtained data for parks areas, golf courses, fishing pier. Other recreational uses exist in Pacifica, including surfing, hang gliding, dog walking, and any others should be included. We recommend reaching out to local organizations to solicit input on these resources. Additional information is needed on public restrooms, parking, showers, and other recreational amenities in the City. Upcoming workgroup meetings will provide an opportunity to discuss these data gaps and solicit input on potential sources.

Natural assets – ESA has information on shoreline habitats, wetlands, and streams from the County study (SMC 2017) and the National Wetlands Inventory managed by USFWS. Critical habitat was obtained from the USFWS ECOS database, and included steelhead habitat in San Pedro Creek and CA red legged frog habitat outside of the coastal zone. It is our understanding that CA red-legged frog habitat exists in the Sharp Park golf course, but this is missing from the database. Also missing from the ECOS database is CA garter snake habitat. ESA will work with the project workgroups to identify sources for these and any other natural asset data.

3. VULNERABILITY ASSESSMENT

This draft vulnerability assessment tabulates the exposure of assets to the highest flooding and erosion hazard scenarios chosen in this study: OCOF coastal flooding for 5.7 feet (175 cm) SLR with and without a 100-year storm impacts as well as Pacific Institute erosion extents assuming high SLR at 2100. The purpose of this first cut is to illuminate all assets that may be exposed due to SLR and to confirm the methodology and reporting format with the City. The Final Vulnerability Assessment will include impacts under all six sea level rise scenarios (Table 1), which includes existing (current sea level).

Consistent with the San Mateo County Sea Change project, asset vulnerabilities are grouped according to the following categories:

- Land Use (residential, commercial, etc.)
- Ecosystem
- Recreation
- Transportation
- Community
- Emergency Response
- Communication
- Hazardous Materials
- Stormwater
- Wastewater
- Coastal Structures

The wetlands dataset from the National Wetlands Inventory currently includes offshore and beach areas, hence the larger than expected acreages, especially in the northern sub-areas. This will be resolved in the final version of this report. Land Use impacts have not been parsed out in the tables for this draft assessment, this will be accomplished in the Final Vulnerability Assessment.

3.1. Hazard Exposure Methodology

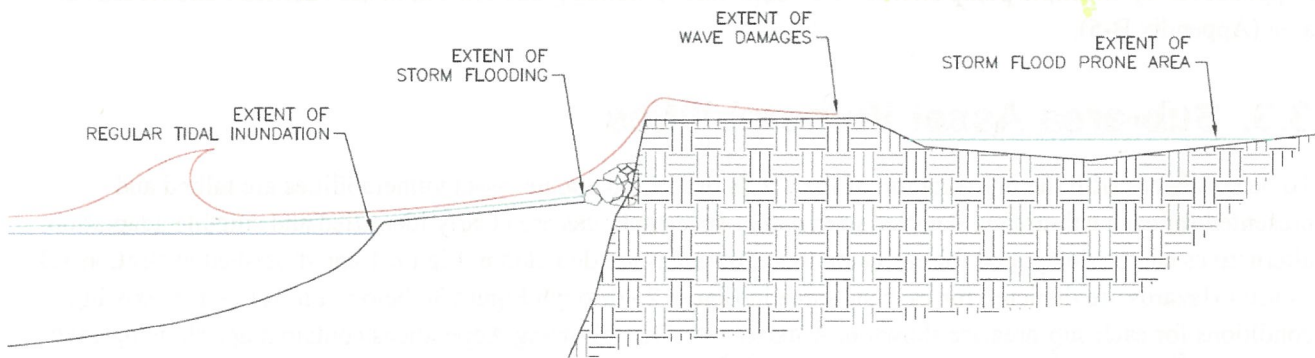
The vulnerability assessments in the sections below report hazard impacts for four groups: long-term erosion, long-term tidal inundation, storm wave damages and storm flooding. Long-term erosion includes both shoreline and bluff erosion. Long-term inundation is based on the OCOF SLR hazard layers that depict areas that are inundated by regular high tides. Storm wave impacts are based on the OCOF maximum inland wave run-up points for a 100-year storm that were generated along the shore at regularly spaced transects (points were interpolated along the shore to create polygons and manually edited for anomalies around headlands as needed). Storm flooding is based on the OCOF SLR hazard flooding layers that include a 100-year coastal storm as well as potential flooding extents from the fluvial sources for San Pedro Creek and Sanchez Creek (discussed in Section 2.2). These four hazards represent decreasing severity:

- Areas subject to long-term erosion would be lost entirely
- Areas experiencing long-term tidal inundation would be regularly flooded by high tides.

- Areas experiencing storm wave damages are likely damaged but could be recoverable.
- Areas experiencing storm flooding are likely to return to service when floodwaters recede.

Note that erosion impacts derived from the Pacific Institute do not account for existing coastal armoring structures, and are used to identify vulnerabilities under a worst case scenario. During the adaptation alternatives analysis of this work, vulnerabilities to erosion will be assessed using hazard maps from the Draft CRSMP (ESA 2015) that include cases with coastal armoring structures.

Coastal inundation and flooding hazards derived from the OCOF mapping products are shown in Figure 22. The figure depicts the various types of flooding hazards used in this study assuming existing conditions (future SLR would increase the elevation and extents of these hazards). The dark blue ocean level represents the regular high tide elevation, which simply raises with SLR. The teal ocean level represents areas that are flooded during a 100-year storm. SLR will increase the elevation and inland extents of coastal storm flooding, especially in areas with a low backshore (such as Sharp Park, Pacifica State Beach and Linda Mar). The red line represents the maximum wave run-up zone (similar to FEMA V-zones, discussed in Section 1.3) where water velocities are great enough to knock over people, move cars and damage buildings etc. Figure 22 shows an example of low lying areas near the coast that are prone to flooding from wave overtopping and fluvial sources (see Section 2.2). Depending on ground elevations and wave exposure, these low areas may become directly connected to the ocean during storms with SLR.



SOURCE: ESA

Pacifica LCP 170663

Figure 22
Schematic of OCOF Coastal Inundation and Storm Flooding Impacts

In addition to the tables summarizing the intersection of the hazard and asset layers, planners may also choose to review this study’s hazard and asset layers using GIS software. Within the GIS environment, planners can select their area(s) of interest along the City’s coastline, choose an appropriate viewing scale, and add other information, such as an aerial photograph as a basemap. The GIS files will be included in further stages of this assessment.

To assess the vulnerability of the City’s assets, the assets in different categories were identified and intersected with each hazard layer. Point assets in each hazard zone are counted, linear assets (like roads and pipelines) are measured by miles, and planar assets (like ecosystem areas) are measured by acre. These results are reported in tables in the following sections.

3.2. Regional and City-wide Asset Vulnerabilities

While vulnerabilities are tabulated per sub-area to facilitate more focused development of adaptation strategies and policies, some vulnerable assets in Pacifica serve more than one sub-area, as well as the entire region. These assets are summarized here from the individual sub-area vulnerabilities below.

Highway 1

Highway 1 is a critical transportation corridor for Pacifica and other coastal communities further south. Highway 1 is vulnerable to coastal flooding impacts with 5.7 feet (175 cm) of SLR in the two adjacent sub-areas of Pacifica State Beach and West Linda Mar (Appendix B-5). The highway is also vulnerable to coastal erosion impacts by 2100 in the West Edgemar and Pacific Manor sub-area and Northwest Sharp Park sub-area (Appendix B-2). Lengths of impacts on Highway 1 are currently included in the streets category in the sub-areas below and noted where impacted. These impacts will be reported separately in the Final Vulnerability Assessment.

Pacifica sanitary sewer

Given the geography of Pacifica, impacts to certain elements of the sewer system would result in system failure upstream. Sewer pump stations are vulnerable to flooding and erosion in the Sharp Park, West Fairway Park, and Mori Point sub-area (Appendix B-3). A pump station is vulnerable to erosion in the Rockaway sub-area (Appendix B-4). Multiple pump stations are vulnerable to flooding and erosion in the Pacifica State Beach sub-area (Appendix B-5).

3.3. Sub-area Asset Vulnerabilities

To be consistent with the organization of the City's draft LCP update, asset vulnerabilities are tallied and presented for each sub-area in Pacifica so that area-specific issues are clearly identified and suitable adaptation alternatives can be developed for each sub-area. Sub-areas are depicted in Figure 1 and described in Section 1.3. Coastal Hazards are depicted for each sub-area in Figure 23 through Figure 30 below. For reference, existing conditions for each sub-area are shown in Appendix A. The following Appendices contain maps showing each sub-area and with assets grouped in the following categories:

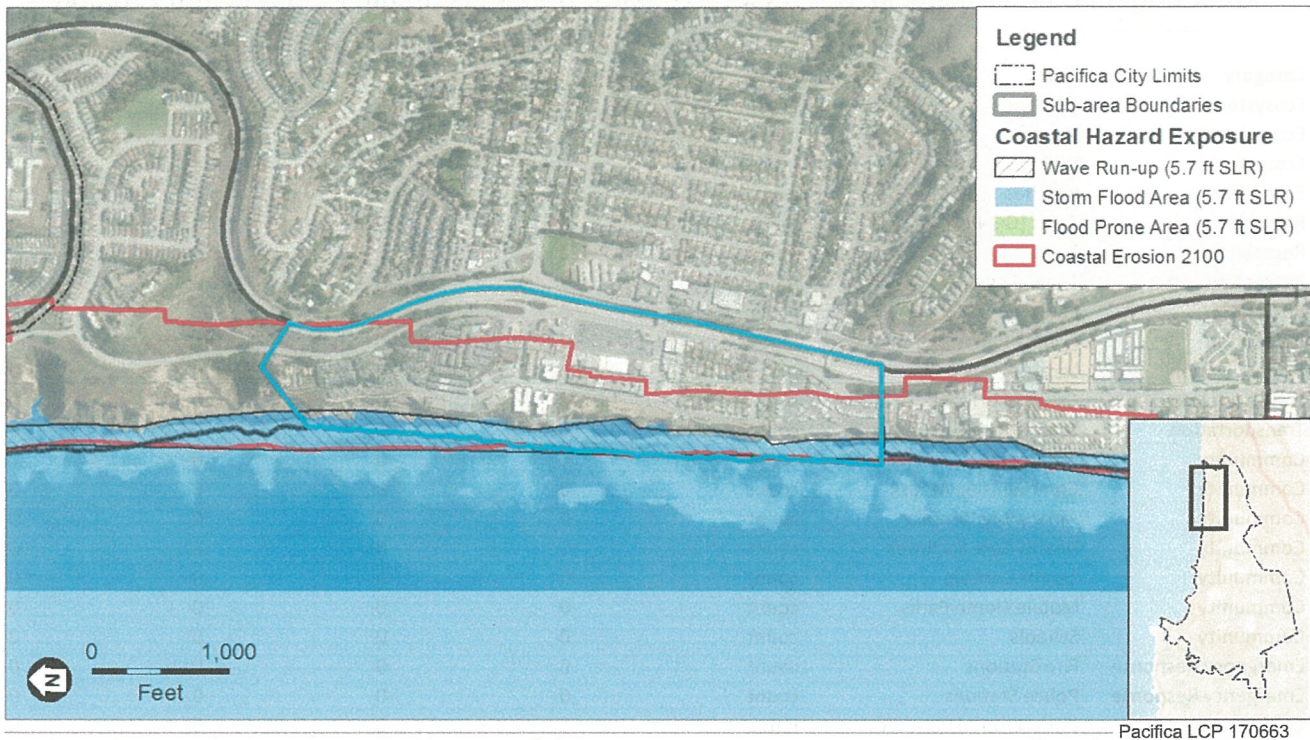
Appendix B – Hazard Mitigation Assets Exposure Maps. Includes coastal armoring structures, stormwater and wastewater infrastructure, essential/emergency services, and hazardous materials.

Appendix C – Community and Land Use Asset Exposure Maps. Includes existing land use, City-owned parcels, landmarks, local streets, utilities, senior centers, affordable rentals and other community assets.

Appendix D – Public Access, Recreation and Ecology. Includes parks and trails, habitats, sensitive species. Public access data such as vertical/lateral coastal access and views, etc. will be added in the Final Vulnerability Assessment.

The multiple data sources for Figures Figure 23 through Figure 30 below include San Mateo County Imagery (2017), Pacific Institute Erosion (2009) and OCOF Coastal Flooding (2014).

West Edgemar and Pacific Manor



SOURCE: Multiple

Figure 24
West Edgemar and Pacific Manor Sub-area – Coastal Hazards at 2100

Similar to Fairmont West, bluffs in the West Edgemar and Pacific Manor sub-area are high enough so that blufftop assets are not exposed to flooding, but are vulnerable to erosion in the future (sub-area shown in teal on Figure 24, Table 4). Coastal flooding and erosion exposure to coastal armoring structures, stormwater and wastewater infrastructure, essential/emergency services, and hazardous materials are shown in Appendix B-2. Exposure to existing land use, City-owned parcels, landmarks, local streets, utilities, senior centers, affordable rentals and other community assets are shown in Appendix C-2. Exposure to parks and trails, habitats and sensitive species are shown in Appendix D-2. Public access data such as vertical/lateral coastal access and views, etc. will be added to Appendix D in the Final Vulnerability Assessment.

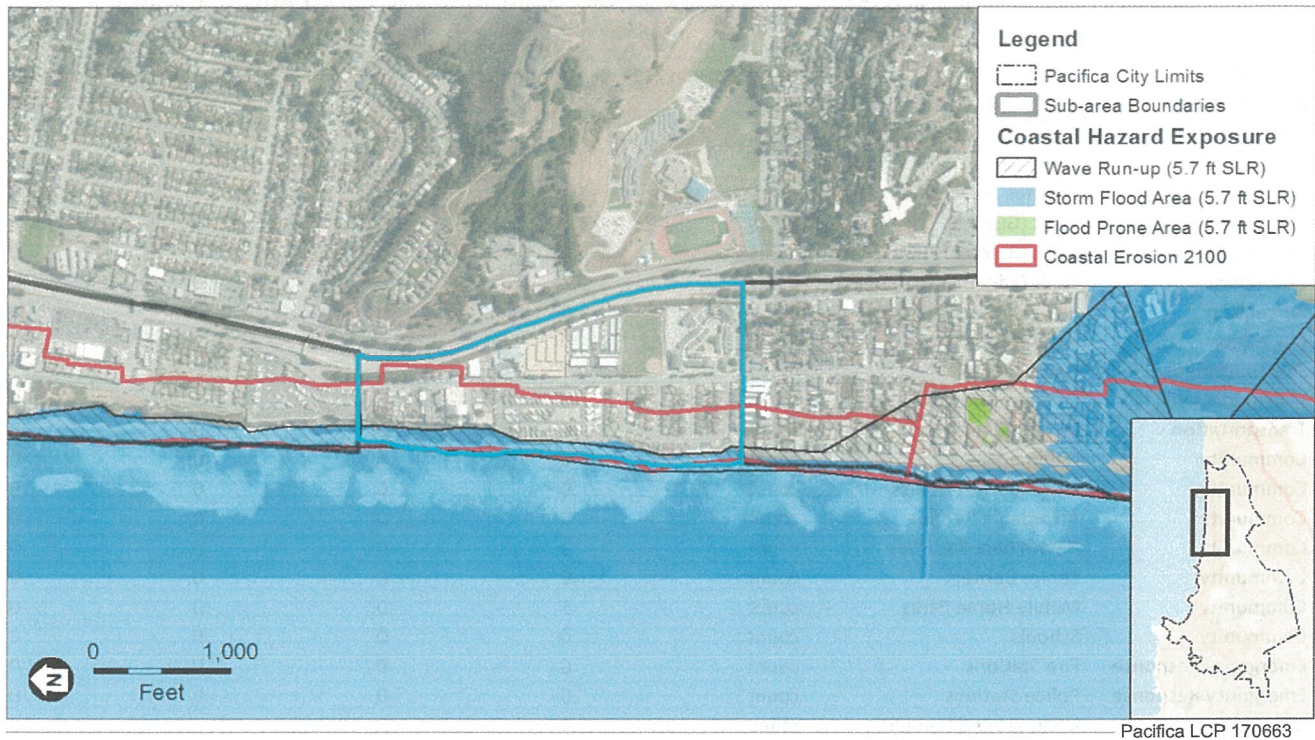
Portions of parcels that extend beyond the bluff edge are vulnerable to flooding. Beaches are the main habitat that is vulnerable, 3.6 to 5.3 acres are exposed to inundation and storm flooding respectively. Most of the coastal armoring in this reach is vulnerable to storm flooding. Two stormwater outfalls are vulnerable to inundation while a third is exposed to storm flooding.

Vulnerabilities to coastal erosion are more prevalent. A total of 96 parcels may be affected by erosion in 2100. All parcels west of Esplanade Ave are vulnerable, including single and multi-family residential, and vacant lands. Erosion also threatens land west of Esplanade including single and multi-family residential, commercial and public use. The SF RV resort is also vulnerable. Approximately 1.2 miles of streets including Highway 1 are vulnerable. One health care facility is also vulnerable. Both wastewater (1.4 miles of pipe) and stormwater (0.6 miles pipe and 3 outfalls) are vulnerable to erosion by 2100. Recreational trails (0.9 miles) are also vulnerable.

Table 4
West Edgemar and Pacific Manor Asset Exposure Under Maximum Flooding and Erosion

Category	Asset	Units	Erosion 2100	175 cm SLR Regular Inundation	175 cm SLR Storm Flooding	175 cm SLR Storm Wave Impacts
Ecosystem	Wetlands	acres	14.7	11.5	13.6	13.8
Ecosystem	Streams	miles	0	0	0	0
Ecosystem	Surfgrass	miles	0	0	0	0
Ecosystem	Beaches	acres	5.4	3.6	5.2	5.3
Recreation	Trails (GGNRA)	miles	0	0	0	0
Recreation	Trails (Reina to PSB)	miles	0	0	0	0
Recreation	Trails (Edgemar to Mori Pt)	miles	0.9	0	0	0
Recreation	Parks	acres	0	0	0	0
Recreation	Fishing Pier	miles	0	0	0	0
Transportation	Local Streets	miles	1.2	0	0	0
Transportation	CalTrans Bridges	count	0	0	0	0
Transportation	Local Bridges	count	0	0	0	0
Community	Landmarks	count	0	0	0	0
Community	Communities At Risk	count	0	0	0	0
Community	Affordable Rentals	count	0	0	0	0
Community	Health Care Facilities	count	1	0	0	0
Community	Senior Centers	count	0	0	0	0
Community	Mobile Home Parks	count	0	0	0	0
Community	Schools	count	0	0	0	0
Emergency Response	Fire Stations	count	0	0	0	0
Emergency Response	Police Stations	count	0	0	0	0
Communication	Underground Conduit	miles	0	0	0	0
Communication	Private Towers	count	0	0	0	0
Hazardous Materials	Solid Waste Facilities	count	0	0	0	0
Hazardous Materials	Underground Storage Tanks	count	0	0	0	0
Hazardous Materials	Clean Up Sites	count	0	0	0	0
Stormwater	Pump Stations	count	0	0	0	0
Stormwater	Pipelines	miles	0.6	0	0	0.1
Stormwater	Outfalls	count	3	2	2	3
Stormwater	EQ Basin	count	0	0	0	0
Wastewater	Pump Stations	count	0	0	0	0
Wastewater	Pipelines	miles	1.4	0	0	0
Lands	Pacifica City Limits	acres	61.1	11.5	14.3	15.7
Lands	Parks and Conservation	acres	10.2	6.1	6.9	7.5
Lands	Land Use	acres	48.9	9.6	11.9	13.3
Lands	Parcels	count	96	10	32	38
Coastal Structures	Seawalls, Rip rap, rubble, etc	miles	0.6	0.1	0.4	0.4

Northwest Sharp Park



SOURCE: Multiple

Figure 25
Northwest Sharp Park Sub-area – Coastal Hazards at 2100

Lower bluffs in the Northwest Sharp Park sub-area lead to higher asset vulnerabilities from coastal flooding (sub-area shown in teal on Figure 25, Table 5). Coastal flooding and erosion exposure to coastal armoring structures, stormwater and wastewater infrastructure, essential/emergency services, and hazardous materials are shown in Appendix B-2. Exposure to existing land use, City-owned parcels, landmarks, local streets, utilities, senior centers, affordable rentals and other community assets are shown in Appendix C-2. Exposure to parks and trails, habitats and sensitive species are shown in Appendix D-2. Public access data such as vertical/lateral coastal access and views, etc. will be added to Appendix D in the Final Vulnerability Assessment.

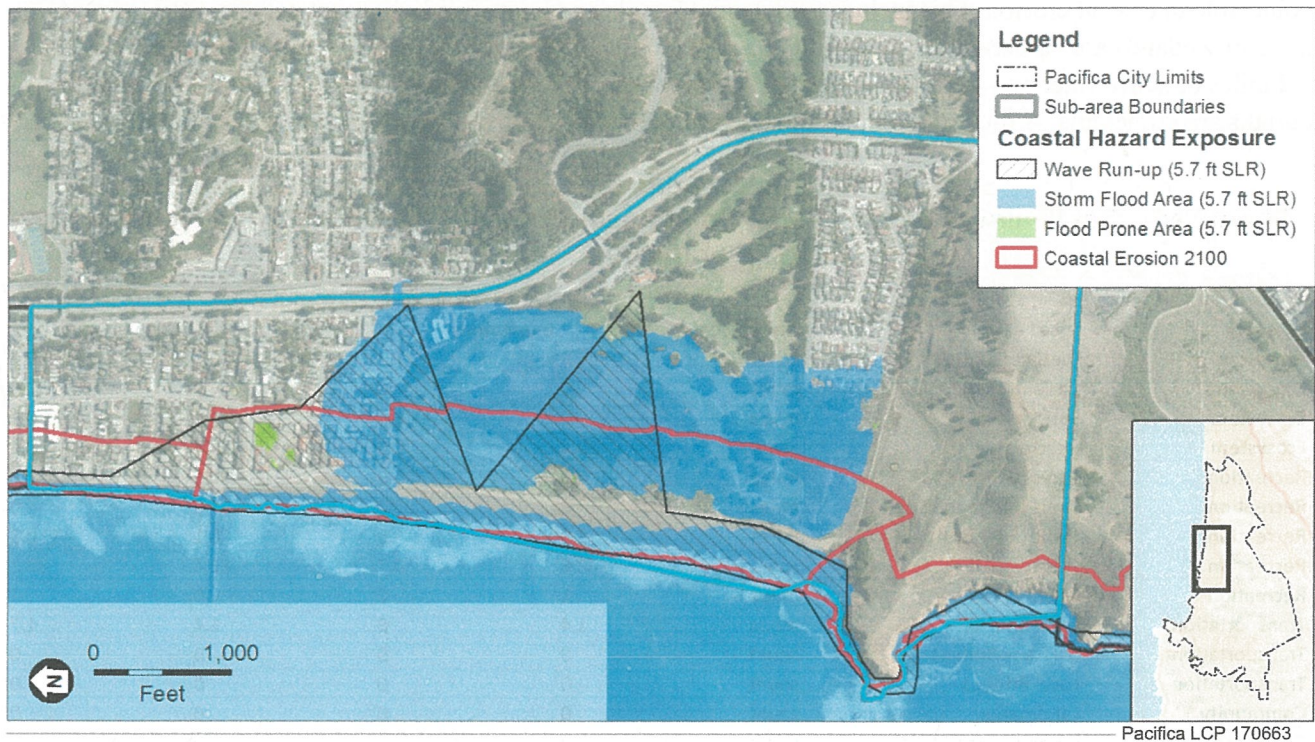
Beaches (over 5 acres) and coastal armoring (0.2-0.4 miles) are vulnerable on the shore. Seaward portions of parcels are exposed to inundation (72) while 80 are exposed to wave damage and 79 are vulnerable to storm flooding. Local streets (0.1 mi) are also exposed to wave impacts. One stormwater outfall is vulnerable to coastal flooding.

A total of 125 parcels are vulnerable to coastal erosion by 2100. This includes industrial north Palmetto, with industrial, residential, office, commercial and auto services. The mobile home park and residential parcels along Shoreview Ave are vulnerable. Recreational trails (0.2 mi) and local streets (1 mi) are vulnerable to coastal erosion. Utilities are also vulnerable; 0.4 mi of communications conduit, 0.3 mi of stormwater pipes and 0.6 mi of wastewater pipes are vulnerable as well as 2 stormwater outfalls. All 0.6 miles of coastal armor are vulnerable.

Table 5
Northwest Sharp Park Asset Exposure Under Maximum Flooding and Erosion

Category	Asset	Units	Erosion 2100	175 cm SLR Regular Inundation	175 cm SLR Storm Flooding	175 cm SLR Storm Wave Impacts
Ecosystem	Wetlands	acres	5.3	5.1	5.7	5.6
Ecosystem	Streams	miles	0	0	0	0
Ecosystem	Surfgrass	miles	0	0	0	0
Ecosystem	Beaches	acres	3.3	2.4	3.3	3.2
Recreation	Trails (GGNRA)	miles	0	0	0	0
Recreation	Trails (Reina to PSB)	miles	0	0	0	0
Recreation	Trails (Edgemar to Mori Pt)	miles	0.2	0	0	0
Recreation	Parks	acres	0	0	0	0
Recreation	Fishing Pier	miles	0	0	0	0
Transportation	Local Streets	miles	1	0	0	0.1
Transportation	CalTrans Bridges	count	0	0	0	0
Transportation	Local Bridges	count	0	0	0	0
Community	Landmarks	count	0	0	0	0
Community	Communities At Risk	count	0	0	0	0
Community	Affordable Rentals	count	0	0	0	0
Community	Health Care Facilities	count	0	0	0	0
Community	Senior Centers	count	0	0	0	0
Community	Mobile Home Parks	count	1	0	0	0
Community	Schools	count	0	0	0	0
Emergency Response	Fire Stations	count	0	0	0	0
Emergency Response	Police Stations	count	0	0	0	0
Communication	Underground Conduit	miles	0.4	0	0	0
Communication	Private Towers	count	0	0	0	0
Hazardous Materials	Solid Waste Facilities	count	0	0	0	0
Hazardous Materials	Underground Storage Tanks	count	0	0	0	0
Hazardous Materials	Clean Up Sites	count	0	0	0	0
Stormwater	Pump Stations	count	0	0	0	0
Stormwater	Pipelines	miles	0.3	0	0	0
Stormwater	Outfalls	count	2	1	1	0
Stormwater	EQ Basin	count	0	0	0	0
Wastewater	Pump Stations	count	0	0	0	0
Wastewater	Pipelines	miles	0.6	0	0	0
Lands	Pacifica City Limits	acres	29.2	5.2	6.9	8.1
Lands	Parks and Conservation	acres	0	0	0	0
Lands	Land Use	acres	24.4	4	5.7	7
Lands	Parcels	count	125	72	79	80
Coastal Structures	Seawalls, Rip rap, rubble, etc	miles	0.6	0	0.2	0.4

Sharp Park, West Fairway Park and Mori Point



SOURCE: Multiple

Figure 26

Sharp Park, West Fairway Park and Mori Point Sub-area – Coastal Hazards at 2100

Inundation and flooding will have a significant impact on the Sharp Park, West Fairway Park and Mori Point sub-area (sub-area shown in teal on Figure 26, Table 6) with SLR. Coastal flooding and erosion exposure to coastal armoring structures, stormwater and wastewater infrastructure, essential/emergency services, and hazardous materials are shown in Appendix B-3. Exposure to existing land use, City-owned parcels, landmarks, local streets, utilities, senior centers, affordable rentals and other community assets are shown in Appendix C-3. Exposure to parks and trails, habitats and sensitive species are shown in Appendix D-3. Public access data such as vertical/lateral coastal access and views, etc. will be added to Appendix D in the Final Vulnerability Assessment.

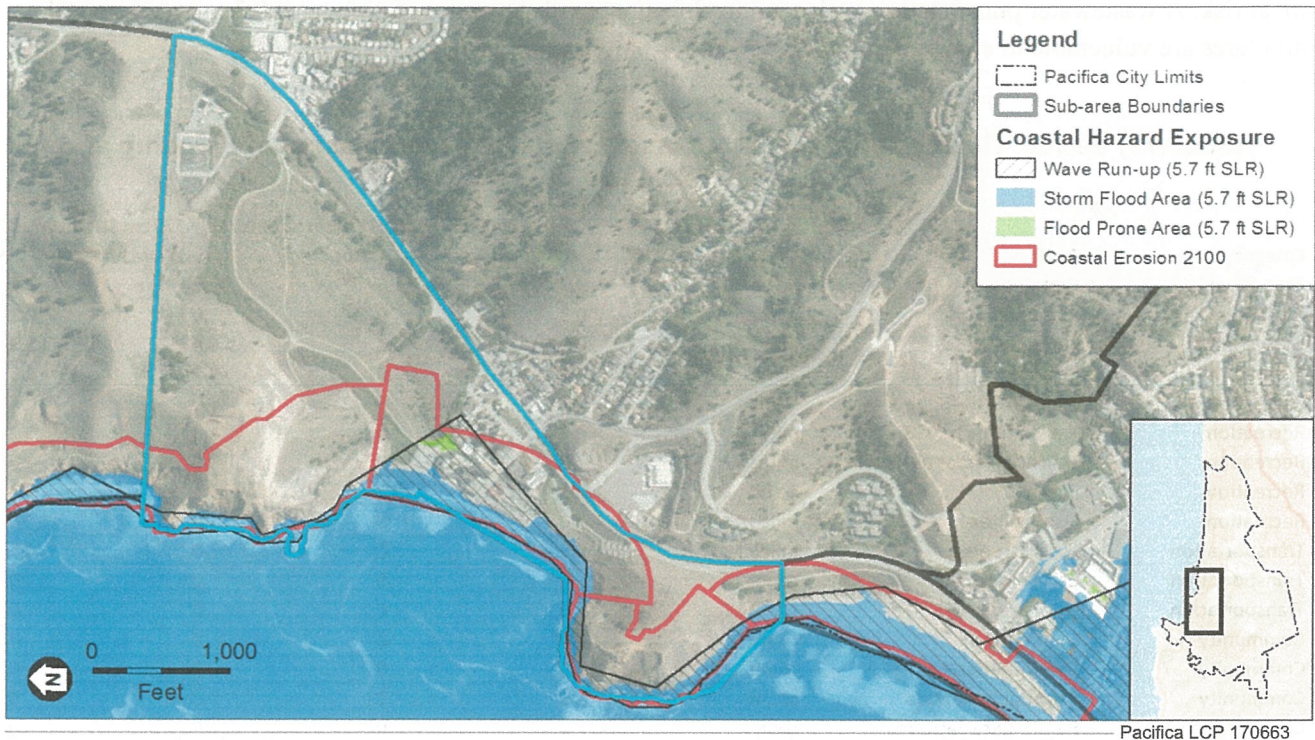
Up to 230 parcels are vulnerable to coastal storm wave impacts, while 156 parcels will be impacted by sustained flooding. Vulnerable land uses include residential, commercial, city-owned public use and parks, mixed use, vacant land, SPGC, one industrial parcel. An affordable rental unit is among the vulnerable. Beaches (7.6 to 20.4 acres) and wetlands in/around the golf course are vulnerable to coastal flooding. Surfgrass habitat (0.1 mi) is also vulnerable. The fishing pier is vulnerable to storm impacts from wave run-up. Up to 0.9 miles of recreational trail and 82.4 acres of parks are vulnerable to storm flooding. One affordable rental unit is vulnerable. Utilities are also vulnerable. Communications conduit (0.7-0.8 mi) are vulnerable to storm flooding. Coastal inundation impacts 0.1 mi of stormwater pipes and 4 outfalls, while storm flooding impacts up to 2 miles of pipe and 7 outfalls. Wastewater pipelines are also vulnerable (1.9 to 2.7 miles) while one to two wastewater pump stations are vulnerable to storm flooding and wave impacts, respectively. Coastal armoring structures are vulnerable to storm flooding (0.3 miles) and wave run-up (1 miles).

A total of 203 parcels may be impacted by coastal erosion. All 1.1 miles of coastal armoring structures are vulnerable to coastal erosion. This includes residential (single and multi-family), vacant parcels, City Over 44 acres of wetlands are vulnerable, including 20.4 acres of beach. Of the utilities in the area, 0.7 miles of conduit, 1.2 miles of stormwater and 2.4 miles of wastewater pipelines, one wastewater pump station and 8 stormwater outfalls are vulnerable. A total of 1.4 miles of streets and 2.1 miles of trails are also vulnerable to erosion.

**Table 6
Sharp Park, West Fairway Park and Mori Point Asset Exposure Under Maximum Flooding and Erosion**

Category	Asset	Units	Erosion 2100	175 cm SLR Regular Inundation	175 cm SLR Storm Flooding	175 cm SLR Storm Wave Impacts
Ecosystem	Wetlands	acres	44.9	21.7	60.3	45.1
Ecosystem	Streams	miles	0	0	0	0
Ecosystem	Surfgrass	miles	0	0.1	0.1	0.1
Ecosystem	Beaches	acres	20.4	7.6	15.3	20.4
Recreation	Trails (GGNRA)	miles	0.8	0	0.1	0
Recreation	Trails (Reina to PSB)	miles	0	0	0	0
Recreation	Trails (Edgemar to Mori Pt)	miles	1.3	0	0.1	0.9
Recreation	Parks	acres	48.6	0.7	82.4	38.1
Recreation	Fishing Pier	miles	1	0	0	1
Transportation	Local Streets	miles	1.4	0	1.4	1.7
Transportation	CalTrans Bridges	count	0	0	0	0
Transportation	Local Bridges	count	0	0	0	0
Community	Landmarks	count	0	0	0	0
Community	Communities At Risk	count	0	0	0	0
Community	Affordable Rentals	count	0	0	1	0
Community	Health Care Facilities	count	0	0	0	0
Community	Senior Centers	count	0	0	0	0
Community	Mobile Home Parks	count	0	0	0	0
Community	Schools	count	0	0	0	0
Emergency Response	Fire Stations	count	0	0	0	0
Emergency Response	Police Stations	count	0	0	0	0
Communication	Underground Conduit	miles	0.7	0	0.7	0.8
Communication	Private Towers	count	0	0	0	0
Hazardous Materials	Solid Waste Facilities	count	0	0	0	0
Hazardous Materials	Underground Storage Tanks	count	0	0	0	0
Hazardous Materials	Clean Up Sites	count	0	0	0	0
Stormwater	Pump Stations	count	0	0	0	0
Stormwater	Pipelines	miles	1.2	0.1	2	1.2
Stormwater	Outfalls	count	8	4	7	7
Stormwater	EQ Basin	count	0	0	0	0
Wastewater	Pump Stations	count	1	0	1	2
Wastewater	Pipelines	miles	2.4	0	1.9	2.7
Lands	Pacifica City Limits	acres	120.1	19.8	134.4	97
Lands	Parks and Conservation	acres	94.9	20.1	113.8	67.5
Lands	Land Use	acres	113	20.1	125.7	87.1
Lands	Parcels	count	207	10	156	230
Coastal Structures	Seawalls, Rip rap, rubble, etc	miles	1.1	0	0.3	1

Rockaway Beach, Quarry and Headlands



SOURCE: Multiple

Figure 27

Rockaway Beach, Quarry and Headlands Sub-area – Coastal Hazards at 2100

The Rockaway sub-area asset vulnerabilities are concentrated at Rockaway Beach where the low backshore is more densely developed than the higher open space at the Quarry and Headlands (sub-area shown in teal on Figure 27, Table 7). Coastal flooding and erosion exposure to coastal armoring structures, stormwater and wastewater infrastructure, essential/emergency services, and hazardous materials are shown in Appendix B-4. Exposure to existing land use, City-owned parcels, landmarks, local streets, utilities, senior centers, affordable rentals and other community assets are shown in Appendix C-4. Exposure to parks and trails, habitats and sensitive species are shown in Appendix D-4. Public access data such as vertical/lateral coastal access and views, etc. will be added to Appendix D in the Final Vulnerability Assessment.

Ten parcels are vulnerable to flooding, 12 parcels are vulnerable to storm flooding, and 34 parcels are vulnerable to wave damages. Land uses include vacant and open space, hotels, office, commercial and mixed use, single and multi-family residential and public use. Beaches here are vulnerable to inundation and flooding with SLR (2.9 to 3.7 acres respectively). Wetlands in Calera Creek are also vulnerable to SLR. Surfgrass habitat (0.4 miles) along the rocky shores are vulnerable. Nearly all coastal structures are vulnerable to flooding, all are vulnerable to wave damages. Trails (0.2 miles) are vulnerable to wave impacts, 3.5 acres of parks are vulnerable to inundation and 4 acres are vulnerable to flooding. Stormwater pipelines (0.3 miles) are within the wave damage zone, as are 0.3 miles of communications lines. A total of three outfalls are vulnerable to flooding and inundation.

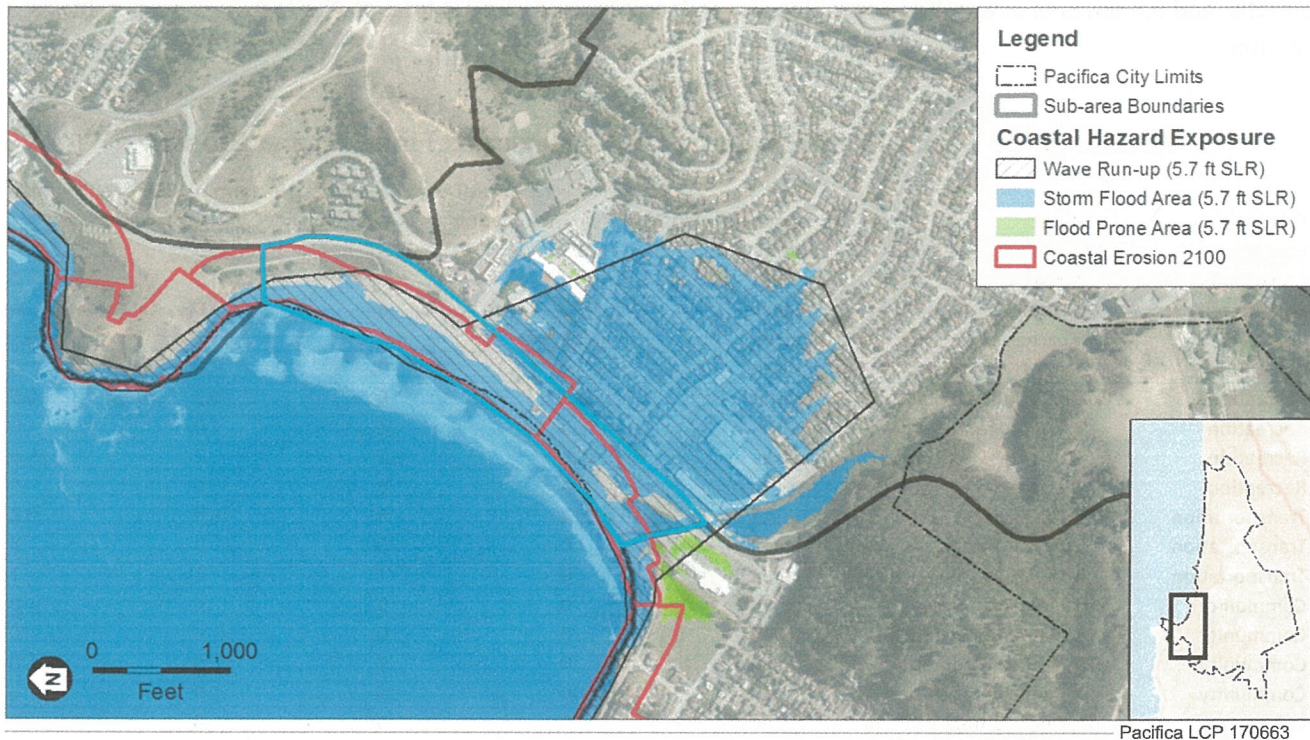
A total of 36 parcels in this sub-area are vulnerable to erosion. Land uses include vacant and open space, hotels, commercial and mixed use, single and multi-family residential and public use. Erosion threatens 3.7 acres of beach, 0.8 miles of trails, and 5.1 acres of parks. Local streets are also vulnerable (0.6 miles) as are 0.5 miles of

communications lines. Stormwater infrastructure is vulnerable, including five outfalls and 0.6 miles of pipelines are at risk. A wastewater pump station is also vulnerable along with 1.1 miles of pipes. All 0.3 miles of coastal structures are vulnerable to erosion.

**Table 7
Rockaway Beach, Quarry and Headlands Asset Exposure Under Maximum Flooding and Erosion**

Category	Asset	Units	Erosion 2100	175 cm SLR Regular Inundation	175 cm SLR Storm Flooding	175 cm SLR Storm Wave Impacts
Ecosystem	Wetlands	acres	9.7	11.6	12.3	9.1
Ecosystem	Streams	miles	0.3	0	0	0.1
Ecosystem	Surfgrass	miles	0.2	0.4	0.4	0.2
Ecosystem	Beaches	acres	3.7	2.9	3.7	3.3
Recreation	Trails (GGNRA)	miles	0	0	0	0
Recreation	Trails (Reina to PSB)	miles	0.8	0	0	0.2
Recreation	Trails (Edgemar to Mori Pt)	miles	0	0	0	0
Recreation	Parks	acres	5.1	3.5	4	3.2
Recreation	Fishing Pier	miles	0	0	0	0
Transportation	Local Streets	miles	0.6	0	0	0.4
Transportation	CalTrans Bridges	count	0	0	0	0
Transportation	Local Bridges	count	0	0	0	0
Community	Landmarks	count	0	0	0	0
Community	Communities At Risk	count	0	0	0	0
Community	Affordable Rentals	count	0	0	0	0
Community	Health Care Facilities	count	0	0	0	0
Community	Senior Centers	count	0	0	0	0
Community	Mobile Home Parks	count	0	0	0	0
Community	Schools	count	0	0	0	0
Emergency Response	Fire Stations	count	0	0	0	0
Emergency Response	Police Stations	count	0	0	0	0
Communication	Underground Conduit	miles	0.5	0	0	0.3
Communication	Private Towers	count	0	0	0	0
Hazardous Materials	Solid Waste Facilities	count	0	0	0	0
Hazardous Materials	Underground Storage Tanks	count	0	0	0	0
Hazardous Materials	Clean Up Sites	count	0	0	0	0
Stormwater	Pump Stations	count	0	0	0	0
Stormwater	Pipelines	miles	0.6	0	0	0.3
Stormwater	Outfalls	count	5	3	3	3
Stormwater	EQ Basin	count	0	0	0	0
Wastewater	Pump Stations	count	1	0	0	1
Wastewater	Pipelines	miles	1.1	0	0	0.7
Lands	Pacifica City Limits	acres	79.9	14.3	16.3	26.2
Lands	Parks and Conservation	acres	32.7	9.8	11	13.3
Lands	Land Use	acres	70	14.3	16	23.9
Lands	Parcels	count	36	10	12	34
Coastal Structures	Seawalls, Rip rap, rubble, etc	miles	0.3	0.1	0.2	0.3

Pacifica State Beach



SOURCE: Multiple

Figure 28

Pacifica State Beach Sub-area – Coastal Hazards at 2100

While the Pacifica State Beach sub-area is mostly beach, there are a number of key assets that are vulnerable (sub-area shown in teal on Figure 28, Table 8). Coastal flooding and erosion exposure to coastal armoring structures, stormwater and wastewater infrastructure, essential/emergency services, and hazardous materials are shown in Appendix B-5. Exposure to existing land use, City-owned parcels, landmarks, local streets, utilities, senior centers, affordable rentals and other community assets are shown in Appendix C-5. Exposure to parks and trails, habitats and sensitive species are shown in Appendix D-5. Public access data such as vertical/lateral coastal access and views, etc. will be added to Appendix D in the Final Vulnerability Assessment.

Eighteen parcels are vulnerable to coastal flooding, and include beach, commercial and public uses and multiple City-owned parcels. Beaches are vulnerable to inundation (7.4 acres) and storm flooding and waves (14.5 to 16.5 acres). Wetlands at San Pedro Creek are also vulnerable along with the creek itself which supports critical steelhead habitat (less than 0.1 miles, does not appear in table). Parks (Pacifica State Beach) are vulnerable to inundation (2.2 acres), flooding (9 acres) and wave impacts (15.6 acres). Highway 1 is vulnerable to flooding and storm impacts (0.8 miles). The stormwater and wastewater systems are particularly vulnerable in this sub-area. Two stormwater pump stations with a total of six pumps are vulnerable to storm flooding and waves, while 0.3 miles of pipe are vulnerable. Two outfalls are vulnerable. One wastewater pump station is vulnerable to flooding along with 1 mile of pipe. The entire seawall is vulnerable to flooding and wave impacts.

Erosion threatens 18 parcels that are vulnerable to flooding impacts. Over 16 acres of parks are vulnerable to erosion along with nearly 16 acres of beach. Highway 1 is also vulnerable (0.3 miles). Both stormwater pump

stations and the wastewater pump station are vulnerable to erosion in addition to 0.3 miles of storm drains, two outfalls, and 0.8 miles of sewer. The seawall is also vulnerable to erosion. A total of 18 parcels are vulnerable to erosion.

**Table 8
Pacifica State Beach Asset Exposure Under Maximum Flooding and Erosion**

Category	Asset	Units	Erosion 2100	175 cm SLR Regular Inundation	175 cm SLR Storm Flooding	175 cm SLR Storm Wave Impacts
Ecosystem	Wetlands	acres	3.3	3.3	4.5	4
Ecosystem	Streams	miles	0	0	0	0
Ecosystem	Surfgrass	miles	0	0	0	0
Ecosystem	Beaches	acres	15.8	7.4	14.5	16.5
Recreation	Trails (GGNRA)	miles	0	0	0	0
Recreation	Trails (Reina to PSB)	miles	0.4	0	0.3	0.5
Recreation	Trails (Edgemar to Mori Pt)	miles	0	0	0	0
Recreation	Parks	acres	16.2	2.2	9	15.6
Recreation	Fishing Pier	miles	0	0	0	0
Transportation	Local Streets	miles	0.3	0	0.8	0.8
Transportation	CalTrans Bridges	count	0	0	0	0
Transportation	Local Bridges	count	0	1	1	1
Community	Landmarks	count	0	0	0	0
Community	Communities At Risk	count	0	0	0	0
Community	Affordable Rentals	count	0	0	0	0
Community	Health Care Facilities	count	0	0	0	0
Community	Senior Centers	count	0	0	0	0
Community	Mobile Home Parks	count	0	0	0	0
Community	Schools	count	0	0	0	0
Emergency Response	Fire Stations	count	0	0	0	0
Emergency Response	Police Stations	count	0	0	0	0
Communication	Underground Conduit	miles	0	0	0	0
Communication	Private Towers	count	0	0	0	0
Hazardous Materials	Solid Waste Facilities	count	0	0	0	0
Hazardous Materials	Underground Storage Tanks	count	0	0	0	0
Hazardous Materials	Clean Up Sites	count	0	0	0	0
Stormwater	Pump Stations	count	2	1	2	2
Stormwater	Pipelines	miles	0.3	0.1	0.3	0.3
Stormwater	Outfalls	count	2	2	2	2
Stormwater	EQ Basin	count	0	0	0	0
Wastewater	Pump Stations	count	1	0	1	1
Wastewater	Pipelines	miles	0.8	0.1	0.6	1
Lands	Pacifica City Limits	acres	27.6	7.6	24	30.7
Lands	Parks and Conservation	acres	21.1	7.4	15.2	21.3
Lands	Land Use	acres	24.6	7.4	19.1	25.2
Lands	Parcels	count	18	14	18	18
Coastal Structures	Seawalls, Rip rap, rubble, etc	miles	0.1	0	0.1	0.1