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Memorandum

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Copy to:	Dave Revell (Revell Coastal)
Date:	January 14, 2017
Project Number:	P2208
Re:	Oxnard LCP Update – Sea Level Rise Vulnerability Assessment Tsunami Analysis

1 BACKGROUND

As part of the effort to update the City of Oxnard's (City) Local Coastal Program (LCP), the City retained Rincon Consultants (Rincon) and Everest International Consultants (Everest) to conduct the analysis summarized in this memorandum. The purpose of this analysis was to evaluate potential tsunami inundation under existing and future sea level conditions (*i.e.,* with sea level rise) for the four Planning Areas in the City and Port Hueneme. This tsunami analysis is supplemental to the work previously conducted by Rincon and Revell Coastal on the impacts of sea level rise within the City's coastal zone. The results of the tsunami analysis will be incorporated into the ongoing comprehensive LCP Update.

2 PURPOSE AND OBJECTIVES

The purpose of this analysis is to determine the degree of potential inundation associated with tsunamis without and with sea level rise. The following objectives were established to fulfill this purpose:

- Select tide condition(s)
- Select future sea level rise condition(s)
- Select tsunami event(s)
- Determine the extent of potential tsunami inundation

3 APPROACH

Potential tsunami inundation elevations were determined from the selected tide condition and tsunami wave heights. These potential tsunami inundation elevations were then mapped for the City LCP Planning Areas using GIS and topographic/bathymetric data to evaluate areas with the potential to be inundated by a tsunami occurring in Year 2015 as well as a tsunami occurring in Years 2030, 2060, and 2100 with sea level rise.

4 INUNDATION ELEVATIONS

4.1 Tides

Tide elevations are monitored by the National Oceanic and Atmospheric Administration (NOAA) along the California coastline at designated tide stations. The Santa Barbara station (Station 9411340) and Santa Monica station (Station 9410840) are the two NOAA stations closest to the City of Oxnard. Tidal datums obtained from NOAA for these two stations are shown in Table 1 with elevations in feet relative to the North American Vertical Datum of 1988 (NAVD88). These tidal datums represent long term average water levels for the latest National Tidal Datum Epoch from Years 1983 to 2001. Since the City is approximately equal distance from the two NOAA stations, the average tide elevation at the two tide stations was used for this analysis. For the potential tsunami inundation analysis, Mean Higher High Water (MHHW) was selected as a representative tide condition for the historical tsunami (2011 Japanese Tsunami). For the locally generated tsunami developed by the State of California (California Geological Survey, 2014), mean sea level (MSL) was selected for the work presented in that report so that tidal datum was selected for the analysis presented in this technical memo.

Table 1. NOAA Tidal Datums for Santa Barbara and Santa Monica

TIDE	ELEVATION (FEET, NAVD88)	
	SANTA BARBARA (STATION 9411340)	SANTA MONICA (STATION 9410840)
Highest Observed Water Level	7.26	8.31
Mean Higher High Water (MHHW)	5.27	5.24
Mean High Water (MHW)	4.51	4.50
Mean Sea Level (MSL)	2.66	2.60
Mean Low Water (MLW)	0.85	0.74
North American Vertical Datum – 1988 (NAVD88)	0.00	0.00
Mean Lower Low Water (MLLW)	-0.13	-0.19
Lowest Observed Water Level	-3.02	-3.03

4.2 Sea Level Rise

Sea level rise scenarios were selected to be consistent with the coastal hazards mapping prepared by ESA PWA (2013) for the County of Ventura. The ESA PWA study followed the intent of the California Coastal Commission Draft Sea Level Rise Policy Guidance (CCC 2013), National Research Council (NRC 2012), and U.S. Army Corps of Engineers guidance (USACE 2011). It also included an adjustment for local vertical land motion using the Santa Monica tide station (NOAA #9410840) for the medium and high SLR projections. The sea level rise projections relative to 2010 extracted from the ESA PWA 2013 are shown in Table 2. The same sea level rise projections for Years 2030, 2060, and 2100 from the ESA PWA study (2013) High Scenario were used for this analysis to define future mean sea level conditions.

TABLE 2. SEA LEVEL RISE PROJECTIONS, RELATIVE 2010 (ESA PWA 2013)

YEAR	SEA LEVEL RISE PROJECTIONS (INCHES)		
	LOW SLR	MEDIUM SLR	HIGH SLR
2030	2.3	5.2	8.0
2060	7.4	16.1	25.3
2100	17.1	36.5	58.1

4.3 Tsunamis

The tsunami data for the historical tsunami and local tsunami used in this analysis are presented below and summarized in Tables 3, 4, and 5.

4.3.1 Historical Tsunami

The 2010 Chilean and 2011 Japanese tsunamis were the most significant tsunamis to hit California since the 1964 Alaska tsunami. The 2010 Chilean tsunami was generated by a magnitude 8.8 earthquake on February 26, 2010 at the Maule region near central Chile, and the tsunami subsequently reached the Los Angeles region around noon on February 27, 2010. On March 11, 2011, a magnitude 9.0 earthquake struck the east coast of the Tohoku region in Japan, and it generated a large tsunami that reached the Los Angeles region at around 8:40 am on March 11, 2011.

The NOAA ocean water level data collected at the Santa Barbara and Santa Monica gages for these two tsunamis were downloaded and analyzed for this analysis. Figure 1 shows a graphic record of the water levels at Santa Monica and Santa Barbara gages for the 2010 Chilean event. In the figure, the blue line shows the observed (measured) ocean water level and the green line shows the predicted ocean water level. The difference between the measured and predicted ocean water level (shown as the red line in the figure) primarily represents the tsunami wave. Based on the data, the maximum measured tsunami amplitude (wave amplitude equals half the wave height) was approximately 1.61 ft at Santa Monica and 1.91 ft at Santa Barbara. Similar plots for the 2011 Japanese tsunami are shown in Figure 2. For this tsunami, the maximum tsunami amplitude at Santa Monica was about 2.43 ft and 2.39 ft at Santa Barbara. The tsunami wave amplitude off the shoreline of Oxnard is likely between those measured at Santa Monica and Santa Barbara so an average value was calculated for these two locations (1.75 ft for the 2010 Chilean event and 2.41 ft for the 2011 Japanese event) to represent the tsunami amplitude. For this analysis, the 2011 Japanese tsunami amplitude was used since it represented the higher tsunami wave condition.

4.3.2 Local Tsunami

Given the lack of measured information for historical tsunamis and the potential for extreme tsunamis that have not been captured in the historical measurements, consideration was given to potential tsunamis that could be generated by distant and local sources that could reach the Oxnard coast. The following sections discuss potential local tsunamis that might impact the City of Oxnard based on studies conducted by the State of California and other scientists.

Tsunamis Based on Analysis Conducted by State of California

The State of California conducted an analysis of tsunamis that could be generated by numerous distant sources (*e.g.,* Cascadian Subduction Zone earthquake) and local sources (*e.g.,* Goleta 2 Landslide). A numerical model was used in the analysis conducted by the State of California to determine the maximum potential tsunami elevation for each individual source and then the maximum tsunami elevation was identified for each source type. The results were provided for different locations along the California coast, including the Oxnard and Ventura area. For the Oxnard area, a maximum tsunami elevation of +12 ft, MSL resulting from the Goleta 2 Landslide source was reported (California Geological Survey, 2014). This tsunami was selected for inclusion in the analysis presented herein to allow consideration of a potentially large tsunami not captured in the historical measured record that could strike the Oxnard coast in the future. This tsunami is also being considered by the City for emergency evacuation planning.

Tsunamis Based on Study for the Pitas Point and Lower Red Mountain Fault Slip

A study published in the Journal of Geophysical Research Letters by UC Riverside and U.S. Geological Survey scientists in 2015 (Ryan et al., 2015) provided new consideration for local tsunami inundation in the Ventura region. The study used a three-dimensional dynamic model to predict the tsunami associated with an earthquake and fault slip along the Pitas Point and Lower Red Mountain Faults offshore of Ventura. Based on the results of the scenario presented in Figure 5 of the publication, the tsunami amplitudes along the Oxnard coast were found to be in the range of approximately 4 to 7 meters (approximately 13.1 to

23.0 feet). The author noted that the study considered one potential earthquake scenario along the Pitas Point and Lower Red Mountain Faults, and did not give an overall distribution of all possible earthquake and tsunami hazards in the Ventura region.

4.4 Potential Tsunami Inundation Elevations

The potential tsunami inundation elevations for the 2011 Japanese Tsunami, Goleta 2 Landslide Tsunami, Pitas Point and Lower Red Mountain Fault Slip Tsunami are summarized in Tables 3, 4, and 5 respectively. The values in Table 3 (for the 2011 Japanese Tsunami) are based on the tsunami occurring during a high tide condition of MHHW in Year 2015 (no sea level rise) as well as Years 2030, 2060, and 2100 (with sea level rise). The values in Table 4 (for Goleta 2 Landslide Tsunami) are based on the tsunami occurring during a tide condition of MSL in Year 2015 (no sea level rise) as well as Years 2030, 2060, and 2100 (with sea level rise). The values in Table 5 (for the Pitas Point and Lower Red Mountain Fault Slip Tsunami) are based on the tsunami occurring during a high tide condition of MHW in Year 2015 (no sea level rise) as well as Years 2030, 2060, and 2100 (with sea level rise). Following the Ryan et al. 2015 study, the MHW vertical datum was used in estimating inundation elevations for this scenario. The tsunami amplitude discussed in the previous paragraph was added to the mean high water (MHW) elevation to generate the tsunami inundation elevations shown in Table 5.

Table 3. 2011 Japanese Tsunami Potential Inundation Elevations

YEAR	MHHW (FT, NAVD88)	TSUNAMI AMPLITUDE [1] (FT)	SEA LEVEL RISE (FT)	INUNDATION ELEVATION [2] (FT, NAVD88)
2015	5.26	2.4	0.00	7.7
2030	5.26	2.4	0.67	8.3
2060	5.26	2.4	2.11	9.8
2100	5.26	2.4	4.84	12.5

(1) Based on NOAA water level data
(2) Inundation Elevation = MHHW + Amplitude + Sea Level Rise

Table 4. Goleta 2 Landslide Tsunami Potential Inundation Elevations

Year	MSL (ft, NAVD88)	Tsunami Nearshore Height [1] (ft)	Sea Level Rise (ft)	Inundation Elevation [2] (ft, NAVD88)
2015	2.63	12.0	0.00	14.6
2030	2.63	12.0	0.67	15.3
2060	2.63	12.0	2.11	16.7
2100	2.63	12.0	4.84	19.5

(1) California Geological Survey, 2014
(2) Inundation Elevation = MSL + Tsunami Nearshore Height + Seal Level RIse

Table 5. Pitas Point and Lower Red Mountain Fault Slip Tsunami Potential Range of Inundation Elevations

Year	MHW (ft, NAVD88)	Tsunami Amplitude [1] (ft)		Sea Level Rise (ft)	Inundation Elevation [2] (ft, NAVD88)	
		Low	High		Low	High
2015	4.50	13.1	23.0	0.00	17.6	27.5
2030	4.50	13.1	23.0	0.67	18.3	28.1
2060	4.50	13.1	23.0	2.11	19.7	29.6
2100	4.50	13.1	23.0	4.84	22.5	32.3

(1) Based on Ryan et. al. 2015 Figure 5
(2) Inundation Elevation = MHW + Amplitude + Sea Level Rise

5 Data Used in GIS-aided Inundation Analysis

5.1 Imagery: World Imagery

The imagery “World Imagery” is available as a basemap in ESRI ArcGIS (ESRI, 2015). World Imagery provides one meter or better satellite and aerial imagery in many parts of the world and lower resolution satellite imagery worldwide. The map features 0.3 m resolution imagery in the continental United States.

5.2 Topographic/Bathymetric Data: 2013 NOAA Coastal California TopoBathy Merged Project

The raster data set was downloaded from the NOAA Digital Coast Data Access Viewer (NOAA, 2015). Data providers include the California State Coastal Conservancy, California Ocean Protection Council, and California Department of Water Resources. The data was extracted from a larger classified data set and only includes points classified as Ground, Model Key-point (mass point), Bathymetric Lidar Points, and Acoustic Bathymetry (bare earth) within the requested geographic bounds. This project merged recently collected topographic, bathymetric, and acoustic elevation data along the entire California coastline from approximately the 10 m elevation contour out to the three-mile State water's boundary.

The topographic Lidar data used in this merged project was the 2009-2011 California State Coastal Conservancy Lidar Project. The bathymetric Lidar data used in this merged project was 2009-2010 U.S. Army Corps of Engineers (USACE) Joint Airborne Lidar Bathymetry Center of Expertise (JALBTCX) Lidar, provided by JALBTCX. The data were collected for the California Coastal Mapping Project (CCMP). The multibeam acoustic data used in this merged project were provided by the California Seafloor Mapping Program (CSMP) Ocean Protection Council and NOAA's National Geophysical Data Center (NGDC). Vertical accuracy of the topographic data is reported at 4.8 centimeters (cm) root mean square error (RMSE). JALBTCX bathymetric data is reported at 15 cm RMSE. As multiple multibeam acoustic datasets from multiple sources were used, the vertical accuracy varies. Horizontal accuracy is 100 cm.

5.3 Storm Drain Data

GIS storm drain data were obtained from the City of Oxnard. The types of data include locations of storm drains, open channels, manholes, inlets and outfalls. Among the information provided in the attribute tables are elevations of pipe inverts, manhole covers and inlets.

5.4 LCP Planning Areas

The four LCP Planning Areas in the City of Oxnard and adjacent Port Hueneme Planning Area are the focus of the analysis. The five areas are listed in Table 6. The boundaries of these Planning Areas were provided by the City in GIS format.

Table 6. Oxnard LCP Planning Areas and Port Hueneme

ID	DESCRIPTION
PA1	McGrath / Mandalay Beach
PA2	Oxnard Shores
PA3	Channel Islands
PA4	Ormond Beach
PA5	Port Hueneme (Not in LCP)

6 POTENTIAL TSUNAMI INUNDATION AREA MAPPING

Potential tsunami inundation elevations accounting for tide, tsunami, and sea level rise for Years 2015, 2030, 2060, and 2100 discussed in the previous section are summarized in Table 7. Areas below these potential tsunami inundation elevations (*i.e.,* at lower elevations) were identified and delineated on topographic maps as areas that may be inundated if there are hydraulic connections between the tsunami waves and low lying areas. An example of a hydraulic connection would be breaches in the beach dune system that lies between the ocean and infrastructure along the shore. Such breaches could occur in the future due to gradual erosion of the beach/dune system associated with decreases in sand supply or such breaches could occur during a tsunami with the initial tsunami waves eroding the beach and breaching the dune system. Another example of a hydraulic connection is a storm drain, which may consist of a series of inlets and pipes through which water is conveyed from one area to another, and ultimately to a river channel, or an ocean outfall.

Table 7. Summary of Potential Tsunami Inundation Elevations

YEAR	INUNDATION ELEVATION (FT, NAVD88)			
	2011 JAPANESE TSUNAMI	LOCAL TSUNAMIS		
		GOLETA 2 LANDSLIDE	PITAS POINT AND LOWER RED MOUNTAIN FAULT SLIP	
			LOW	HIGH
2015	7.7	14.6	17.6	27.5
2030	8.3	15.3	18.3	28.1
2060	9.8	16.7	19.7	29.6
2100	12.5	19.5	22.5	32.3

As can be seen in Table 7, the Goleta 2 Landslide Tsunami inundation elevations are higher than those of the 2011 Japanese Tsunami, while the inundation elevations caused by the Pitas Point and Lower Red Mountain Fault Slip Tsunami are the highest among the studied scenarios. This implies that the potential tsunami inundation impact areas of the local tsunamis (Goleta 2 Landslide, and Pitas Point and Lower Red Mountain Fault Slip Tsunamis) would likely be more extensive than the impact areas of the Japanese Tsunami.

Potential inundation resulting from the local tsunamis were mapped for Planning Areas 1, 2, 3, 4, and 5 and are shown in Figures 3, 4, 5, 6, and 7, respectively. In each figure, the inundation areas for Years 2015, 2030, 2060, and 2100 are shown from left to right. The yellow lines in the figures designate the boundaries of the Planning Areas and the colored (light and dark blue) areas depict the potential tsunami inundation areas. In the figures, the areas potentially inundated by the local tsunamis are shaded in light, medium, and dark blue. The light blue areas represent the lowest elevations and would be potentially inundated by all tsunami scenarios in Table 7. The medium blue shaded areas would be potentially inundated by the Pitas Point and Lower Red Mountain Faults slip Tsunami (low to high range). The dark blue areas would be potentially inundated if the high range of the Pitas Point and Lower Red Mountain Faults Slip Tsunami occurred. The areas below the inundation elevations would experience potential inundation impacts if hydraulic connections are present. The storm drain data are plotted in Figures 3 to 7 to provide information regarding potential hydraulic connections.

7 SEA LEVEL RISE VULNERABILITY ASSESSMENT TSUNAMI ANALYSIS SUMMARY

The results of the potential tsunami inundation analysis show that the LCP Planning Areas could experience inundation impacts if a tsunami occurs now or in the future with higher sea levels. The inundation impacts due to local tsunami sources could potentially be more severe than from a distant source, such as a tsunami initiated in Japan. While most LCP Planning Areas could potentially be impacted by inundation from tsunamis, LCP Planning Areas 1 and 2 experience relatively less inundation than Planning Areas 3, 4 and 5. Due to lower ground elevations, Planning Areas 3, 4 and 5 could experience inundation, whether a tsunami occurred in recent years or future years with sea level rise. The results presented in this study were based on scenarios analyzed by the State of California and other recent research referenced in this memorandum.

8 References

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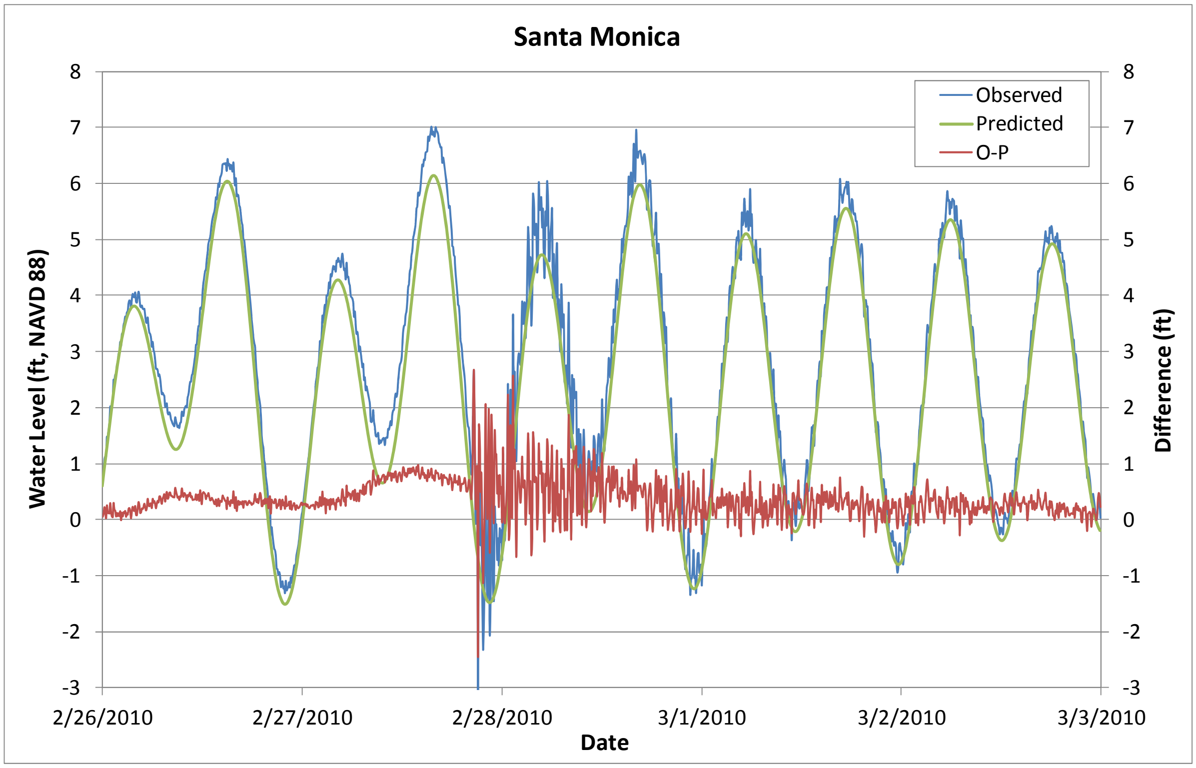
Ryan, K. J., E. L. Geist, M. Barall, and D. D. Oglesby (2015), Dynamic Models of an Earthquake and Tsunami Offshore Ventura, California, American Geophysical Union, Geophysical Research Letters, 42, doi:10.1002/2015GL064507



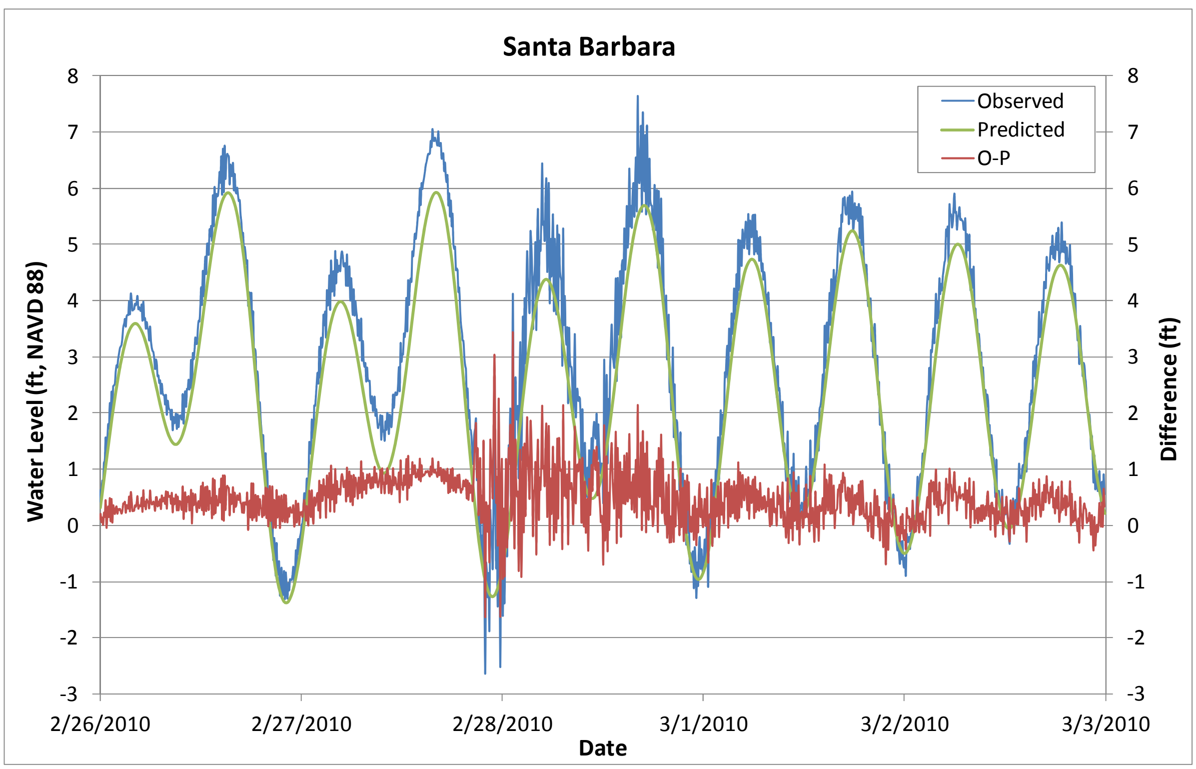
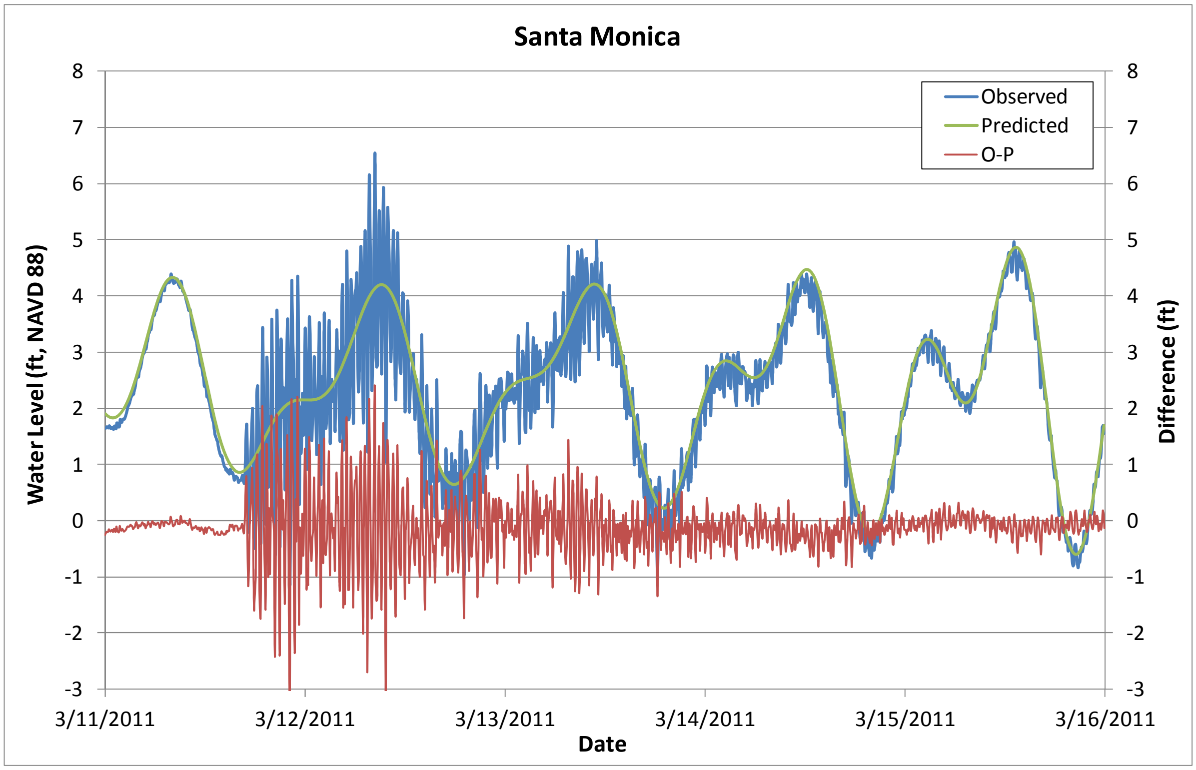


Figure 1. Water Levels at Santa Monica and Santa Barbara NOAA Tide Gages during the February 27, 2010 Chilean Tsunami



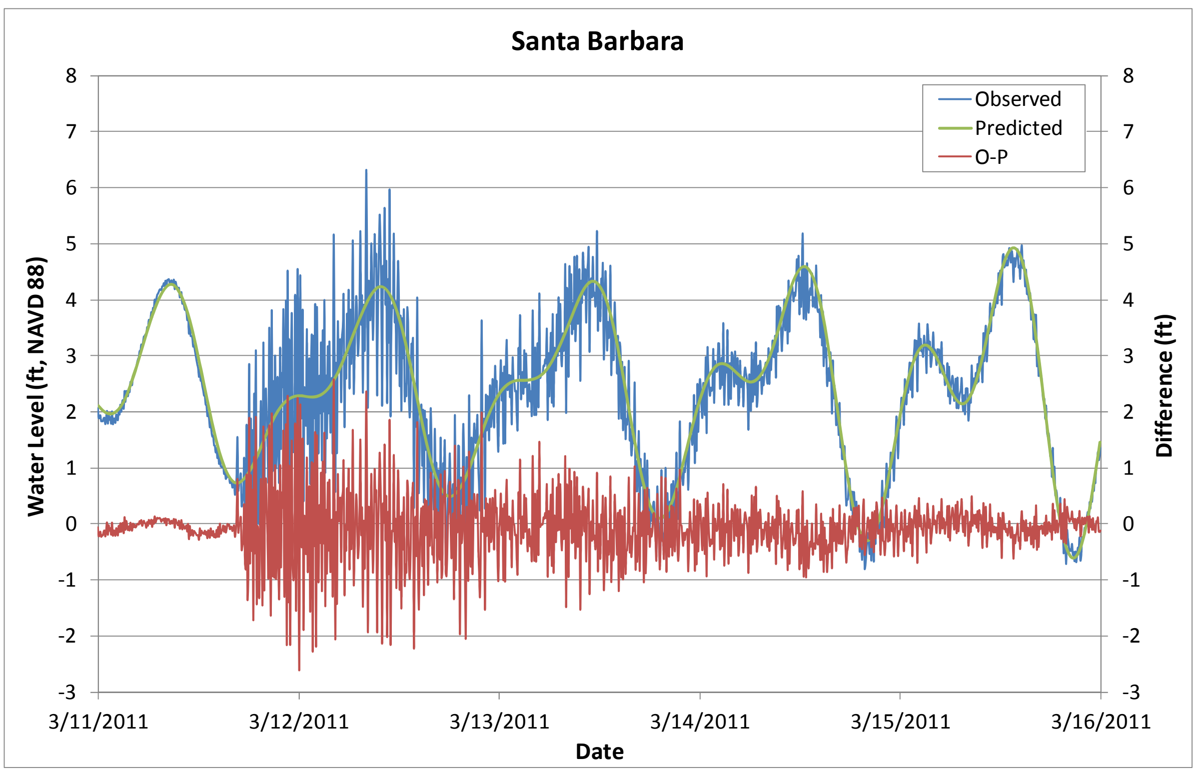
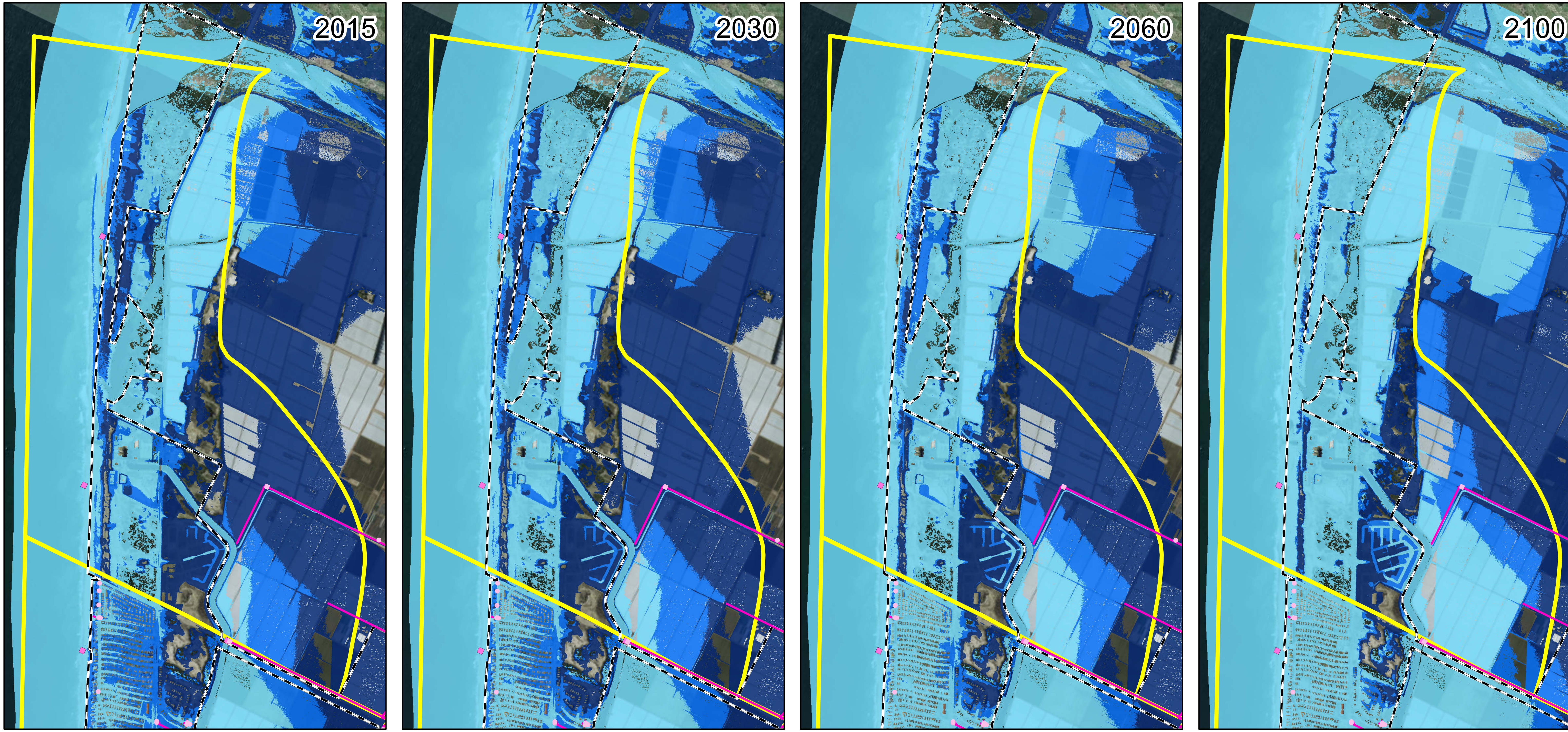


Figure 2. Water Levels at Santa Monica and Santa Barbara NOAA Tide Gages during the March 11, 2011 Japanese Tsunami



Tsunami Scenario 2015

- Potential inundation area below 14.6' NAVD (G, L or H Tsunami + 2015 Sea Level)
- Potential inundation area below 17.6' NAVD (L or H Tsunami + 2015 Sea Level)
- Potential inundation area below 27.5' NAVD (H Tsunami + 2015 Sea Level)
- City Boundary
- City of Oxnard LCP Planning Area
- Adjacent Jurisdictions
- Storm Drain Inlet/Catch Basin
- Storm Drain Pipe/Open Channel

Tsunami Scenario 2030

- Potential inundation area below 15.3' NAVD G, L or H Tsunami + 2030 Sea Level)
- Potential inundation area below 18.3' NAVD (L or H Tsunami + 2030 Sea Level)
- Potential inundation area below 28.1' NAVD (H Tsunami + 2030 Sea Level)

0 0.5 1 Miles

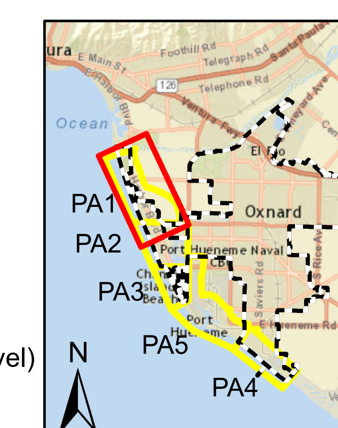
N

Tsunami Scenario 2060

- Potential inundation area below 16.7' NAVD (G, L or H Tsunami + 2060 Sea Level)
- Potential inundation area below 19.7' NAVD (L or H Tsunami + 2060 Sea Level)
- Potential inundation area below 29.6' NAVD (H Tsunami + 2060 Sea Level)

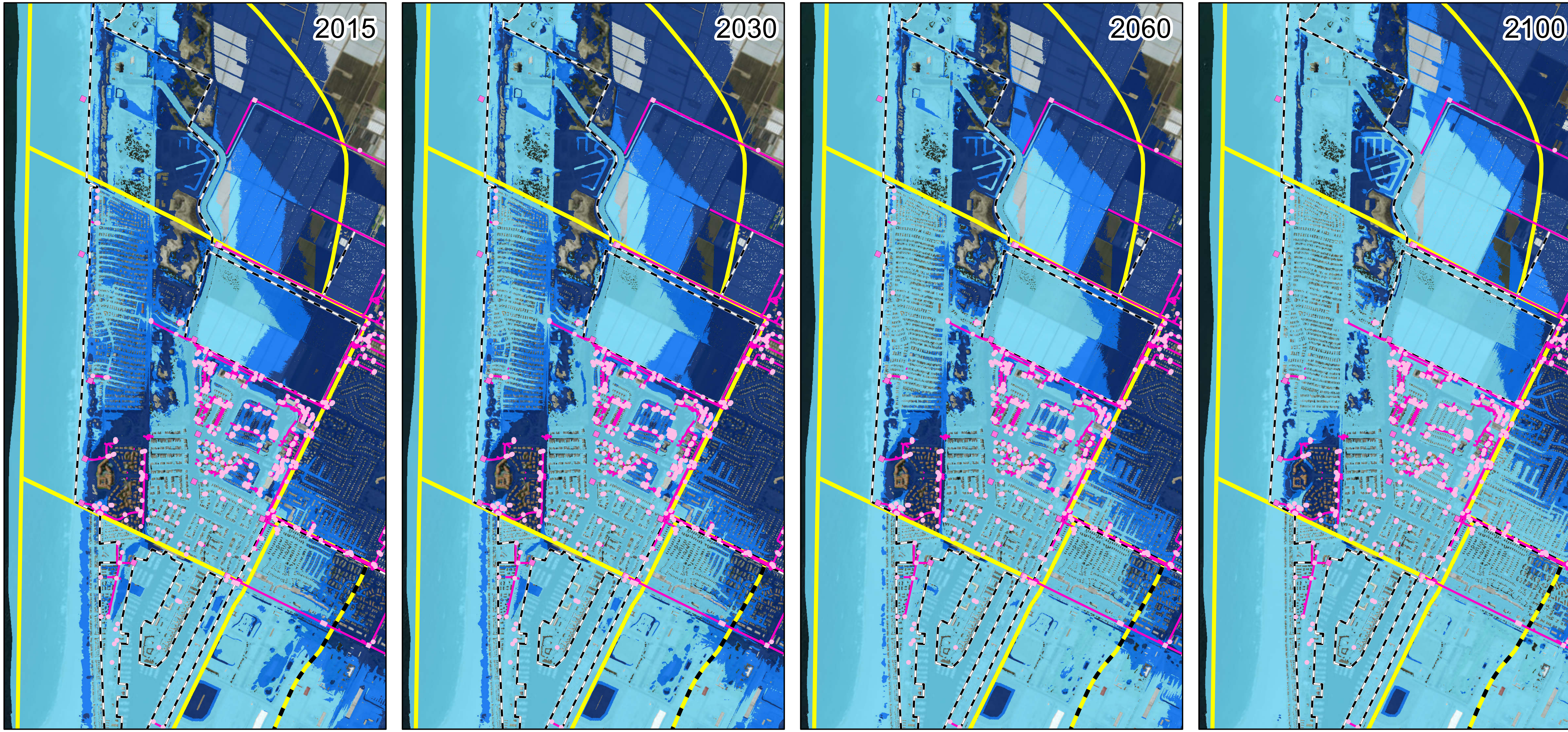
Tsunami Scenario 2100

- Potential inundation area below 19.5' NAVD, (G, L or H Tsunami + 2100 Sea Level)
- Potential inundation area below 22.5' NAVD (L or H Tsunami + 2100 Sea Level)
- Potential inundation area below 32.3' NAVD (H Tsunami + 2100 Sea Level)



Abbreviations: G = Goleta 2 Landslide Tsunami;
L and H = Low and High range estimates respectively of Pitas Point and Lower Red Mountain Fault Slip Tsunami

Figure 3. Potential Tsunami Inundation Mapping for Planning Area 1: McGrath / Mandalay Beach



Tsunami Scenario 2015

- Potential inundation area below 14.6' NAVD (G, L or H Tsunami + 2015 Sea Level)
- Potential inundation area below 17.6' NAVD (L or H Tsunami + 2015 Sea Level)
- Potential inundation area below 27.5' NAVD (H Tsunami + 2015 Sea Level)
- City Boundary
- City of Oxnard LCP Planning Area
- Adjacent Jurisdictions
- Storm Drain Inlet/Catch Basin
- Storm Drain Pipe/Open Channel

Tsunami Scenario 2030

- Potential inundation area below 15.3' NAVD G, L or H Tsunami + 2030 Sea Level)
- Potential inundation area below 18.3' NAVD (L or H Tsunami + 2030 Sea Level)
- Potential inundation area below 28.1' NAVD (H Tsunami + 2030 Sea Level)

0 0.5 1 Miles

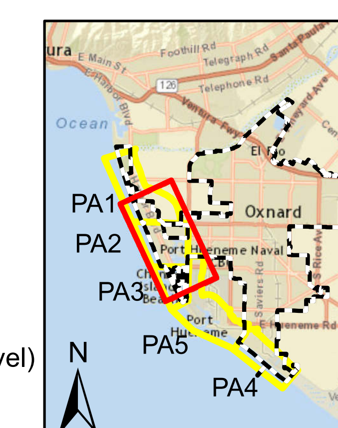
N

Tsunami Scenario 2060

- Potential inundation area below 16.7' NAVD (G, L or H Tsunami + 2060 Sea Level)
- Potential inundation area below 19.7' NAVD (L or H Tsunami + 2060 Sea Level)
- Potential inundation area below 29.6' NAVD (H Tsunami + 2060 Sea Level)

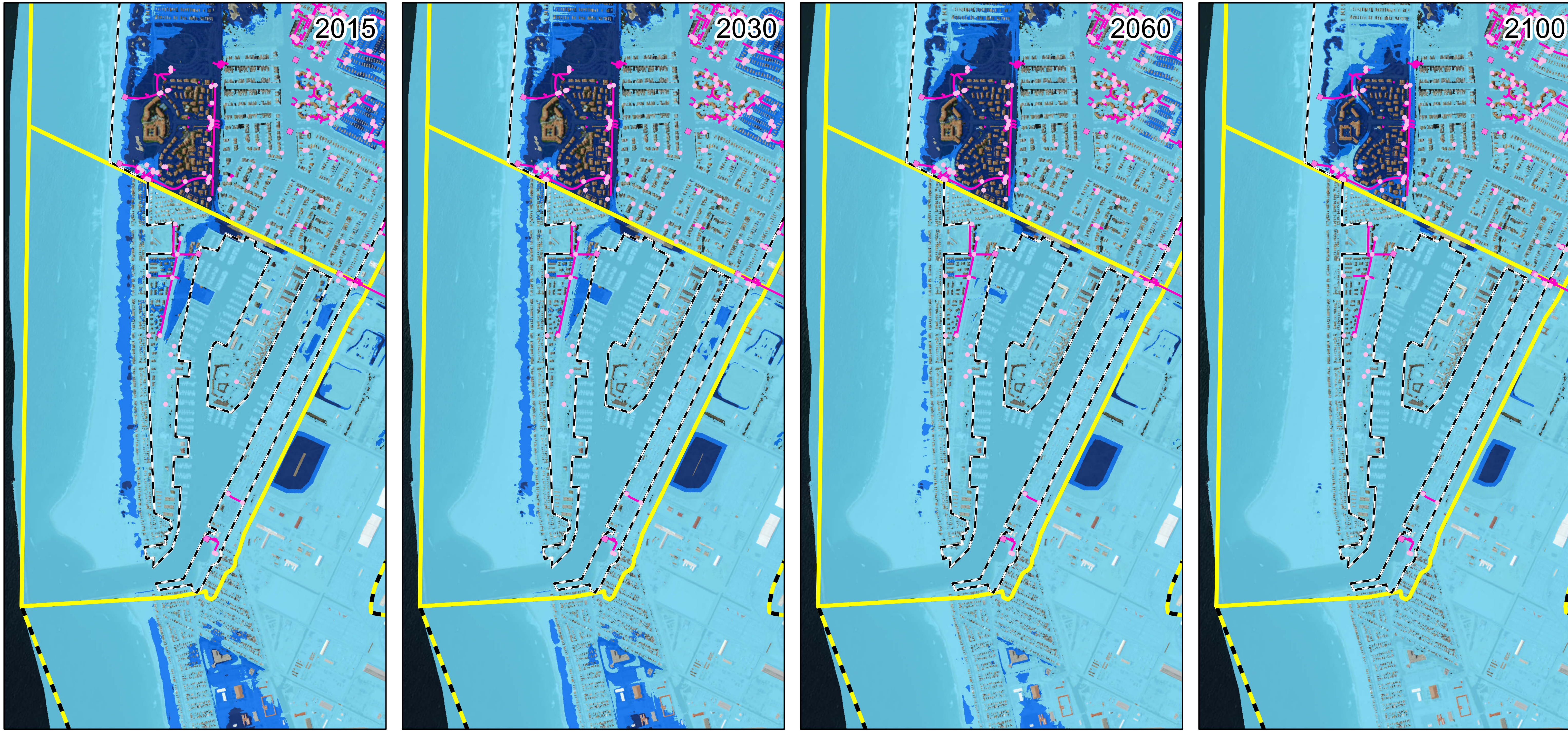
Tsunami Scenario 2100

- Potential inundation area below 19.5' NAVD, (G, L or H Tsunami + 2100 Sea Level)
- Potential inundation area below 22.5' NAVD (L or H Tsunami + 2100 Sea Level)
- Potential inundation area below 32.3' NAVD (H Tsunami + 2100 Sea Level)



Abbreviations: G = Goleta 2 Landslide Tsunami;
L and H = Low and High range estimates respectively of Pitas Point and Lower Red Mountain Fault Slip Tsunami

Figure 4. Potential Tsunami Inundation Mapping for Planning Area 2: Oxnard Shores



Tsunami Scenario 2015

- Potential inundation area below 14.6' NAVD (G, L or H Tsunami + 2015 Sea Level)
- Potential inundation area below 17.6' NAVD (L or H Tsunami + 2015 Sea Level)
- Potential inundation area below 27.5' NAVD (H Tsunami + 2015 Sea Level)
- City Boundary
- City of Oxnard LCP Planning Area
- Adjacent Jurisdictions
- Storm Drain Inlet/Catch Basin
- Storm Drain Pipe/Open Channel

Tsunami Scenario 2030

- Potential inundation area below 15.3' NAVD G, L or H Tsunami + 2030 Sea Level)
- Potential inundation area below 18.3' NAVD (L or H Tsunami + 2030 Sea Level)
- Potential inundation area below 28.1' NAVD (H Tsunami + 2030 Sea Level)

Tsunami Scenario 2060

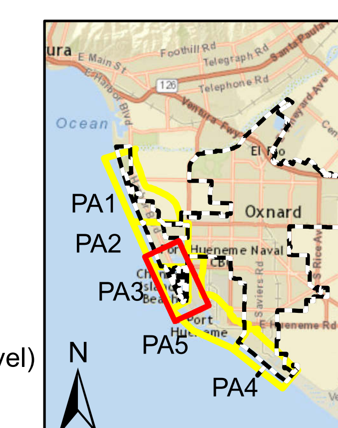
- Potential inundation area below 16.7' NAVD (G, L or H Tsunami + 2060 Sea Level)
- Potential inundation area below 19.7' NAVD (L or H Tsunami + 2060 Sea Level)
- Potential inundation area below 29.6' NAVD (H Tsunami + 2060 Sea Level)

Tsunami Scenario 2100

- Potential inundation area below 19.5' NAVD, (G, L or H Tsunami + 2100 Sea Level)
- Potential inundation area below 22.5' NAVD (L or H Tsunami + 2100 Sea Level)
- Potential inundation area below 32.3' NAVD (H Tsunami + 2100 Sea Level)

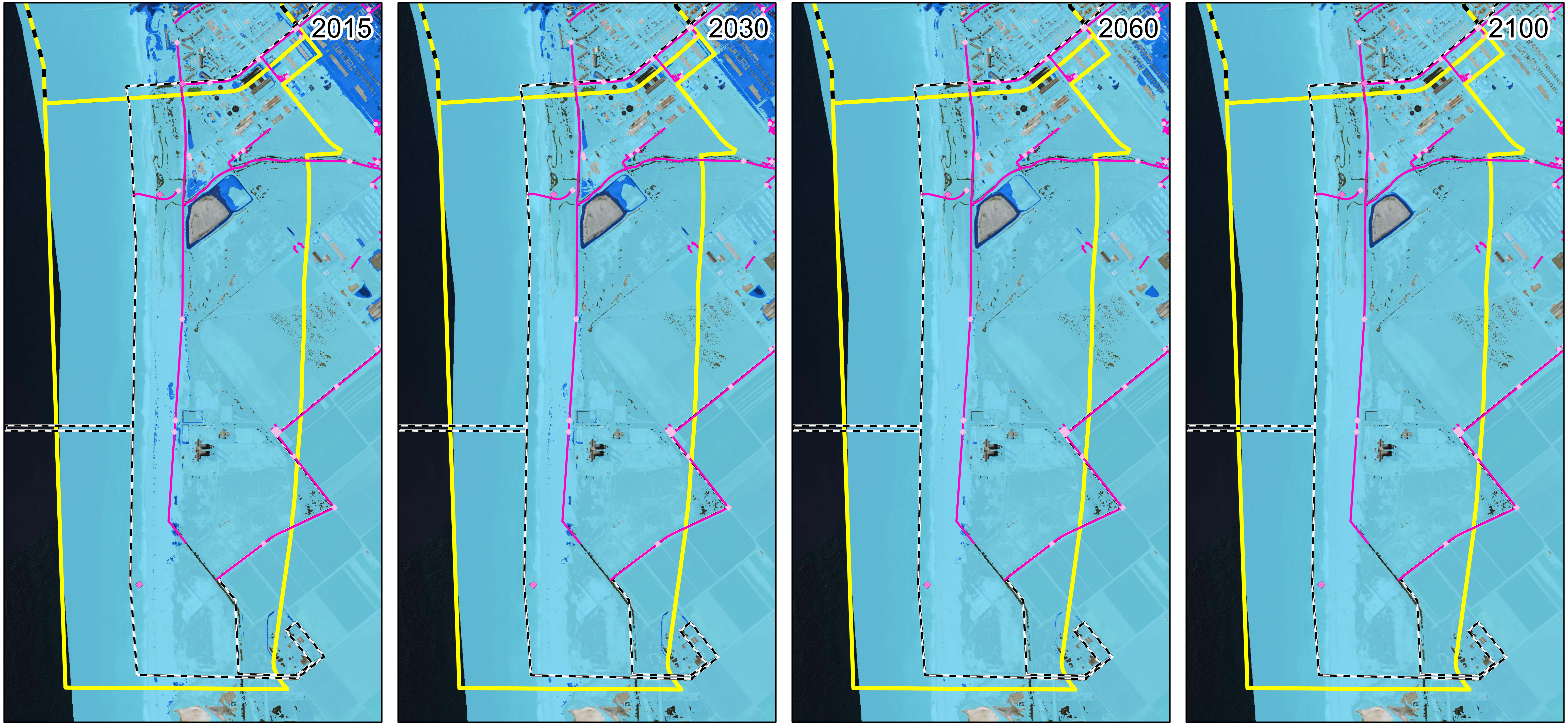
0 0.5 1 Miles

N



Abbreviations: G = Goleta 2 Landslide Tsunami;
L and H = Low and High range estimates respectively of Pitas Point and Lower Red Mountain Fault Slip Tsunami

Figure 5. Potential Tsunami Inundation Mapping for Planning Area 3: Channel Islands



Tsunami Scenario 2015

- Potential inundation area below 14.6' NAVD (G, L or H Tsunami + 2015 Sea Level)
- Potential inundation area below 17.6' NAVD (L or H Tsunami + 2015 Sea Level)
- Potential inundation area below 27.5' NAVD (H Tsunami + 2015 Sea Level)
- City Boundary
- City of Oxnard LCP Planning Area
- Adjacent Jurisdictions
- Storm Drain Inlet/Catch Basin
- Storm Drain Pipe/Open Channel

Tsunami Scenario 2030

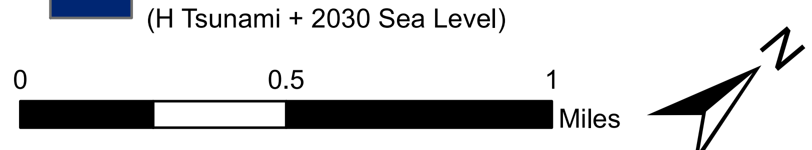
- Potential inundation area below 15.3' NAVD G, L or H Tsunami + 2030 Sea Level)
- Potential inundation area below 18.3' NAVD (L or H Tsunami + 2030 Sea Level)
- Potential inundation area below 28.1' NAVD (H Tsunami + 2030 Sea Level)

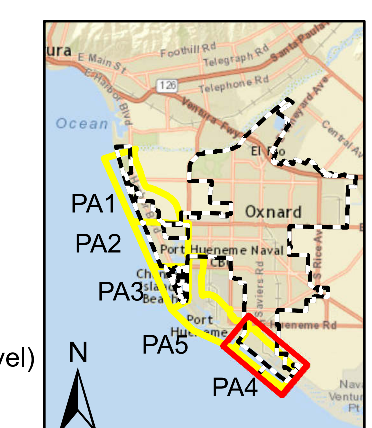
Tsunami Scenario 2060

- Potential inundation area below 16.7' NAVD (G, L or H Tsunami + 2060 Sea Level)
- Potential inundation area below 19.7' NAVD (L or H Tsunami + 2060 Sea Level)
- Potential inundation area below 29.6' NAVD (H Tsunami + 2060 Sea Level)

Tsunami Scenario 2100

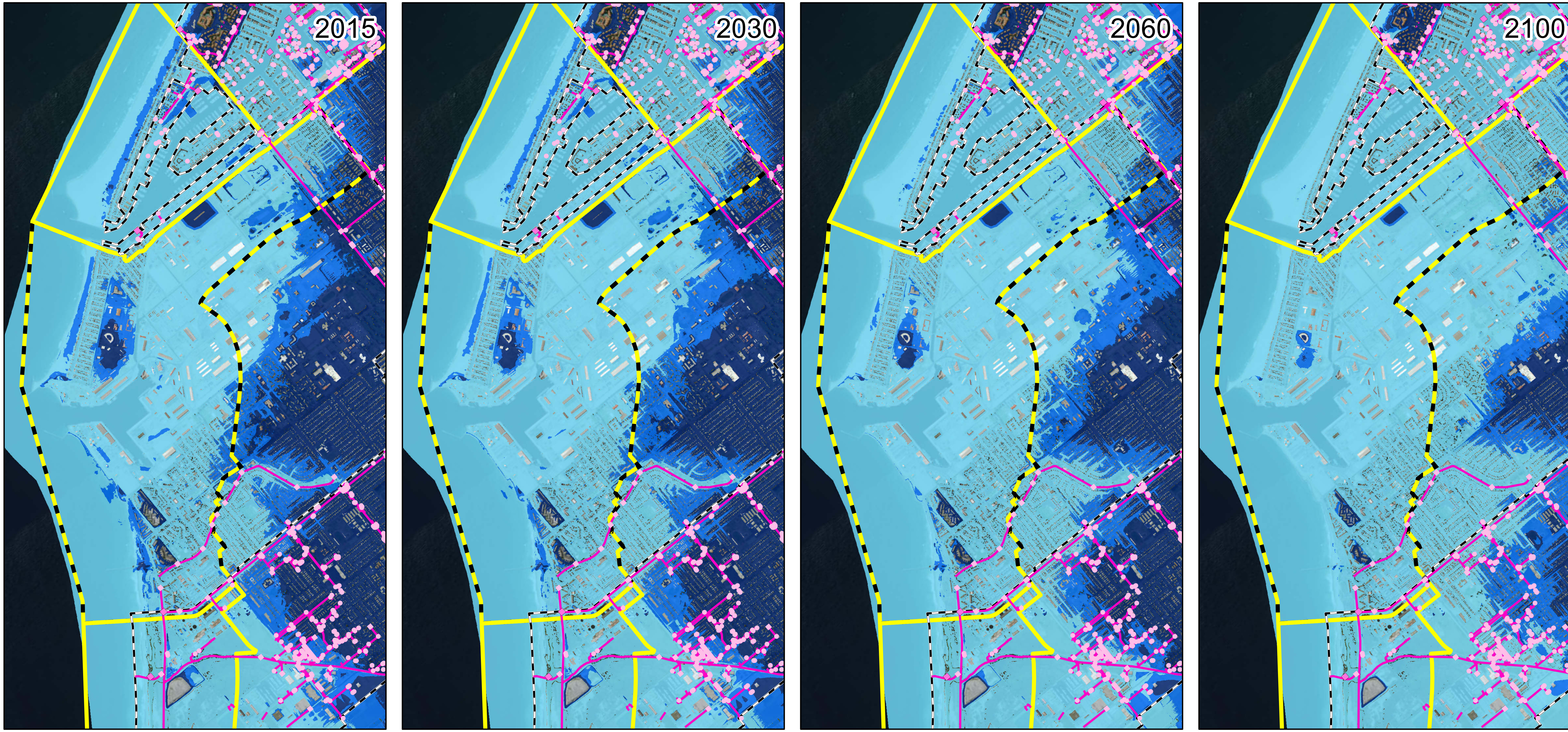
- Potential inundation area below 19.5' NAVD, (G, L or H Tsunami + 2100 Sea Level)
- Potential inundation area below 22.5' NAVD (L or H Tsunami + 2100 Sea Level)
- Potential inundation area below 32.3' NAVD (H Tsunami + 2100 Sea Level)





Abbreviations: G = Goleta 2 Landslide Tsunami;
L and H = Low and High range estimates respectively of Pitas Point and Lower Red Mountain Fault Slip Tsunami

Figure 6. Potential Tsunami Inundation Mapping for Planning Area 4: Ormond Beach



Tsunami Scenario 2015

- Potential inundation area below 14.6' NAVD (G, L or H Tsunami + 2015 Sea Level)
- Potential inundation area below 17.6' NAVD (L or H Tsunami + 2015 Sea Level)
- Potential inundation area below 27.5' NAVD (H Tsunami + 2015 Sea Level)
- City Boundary
- City of Oxnard LCP Planning Area
- Adjacent Jurisdictions
- Storm Drain Inlet/Catch Basin
- Storm Drain Pipe/Open Channel

Tsunami Scenario 2030

- Potential inundation area below 15.3' NAVD G, L or H Tsunami + 2030 Sea Level)
- Potential inundation area below 18.3' NAVD (L or H Tsunami + 2030 Sea Level)
- Potential inundation area below 28.1' NAVD (H Tsunami + 2030 Sea Level)

0 0.5 1 Miles

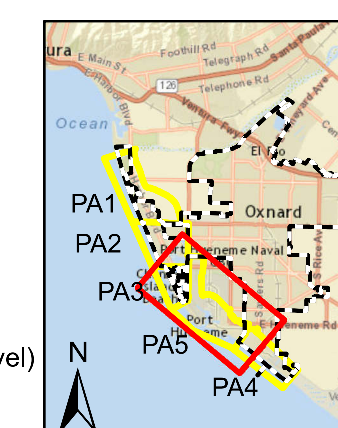
N

Tsunami Scenario 2060

- Potential inundation area below 16.7' NAVD (G, L or H Tsunami + 2060 Sea Level)
- Potential inundation area below 19.7' NAVD (L or H Tsunami + 2060 Sea Level)
- Potential inundation area below 29.6' NAVD (H Tsunami + 2060 Sea Level)

Tsunami Scenario 2100

- Potential inundation area below 19.5' NAVD, (G, L or H Tsunami + 2100 Sea Level)
- Potential inundation area below 22.5' NAVD (L or H Tsunami + 2100 Sea Level)
- Potential inundation area below 32.3' NAVD (H Tsunami + 2100 Sea Level)



Abbreviations: G = Goleta 2 Landslide Tsunami;
L and H = Low and High range estimates respectively of Pitas Point and Lower Red Mountain Fault Slip Tsunami

Figure 7. Potential Tsunami Inundation Mapping for Planning Area 5: Port Hueneme (Not in LCP)