ADVERSE TSUNAMI IMPACTS RELATED TO THE DEIR/DEIS'S PROPOSED MODIFICATIONS OF THE BALLONA WETLANDS ECOLOGICAL RESERVE

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for the Sierra Club

January 31, 2018

"It is sad that it took 230,000 deaths to get attention that tsunamis are real, are deadly, and can visit with no notice anywhere causing upheaval in catastrophic proportions."

Dr. Laura S. L. Kong**,** Director, NOAA/NWS, International Tsunami Information Center, referring to the 2004 Sumatra, Indonesia Tsunami.

Introduction

The Draft Environmental Impact Study/Environmental Impact Report, State Clearinghouse No. 2012071090 (for brevity "DEIR"), concludes that regarding the project proposal it studies at the Ballona Wetlands ("Ballona") "the damage potential from a tsunami is expected to be low." (DEIR Appendix E-42) This conclusion is demonstrably and dangerously false, and the DEIR's methodological foundation for it is seriously inadequate. Evidence of these critical deficiencies examined below include:

1) Unassailable recalculations of DEIR predicted tsunami height maximums, correcting both arithmetic and reporting errors in the DEIR, using data found solely either in the DEIR itself or in other documents certified by the Los Angeles County Board of Supervisors;
2) Current land elevation readings taken by the U.S. Geological Survey 3D Elevation Program showing that DEIR land elevation maps—maps that the DEIR relies upon when trying to demonstrate the existence of, and also to depict, alleged tsunami damage-immune project areas—significantly misrepresent supposedly inundation-proof land elevations along and near populated designated tsunami evacuation routes within the Project area;
3) Recalculations of DEIR predicted 100-year tsunami run-up water elevations within and around the Ballona Wetlands, using only DEIR sources. (These recalculations will factor in sea level rise data, high tide levels, and storm surge elevations, which the DEIR-referenced tsunami models do not include);
4) Historical photos showing severe flooding in 1956 along Culver Blvd, the only designated tsunami evacuation route from the project area south of Ballona Creek and west of Lincoln Blvd; and
5) Analysis of a critical methodological deficiency in that the DEIR examines only tsunami "run-up" data while completely failing to study or even acknowledge what will happen when tsunami run-up waters encounter obstacles, bottlenecks and funneling caused by the proposed levees and other structures in the populated project area (Part II of this document).

Part I

Proposed Project Description

The most prominent structural component of the project proposal consists of five approximately 20 feet tall armored levees, all of them west of Lincoln Blvd ("Main Levee System", Exhibit 1). The first of these, the Fiji Way levee in Marina del Rey, would run from near Lincoln Blvd, seaward along Fiji Way and Area A, before curving southward, then ending near/at the north side of Ballona Creek. The second, more southerly Culver Blvd. levee in Playa del Rey, would begin somewhat west of Lincoln Blvd. and run seaward along the north side of Culver Blvd, before curving northward and ending at/near the south side of Ballona Creek just across the creek from the seaward most terminus of the Fiji Way levee.

The southwestern most sub-section of the Fiji Way levee (beginning where Fiji Way angles southward at Fisherman's Village) and the northwestern most sub-section of the Culver Blvd. levee (where the levee turns northward away from Culver Blvd.)--these two levee sub-sections run continuously except for the opening at Ballona Creek, where they terminate across Ballona Creek from each other. These two levee subsections, considered together, extend unevenly for about 400 meters very approximately parallel to the Pacific Ocean. For our purposes we will call this 400-meter levee stretch the "Coast-facing Levee System", although again it is actually composed of the seaward most, sea-facing parts of two levees, the Fiji Way and Culver Blvd. levees). The third South Area B/East Area B levee would run parallel to part of the Culver Blvd. levee but on the opposite, southern side of Culver Boulevard. The remaining two levees run immediately adjacent to and on either side of the proposed, reconfigured Ballona Creek.

In Part I, when examining tsunami run-up, we will be essentially reanalyzing and updating the DEIR's predictions of future tsunami water levels. Such predictions do not attempt to account for the effect of obstacles, for example levees, encountered as flood water inundates. In Part II, when examining run-up, we will be studying the run-ups of past tsunamis and the implications for future Ballona area tsunamis when they encounter obstacles and especially the levees that the proposed project would create.

Our analysis will show that 100-year tsunami waters predicted by DEIR sources (correctly reanalyzed) will encounter the DEIR's Main Levee System, resulting in flood levels surrounding the levees that are higher than would occur in the absence of this Main Levee System. This increased flooding will occur in important part because the tsunami waters from the Pacific Ocean—waters that would currently flow straight ahead, disbursing across the 400-meter-wide part of the wetlands immediately bordering Ballona Creek—such waters would instead be redirected by the Coast-facing Levee System toward the north along Fiji Way and toward the south along Culver Blvd. Both Fiji Way and Culver Blvd. are designated tsunami escape routes and, in fact, the only such escape routes available to approximately one thousand people. The increased tsunami water levels resulting from this redirection of water will also reach and adversely impact, more generally, the populated areas to the north, south and west of the Main Levee System and also the populated area immediately north of the Fiji Ditch.

The analysis below focuses on tsunami risk factors shared only by Project Alternatives 1 and 2, hereinafter referred to as "project".

Predicted Tsunami Elevations

The DEIR discussion of predicted tsunami flood levels at the Ballona Wetlands during the next 100 years is filled with serious errors and omissions of the kind that could cost lives and cause major property loss. The report states: "A 5-foot run-up for a 100-year tsunami (is) predicted near the Marina del Rey area (Ziony, Ed, 1985)." The report adds that "If a 100-year . . .tsunami coincides with high tide the maximum water elevation near the site may reach El +11...feet NAVD. . ." then concludes from these numbers that "although the damage potential from a tsunami is expected to be low, it cannot be ruled out (DEIR, Appendix E-42)

There are a number of fundamental problems with this analysis. First, the DEIR cites only the outdated 1985 Ziony report to support this prediction of a **5-foot** 100-year tsunami run-up[1] However, the DEIR is incorrect. The Ziony report nowhere in its 521 pages asserts or implies a 5-foot run-up for a 100-year tsunami at or near Ballona. Instead, in the attached Figure 208 (locations 79-80) copied from Ziony's report, Ziony predicts a **9-foot** 100-year run-up for the project area (Exhibit 2)[2]

The Ziony report's conclusion of a 9-foot 100-year run-up is reinforced by Los Angeles County Board of Supervisor's certification, in the Marina del Rey Land Use Plan, of a J.H. Wiggins finding of a 9.6 foot expected 100-year run-up at Venice Beach (Venice Beach reaches the northern edge of the project area.) [3] This Land Use Plan further clarifies Wiggins' analysis as follows: "the predicted heights are not maximum credible heights and do not presume coincidence of the highest tsunami wave with peak high tied or with storm induced high-water setup and superimposed storm waves...." [4] In other words, the predicted 9.6-foot predicted run-up, as with the DEIR's Ziony source[5], is a **minimum** expected run-up occurring during calm seas and not during high tide.

Returning then to the DEIR's Ziony report, if we add in the assumption of high tide, then, following the DEIR analysis above, which for high tide adds 6 feet above the mistakenly posited run-up of 5 feet, we arrive at a (recalculated) predicted minimum **15-foot** run-up at highest tide (i.e., 9' + (11'-5') for a 100-year tsunami run-up at Ballona. Again, this conclusion is based entirely on recalculating corrected data from the DEIR and its sources. Furthermore, high tides will often be even higher than the 6 feet posited here as can be seen from 2018 Santa Monica Bay high tide charts.[6]

Tsunami and Sea Level Rise

The materials on 100-year run-up examined above (Ziony, 1985, Wiggins, 1974 and DEIR Appendix E) never mention or show any awareness of the additional contribution sea level rise will make to tsunami flood levels. We discover the reason for this silence by turning to the main body of the DEIR, which does examine sea level rise. There we learn that the earliest study that attempted to project future sea level rise along the west coast of the United States was done by Hayhoe et al. in the year

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1 Ziony, J.I., Editor, 1985, "Evaluating Earthquakes in the Los Angeles Region-An Earth Science Perspective", United States Geological Survey Professional Paper 1360.

2 Ibid., p. 400

3 Los Angeles County Planning Department, Marina del Rey Land Use Plan, 2012, p. 10-6

4 The original MDR Land Use Plan for this information is *Seismic Safety Study, City of Los Angeles*, Technical Report 74-1199-1, John H. Wiggins, et al, 1974

5 The Ziony report, according to the DEIR as we saw above, adds 6-feet to the 5-feet, totaling 11-feet high tide, but adds in no increased elevation to account for Wiggins' "storm induced high-water setup and superimposed storm waves".

6 https://tidesandcurrents.noaa.gov/noaatidepredictions.html?id=9410777&units=standard&bdate=20180129&edate=20180130&timezone=LST/LDT&clock=12hour&datum=MLLW&interval=hilo&action=dailychart

2004.[7] And so, these 20th century investigators were silent because such a scientific sea level rise prediction post-dated and therefore was not available to Wiggins or Ziony.

By contrast, in the main body of the DEIR, there is an examination of the National Research Council's (NRC) study, a study which acknowledges that "estimates of sea level rise can be used to evaluate potential flooding conditions. (DEIR, p. 3.7-4) The DEIR, referencing this same source, then tells us to expect sea level rise on the California Coast by 2100 of 43-69 inches.[8] The NRC document itself then adds that its own estimate is similar to an Army Corp of Engineers estimate of 59 inches of sea level rise by 2100 for California.[9] So, a mean of approximately 5 feet of sea rise is being predicted by both the NRC and the Army Corp, two DEIR sources, (approximately) during the next 83 years of the current century.

If we add this 5-feet of sea level rise to the previous recalculated finding of a predicted 100 year 15-foot run-up at Ballona, we now have a run-up predicted solely by DEIR sources that will reach **20 feet** during the current century. This 20-feet prediction is subject to two further variations. First the 5-foot predicted increase will occur progressively throughout the century. On the other hand, 20 feet is a low estimate, because as the NRC study points out: ". . . the predicted heights are not maximum credible heights and do not presume coincidence of the highest tsunami wave with peak high tide *or with storm-induced high-water setup and superimposed storm waves*." (Italics ours)[10] In other words, since we have already added, as per the DEIR, 6 feet for a predicted high tide tsunami, we must now additionally consider that when the predicted 20 foot high tide run-up tsunami potential reaches Ballona during already pre-existing storm-induced high-water set-up and superimposed storm wave conditions, then these preexisting conditions will result in a **20+ feet** water level, where the height above 20 feet could amount to several feet depending on the storm-related sea conditions greeting its arrival.

DEIR Land Elevation Map

The added fact that there are significantly lower land elevation levels immediately surrounding the project area than is portrayed by DEIR maps makes this entire populated area much more vulnerable to catastrophic tsunami inundation than the DEIR claims. This is especially true throughout the entire populated areas including: 1) on and near the roadways immediately outside the Fiji Way and Culver Blvd. levees, 2) west of the "Coast-facing Levee System" and 3) along the two Ballona Creek levees and along the Fiji Ditch just to the east of Lincoln Blvd. The DEIR authors indicate little awareness of this risk not only because of their underestimates of tsunami waters that we have just considered, but also, in important part, because their risk assessment relies on two outdated, substantially inaccurate land elevation-based tsunami inundation maps (Exhibits 3 and 4).

By contrast, evidence from more recent U.S. Geological Survey based elevation readings, together with the above analysis of 20+ feet 100-year tsunami run-up risk, imply that a tsunami can be expected to cause deep flooding as follows: 1) along both the Fiji Way and the Culver Boulevard designated tsunami evacuation routes, 2) throughout nearby neighborhoods, 3) to the Playa del Rey neighborhood just west of the Coast-facing Levee System and finally 4) to the business/residential areas immediately adjacent to Ballona Creek and also to the business/residential areas just east of Lincoln Blvd.

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7 National Research Council (NRC), 2012. *Sea-Level Rise for the Coasts of California, Oregon, and Washington: Past, Present, and Future*. [http://www.nap.edu/catalog.php?record_id=13389] June 2012, p. 95

8 The DEIR posits a 59-inch sea-rise, an average between the high/low range predicted by the NRC.

9 NRC, Ibid.

10 NRC, Ibid., p. 399

immediately north of the Fiji Ditch. Furthermore, as we will see more fully in Part II, the proposed Main Levee System, functioning at points as an obstacle and/or a funnel, will even further significantly increase the destructive potential of the 100-year tsunami predicted for the Ballona project area.

The DEIR's first Ballona area map (DEIR, Ap., F7-112, also Exhibit 3), color codes land elevations in the project area on a scale ranging from 0 to >16-foot elevation. (DEIR F7-112, Figure 5) It inaccurately portrays almost the entire (maroon-colored) land area exterior to the proposed Main Levee System as standing at >16 feet. In fact, much of this area, and almost all of the land portrayed south of the Culver Blvd. levee, stands at less than 16 feet. This inaccurate map based on an outdated 1997 methodology[11] also shows that inundation of a 100-year tsunami (green line), on the Playa del Rey or southern side of Ballona creek, is expected to stop short of the Culver Blvd Levee, thus traveling no further inland than Vista del Mar, a street which is approximately parallel to and about 125-meters yards inland from the Pacific shoreline. On the Marina del Rey side, this map shows that a tsunami would reach some of the Marina channel-facing structures at the seaward most end of Fiji Way from the Breakwater Apartments landward past Fisherman's Village and also would reach a raft of boats at and near Dock 52 even though all of those areas are (inaccurately) colored maroon and thus allegedly lie above 16 feet.

There's a pervasive, fundamental flaw in this map and conclusions drawn from it, especially with respect to the flooding dangers south of Ballona Creek including along the Culver/Jefferson Boulevard designated tsunami evacuation route. Proof of this flaw comes from current elevation measurements taken by use of a software Google Application called "My Elevation". "My Elevation, Version 1.39" was developed for Google by RDH Software in 2014. For purposes of the present analysis, this application was installed in a Samsung 5S Smartphone which uses an Android operating system. On December 4, 2017, this elevation recording device was placed at various locations in and near the project area for the purpose of recording land elevations at those localities. Use of the application requires an internet connection since the application uses coordinates built into the software to determine precise latitude and longitude where the measurements are being recorded. United States elevation level readings in this application are based on data taken from the U.S. Geological Survey 3D Elevation Program. Elevation values are expressed as surface or ground level elevations above mean sea level. Each elevation reading taken was sent from the "My Elevation" application by email to one of the authors' email addresses, dr.delange@socal.rr.com. These emailed elevation readings, numbered 1-15, were then copied and pasted from west to east in sequence in Exhibit 5.

There are several pathways in Playa del Rey from the Pacific Ocean to Lincoln Boulevard that reach no higher than 16 feet elevation. The "My Elevation" readings numbered 1-15 were taken along one of these pathways. The 15 measurements begin on the Playa del Rey shore directly west of the southern end of the Del Rey Lagoon, then next on nearby Argonaut Street, then on the one block of Vista del Mar connecting Argonaut St. to Culver Blvd, next eastward on Culver Blvd until it connects with Jefferson Blvd and finally eastward on Jefferson ending in the #15 reading near Lincoln Blvd. These same 15 elevation readings from Exhibit 5 are also superimposed on the (inaccurate) color-coded DEIR-provided elevation Map referenced above as Exhibit 3, revealing the map's substantial inaccuracies. (Other maximum-16-foot available tsunami pathways exist, for example, running immediately to the north of Vista del Mar between Argonaut St. and Culver Blvd. before connecting

11 The methodology was published by Titov and Sinolakis in 1997 at: http://www.conservation.ca.gov/cgs/geologic_hazards/Tsunami/Inundation_Maps/Documents/AGU08_tsunami_poster.pdf (Inundation Map Methodology Poster)

eastward to Culver Blvd.)

The "My Elevation" findings provide clear proof that the DEIR's outdated elevation map (Exhibit 3) significantly over-states elevation levels along the only designated tsunami evacuation route south of Ballona Creek and north of the Playa del Rey bluffs.[12] The DEIR map shows alleged elevation levels along almost the entire designated Playa del Rey side tsunami evacuation route, which runs northeast along Culver Blvd, then onto Jefferson Blvd. as standing at >16 feet elevation (illustrated by the map's maroon color). However, as described just above, "My Elevation" readings show that there is an available tsunami pathway from the ocean to Lincoln Blvd. that never exceeds 16 feet elevation. Only an approximately 75 meters stretch of Culver Blvd, inland of the mapped Vista del Mar inundation line, measures between 12 and this maximal 16 feet, and the remainder of the tsunami evacuation route measures 7 feet elevation. Put another way, landward of the DEIR's acknowledged (green) inundation line, there is a path to the ocean which (briefly) reaches no higher than a maximum elevation of 16 feet before descending to and remaining at 7 feet all the way to Lincoln Blvd.

Putting all the numbers together, we conclude that, based on DEIR sources together with the U.S. Geological Survey based elevation readings just cited, a 100-year tsunami would not be obstructed by land elevations from deeply flooding the populated areas west of Vista del Mar between Ballona Creek and the Playa del Rey Bluffs as well as the Culver/Jefferson Boulevard tsunami evacuation route with a predicted 100-year run-up exceeding the highest correctly measured land level throughout that area by **at least 4 feet** ((20+)-16 feet). Where Culver and Jefferson Boulevards west of Lincoln are at 7 feet elevation—which they are over the vast majority of their extent—the predicted tsunami waters would be much deeper than the minimum of 4 feet shown by the immediately preceding analysis.

Ballona Tsunami Inundation Area Map

The second map presented in the DEIR (DEIR F7-110), unlike the map just considered, contains no elevation data, only an outline of where tsunami 100-year inundation is expected to occur. This map appears to set the inundation lines at the same place as the first map. The DEIR's use of this map and the map itself are also seriously flawed. To begin, the DEIR fails to disclose the "Method of Preparation" from the original source that was used in creating the map.[13] This "Method of Preparation," is the missing bottom part of the map as the map is presented in the DEIR. This "Method of Preparation", copied from the DEIR's just cited source, reveals three key oversights in the DEIR's use of the map, oversights which, once again, have the effect of diminishing tsunami risk. First, the "Method of Preparation" states: "The accuracy of the inundation line shown on these maps is subject to limitation in the accuracy and completeness of available terrain and tsunami source information, and the current understanding of tsunami generation and propagation phenomena as experienced in the models. Thus, although an attempt has been made to identify a credible upper bound to inundation at any location along the coastline, *it remains possible that actual inundation could be greater in a major tsunami event."* (Italics mine) A second problem with the map is that all of the reference sources used in constructing it come from the year 2004 and earlier thus making it outdated in that the tsunami "models" it refers to are neither the most recent nor the most relevant tsunami modeling available. To

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[12] Only approximately 60 meters of Culver Blvd. west of Lincoln Blvd elevates above 16 feet (to 18 feet). This stretch of Culver Blvd lies immediately inland of the ocean. But gravity would presumably first take a tsunami through a 16-foot maximum pathway from just south of the Del Rey Lagoon via Argonaut St. to Vista del Mar, disbursing from there, as sketched above, along various sub-16-foot pathways eastward to Lincoln Blvd.

[13] State of California. (2009). Tsunami Inundation Map for Emergency Planning, Venice Quadrangle, County of Los Angeles; produced by California Emergency Management Agency, California Geological Survey, and University of Southern California – Tsunami Research Center; dated March 1, 2009, mapped at 1:24,000 scale.

this point, as we saw above, the first tsunami model specifically designed for the west coast of the United States was created by Hayhoe et. al. (see footnote 7); yet all but one of the map's referenced sources are dated prior to 2004 and the remaining one from 2004 is not authored by Hayhoe et. al. Third, the source for this second map is the same as for the first map, which as we saw, is based on a methodology published in 1997. A map constructed from 20-year-old information does not include and could not have included the updated sea level rise predictions of 2012, which were considered above. (See footnote 6) Finally this second map fails to incorporate an analysis of possible preexisting storm induced high-water setup and superimposed storm waves that might be encountered by the arriving tsunami. For all these reasons this map significantly under-reports 100-year run-up tsunami risk for Ballona.

Still, despite these serious deficiencies and the resulting implicit underestimates of sea level rise and non-inclusion of storm-induced high-water setup and superimposed storm waves surge contributions to tsunamic risk, this second map portrays all of Marina del Rey, which is north of Ballona Creek, with its thousands of inhabitants, and its businesses, boaters, visitors and frequent traffic intensities along Admiralty Way and Lincoln Blvd., as being just a little underwater come the predicted 100-year tsunami. What the DEIR does not recognize, however, is just how far under water Fiji Way will be when this tsunami arrives at 20+ feet elevation. The U.S. Geological Survey ('My Elevation") places the terminus of Fiji Way at 15 feet. Just seaward of this terminus, the 240-unit Breakwater Apartments, contrary to the DEIR Map in Exhibit 3, sit on land a mere 12 feet above sea level. (Exhibit 5, #16-17)

As we will see in part II of this report, the presence of the proposed levee system will significantly worsen the destructive power of the predicted flooding. This is because, instead of being allowed to disburse from the Fiji Way area southward and from Culver Blvd northward across the Ballona wetlands, arriving tsunami flood waters will instead be forced by the presence of the Fiji Way levee, and the Culver Blvd. levees together with the Playa del Rey Bluffs, to gather in higher volumes than they otherwise would along these two tsunami evacuation routes and also across the inhabited areas north of the Fiji Way levee and south and west of the Culver Blvd. levee.

Potential Tsunami Impacts East of Lincoln Blvd.

Tidal waters from Marina del Rey's Basin H currently reach project areas east of Lincoln Blvd. via the Fiji Ditch. The Fiji Ditch passes via a culvert containing a catchment beneath Lincoln Blvd. The Fiji Ditch is an essentially unobstructed, very low elevation pathway for tsunami inundation of the residential/business area immediately east of Lincoln Blvd. Perhaps because the DEIR authors believed that a considerably lower than 20+ foot 100-year tsunami would hit the Ballona Valley, they did not mention, much less analyze, any flooding possibilities to this neighborhood. However, immediately east of Lincoln, all along the Fiji Ditch's north side before it turns more southward, the business/residential area sits unprotected from the Fiji Ditch at 12 feet elevation (See Exhibit 5, #18-19 for sample elevation readings.) The presence of a berm south of the Fiji Ditch would only further force any flood waters northward toward this populated area by preventing these waters from disbursing to the south.

Historic Flood Photo South of Ballona Creek

The large majority of the project area south of Ballona Creek and along Culver and Jefferson Blvds. we have seen, consists of a flood plain. The majority of this plain is at a continuous 7 feet elevation. Once tsunami waters have cleared the tsunami pathway's highest elevation point between the sea and Lincoln Blvd at 16 feet, tsunami waters would descend inland into this flood plain. That the drainage of this plain is very poor can be seen from the attached before and after photos of a 1956 flooding of Culver Blvd. (Exhibit 6) One of the structures depicted in the photo still stands at 335 Culver Blvd in Playa del

Rey. This location is approximately 100 meters inland from the inaccurately drawn inundation line at Vista del Mar as portrayed in the two DEIR cited maps above. "My Elevation" places these flooded structures at 10-foot elevation. ("My Elevation", RDH Software, Google, Inc., 2014) All of the continuous 7-foot elevations along Culver Blvd. discussed above lie even further inland from these flooded structures. Clearly, this documented vulnerability to flooding along this designated and only tsunami evacuation route for this area illustrates the destructive potential of the 20+ foot tsunami inundation predicted over the next 100 years. But this added tsunami risk as illustrated in the photos has neither been analyzed, much less disclosed, in the DEIR.

DEIR Maps' Inundation Line Reconsidered

The two DEIR tsunami-related maps, as we noted above, place the Playa del Rey inundation line (green line, Exhibits 3 and 4) along Vista del Mar, near the Pacific Ocean. When we outlined the lowest available tsunami pathway across Culver Blvd to Lincoln Blvd, we found that the highest elevation (at 16 feet) through which tsunami waters would have to pass on their way to Lincoln Blvd occurred at the junction of Vista del Mar with Culver Blvd. But this implies that this small stretch of the DEIR sources' inundation line through which tsunami waters would pass lies at 16 feet. Reconsidered in this different way, we can see clearly once again that, based on the DEIR sources' maps, the predicted 20+ foot 100-year tsunami waters will have a clear path eastward as elevations immediately east of Vista del Mar descend rapidly to a continuous 7 feet all the way to Lincoln Blvd.

Summary

Because the DEIR, as we have just seen, used inaccurate ground elevation maps that placed almost all of the project area exterior to the Fiji Way and Culver Blvd levees at >16 feet, and at the same time used outdated, understated tsunami run-up elevations (alleging a maximum of a mere11-foot 100 year run up at high tide, Ziony, 1985), the DEIR had no basis for studying the impacts related to the Main Levee System of the predicted 100-year tsunami as recalculated herein at 20+ feet. This is because the DEIR incorrectly predicts an inundation that stops about 125 meters inland in Playa del Rey at Vista del Mar and just barely onshore along Fiji Way, all of this well short of the Culver Blvd. and Fiji Way levees. Our recalculated findings, however, showing the predictable occurrence of 100-year run-up tsunami waters at 20+ feet across land no higher than 16 feet means that such tsunami waters would have a clear path to not only what we labeled the populated Coast-facing Levee System but thereafter further inland along the populated and sometimes heavily trafficked Culver Blvd. and Fiji Way levees. We turn in the second part of the present report to a deeper analysis of what happens when this now more accurately analyzed tsunami hits Ballona.

Part II

The following bullet points give the specific supporting facts used to further analyze the impact of a future tsunami on Ballona given construction of the proposed project. We then offer our summary statement.

- One of the most prominent structural components of the proposed project (Alternatives 1&2) consist of a main levee system (Exhibit 1). The proposed levee system is designed to protect the low-lying areas and other structures (e.g., roads) from potential flooding of the Ballona Creek (e.g., DEIR pages 3.9-67, 3.9-76, 3.9-77). To provide this protection, the levees are being designed at significant heights.
- Under Alternatives 1 & 2, Culver Blvd will be protected by two levees, stretching along its north side and its south side., two more levees running along Ballona Creek, and a levee running along

Fiji Way and Area A ("Main Levee System")

- The Playa Del Rey bluffs, stretching across the entire south side of the proposed project area are over 150 feet high.
- The Los Angeles County Office of Emergency Management has designated Culver Blvd as the only tsunami evacuation route out of the Playa del Rey side of the Ballona area. See below for a map of the county designated tsunami evacuation routes in the Marina del Rey and Playa del Rey areas (Exhibit 7). Populated Culver Blvd. is the most southern route between the Ballona Creek and the Playa del Rey bluffs. Besides, populated Fiji Way, alongside the northernmost levee is especially vulnerable to tsunami flooding (DEIR Map in Exhibit 3 and Exhibit 8)
- Studies show that "… a simulation of inundation and run-up remains challenging, especially in the case of urban areas. These aspects of local tsunami behavior not only are sensitive to high-resolution bathymetric and topographic data, wave breaking, diffraction, and the other hydrodynamic effects, but also relate to the locations of buildings, streets, and other elements of urban infrastructure" (e.g., Karlsson et al., 2009).[14] Other studies show that tsunami damages depend on its run-up height, which in turn depends on complex water diffractions. Built structures have been implicated for increased tsunami hazards in recent tsunamis[15]. Moreover, wave propagation distance depends on the shapes of structures, rivers, channels, roads, etc. For Tohoku tsunami, the water damage was experienced about a kilometer inland. Had it been the same magnitude earthquake near field, the water would have moved eastbound along Culver Blvd and Jefferson Blvd. Also, it is important to note that during the Tohoku tsunami, the water moved inland about 5 kilometers in some areas, especially where channels, rivers or creeks were present.

- The 2004 Indian Ocean earthquake and tsunami generated waves of 15 to 30 meters (50 to 100 ft.) with maximum run-up of 51 m (167.3 ft.) at shoreline, and in many places the waves reached as far as 2 km (1.2 mi) inland (source: visited on 12/1/2017). This tsunami demonstrates what happens when an incoming tsunami wave encounters obstacles and is forced to a much higher elevation.

Analysis

There is a clear and significant tsunami hazard (loss of life and property damage) associated with the proposed project due to the positioning of the proposed levees. Especially in a strong near field earthquake, the tsunami waves of massive force would move from west to east entering into the opening between the Playa Del Rey bluffs and the proposed levees. The bluffs and the West Area B levee (south of Culver Blvd.) will act as a funnel/channel, forcing the water into the Culver Blvd corridor, possibly reaching Lincoln Blvd and beyond. We may also experience a situation where the tsunami waves enter the main Marina channel and Ballona Creek. And as the waters move eastbound, they will break into two distinct flows where the Area A (northside of Ballona Creek) and Fiji Way levees join together. One flow enters Ballona Creek, and the other moves onto the Marvin Braude Bike

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[14] Karlsson, J. M., A. Skelton, M. Sanden, M. Ioualalen, N. Kaewbanjak, N. Pophet, J. Asavanant, and A. von Matern (2009), Reconstructions of the coastal impact of the 2004 Indian Ocean tsunami in the Khao Lak area, Thailand, Journal of Geophysical Research, 114, C10023, doi:10.1029/2009JC005516.

[15] Wilson, R.I., Admire, A.R., Borrero, J.C., Dengler, L.A., Legg, M.R., Lynett, P., McCrink, T.P., Miller, K.M., Ritchie, A., Sterling, K., Whitmore, P.M. (2013). Observations and Impacts from the 2010 Chilean and 2011 Japanese Tsunamis in California (USA). Pure and Applied Geophysics, Volume 170, Issue 6–8, pp 1127–1147.

Path, then encounters the Breakwater at Marina del Rey Apartments and thereafter Fiji Way. The following map (Exhibit 8) is designed to show the major flows of tsunami waves into these areas and their direction based on the current DEIR Alternative 1 and 2 designs. The background black lines are given by the current DEIR (Alternative 1, Phase 2: Preliminary Grading Plan, page 2-33). The large hollow red arrows are designed by the authors of this document to indicate the direction of large tsunami waves. The solid red arrows are the effects of water channeling into the tsunami evacuation route and Fiji Way. The solid red lines are dangerous water flows primarily due to the location, positioning, angle, and height of the proposed levees.

Summary

The 20-foot-high Culver Blvd and Fiji Way levees are proposed to replace the existing levees so as to contain increased future downstream flooding from Ballona Creek that the DEIR states will result in part from expected sea rise. Yet, during the predicted 100-year tsunami run-up, these same proposed levees would significantly increase flooding levels along Culver Blvd and Fiji Way, the only evacuation routes available to some inhabitants, and also increase flooding throughout surrounding neighborhoods. If these levees were designed substantially lower, the rising water in Ballona Creek from inland storms would, in the view of the DEIR, flood Fiji Way and Culver Blvd. If the levees are designed high as proposed, the levees will act as walls along Culver Blvd and Fiji Way, channeling and guiding the tsunami waves into the Culver Blvd and Fiji Way levees instead of allowing these flood waters to disburse across the part of the Ballona Wetlands enclosed by the Culver Blvd and Fiji Way levees. There's an added danger along Culver Blvd. caused by the presence of the Playa del Rey Bluffs and the South Area B/East Area B levee which, together with the Culver Blvd levee will cause a funneling and thus rising and rushing of water through the bottleneck created by their conjoint presence. The presence of the project next to the Fiji Ditch, which is completely open to the ocean waters via the Marina del Rey boat basin to the north of the Dock 52 parking lot, brings with it yet one more increased flooding risk. None of these impacts have been analyzed or even recognized by the DEIR. This is due in important part to the fact that, as we saw in Part I, the DEIR seriously understated the height of the predicted 100-year tsunami flood waters and also significantly overstated the height of existing land elevations throughout the project area. Clearly, Project Alternatives 1 and 2 would significantly increase the risk of death and destruction throughout the western end of the Ballona Valley.

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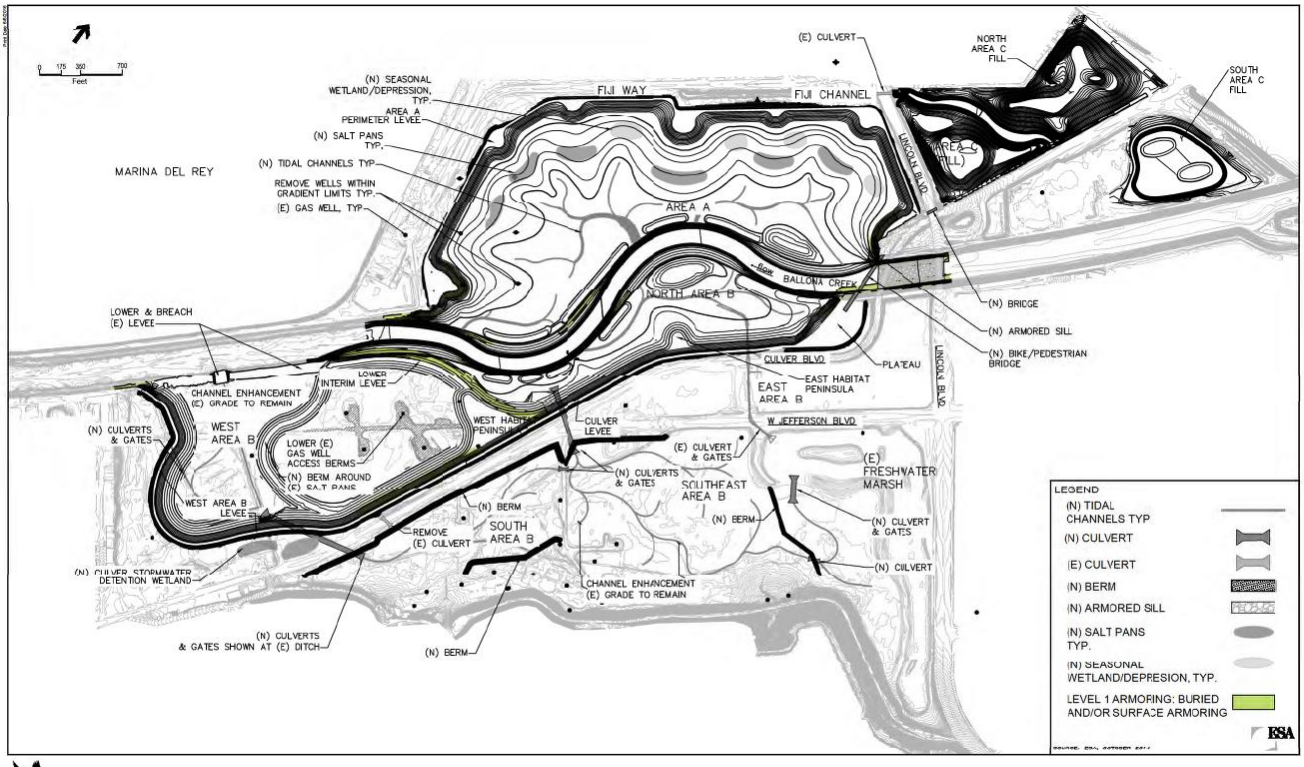
About the Authors

Mansour Rahimi, has a PhD in Industrial and Systems Engineering from Virginia Polytechnic and State University (Virginia Tech). Over the past 30 years, he has performed a wide variety of research in health, safety and environmental aspects of industries and technologies. He has also performed research for the National Science Foundation on earthquake safety and human behavior. He is a professor at the University of Southern California's Epstein Department of Industrial and Systems Engineering in Los Angeles.

David DeLange has an M.A. from the University of Chicago and a PhD in Analytic Philosophy from Brown University, where he specialized in conceptual analysis and research. He is the former President and Executive Director of the Coalition to Save the Marina. He has regularly, for the past 20 years, provided research based expert analysis and commentary on the environmental and human impacts of various development proposals in California's Coastal Zone.

Exhibit 1



Ballona Wetlands Restoration Project

FIGURE 2-2
ALTERNATIVE 1, PHASE 2: PRELIMINARY GRADING PLAN

2-33

Exhibit 2

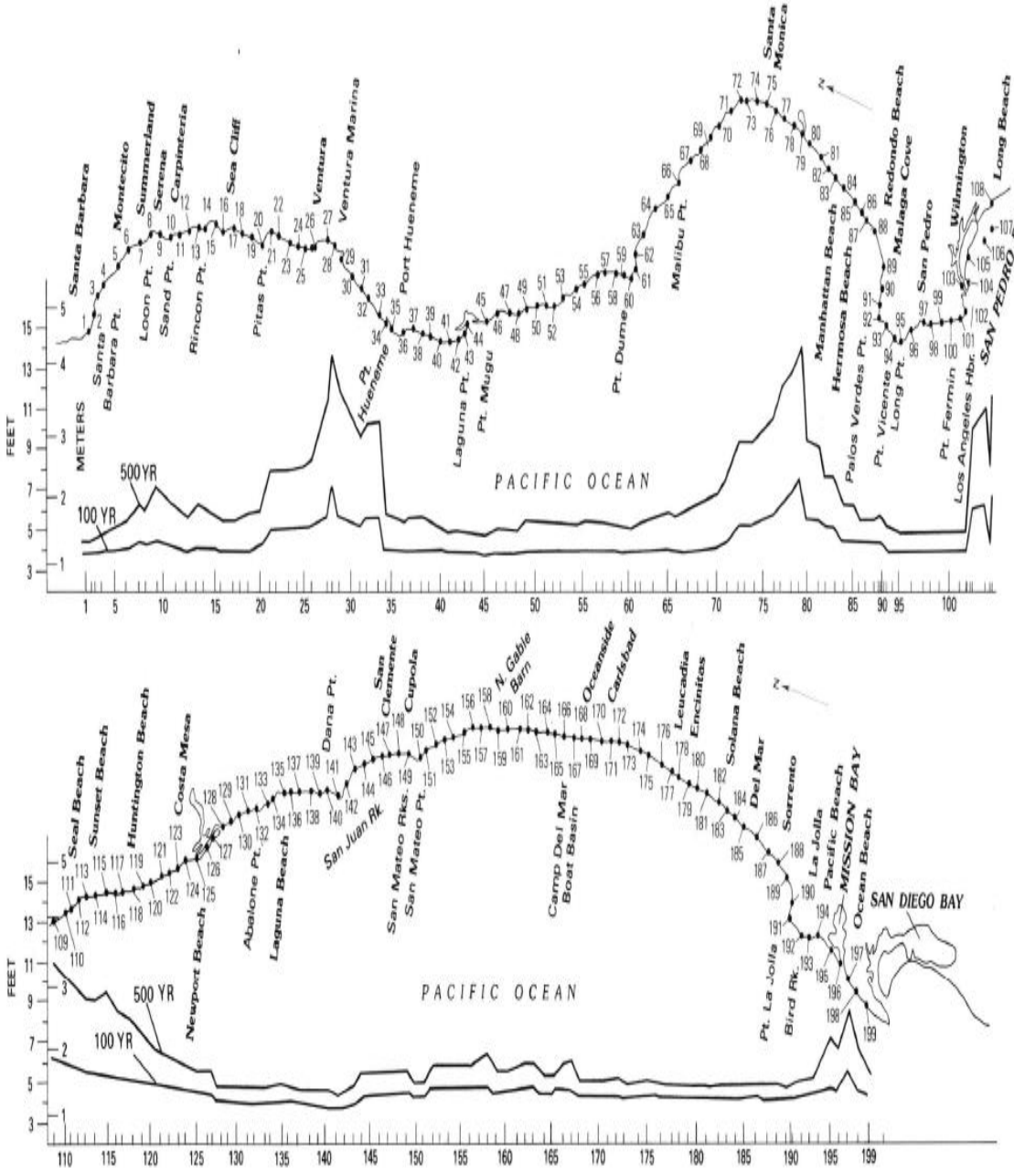
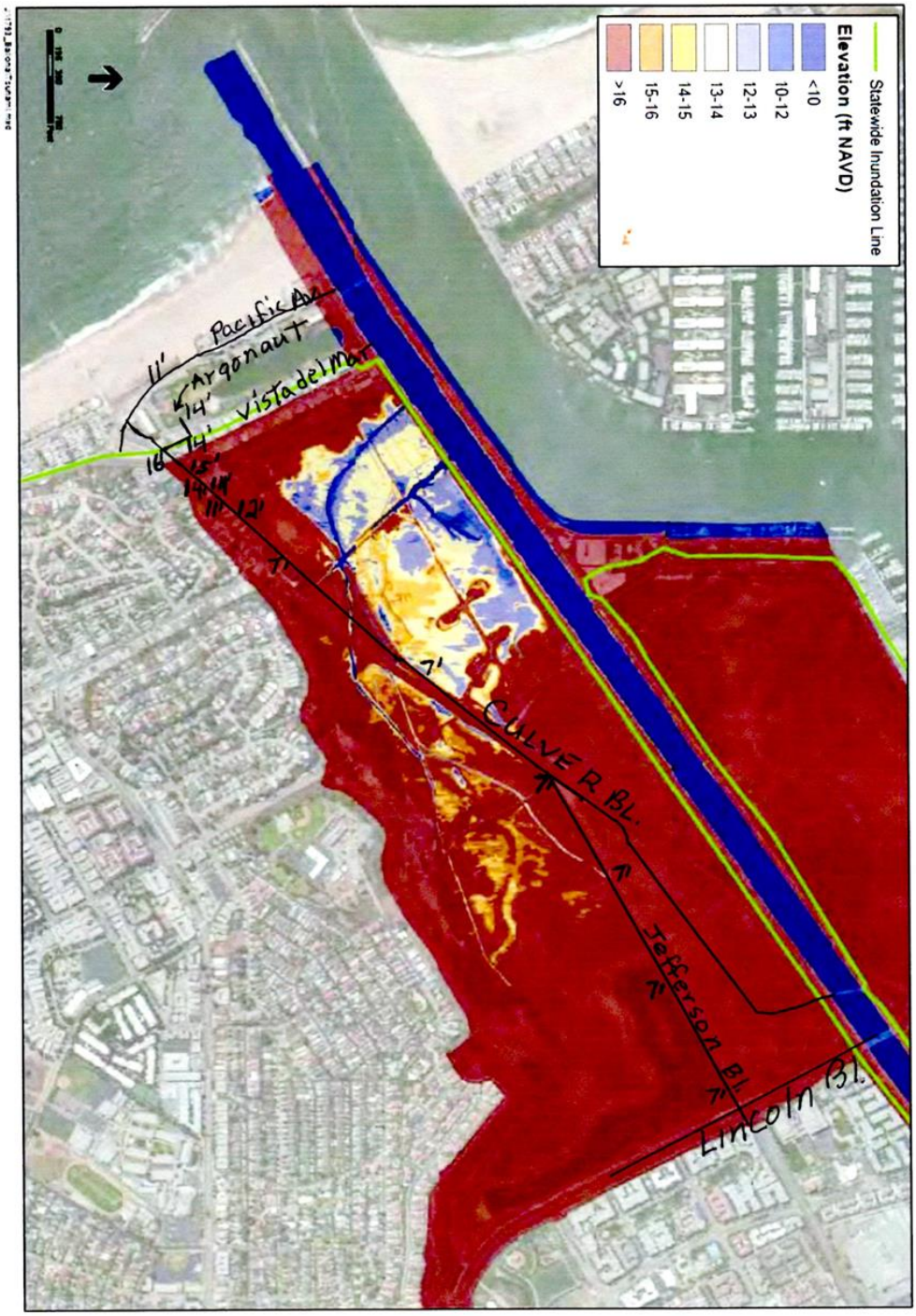


FIGURE 208.—Heights of the 100- and 500-yr tsunamis along the southern California coast (Santa Barbara to San Diego) as predicted by numerically modeled tsunamis. Modified from Houston (1980). Wave heights given for each numbered coastal location are the values predicted as the wave crosses the shoreline and include the effects of astronomical tides. Runup elevations may be higher where waves encounter steep topography at or near the shoreline or lower where waves flood low-lying or estuarine areas.

Exhibit 3



SOURCE: State of California (2009).

Ballona Wetlands . D120367

Figure 5

State Tsunami Inundation Line at Ballona

FHWA

F7-112

Exhibit 4

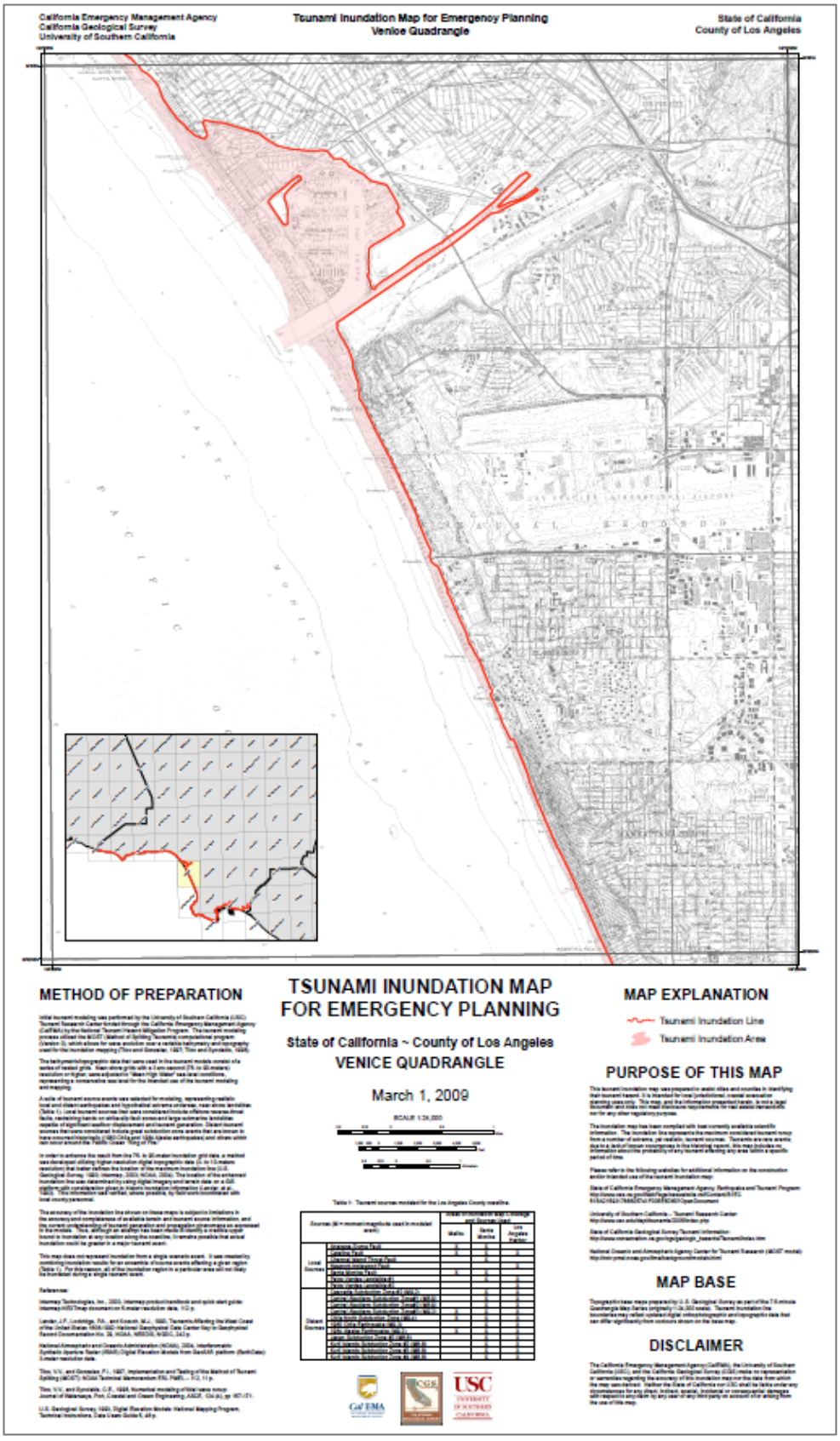

California Emergency Management Agency
California Geological Survey
University of Southern California
Tsunami Inundation Map for Emergency Planning
Venice Quadrangle
State of California
County of Los Angeles
METHOD OF PREPARATION
TSUNAMI INUNDATION MAP
FOR EMERGENCY PLANNING
State of California ~ County of Los Angeles
VENICE QUADRANGLE
March 1, 2009
MAP EXPLANATION
Tsunami Inundation Line
Tsunami Inundation Area
PURPOSE OF THIS MAP
MAP BASE
DISCLAIMER

Exhibit 5

Results Below Created by using "My Elevation" based on data from the U.S. Geological Survey 3D Elevation Program.
http://goo.gl/ntnR9r

Culver Blvd. Area

1) Look Where I Am!. I am at Elevation: 11 ft. and located at Lat:33.95816 Lng:-118.45073
See it In Google Maps
http://maps.google.com/maps?z=18&t=m&q=loc:33.95816,-118.45073

2) Look Where I Am!. I am at Elevation: 14 ft. and located at Lat:33.95843 Lng:-118.45019
See it In Google Maps
http://maps.google.com/maps?z=18&t=m&q=loc:33.95843,-118.45019

3) Look Where I Am!. I am at Elevation: 14 ft. and located at Lat:33.95925 Lng:-118.44868
See it In Google Maps
http://maps.google.com/maps?z=18&t=m&q=loc:33.95925,-118.44868

4) Look Where I Am!. I am at Elevation: 16 ft. and located at Lat:33.95899 Lng:-118.44857
See it In Google Maps
http://maps.google.com/maps?z=18&t=m&q=loc:33.95899,-118.44857

5) Look Where I Am!. I am at Elevation: 15 ft. and located at Lat:33.95900 Lng:-118.44849
See it In Google Maps
http://maps.google.com/maps?z=18&t=m&q=loc:33.95900,-118.44849

6) Look Where I Am!. I am at Elevation: 14 ft. and located at Lat:33.95910 Lng:-118.44856
See it In Google Maps
http://maps.google.com/maps?z=18&t=m&q=loc:33.95910,-118.44856

7) Look Where I Am!. I am at Elevation: 14 ft. and located at Lat:33.95910 Lng:-118.44856
See it In Google Maps
http://maps.google.com/maps?z=18&t=m&q=loc:33.95910,-118.44856

8) Look Where I Am!. I am at Elevation: 11 ft. and located at Lat:33.96049 Lng:-118.44659
See it In Google Maps
http://maps.google.com/maps?z=15&t=m&q=loc:33.96049,-118.44659

9) Look Where I Am!. I am at Elevation: 12 ft. and located at Lat:33.96088 Lng:-118.44608
See it In Google Maps
http://maps.google.com/maps?z=15&t=m&q=loc:33.96088,-118.44608

10) Look Where I Am!. I am at Elevation: 7 ft. and located at Lat:33.96343 Lng:-118.44337
See it In Google Maps
http://maps.google.com/maps?z=15&t=m&q=loc:33.96343,-118.44337

11) Look Where I Am!. I am at Elevation: 7 ft. and located at Lat:33.96584 Lng:-118.44134
See it In Google Maps
http://maps.google.com/maps?z=15&t=m&q=loc:33.96584,-118.44134
12) Look Where I Am!. I am at Elevation: 7 ft. and located at Lat:33.96807 Lng:-118.43862
See it In Google Maps
http://maps.google.com/maps?z=15&t=m&q=loc:33.96807,-118.43862

13) Look Where I Am!. I am at Elevation: 7 ft. and located at Lat:33.96894 Lng:-118.43681
See it In Google Maps
http://maps.google.com/maps?z=15&t=m&q=loc:33.96894,-118.43681

14) Look Where I Am!. I am at Elevation: 7 ft. and located at Lat:33.97068 Lng:-118.43309
See it In Google Maps
http://maps.google.com/maps?z=15&t=m&q=loc:33.97068,-118.43309

15) Look Where I Am!. I am at Elevation: 7 ft. and located at Lat:33.97186 Lng:-118.4307
See it In Google Maps
http://maps.google.com/maps?z=15&t=m&q=loc:33.97186,-118.43073

Fiji Way Area

16) Marvin Braude Bike Path, Marina Del Rey, CA 90292, USA, Marina del Rey, United States
It is at Elevation = 15 feet and located at Lat:33.96891 Lng:-118.44564
http://maps.google.com/maps?z=17&t=m&q=loc:33.96891,-118.44564

17) 13906 Fiji Way, Marina Del Rey, CA 90292, USA, Marina del Rey, United States
It is at Elevation = 12 feet and located at Lat:33.96876 Lng:-118.44602
http://maps.google.com/maps?z=17&t=m&q=loc:33.96876,-118.44602

Fiji Ditch Area

18) It is at Elevation = 12 ft. and located at Lat:33.97824 Lng:-118.43548
See it In Google Maps
http://maps.google.com/maps?z=18&t=m&q=loc:33.97824,-118.43548

19) 13234 Fiji Way, Marina Del Rey, CA 90292, USA, Marina del Rey, United States
It is at Elevation = 12 ft. and located at Lat:33.97893 Lng:-118.43387
See it In Google Maps
http://maps.google.com/maps?z=17&t=m&q=loc:33.97893,-118.43387

Exhibit 6

Before November 1956 Flood

After November 1956 Flood

Exhibit 7

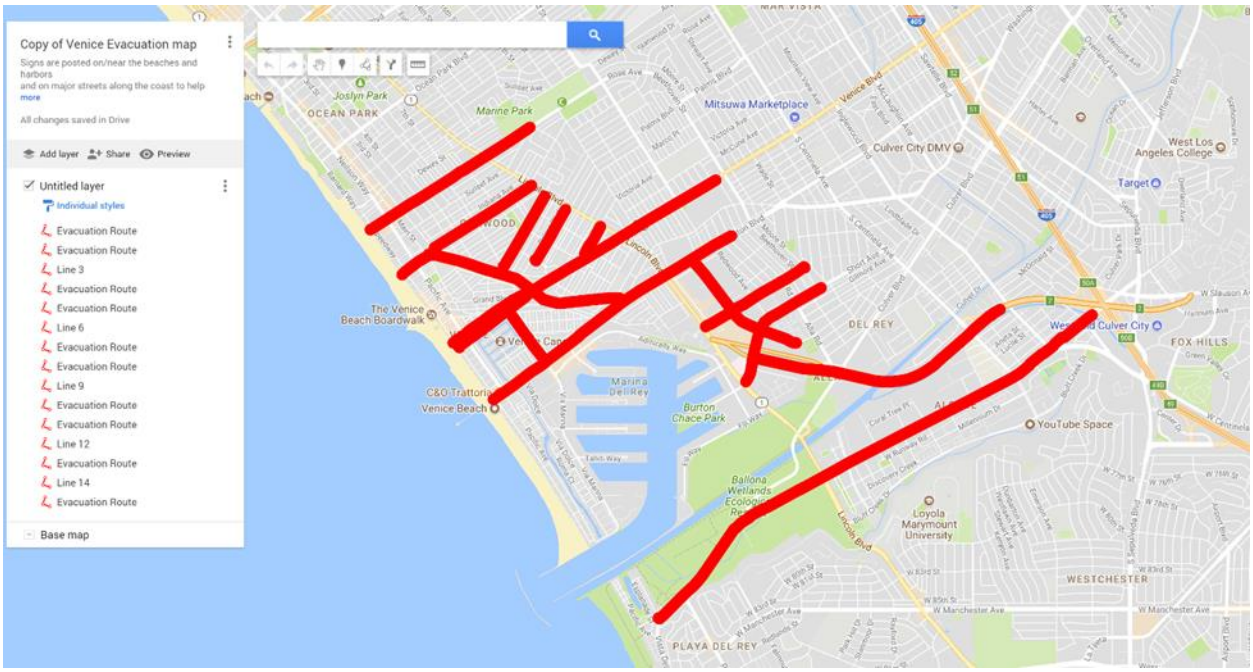


Exhibit 8

West to East Tsunami Pathways When Forced by Project Levees to Circumvent Them