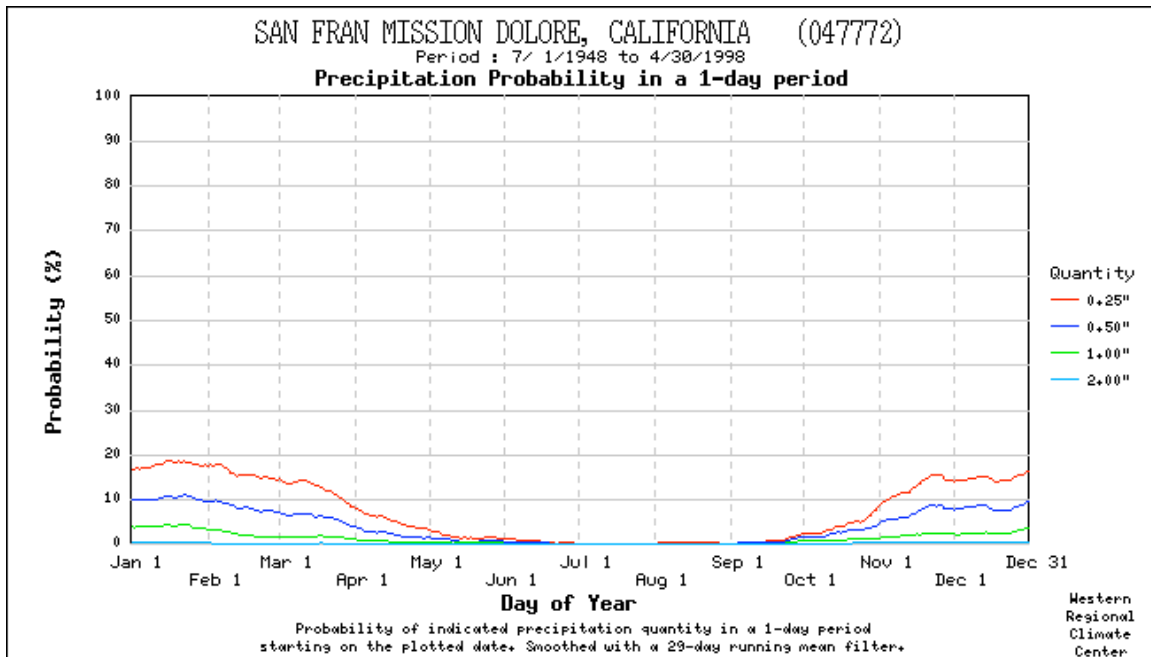


Significant Rainfall and Peak Sustained Wind Estimates For Downtown San Francisco



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July 30, 1998

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1. Impact of Location

The location of the property is in an area of downtown San Francisco relatively exposed to southerly winds typical of winter storms. On the other hand, the property is in the lee of the Bay Bridge and in somewhat of a protected topographic location.

It is not possible to infer exact wind conditions on the site because complicated microscale interactions would occur between the wind (in southerly wind episodes) and the surrounding topography and structure of the Bay Bridge. For example, it is common for “swirls” to be generated by structures and topography such that there is unpredictable local augmentation or suppression of wind speeds on various faces of the affected structure.

There is no National Weather Service recording site nearby. Wind data is recorded at San Francisco State University, but that is a completely different setting topographically and with respect to exposure and siting of surrounding structures.

Since the wind instrumentation at San Francisco International Airport (approximately 13 statute miles south) is in a similar, but slightly more exposed location, but with fewer structures to cause local eddying and augmentation, the consultant feels that the sustained wind speeds observed there would be representative of those observed at the site.

Only a field study could determine exact nature of the wind at the site.

2. Data

Wind information for San Francisco International Airport (Source: Climatological Data, California) for the period 1982-1991 was obtained. The period was chosen because: (1) ten years of data is needed in order to adequately sample the weather record; and, (2) the years in question spanned very wet years and very dry years. Rainfall data were obtained for the same period for the National Weather Service observing site in downtown San Francisco. Note that for the first few years of the period this site was located at the Old Federal Office Building in Civic Center, but was subsequently moved to Mission Dolores.

3. Results

During the period considered, all significant daily rainfall totals observed in downtown San Francisco were associated with a peak sustained wind at San Francisco Airport for the same day. “Significant” here is defined as any rainfall greater than 0.19” and sustained wind refers either to the average 1-minute or average 2-minute wind speeds. The study was also limited to the usual “rainy season” months of January, February, March, April, October, November and December. Table 1 summarizes the results of the study.

The data were further stratified on the basis of heaviness of rainfall. Thus, wind speeds were determined for days in which “light to moderate” (0.20” to 0.75”) rainfall was observed, “moderate” (0.76” to 0.99”), “heavy” (1.00” to 1.75”) and “very heavy” (>1.75”).

<i>San Francisco Daily Rainfall Totals (in) And Peak Sustained Wind Speed (mph) (1-min average) SFO for JFMAOND, 1982-1991</i>			
	<i>Number of Events</i>	<i>Avg Event Rainfall (in)</i>	<i>Avg Event Sustained Wind (mph)</i>
>0.19"	291	0.62	24.1
0.20" to 0.75"	216	0.41	23.1
0.76"to 0.99"	33	0.86	26.5
1.00" to 1.75"	33	1.26	26.9
>1.75"	8	2.37	29.3

The reader will note that there is a logical progression as rainfall intensities increase, with the heaviest event rainfall being associated with the strongest winds. This is to be expected, since the heavier events are often associated with very strong storms, associated with the most inclement conditions. One can also note that the very heaviest rainfall events are relatively rare, at least for the period of record considered here. (Note: the consultant should comment here that there have been a great number of very heavy events observed in downtown San Francisco since 1991, including the 24-h record rainfall of 6.36” in November 1994).

Based upon the limited period of record, one can assume that the typical sustained wind speed observed with significant rainfall is on the order of 25 mph and that the wind speed can be expected to be larger for the heavier rainfall events. This is illustrated in Fig. 1 which fits a regression line to the information given in Table 1. Please note that statistical significance is not claimed to the suggested relation.

Fig. 2 is provided to allow an intelligent estimate of the relation between rainfall amounts and wind speed in downtown San Francisco. It should not be used as a substitute for a field study. All 291 24-h rainfall events that exceeded 0.19” at Downtown San Francisco were regressed on peak sustained wind speed (mph) at SFO for the Jan-Apr and Oct-Dec periods of 1982-1991. An estimate of the expected sustained wind for a given rainfall amount can be obtained by use of the regression line plotted on Fig. 2.

Finally, peak gusts were not examined in this study. However, an estimate of potential peak gusts can be obtained by multiplying the sustained wind speed by a factor of 1.5.

Average Event Rainfall (in) Downtown SF vs Peak Sustained Winds (mph) SFO, Jan Feb Mar Apr Oct Nov Dec 1982-1991

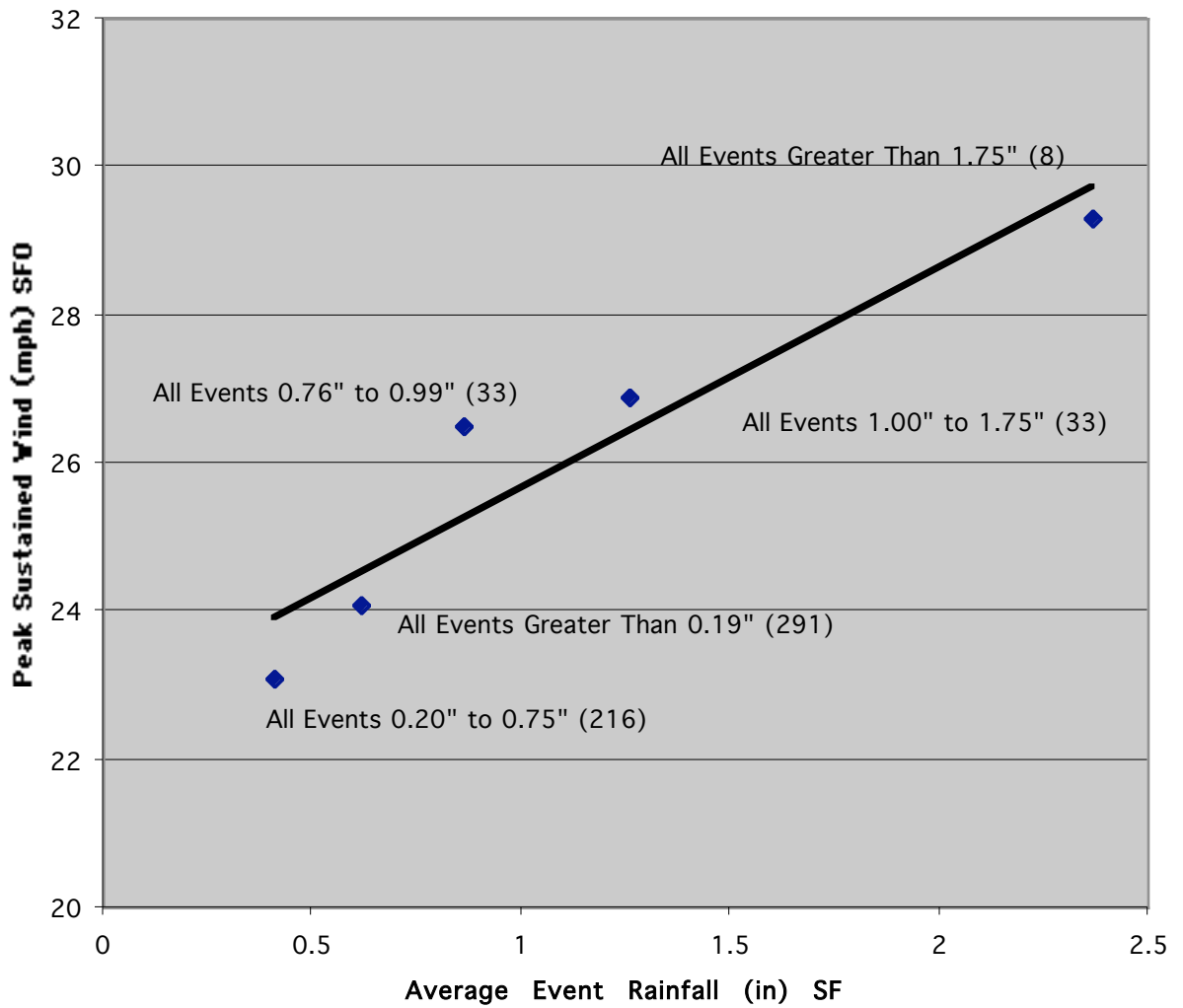


Figure 1. Average Event Rainfall and Sustained Winds (Explained in Text) for Downtown San Francisco.

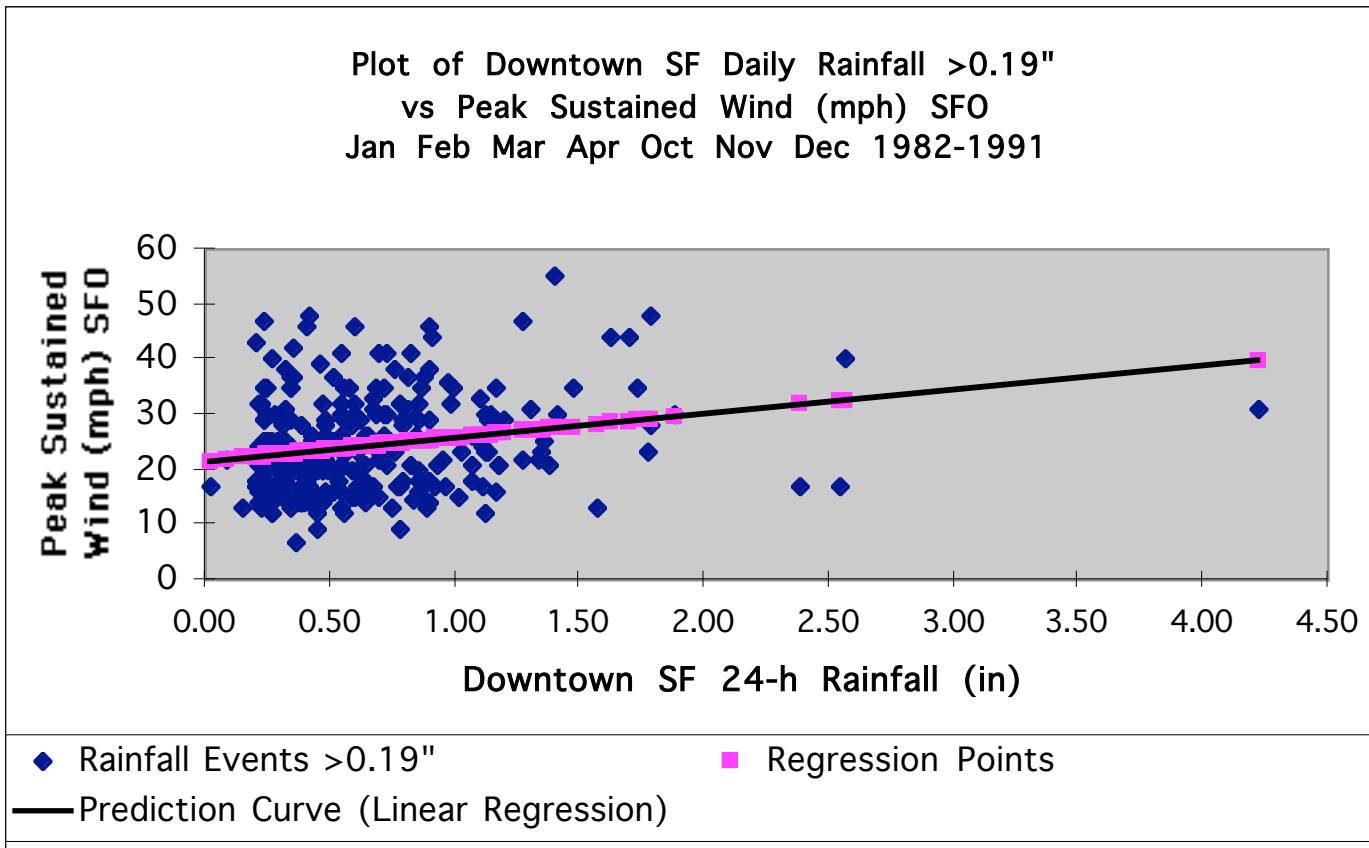


Fig. 2. Plot of Downtown SF Daily Rainfall >0.19" vs Peak Sustained Wind (mph) at SFO for the Period 1982-1991, as explained in Text.