via electronic mail and USPS

April 2, 2014

Michael Watson
Coastal Commission
California Coastal Commission
45 Fremont Street, Suite 2000
San Francisco, CA 94105-2219

Re: Coastal Hazards – Comments of Ed Thornton, Ph.D. on behalf of Sierra Club re - Agenda Item Wednesday 10a concerning Application No. A-3-SNC-98-114 for Monterey Bay Shores

Dear Mr. Watson:

I have been requested by Sierra Club to comment on the coastal hazards section of the Staff Report for the above-captioned project. The hazards addressed below include erosion rate, set-back and wave run-up. The overall conclusion is that the set-back distance and maximum run-up values proposed by SNG through their consultant HKA are non-conservative. A number of available studies readily available in the scientific literature and consultant reports that are directly applicable to the proposed site have not been included. These studies support the conclusion that the HKA values are non-conservative.

It is noted that a common misunderstanding exists that a 100-year event is likely to occur only once in a 100-year period. In fact, there is approximately a 63.4% chance of one or more 100-year events occurring in any 100-year period. The event can occur at any time. The expected value of the number of 100-year events occurring in any 100-year period is 1, but more than one can occur.

The Sierra Club supports the Coastal Commission Staff report requirement dated March 21, 2014 that the portions of the project would be required to be removed as they become threatened or exposed as a condition of approval. A further requirement would be that all shoreline protective devices be prohibited now and in the future. This insures that the project does not inhibit lateral access along the beach in the future.

Erosion Rates

The coastal processes at Sand City can be characterized as having high temporal and spatial variability on both short term (daily to seasonal) and long-term (years to decades). Persistent year around rip currents occur at Sand City and all along southern Monterey Bay. Beach and dune erosion have been correlated with rip current embayments that coincide with the center of beach mega-cusps (Thornton *et al*, 2007; Quan *et al*, 2013). The beach is the narrowest at the embayment, allowing swash and wave run-up to undercut the toe of the dune and cause erosion during coincident high tides and storm waves. This results in large spatial variation in alongshore erosion, often referred to as "erosion hot spots". At Sand City the alongshore spacing of the rip embayments and consequent erosion hot spots are in the order of 600 feet. The alongshore variability and erosion rates were measured by Quan, et al. (2013) by comparing 5 Lidar surveys of the dune face obtained between 1997 and 2010 (Figure 1 below). It is assumed here that the recession of the dune top edge is the same as the recession of the dune face, and that the recession of dune top edge is the appropriate parameter for siting a building on the dune top. As can be seen in Figure 1, recession of 28 feet (8.5 m) occurred at the designated Sand City site and 47 feet (14 m) just 800 feet (250 m) to the north. Therefore, it is important to consider a length of beach in considering erosion rate and recognize temporal and alongshore spatial variability.

Set-Backs

The Nature Conservancy, City of Capitola, and other agencies contracted with PWA-ESA to examine the impacts of future anticipated sea level rise on the Monterey Bay shoreline and provide risk maps showing recession and flooding of dune top edge and shoreline for years 2030, 2040, 2050, 2060 and 2100 (referenced to 2010). The coastal erosion hazard results were presented at an open forum held at the Monterey City Hall on 24 January 2014.

The coastal hazard zones are calculated based on historic erosion, additional erosion owing to sea level rise, and the potential erosion impact caused by a 100-year storm wave event. The potential inland shoreline retreat caused by sea level rise and the impact from the 100-year storm were estimated using a geometric model of dune erosion and applied with different slopes alongshore to make the model more applicable to sea level as described in Revel *et al*. (2011). This method is consistent with the FEMA Pacific Coast Flood Guidelines (FEMA, 2005) and the analysis is interpreted to be consistent with the draft guidelines published by the Coastal Commission (2013). The risk maps were calculated in blocks of 500-meter (or smaller) length alongshore. The risk map for Sand City is shown in Figure 2 below.

Wave Run-up

Maximum run-up owing to extreme wave conditions was inferred by Thornton and McMahan (2014) at two beaches at Sand City based on the distribution of sea glass found on the dune tops. Sea-glass is broken glass that has been introduced into the ocean and modified to have rounded, smoothed edges and an opaque character by the abrasion by the relative motion of sand moved by wave action and currents. By comparison, ordinary broken glass is transparent with sharp edges. The sea-glass is collected commercially and by hobbyists for art works at these sites. The hypothesis that sea-glass is an indicator of maximum run-up is based on the observation that the sorting of sediments on a beach results in the maximum size sand particles residing at the top of the berm. Glass has the same density as a grain of sand. The hypothesis is verified by the observation that newly deposited sea-glass on a beach is found at the rack-line, the location of sea-grass, detritus and other large particles dropped out there by the maximum extend of the swash (run-up). The source of the sea-glass is an old city garbage dump located on the dune between the SNG and Sterling properties in Sand City from 1937-1951. It is estimated that the dump was falling into the ocean by at least 1960, so that the maximum run-up values have a return period of at least 50 years.

The beach and dune profile inside the northern edge of the SNG property (see profile line located on Figure 2) along with the distribution of the sea-glass at the top of the dune edge on this profile is shown in Figure 3. A Guassian distribution is shown for comparison with the sea-glass distribution. Sea-glass is not found on the face of the dune as the dune is being eroded back. The mean elevation of the sea-glass distribution is 55 feet (16.7 m) NGVD, which is indicative of the mean maximum wave run-up at this location occurring over a period of 50-65 years.

The data are used to test run-up formulas, including the formula used by FEMA. The formulas are parameterized on beach slope, wave height and period, plus the tide. It is assumed the storm waves occur over a sufficient period of time that includes high tide. The active slope of the profile here, where the waves run-up the dune face, is 0.63 (1 on 1.6) (see Figure 3). Deep water hindcast waves (1958-1983) and measured deep water wave spectra (1979-2013) refracted to 4m water depth at Sand City are used as input to test the model. The models are tuned to fit the data using a reduction factor to account for beach permeability, berm characteristics, non-normal wave incidence and surface roughness influence. Good comparison with the FEMA model is obtained with a reduction factor ~1. This is the first test of the FEMA model using extreme waves in nature.

Run-up is formulated as proportional to the active slope. The SNG project proposes a slope of 0.5 (1 on 2). For a slope of 0.5 the measured maximum run-up would be reduced by a factor of 0.5/0.63 = 0.8, to give a mean maximum run-up with a recurrence period of 50-65 years equal to 0.8x55 feet= 44 feet, which is consistent with the 46 feet calculated earlier by HKA. It is not clear why the 32 feet elevation is used for maximum run-up for the project as it appears to underestimate the potential run-up and flooding. The 32-foot elevation can be mitigated by decreasing the graded slope to 0.37 (1 on 2.7), which will require an adjustment in the set back. However, it is expected that as the dune erodes back, the natural slope will be steeper, increasing the potential for flooding.

I have further been requested to respond to the letter submitted to the Commission Chair by the developer's attorneys, Richards, Watson, Gershon dated April 3, 2014. The RWG letter states (p. 19, 2nd paragraph) that "the property has not experienced erosion." The CRSMP report, however, documented the long-term erosion rate at this site between 2.7-6.2 feet per year.

Quan et al, (2013) measured recession at Sand City of 28 feet between 1997-2010 and 47 feet jest 800 feet north. The erosion here occurs both long-term and episodically and is well documented. (See figure 1). Projected future coastal hazard zones using historical erosion rates and accounting for sea-level rise and run-up due to major storms were calculated by Vandebroek et al. (2014) for 2050, 2060, and 2100. Extrapolating between 2060 and 2100 to obtain the 2085 (75 year line), projects that portions of the project will be well within the hazard zone before 75 years. (See figure 2)

The development is to be sited at elevation 32 feet NGVD. There does not seem to be a basis for the elevation. Their consultant HKA calculated a run-up elevation of 46 feet. This is similar to the 44-foot run-up elevation for a 1 on 2 slope that I extrapolate from evidence of measured long-term run-up at this site. This is further evidence that the development is being built in a hazard zone. (See figure 3).

Thank you for this opportunity to comment.

Sincerely,

Edward Thornton
On behalf of Sierra Club

FIGURE 1

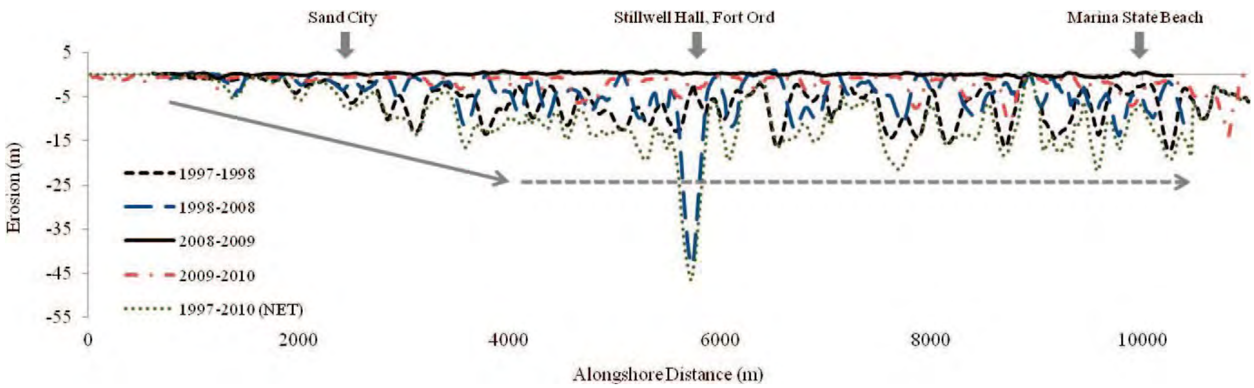

Figure 1. Southern study area plot of shoreline recession (of dune face) with a 100m running average at 10m elevation (NAVD88). X axis represents alongshore distance (m) starting in Sand City and ending at Marina Sate Beach. Y axis represents shoreline recession (m). The solid line depicts a trend of increasing erosion magnitude alongshore, whereas the dashed line depicts signs of shoreline averaging found along this stretch of coastline. (excerpted from Quan et.al., 2013)

FIGURE 2

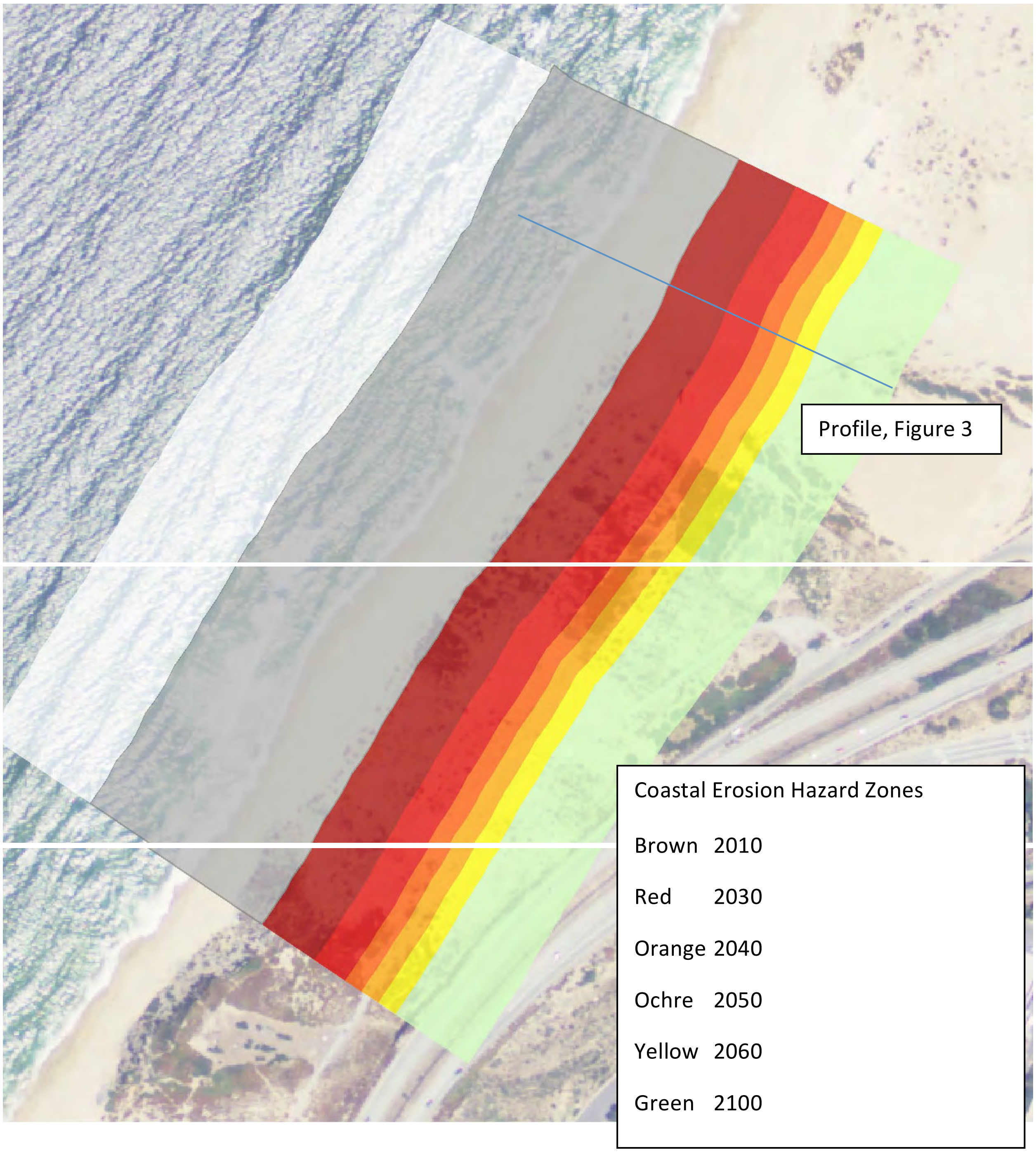

Figure 2. Coastal Erosion Hazard Map for Sand City (excerpted from Vandebroek et.al., 2014). The blue line depicts the profile line shown in Figure 3.

FIGURE 3

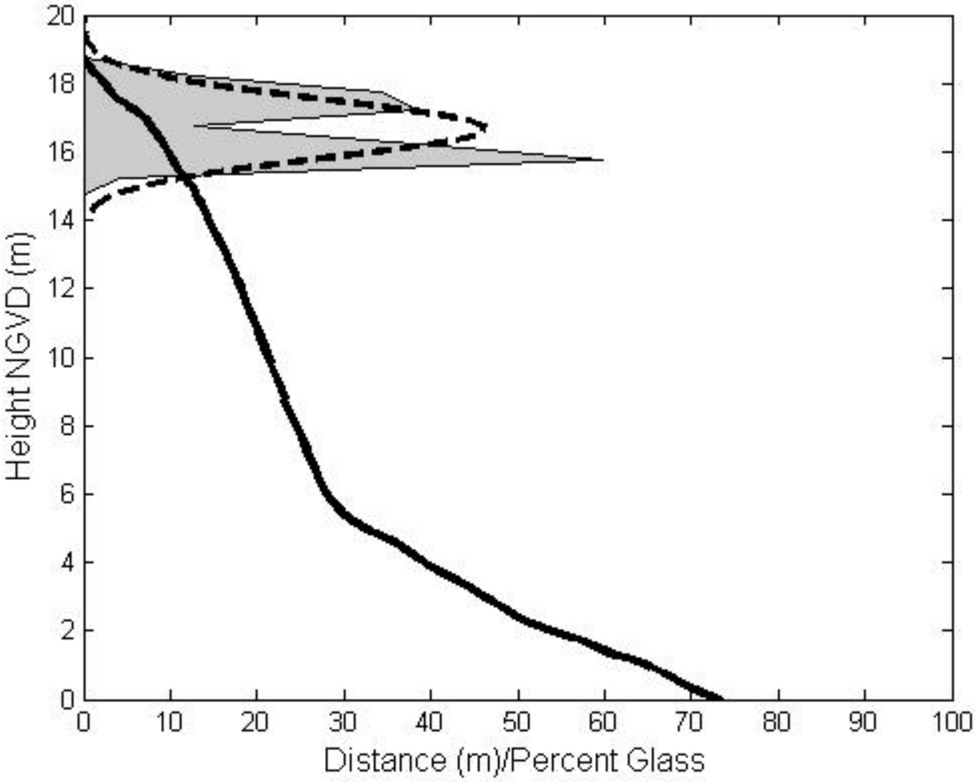

Figure 3. Beach and dune profile inside northern edge of SNG property as depicted on Figure 2 (solid line), and distribution of measured sea-glass (filled area) compared with Guassian distribution (dashed line) (excerpted from Thornton and MacMahan, 2014).

APPENDIX A

Biographical Information Re: Ed Thornton

Edward Thornton is a Distinguished Professor Emeritus at the Naval Postgraduate School in the Oceanography Department where he has taught and researched for the past 40 years. His expertise is with regard to the physical processes in the nearshore ocean, which includes societal problems such as beach erosion and ocean pollution. Thornton is a recognized expert on the physical aspects of beaches in southern Monterey Bay and Carmel and was an author of the Regional Sediment Management Plan for southern Monterey Bay that was adopted by AMBAG in November 2008. He received the International Coastal Engineering Award for 2007, which is the highest award accorded by his profession, and the Citizen of the Year Award for 2007 by the Monterey Bay National Marine Sanctuary.

APPENDIX B

REFERENCES

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Quan, S., R. G. Kvitek, D. P. Smith, and G.B. Griggs, 2013, *Using Vessel-Based LIDAR to Quantify Coastal Erosion during El Niño and Inter-El Niño Periods in Monterey Bay, California, Journal of Coastal Research*, 29 (3), 555-565; DOI:12.2112/JCOASTRES-D-12-00005.1

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Vandebroek, E., D. Revell and D. George, 2014, *Analysis of Historic and Future Coastal Erosion with Sea Level Rise, ESA PWA Report for Monterey Peninsula Water Supply Project dated March 19, 2014*, 23 pp.