DOCKETED

Docket Number:	15-AFC-01
Project Title:	Puente Power Project
TN #:	220221
Document Title:	Closing Testimony of David Revell Phd on Proposed Puente Site
Description:	N/A
Filer:	PATRICIA LARKIN
Organization:	SHUTE, MIHALY & WEINBERGER LLP
Submitter Role:	Intervenor Representative
Submission Date:	7/14/2017 5:08:54 PM
Docketed Date:	7/17/2017

REVELL COASTAL
Surf. Sand. Sustainability.

568 Bethany Curve
Santa Cruz, CA 95060
Phone: 831-854-7873
Email: revellcoastal@gmail.com
Website: *www.revellcoastal.com*

MEMORANDUM

Date: July 14, 2017

To: City of Oxnard

From: David Revell, PhD

Subject: Closing Testimony on Proposed Puente Site

Executive Summary

- Presently, the proposed site has an elevation of around 14 feet at least 6 feet below calculated maximum wave run up elevations and is protected by a sand dune of uncertain stability. Dune erosion extents are not explictly mapped in 2 of the 3 available models (FEMA, COSMOS). The one model (Coastal Resilience) in which dune erosion extents are mapped is not considered in the Supplemental FSA.

- While COSMOS 3.0 validation seems reasonable for measurements of relevant physical forcing parameters (tides and waves),. COSMOS 3.0 maps dynamic wave set up and not the FEMA coastal flood standard of maximum wave run up or total water level used by FEMA and Coastal Resilience.

- Substantial differences in the mapping of flood hazard extents exist between the various models and observed flooding during large wave events.

- Coastal Resilience modeling of existing conditions does the best job of replicating observed flooding from major storm wave events, followed by FEMA, then COSMOS for multiple locations near the proposed site where storm photos are available.

- The CEC's application of the Technical Methods Manual for escalating existing FEMA flood hazards relies on Mean High Water shoreline which does not provide information on the storm or long term erosion of the dunes fronting the site.

- Before allowing a project of this scale to move, the CEC should not rely on a planning scale model without conducting substantial senstivity and frequency analysis and verification of all of the model results. Such analyses should be conducted and funded by the Applicant as opposed to this continued reliance on State and City resources to address the impacts of a private energy company's project.

Revell Coastal
Surf. Sand. Sustainability.

568 Bethany Curve
Santa Cruz, CA 95060
Phone: 831-854-7873
Email: revellcoastal@gmail.com
Website: *www.revellcoastal.com*

Introduction

This closing testimony responds to the Supplemental testimony from the CEC and takes into account information presented at the March 28, 2017 workshop, final COSMOS results recently made available, and the Testimony of Mr. Philip Mineart.

Coastal processes are very complicated and dynamic, and since every wave breaks differently, all modeling of coastal hazards requires simplifying assumptions and equations to provide best estimates. Projecting hazards into the future becomes even more difficult as the complexities of both the physical processes and uncertainties with the magnitude and rates of climate change-induced impacts shifts in new ways. All of the models and modelers—USGS, FEMA, and TNC—have broken new ground and applied unique approaches based on the modeling teams expertise and professional and scientific experience. There is no one right answer. We all must continue to push and encourage each other to refine methods and deliverables to support these planning and management decisions.

> *Everyone therefore who hears these words of mine, and does them, I will liken him to a wise man, who built his house on a rock. The rain came down, the floods came, and the winds blew, and beat on that house; and it didn't fall, for it was founded on the rock. Everyone who hears these words of mine, and doesn't do them will be like a foolish man, who built his house on the sand. The rain came down, the floods came, and the winds blew, and beat on that house; and it fell—and great was its fall.*
>
> *—The Bible - Matthew 7:24–27*

COSMOS 3.0 Validation of Input Parameters

After review of the Barnard et al presentation at the March 28 workshop, and some of the supporting scientific literature referenced there in, it is clear that a tremendous amount of work has gone into the COSMOS modeling by the entire USGS team. The scientific literature shows strong validation with available measured data sets and it is my opinion that this effort represents the state of the art application of Global Climate Model downscaling, and nested Tier 1 and 2 modeling to bring the Global Climate Model into nearshore conditions.

However, as discussed in detail below, my review of the COSMOS projected flood hazards reveals that the COSMOS model understates actual flood extents when it translates its reasonably-validated physical forcing parameters (waves and tides) into the actual mapping of hazard zones. Some of these discrepancies may be a result of the use of the dynamic wave set up water levels rather than total water level (tides + wave runup+dynamic wave run up) to predict flood hazards. Figure 1 is a conceptual definition figure showing the differences between water levels that result from using dynamic wave set up versus maximum wave run up or total water level. The use of a single topographic data set, which would reflect impacts based on only on one set of data at one particular time, may also understate hazards. However, the source of the apparent understatement of hazards remains unclear.

Revell Coastal
Surf. Sand. Sustainability.

568 Bethany Curve
Santa Cruz, CA 95060
Phone: 831-854-7873
Email: revellcoastal@gmail.com
Website: *www.revellcoastal.com*

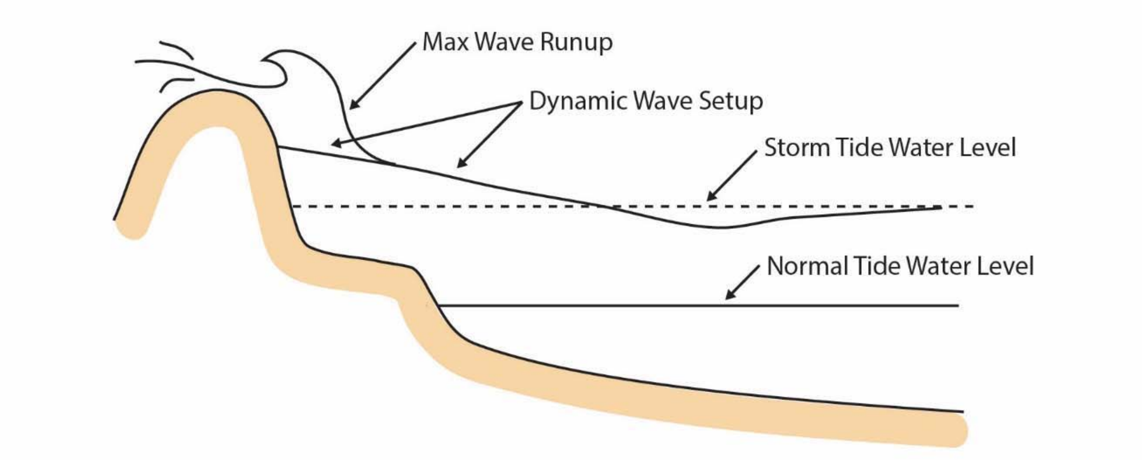

Figure 1. Water level differences between dynamic wave set-up and maximum wave run-up.

This is not the forum to discover the reasons for the mapping underestimates which will require additional work and collaboration to discover. Perhaps once the final COSMOS data sets that include maximum wave run-up extents and the full profile representation of long term erosion (e.g. projections of future dune crest locations) become available, further evaluation of these underestimated hazards will be possible. Hopefully the state and perhaps the applicant will continue to fund this and other necessary investigations to provide better information in the future. However as the CEC has chosen COSMOS as the model to rely on informing this decision, I will highlight some current deficiencies in the hazard mapping that calls into question CEC's staff decision to rely solely on COSMOS. This assessment is offered as a peer review of some of the COSMOS results with the ultimate goal of improving modeling in support of coastal management and the scientific community of practice.

Site specific application

Dr. Barnard and the COSMOS FAQ's have stated that this model was not designed for site specific engineering analysis, but rather to support regional and local planning efforts. The same is true for the Coastal Resilience modeling which was funded by the Nature Conservancy, County of Ventura, and State of California. Although they approach the issues differently, both models consider sea level rise, and the impacts of large storm events. The City of Oxnard, like most jurisdictions in Ventura County, relies on Coastal Resilience to make planning level decisions about coastal hazards and coastal resiliency planning.

Given that this is a site specific decision by the CEC, this would imply that the applicant would conduct or fund such site specific modeling following the federal coastal hazard methods from FEMA. However this has not been done, leaving this daunting task to CEC staff. In the absence of such site specific modeling, prudence suggests that any model used should be thoroughly interpreted and model results verified to provide the most robust assessment of coastal flood hazards at the proposed site. This has not been done adequately in my opinion. Rather the FSA and Supplemental FSA has largely relied on one model (COSMOS) that supports the project by showing no risk at the site, while dismissing another model (Coastal Resilience) as being a "worst case overly conservative scenario."

Revell Coastal
Surf. Sand. Sustainability.

568 Bethany Curve
Santa Cruz, CA 95060
Phone: 831-854-7873
Email: revellcoastal@gmail.com
Website: *www.revellcoastal.com*

Interpretation of Model Outputs

There are several methods to assess the accuracy of coastal hazard model outputs. Ideally, one would collect pre- and post-storm data and validate the model outputs by measuring how well the model does in recreating those data. In coastal process science, instrumentation that measures storm intensity, as well as pre- and post-storm geomorphic measurements are the best way to validate a model. However these data are difficult to obtain for individual storms. In some instances data collection captures the beginning and end of a single storm season (e.g. Fall 1997 and Spring 1998 bracketing the 1997- 98 El Niño) providing glimpses into seasonal cycles and sequences of storm impacts. New technologies, such as LIDAR, drone-collected aerial photography, and structure from motion imagery, are making it more feasible to do single storm evaluations, but it remains very difficult to obtain such geomorphic response data for single large historic storm events (e.g. 1/27/83, 1/18/1988, 2/1998, 12/11/2015, etc).

In the absence of site-specific geomorphic data documenting before and after storm conditions, it is possible to assess the relative accuracy of coastal hazard models outputs with two simple questions:

1. Does the beach get wet during an extreme wave event?
2. How well do the coastal hazard maps replicate ground photos and videos taken during large events?

Answers to both questions should be YES before confidence in the model can be gained.

Model comparisons versus observations

"If a model can accurately hindcast, we can have some confidence in its forecasts of the future."
- Supplemental FSA

To support the CEC deliberations, these two simple methods/questions have been evaluated to each of the potential models performance for the existing conditions hazards associated with a 100 year event. For this comparison three sites were selected that have experienced notable flooding and or erosion in the near vicinity of this site and that have good ground photos and videos available during the storm event.[1] These three sites, from south to north, are: Oxnard Shores just south of the proposed site; Pierpont just north of the site; and Goleta Beach, a well studied erosion hotspot to the northwest of the site within the same littoral cell. Notably, none of the historic storm events depicted below is considered a 100 year event.

The following figures are organized as follows: COSMOS-mapped flood extents (Figures A), FEMA-mapped flood extents (Figures B), and Coastal Resilience-mapped flood events (Figures C). Following these figures are ground photos taken during or shortly after a major coastal wave event (Figures D-F). The model outputs are direct screen grabs taken from the webviewer tools available for COSMOS (Our Coast Our Future), Coastal

[1] Without direct measurements, historic ground photos and videos often provide the only reliable "observations" of these coastal evolving events. Photos and videos can also be difficult to find, coming from newspapers, residents, passing tourists, and not centralized or archived in any single location. More recently, the internet and youtube have provided more access to photo data, which can be used to provide a snapshot of the ability of a model to predict actual events.

568 Bethany Curve
Santa Cruz, CA 95060
Phone: 831-854-7873
Email: revellcoastal@gmail.com
Website: *www.revellcoastal.com*

Resilience (maps.coastalresilience.org), or excerpt from the Preliminary Flood Insurance Rate Maps prepared by the Region 9 FEMA contractor AECOM/Michael Baker and currently under review by the County of Ventura.

All sites and model outputs represent a 100 year coastal flood hazard with NO sea level rise.
Red arrows indicate approximate location (dot) and and orientation of photo.

REVELL COASTAL
Surf. Sand. Sustainability.

568 Bethany Curve
Santa Cruz, CA 95060
Phone: 831-854-7873
Email: revellcoastal@gmail.com
Website: *www.revellcoastal.com*

Site 1: Oxnard Shores

Oxnard Shores is located about ½ mile south of the proposed Puente site.

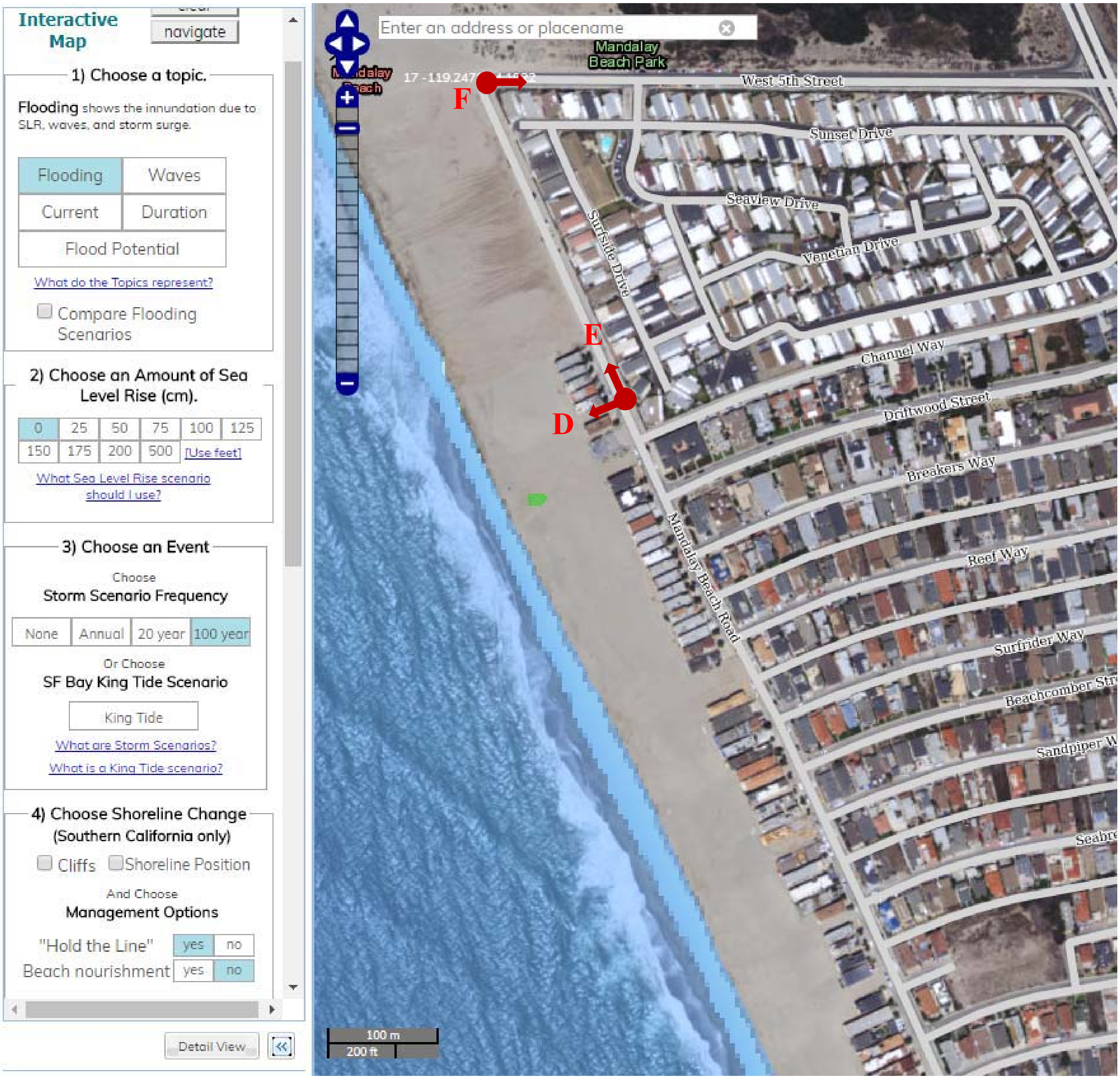

Figure 2A. COSMOS 3.0 Modeling at Oxnard Shores 100 year event, No sea level rise. Flooded area shown in light blue. Red arrows indicate approximate location (dot) and and orientation of photo. Letters correspond to the ground photo figures for the site (Figures 2D, 2E, 2F).

568 Bethany Curve
Santa Cruz, CA 95060
Phone: 831-854-7873
Email: revellcoastal@gmail.com
Website: *www.revellcoastal.com*

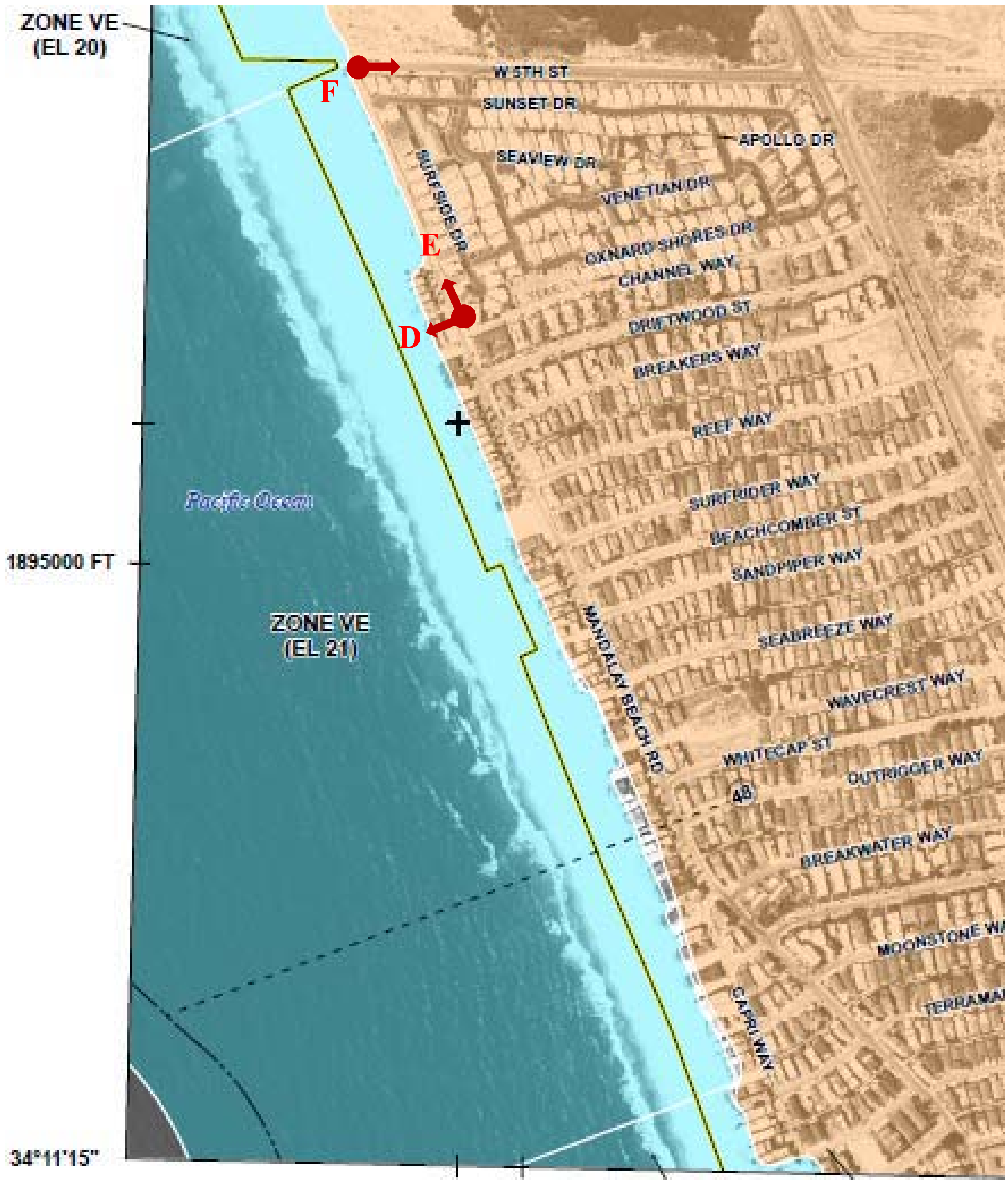

Figure 2B. FEMA Preliminary FIRM map at Oxnard Shores 100 year event, No sea level rise. Extent of flooded area shown in lighter blue. Red arrows indicate approximate location (dot) and and orientation of photo. Letters correspond to the ground photo figures for the site.

568 Bethany Curve
Santa Cruz, CA 95060
Phone: 831-854-7873
Email: revellcoastal@gmail.com
Website: www.revellcoastal.com

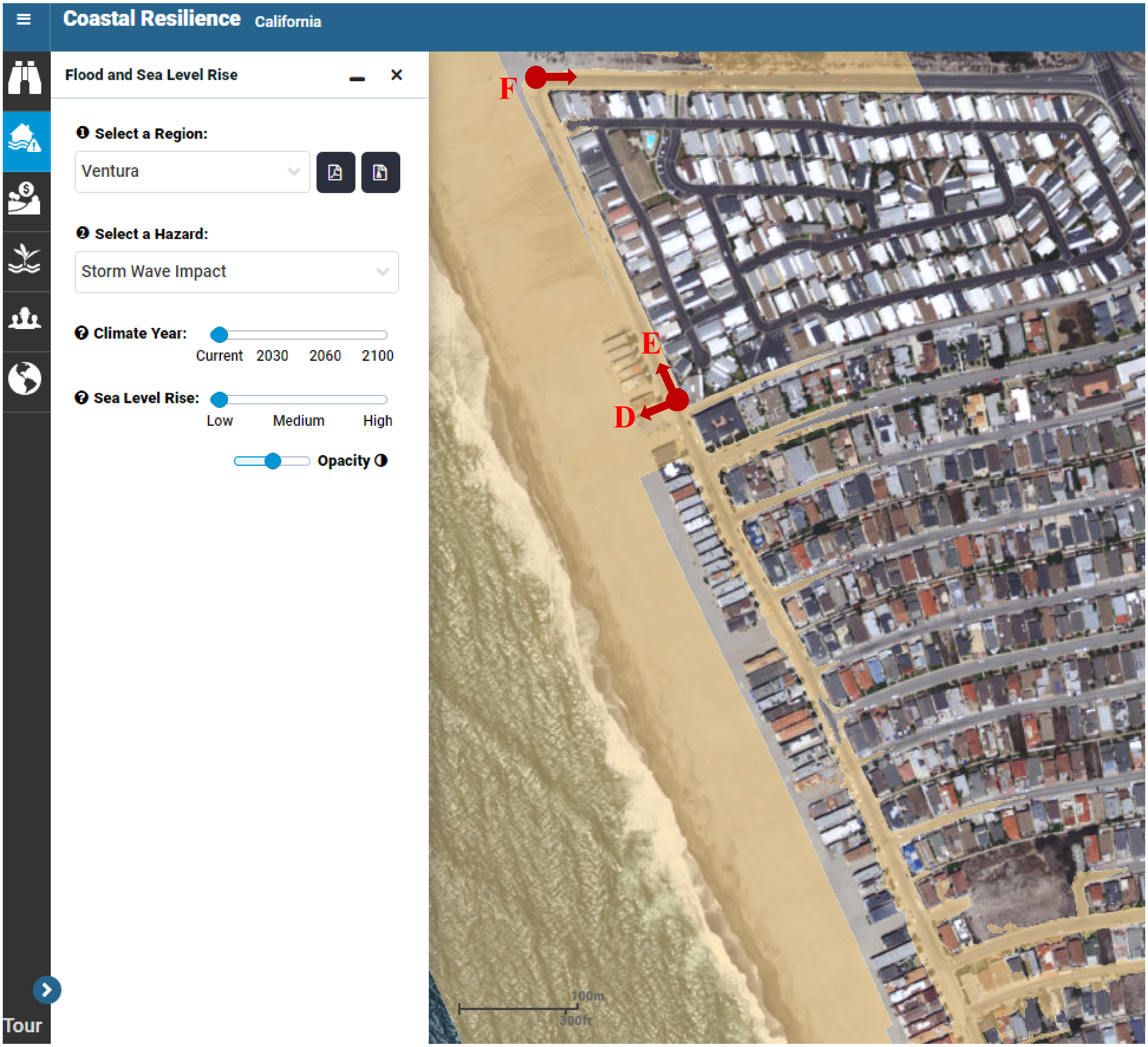

Figure 2C. Coastal Resilience modeling at Oxnard Shores 100 year event, No sea level rise. Extent of flooded area show as tan. Red arrows indicate approximate location (dot) and and orientation of photo. Letters correspond to the ground photo figures for the site.

Surf. Sand. Sustainability.

568 Bethany Curve
Santa Cruz, CA 95060
Phone: 831-854-7873
Email: revellcoastal@gmail.com
Website: www.revellcoastal.com

Figure 2D. Oxnard Shores Flooding December 11, 2015 high tide (5.8') large wave event. Mandalay Beach Road looking west between homes to Pacific Ocean. Photo taken by Chris Williamson.

568 Bethany Curve
Santa Cruz, CA 95060
Phone: 831-854-7873
Email: revellcoastal@gmail.com
Website: www.revellcoastal.com

Figure 2E. Oxnard Shores Flooding December 11, 2015 high tide (5.8') large wave event. Mandalay Beach Road looking north toward 5th Street. Photo taken by Chris Williamson

568 Bethany Curve
Santa Cruz, CA 95060
Phone: 831-854-7873
Email: revellcoastal@gmail.com
Website: www.revellcoastal.com

Figure 2F. Mandalay Beach Road at rth Streeet looking East toward Harbor Blvd on December 11, 2015. Photo taken by Chris Williamson.

Summary

	COSMOS 3.0	FEMA	Coastal Resilience
Cover the Beach?	NO	YES	YES
Match Observations?	NO	MOSTLY	YES

REVELL COASTAL
Surf. Sand. Sustainability.

568 Bethany Curve
Santa Cruz, CA 95060
Phone: 831-854-7873
Email: revellcoastal@gmail.com
Website: *www.revellcoastal.com*

Site 2: Pierpont Neighborhood

The Pierpont neighborhood is located about 3.5 miles north of the proposed Puente Site and has an artificially widened beach retained by a series of cross shore oriented groins.

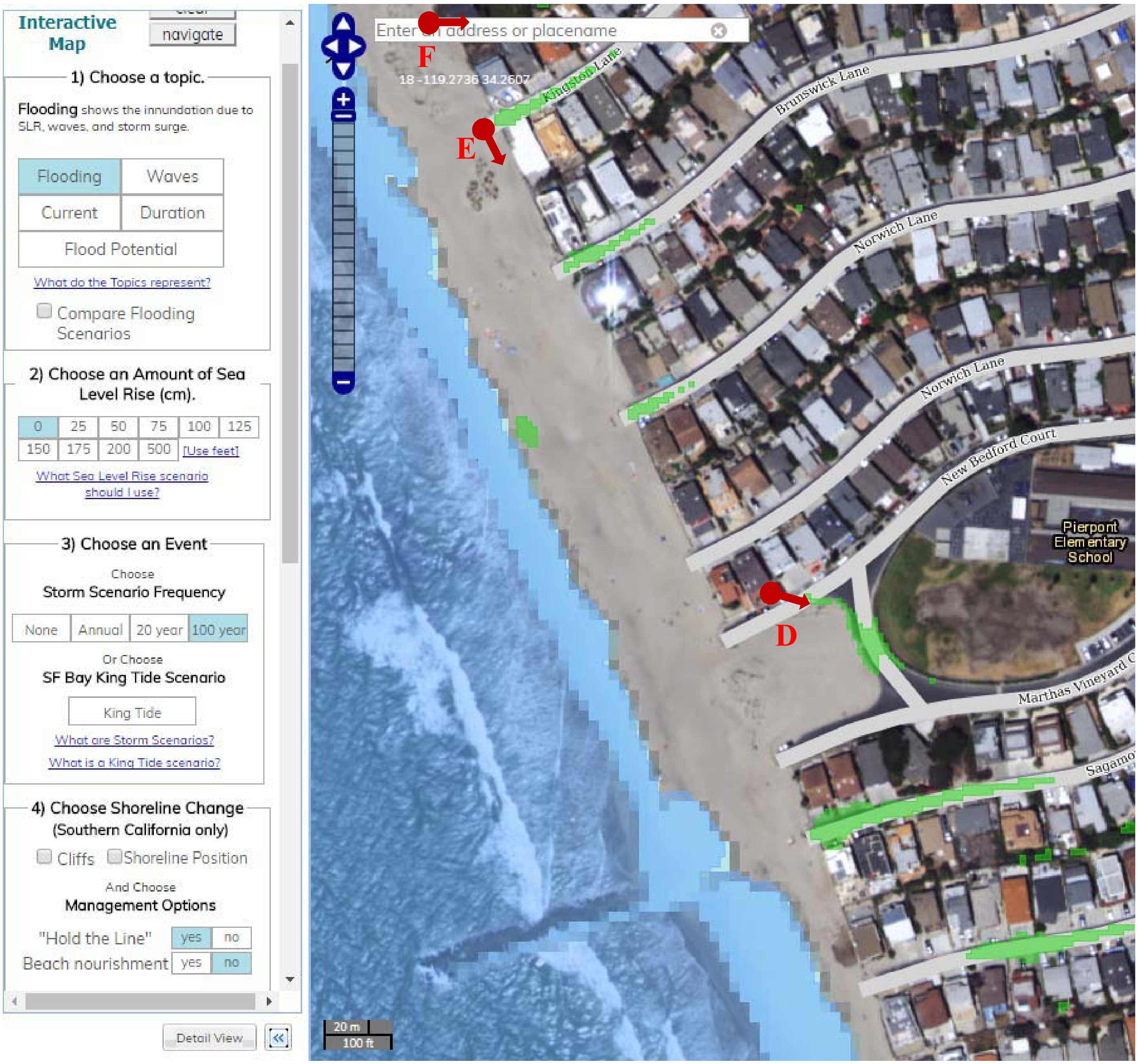

Figure 3A. COSMOS 3.0 Modeling at Pierpont 100 year event, No sea level rise. Flooded area shown in light blue. Red arrows indicate approximate location (dot) and and orientation of photo. Letters correspond to the ground photo figures for the site.

Surf. Sand. Sustainability.

568 Bethany Curve
Santa Cruz, CA 95060
Phone: 831-854-7873
Email: revellcoastal@gmail.com
Website: www.revellcoastal.com

Figure 3B. FEMA Preliminary FIRM map at Pierpont 100 year event, No sea level rise. Flooded area shown in lighter blue. Red arrows indicate approximate location (dot) and and orientation of photo. Letters correspond to the ground photo figures for the site.

568 Bethany Curve
Santa Cruz, CA 95060
Phone: 831-854-7873
Email: revellcoastal@gmail.com
Website: www.revellcoastal.com

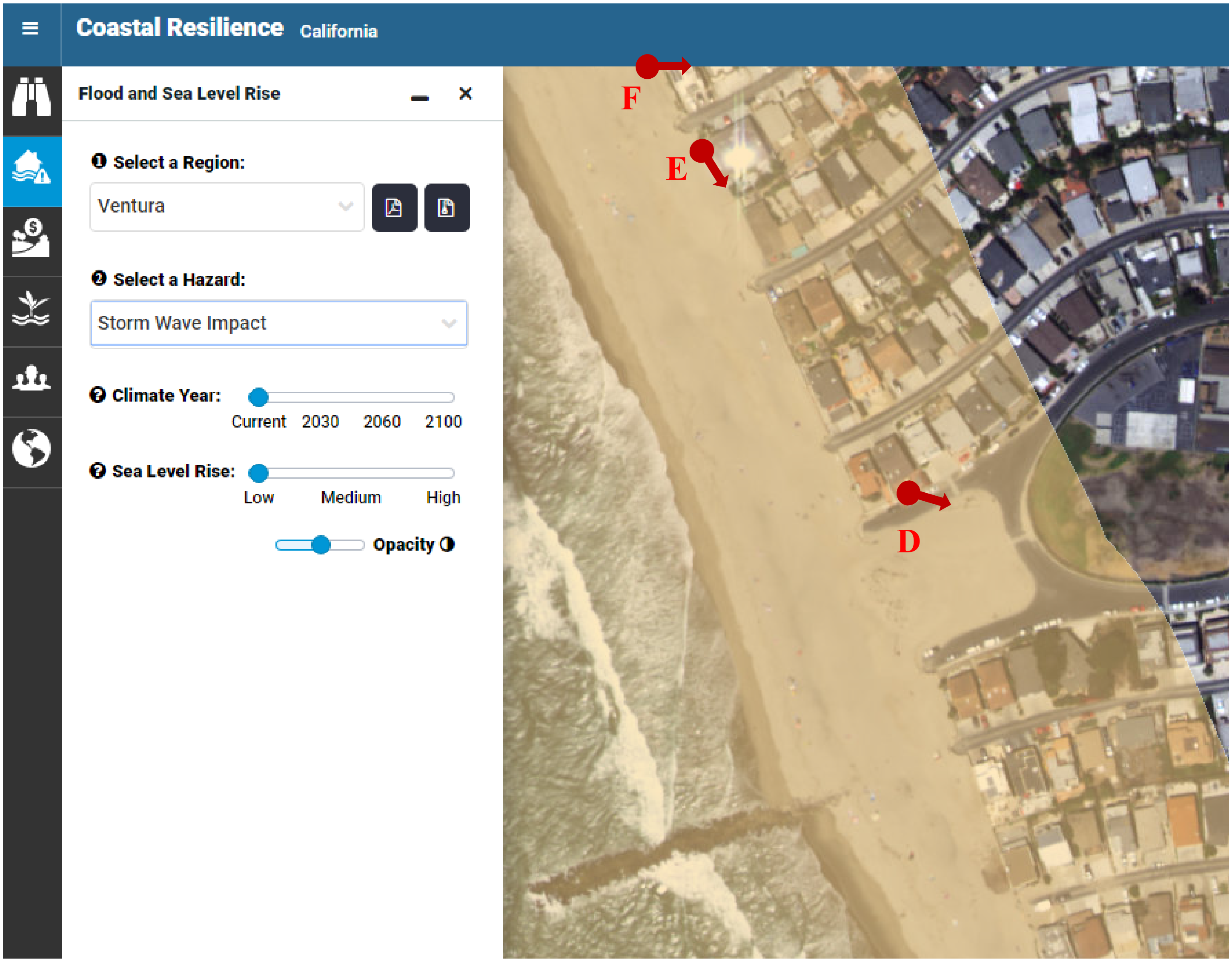

Figure 3C. Coastal Resilience modeling at Pierpont 100 year event, No sea level rise. Flooded area shown in tan. Red arrows indicate approximate location (dot) and and orientation of photo. Letters correspond to the ground photo figures for the site.

568 Bethany Curve
Santa Cruz, CA 95060
Phone: 831-854-7873
Email: revellcoastal@gmail.com
Website: www.revellcoastal.com

Figure 3D. Framegrab from video at New Bedford Court. Note large wrack (kelp wads) and wood being moved by wave velocity (blue arrows). Taken during December 11, 2015 storm event. Video also submitted in testimony.

568 Bethany Curve
Santa Cruz, CA 95060
Phone: 831-854-7873
Email: revellcoastal@gmail.com
Website: www.revellcoastal.com

Figure 3E. Pierpont Beach December 11, 2015. Photo taken by Brian Brennan.

568 Bethany Curve
Santa Cruz, CA 95060
Phone: 831-854-7873
Email: revellcoastal@gmail.com
Website: *www.revellcoastal.com*

Figure 3F. Flooding at Hanover Lane on December 15, 2011. Framegrab from video here https://www.youtube.com/watch?v=9aboWsUQth0

Summary

	COSMOS 3.0	FEMA	Coastal Resilience
Cover the Beach?	NO	YES	YES
Match Observations?	NO	NO	YES

Surf. Sand. Sustainability.

568 Bethany Curve
Santa Cruz, CA 95060
Phone: 831-854-7873
Email: revellcoastal@gmail.com
Website: www.revellcoastal.com

Site 3: Goleta Beach

Goleta Beach is a County Park in Santa Barbara located about 35 miles to the northwest and is extremely well studied erosion hotspot that has experienced many wave overtopping and erosion events in the last 20 years. This past winter resulted in a complete armoring of the entire length of the model outputs.

Please note that the preliminary FIRM maps were unavailable for this site, so Figure A is COSMOS results and Figure B is Coastal Resilience results (also completed for Santa Barbara and LA Counties).

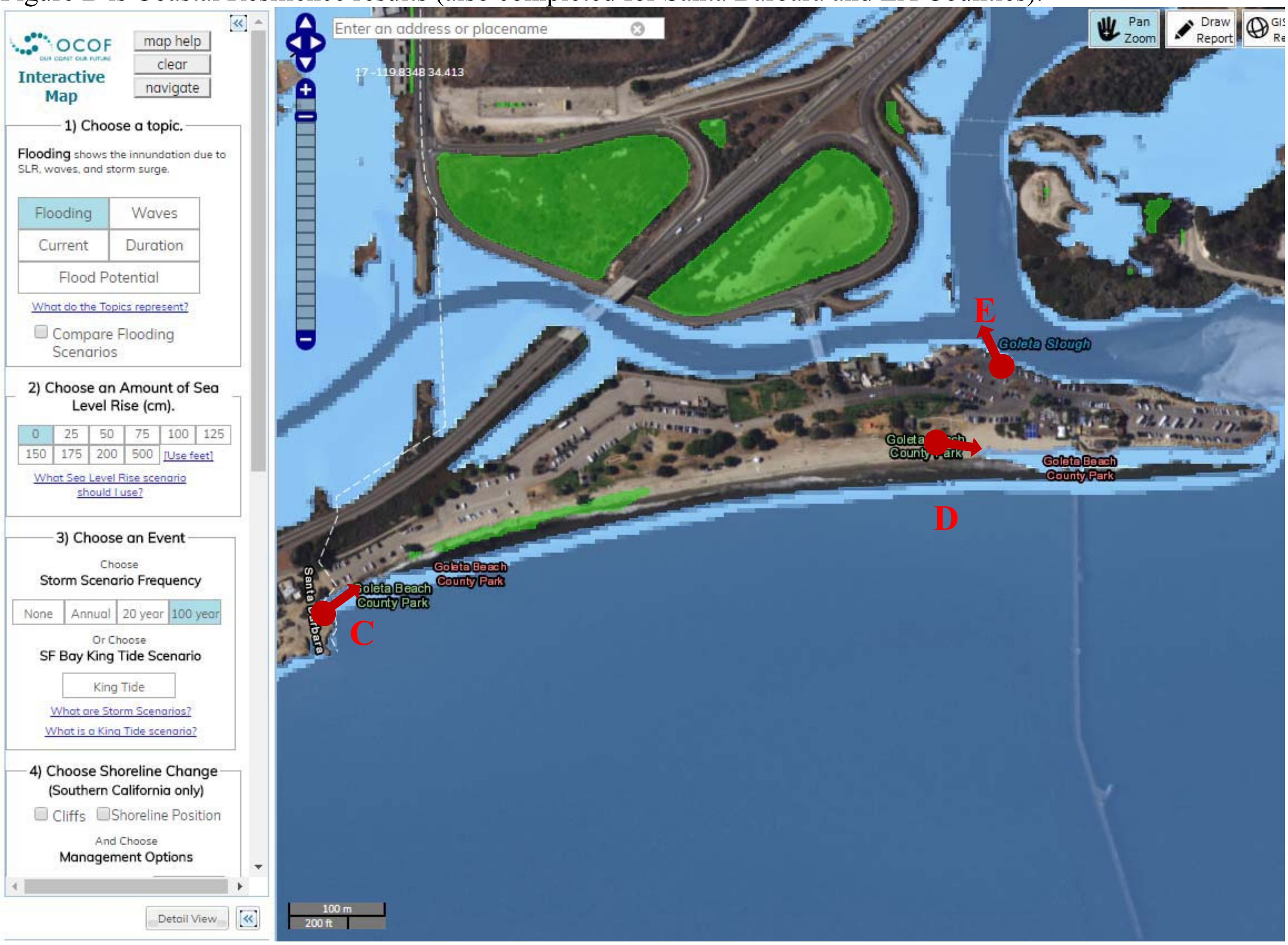

Figure 4A. COSMOS 3.0 Modeling at Goleta Beach 100 year event, No sea level rise. Flooded area shown as light blue. Red arrows indicate approximate location (dot) and and orientation of photo. Letters correspond to the ground photo figures for the site.

Surf. Sand. Sustainability.

568 Bethany Curve
Santa Cruz, CA 95060
Phone: 831-854-7873
Email: revellcoastal@gmail.com
Website: www.revellcoastal.com

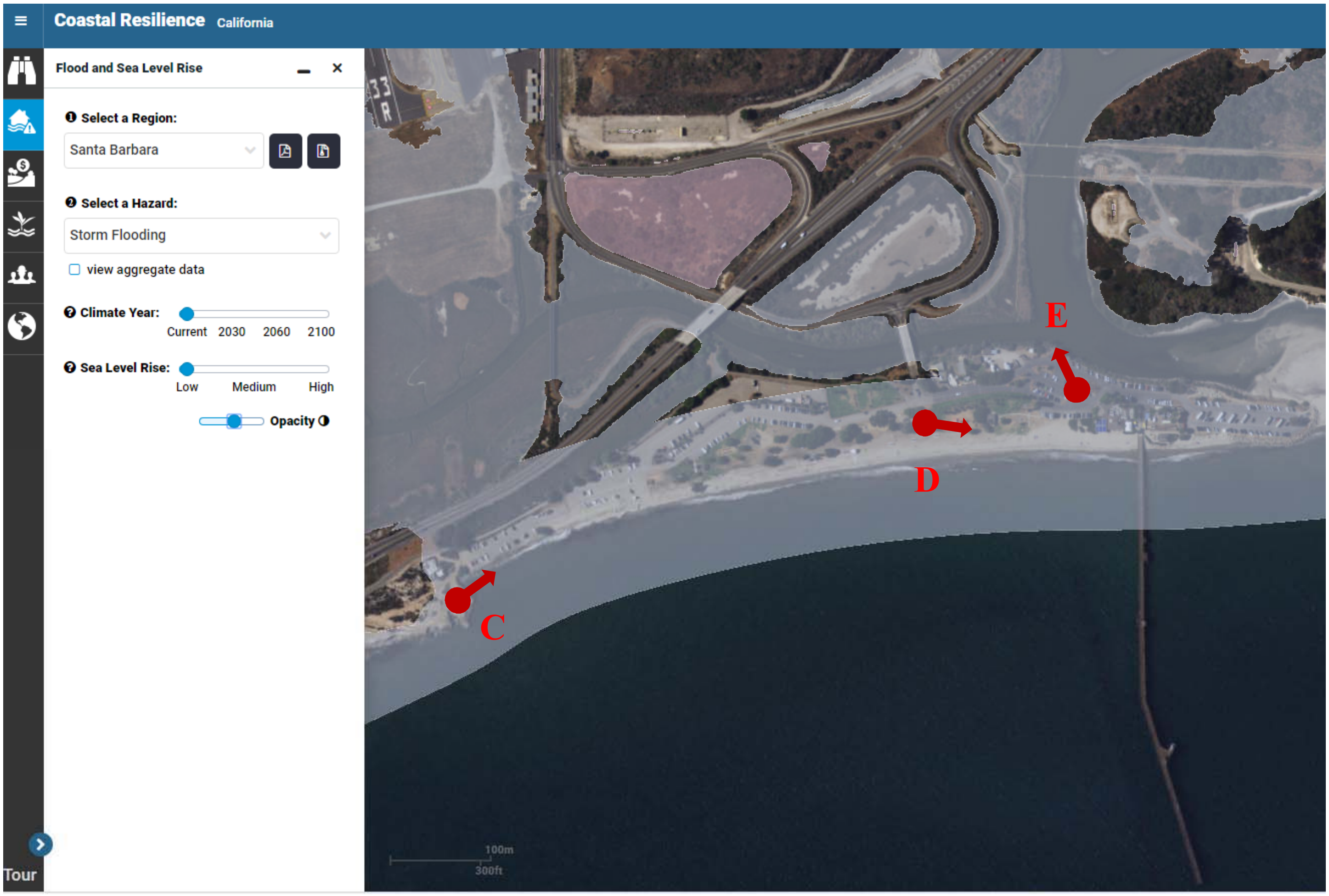

Figure 4B. Coastal Resilience modeling at Goleta Beach 100 year event, No sea level rise. Flooded areas shown as gray. Red arrows indicate approximate location (dot) and and orientation of photo. Letters correspond to the ground photo figures for the site.

Figure 4C. Goleta Beach February 1998 El Niño. (Photo by Mark Morey)

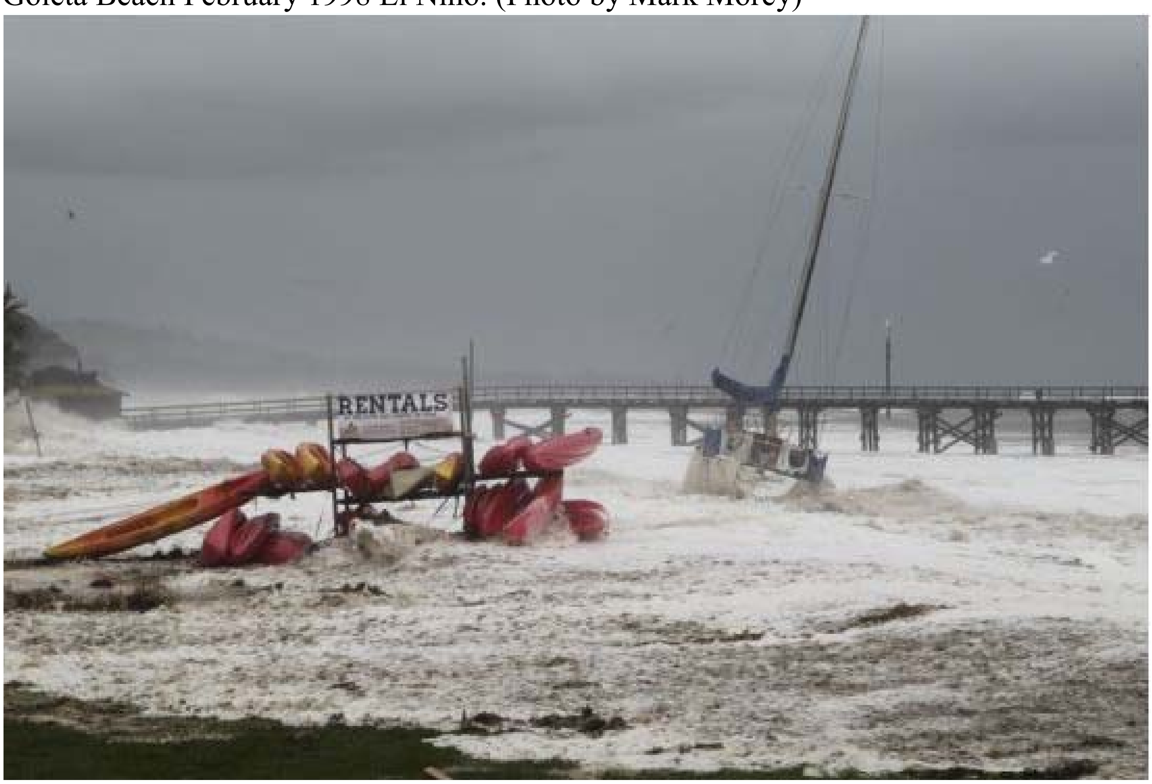

Figure 4D. Goleta Beach March 1, 2014

Surf. Sand. Sustainability.

568 Bethany Curve
Santa Cruz, CA 95060
Phone: 831-854-7873
Email: revellcoastal@gmail.com
Website: www.revellcoastal.com

Figure 4E. Sand deposited from wave overtopping event on March 1st at the back of the parking lot. Photo taken March 3, 2014 by David Revell.

Summary

	COSMOS 3.0	FEMA	Coastal Resilience
Cover the Beach?	NO	Not Available	YES
Match Observations?	NO	Not Available	YES

Maximum flood potential

I also reviewed other aspects of the model performance in the vicinity of the project site. On this page and the following are figures taken from the Our Coast Our Future website (COSMOS webmapper) which shows the extent of flooding predicted by COSMOS at the project site. The first figure (Figure 5) shows the maximum flood potential (with uncertainty) for a 100 year wave event and No Sea Level rise. This figure shows two areas immediately adjacent to the site that are projected to be flooded (highlighted in the red circles.) The approximate crest elevations of these areas, based on LIDAR data, are depicted in the text boxes in the figure

Revell Coastal
Surf. Sand. Sustainability.

568 Bethany Curve
Santa Cruz, CA 95060
Phone: 831-854-7873
Email: revellcoastal@gmail.com
Website: www.revellcoastal.com

and shown as 19-20 and 30 feet. The relatively flat Puente site has a ground elevation of ~14 to 14.5 feet (stated by the applicant and verified by multiple LIDAR data sets the LIDAR data.) Although the COSMOS models shows these higher areas would flood under existing conditions in a 100 year storm, the proposed project site (which is lower) does not. If this model is correct in the circled areas, then the proposed site should also be flooded given that there is no intervening berm or topography of sufficient elevation that would prevent water in these locations from flooding onto the project site.

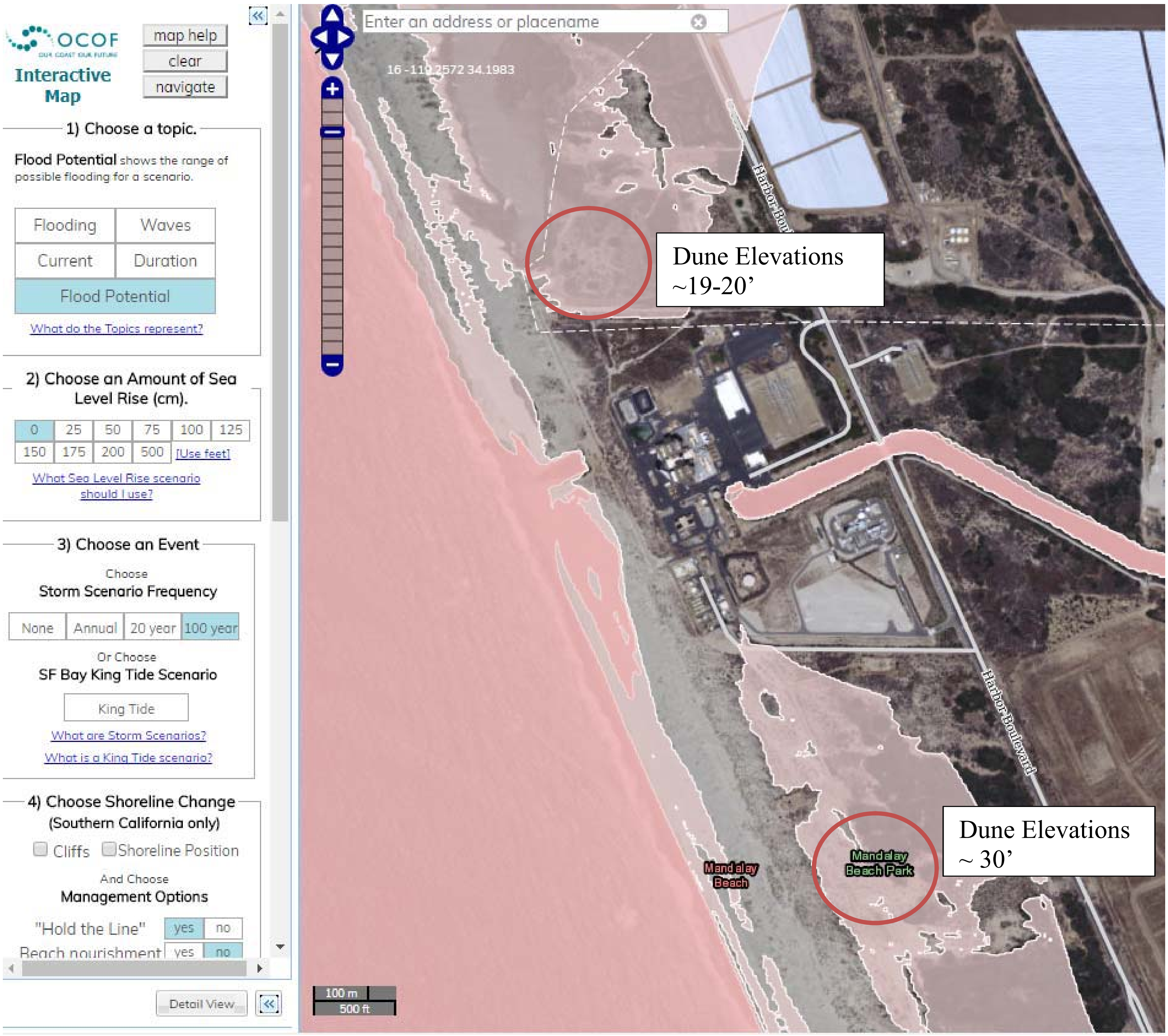

Figure 5. COSMOS 3.0 output of maximum flood potential for a 100 year wave event and No Sea level rise. The red circles simply allow for comparison of the same locations with Figure 6.

568 Bethany Curve
Santa Cruz, CA 95060
Phone: 831-854-7873
Email: revellcoastal@gmail.com
Website: *www.revellcoastal.com*

Figure 6 (which maps risks with 2 meters of sea level rise) demonstrates other discrepancies in the mapped flood hazards. First, the red-circled areas that were shown as fully flooded with no sea level rise in Figure 5 are now shown to have a substantial reduction in the maximum potential flood inundation area, even though water levels alone would have risen by 6.6 feet (2 meters).

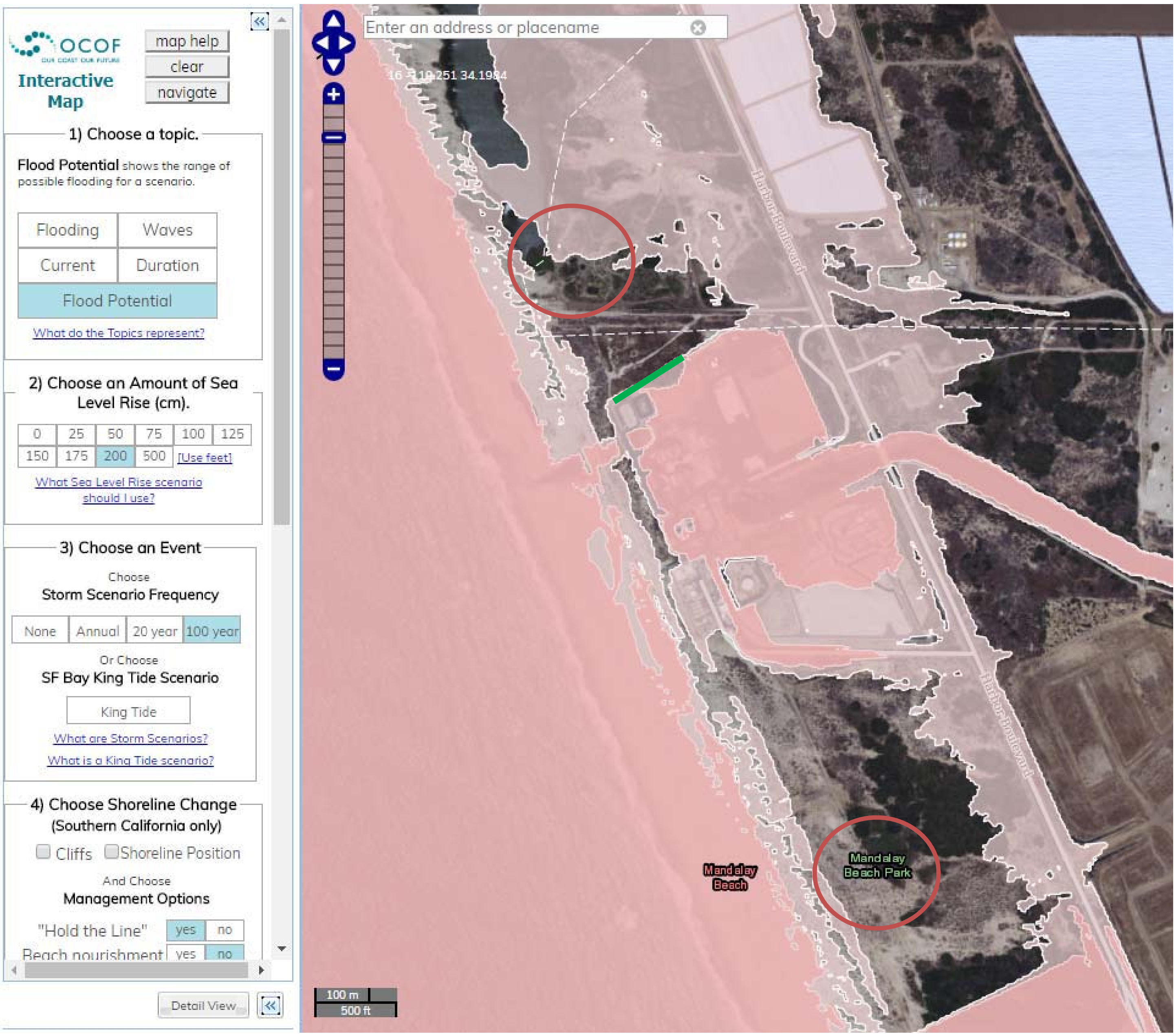

Figure 6. COSMOS 3.0 output of maximum flood potential for a 100 year wave event and 2.0m (6.6 feet) Sea level rise. The red circles simply allow for comparison of the same locations with Figure 5. The green line is the approximate location of the flood depth comparison.

568 Bethany Curve
Santa Cruz, CA 95060
Phone: 831-854-7873
Email: revellcoastal@gmail.com
Website: www.revellcoastal.com

Finally, regardless of the COSMOS flood potential and scenario used, the proposed site seems to avoid any flooding even though immediately adjacent, higher elevation areas are flooded. (Figure 7 in the Supplemental FSA). As a result, I reviewed the COSMOS projected flood depths for the site. At the green line depicted in Figure 6, the flood depth would range between 20-60 centimeters.[2] Based on my understanding of the COSMOS model, without any substantive topographic relief that would block 2 feet of water, this water should also flood the project site. If one wanted to be conservative and add the potential uncertainty regarding flood depths reported by USGS (0.68 m or 26.7 inches), it is exremely difficult to imagine that with up to a ~34 to 50 inch flood depth at the green line on a relatively flat site, that there would not be additional flooding into the proposed powerplant site beyond what has been mapped.

Both of these two flood depth issues seem to point to either some digitial elevation model data issues or some discrepancies in the flow connections across the landscape.

FEMA Escalation

The CEC dismisses Revell Coastal's FEMA escalation analysis, which applies the Technical Method Manual (TMM) for escalating the FEMA Base Flood Elevations with sea level rise. The TMM method considers both the increase in Base Flood elevation as a function of local geomorphology and a landward shift in the projected high wave velocity hazard zone. Instead, CEC staff replaces the landward shift term in the model with the results from the COSMOS Coast and then adds 2 feet to the Base flood elevation. Because the COSMOS Coast model assumes no erosion in front of the project site, the result is to simply add the projected amount of sea level rise to existing total water levels.

This approach significantly understates potential flooding, because the COSMOS Coast model only projects future mean high water levels (MHW). The MHW measure is not the equivalent to a high velocity Total Water Level/Maximum Wave run up extent which FEMA maps and which is used in the TMM for escalating FEMA flood elevations with sea level rise. The full profile representation by COSMOS of how the mapped MHW would project into the future dune crest location is not available. Moreover, COSMOS has not yet provided mapped results for a high velocity maximum wave run up zone, but relies instead on a dynamic water level. Maximum wave run–up results from USGS are not yet available. Given the lack of data sets, it is not prudent to rely on the COSMOS Coast results for the long term shoreline transgression component of the TMM analysis.

Coastal dune erosion

Presently, the dunes provide the sole protection to the site. Erosion is caused not only by waves the reach over the top of the dune crest, but also by waves that impact the toe of the dune. This toe elevation varies widely but is around an elevation ~13 to 15 feet depending on season and antecedent conditions. Once waves reach this elevation then dune erosion can occur. Understanding the magnitude and frequency of dune erosion is paramount to assessing the stablility of the fronting dunes at the proposed site.

FEMA has calculated maximum wave run up (total water level) at over 20 feet NAVD. The proposed site is around elevation 14 feet, 6 feet below this maximum wave run up elevation. Therefore, wave run-up at 14 feet

---

[2] COSMOS 3.0 Phase 2 data flood depth grid (slr200_100yr_flood_depth VE04…tif) downloaded at https://www.sciencebase.gov/catalog/item/58e6bf9fe4b09da6799ac958

(toe of dune elevation) is sufficient to cause dune erosion. As sea level rises, the wave heights necessary to reach this same 14' elevation get smaller. Given that as sea level rises and the beach narrows, less wind blown sand will be available to maintain the dunes. The question should be not on which model is right or wrong, but how many hours of wave attack that dune capable of withstanding.

CoSMoS and FEMA both assume that the modeled 100-year storm occurs only once. Yet actual coastal processes, as has been documented for many of the major El Niño events, are the result of series of large storm events that cause erosion in excess of any single event. In reality, none of the models (including Coastal Resilience) map the impact of multiple large storm events explicitly.

Presently there is no way to evaluate the erosion extent to the dunes caused by storms or sea level rise in either the COSMOS (Figure 7), or the FEMA model which aside from one lone analysis transect in Oxnard has largely failed to consider event based erosion as called for in the FEMA Pacific Coast Flood guidelines.

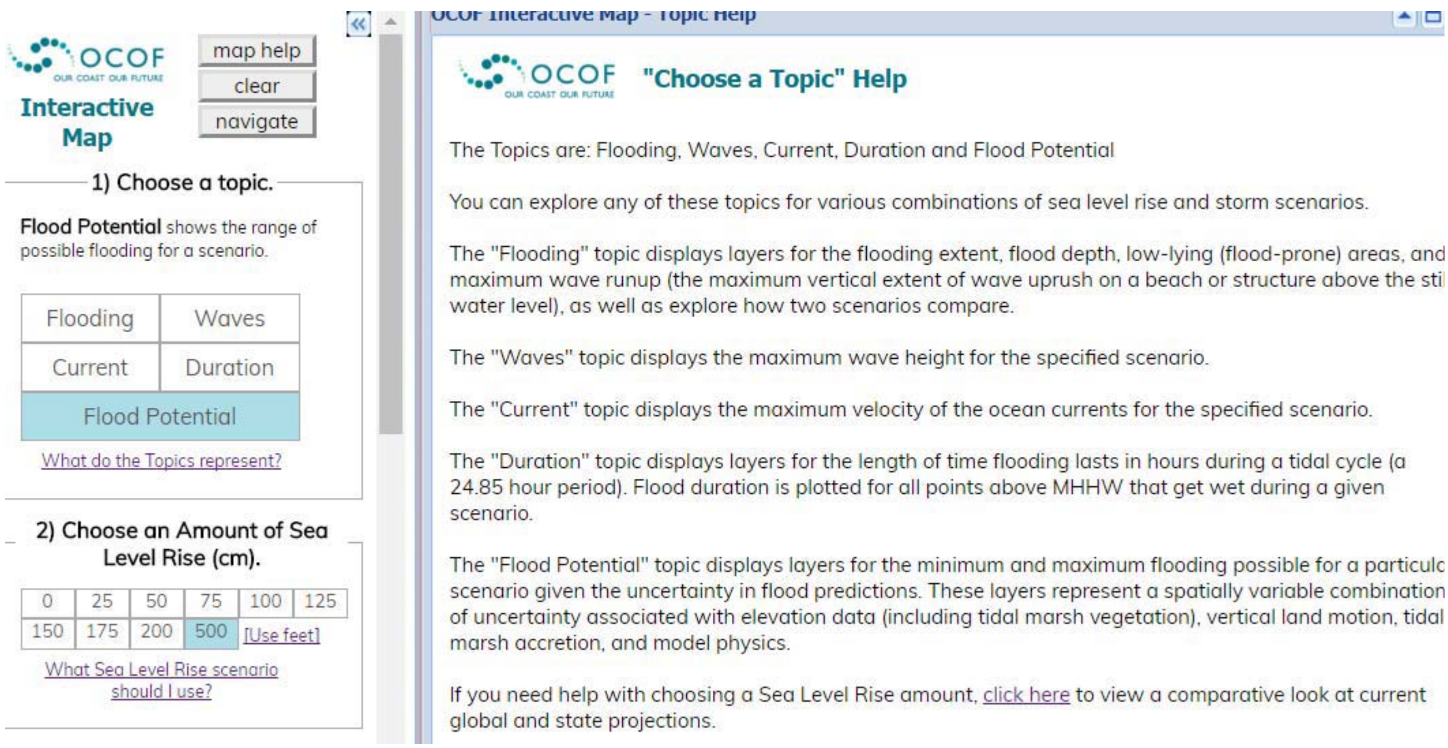

Figure 7. Snapshot of the OCOF tool data sets and descriptions. Data specific to or even the word erosion is not to be found. It is not yet possible to access the maxium wave run up data described under the flooding topic.

Coastal Resilience modeling attempts to account for the occurrence of multiple storm events by incorporating a storm of unlimited duration. This assumes that there could be a storm of enough duration to erode the dunes and expose areas behind it such as the proposed Puente site to coastal flooding (see next section for more discussion of Coastal Resilience storm of unlimated duration

It is important to note that this is a significant point of difference between the models. COSMOS has approached the duration problem differently than Coastal Resilience by doing extensive downscaling of a

568 Bethany Curve
Santa Cruz, CA 95060
Phone: 831-854-7873
Email: revellcoastal@gmail.com
Website: *www.revellcoastal.com*

Global Climate model to generate a future time series of future waves and tides and trasnforming those conditions to all of the southern California Coast. Different time series run through XBeach (COSMOS Tier 3) may provide different results in terms of the impact on coastal erosion and coastal flooding However, (as addressed below), presently, it is not possible to evaluate the extent of dune erosion predicted by the COSMOS model, or the duration necessary to erode through the dunes fronting this site. This is an opportunity to collaborate with the USGS researchers to understand the sensitivity of their analysis to various parameters.

Coastal Resilience modeling and the storm of unlimited duration

The Coastal Resilience Ventura Model has been criticized and dismissed largely based on the assumption of erosion of the dunes caused by an historic storm assumed to have an unlimited duration. Specifically, it has been pointed out that the Coastal Resilince model would have projected flooding to the proposed site on January 27, 1983 that did not allegedly happen. Testimony by Philip Mineart, P.E. again points this out and provides additional discussion.

Based on my review of aerial photos at the site and on nearby impacts, I observe dune erosion in front of the Puente site caused by the 1983 storm. This dune erosion was predicted by the Coastal Resilience model. However, the storm was not at a high enough elevation for a long enough time duration to fully erode the dunes. If the MGS site did not flood, that is likely the reason. If the storm had lasted longer or been part of a larger series of storms, it would have resulted in erosion of the dune and flooding of the site. Maximum wave run up most likely reached elevations well above the ground elevation at the site. As mentioned previously, ground photos during historic storm events are extremely hard to obtain. I know of no photos during the 1983 event taken at or directly in front of the site. I have not seen any photos that demonstrate that the dune was not eroded, or that the proposed site was not flooded.

In fact, Mr. Mineart submitted several photographs in his testimony (TN218900). Figure 5-1 is a color infrared aerial photograph from 1984, (date unknown). With color infrared remote sensing, any area with vegetation shows up as a shade of red. In addition, Mr. Mineart submitted some oblique aerial images. Figure 5-2a from 1979 precedes the 1982-83 erosion event and clearly shows vegetated dunes immediately adjacent to the Beach Road. Figure 5-1 from 1984, however, shows that across most of the MGS site, this vegetation has disappeared, particularly in the northern portion of the site in front of the proposed Puente Site. In addition, the entire proposed site in Figure 5-1 is completely void of vegetation which indicates that some substantive disturbance to the site occurred between 1979 and 1984. In both 1979 (Figure 5-2a) and 1987 (Figure 5-2b), this same proposed site has extensive vegetation. This may actually be evidence that in addition to dune erosion, salt water flooding occurred at the proposed site which appears darker, possibly indicating that the site was still wet. Figure 5-2b show that some vegetative recovery occurred by 1987. Again without ground photos taken during or immediately following the event, these interpretations are difficult to make based on the available photos.

I believe it remains appropriate for the Coastal Resilience modeling to rely on the storm of unlimited duration because the assumption that only one 100 year storm would occur does not reflect historic multiple storm patterns and would underestimate storm-induced erosion, particularly as storms potentially become more intense or more frequent with climate change. The elevation of the 100 year maximum wave run up today, when combined with sea levels in the future, will become a much more frequently reached wave run up elevation in the future (e.g. a 100 year even becomes a 10 year event becomes a seasonal winter event with sea level rise). Ultimately, the Coastal Resilience modeling assumption eliminates the difficulty of trying to calculate joint

REVELL COASTAL
Surf. Sand. Sustainability.

568 Bethany Curve
Santa Cruz, CA 95060
Phone: 831-854-7873
Email: revellcoastal@gmail.com
Website: *www.revellcoastal.com*

probablilities (for example, the likelihood of a storm event coinciding with a king tide, as it did in December 2015) or estimate a specific time series or sequence of tides and waves in the future.

The erosion to the dunes from either long term sea level rise or storm induced erosion is of critical importance to evaluating the proposed site's exposure to coastal flood hazard. The proposed site presently sits less than a foot above the COSMOS calculated dynamic water level and is ~6 feet below the calculated FEMA Base flood elevation in the Preliminary FIRM maps.[3]

In Appendix A to his testimony, Mr. Mineart uses a single relatively flat beach slope from a single day in time to allegedly calculate dune erosion probabilities in front of the site. However, this analysis does not provide the actual 50-year time series of storm events used to model dune erosion. As a result, it is not possible to assess the accuracy of the analysis and does not allow for an assessment of how the dune erosion probabilities would be affected by the range of foreshore beach slopes that have been measured in front of the project site.

However, testimony has been submitted previously (TN 215427) showing the range of beach slopes through time (Table 1) and the implications to total water level or maximum wave run-up using the Stockdon equation (Table 2). Applying the same storm parameters with this range of beach slopes demonstrates that maximum wave run-up in front of the project site can vary from 18.9 to 38.6 feet elevation solely by varying different beach slopes.

In addition, Mr. Mineart claims that water levels would only be high enough to impact the toe of the dune onces every ten years. However, the same 50 year hindcast data set developed by the Baker/AECOM team for FEMA, when applied to the same FEMA transect that fronts the project site, shows 130 wave events where the total water level meets or exceeds the assumed 14.5 foot toe of dune elevation.[4] As a result, Mr. Minehart's assumption that the toe of the dune would be impacted only once every 10 years is likely too low.

Conclusion

The purpose of this testimony is not here to criticize COSMOS modeling, but to address its use by CEC staff as a site specific model to find no threat to the project site. COSMOS modeling has some aspects that have broken new ground. Flood depth modeling, for instance, is quite complicated and the COSMOS model is the only planning level model that attempts to provide this critical piece of information at a regional scale (e.g. All of Southern California).

Given the difficulties associated with forecasting future coastal hazards and the uncertainties associated with both climate change projections and future rates of change, as well as model uncertainty alone, it is prudent to evaluate all 3 of the available models, including escalating the FEMA maps with sea level rise, to provide a site specific verification and interpretation of the models results to the site specific characteristics.

[3] See TN215427 (Testimony of Dr. Revell).

[4] BakerAECOM. 2016. Intermediate Data Submittal #3. Appendix D, Analysis transect. Nearshore Hydraulics Ventura County, California. California Coastal Analysis and Mapping Project/Open Pacific Coast Study. Submitted to FEMA Region IX. April 6.

568 Bethany Curve
Santa Cruz, CA 95060
Phone: 831-854-7873
Email: revellcoastal@gmail.com
Website: www.revellcoastal.com

All of the models should be rerun in a site specific fashion with a sensitivity analysis to determine how sensitive the models are to input parameters at the proposed location and to provide critical information that is lacking from each model.

- Sensitivity analysis would include
  - Range of observed topographic conditions (beach widths, dune height and width)
  - Range of beach slopes
  - Range of storms from historic extremes to GCM modeled extremes

- Additional information that would be useful to analyze from all models as applied to this site specific analysis. This seems something that would be prudent
  - Maximum wave run up extent and elevation
  - Extent of dune storm erosion caused by a 100-year event
  - Duration of storm induced erosion necessary to erode the existing fronting dune field
  - At what sea level rise elevation or rate of sea level rise does the beach width accretion trend turn to erosion?
  - What is the implication of harbor dredging on controlling these beach widths fronting the site?

Funding for this type of analysis should come from the applicant who thus far has leveraged a tremendous amount of federal, state, and city resources.

909957.6

I, Dr. David Revell, prepared the forgoing testimony and the basis for this testimony is set forth in the testimony itself and is incorporated by reference.

It is my professional opinion that the prepared testimony is valid and accurate with respect to the issues and statements expressed therein.

I am personally familiar with the facts and conclusions in the prepared testimony and, if called as a witness, could testify competently thereto.

I declare under penalty of perjury under the laws of the State of California that the forgoing is true and correct.

Executed July 14, 2017, at Santa Cruz, CA.

David Revell