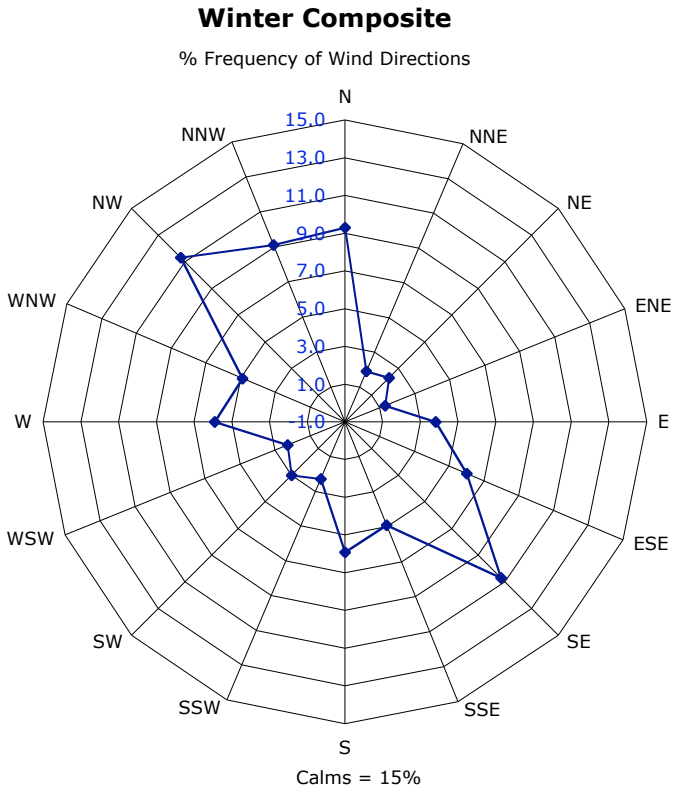
Background Information: Wind and Rainfall Climatology for the Lake Merritt Area of Oakland, CA: Period 1950-1970



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for

Mayacamas Weather Consultants

Report on Wind and Rainfall Climatology
for the Lake Merritt Area of Oakland, CA: Period 1950-1970

A. Assignment

The consultant was given the task of reporting on the general wind conditions and rainfall conditions in the area of Lake Merritt, Oakland, CA for the period 1950-1970. In particular, he was asked to obtain general wind directions and wind speeds and monthly rainfall on the basis of techniques used by meteorologists to estimate such conditions if site observations are not available.

B. Location of Property and Data Limitations

The site for which climatological information was to be estimated is near the western side of Lake Merritt in Oakland, CA (see Fig. 1 for locations). During the period 1950-1970, there was no official National Weather Service recording site located at or near the property, although there is more recent rainfall information for Oakland Museum. Although there is long term wind and rainfall information for Oakland International Airport (KOAK), Alameda Naval Air Station (KNGZ) is located much closer, only about 3 miles WSW of the site, and does have summarized wind information for the period.

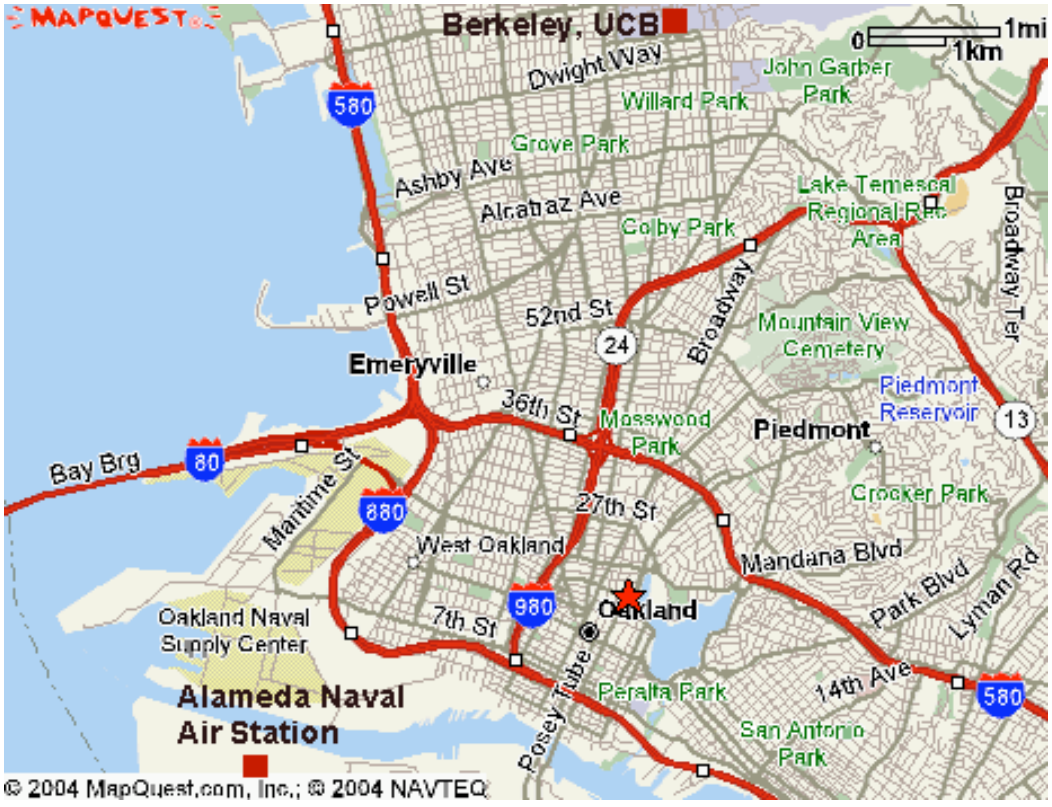

Figure 1: Location Map. Star marks approximate location of site for which information is estimated. Location of nearest long term wind site (Alameda Naval Air station) and rainfall information (Berkeley, UCB) shown by read squares.

In addition, KNGZ is situated at the same latitude as the site with respect to the Golden Gate, and could be expected to experience similar wind directions and wind speeds, although speeds at KNGZ would be slightly greater due to its greater open exposure. Influence of the buildings around Lake Merritt could lead to either greater or lesser wind speeds in the vicinity of the site than at KNGZ, depending upon the point of estimation and would be impossible to estimate without a site study. With all these factors considered, the consultant makes the judgment that the wind information for KNGZ is most representative of conditions at the site during the period in question.

Also, although long term rainfall information is available for KOAK, its average annual rainfall (as well as monthly totals and sequencing of daily rainfall amounts) would be less representative of those on the site than the totals from the National Weather Service cooperative observing point at University of California, Berkeley. Moreover, the consultant was the actual weather observer at UC Berkeley during the late 1960s and 1970s and can vouch for the accuracy of those totals. Moreover, the mean annual rainfall at UC Berkeley is roughly the same as that at the site as estimated from annual precipitation maps (around 23 inches) whereas the mean annual rainfall at KOAK is slightly less than 18 inches. With all these factors considered, the consultant makes the judgment that the rainfall information for the UC Berkeley site is most representative of conditions at the site during the period in question.

C. Sources of Information Used in this Report

The consultant used the following information (either included in report or as an attachment) in arriving at his opinions regarding the wind conditions at the accident site:

- Weather information at official NWS observation sites at Berkeley, and KOAK [archived and available from Western Regional Climate Center (www.wrcc.dri.edu) and the National Climatic Data Center (http://lwf.ncdc.noaa.gov/oa/ncdc.html)]

- Summarized wind information for Alameda Naval Air Station from California Air Resources Board, 1984: California Surface Wind Climatology

D. Qualifications of Consultant

The consultant is a Professor of Meteorology at San Francisco State University and has taught there since 1979. He holds the BA, MA and PhD degrees and also has been certified by the American Meteorological Society (AMS) by oral and written exams as competent to serve as consultant in the area of meteorology and has been awarded the status of Certified Consulting Meteorologist (CCM). The consultant's research area is in severe and unusual weather in California and he has authored many refereed publications in the meteorological literature and several technical memoranda. He has served as Co-Editor of the AMS journal *Weather and Forecasting*, as a member of the AMS Committee on Severe Local Storms, and as Chair of the Department of Geosciences at San Francisco State University. My rates for consulting are $275 per hour of my time

with a minimum of 3 hours for expert witness testimony and 1 hour minimum plus expenses for deposition.

E. Interpretation of the Wind Information

i. Wind roses and average speed histograms

Meteorologists often array wind information not in tabular form, which is difficult to visualize, but in a circular table called a "wind rose". The wind rose is a way of portraying the frequency (usually as a percentage of the total number of observations) that the wind direction lies on one of the 16 compass points.

Each of the points in the 16-point circular display is labeled with the wind direction (as the direction from which the wind is coming). The circular rings within this circular display represent the percentage frequency that each of the shown wind directions was observed during the period of record.

For the purposes of this study, the period of record (1945-1968) is broken into seasonal quarters, as follows: (a) Winter – December, January, February; (b) Spring – March, April, May; (c) Summer – June, July, August; (d) Fall – September, October, November. The wind rose for winter, for example, would show the frequency (based upon the total number of observations during all Decembers, Januarys, and Februarys in the period 1945-1968) that the given wind direction occurred as a percentage of the total number of observations. In the case of KNGZ, observations were available for each hour of the day.

Although some wind roses have the average wind speed for each of the wind directions also shown, the consultant chose to display those on a separate histogram chart, placed directly under the corresponding wind rose.

ii. Summer Wind Information

Summer wind information at the site during the period can be estimated from Fig. 2(a) and 2(b), the summer wind rose and wind speed histogram for KNGZ. The dominant wind (prevailing wind) is clearly westerly. Note that the average wind speed of westerly winds is over 12 mph. Only the spring wind pattern has an average wind speed that is that great. The fact that winds are almost uniformly from a westerly quadrant during the summer is indicated by the fact that nearly 72% of all observations during the summer are either SW, WSW, W, or WNW.

This is consistent with the meteorology of the region, in which onshore (from the ocean) flow occurs nearly incessantly from the offshore Pacific High pressure area to the California Thermal Low to our east. These circulation features begin dominating the weather of the region in late Spring and continue through early Fall.

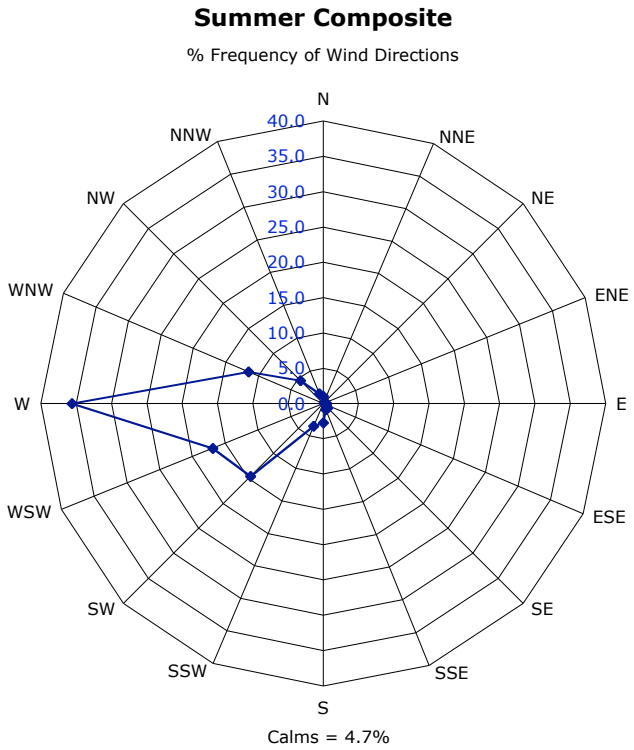

Figure 2(a): Summer Composite (June, July and August) Wind Rose. Wind direction defined as the direction from which wind is blowing (e.g., W = west wind...wind moving from west to east). Wind rose shows number of observations of a given wind direction as a percentage of the total hourly observations in 24 hours for each day of 3 month period.

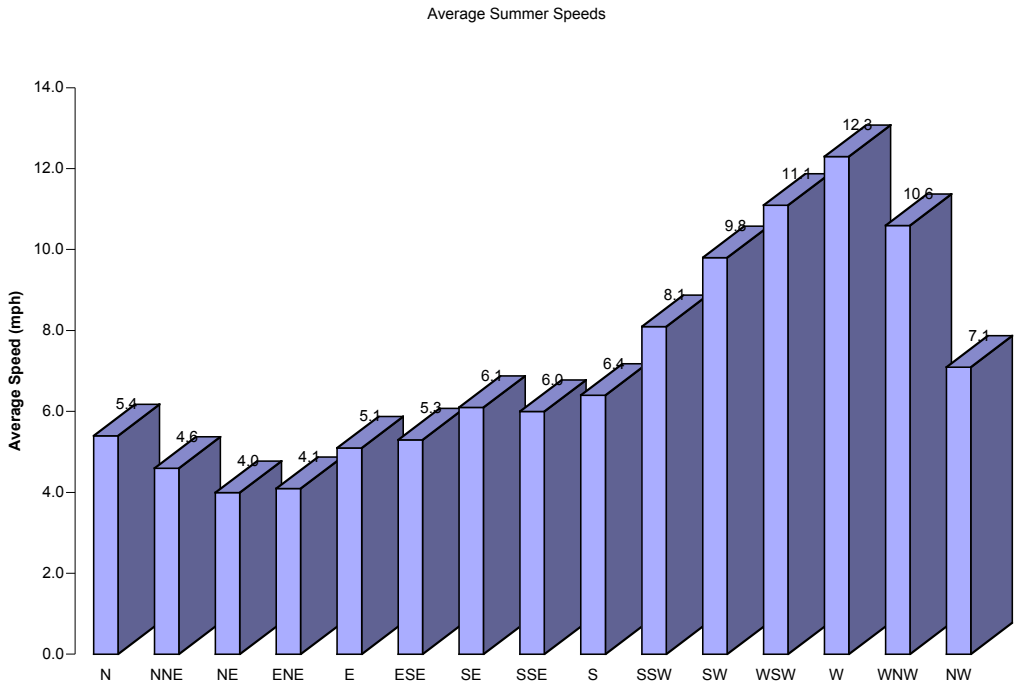

Figure 2(b): Summer Average Wind Speeds (mph) for each direction shown in Fig 2(a)

iii. Winter Wind Information

Winter wind information at the site during the period can be estimated from Fig. 3(a) and 3(b), the winter wind rose and wind speed histogram for KNGZ. The dominance of the westerly wind in the summer is no longer apparent. Two factors explain the double prevailing wind direction (northwest and southeast). First, the part of the pressure pattern dominated by heating/cooling effects of the continent and the oceans is reversed from summer to winter, so that high pressure lies on the continent and lower pressures offshore, particularly at night. This results in southeasterly flow.

During the day, a weak onshore pressure gradient returns as the continent warms, resulting in a tendency for northwest winds to be observed. But also, winter storms that approach the coast often have southerly or southeasterly winds ahead of them, and northwest winds behind. All these factors together account for the marked difference in the winter wind rose for the summer wind rose.

Since winter storms often have strong winds just ahead (in the southeast flow) and behind (in the northwest flow), the strongest wind speeds in Fig. 3 (b) are associated with these two wind directions.

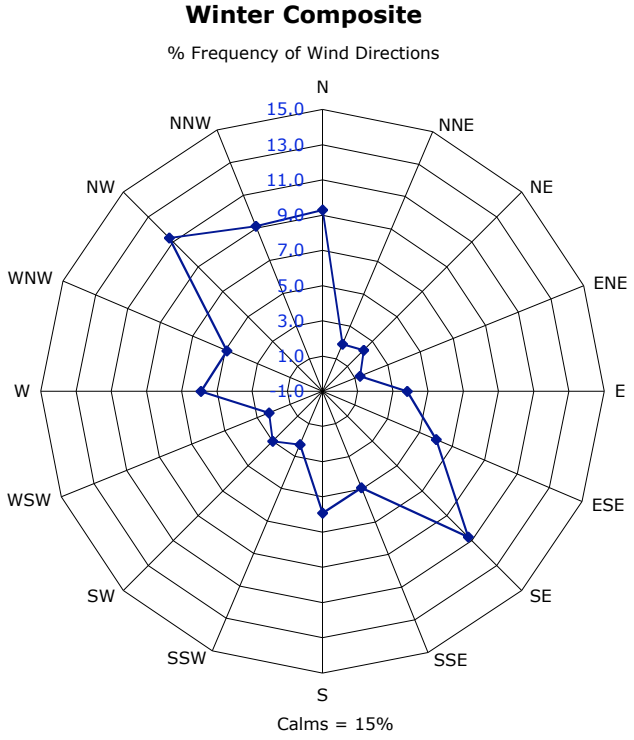

Figure 3(a): As in Fig 1(a) except for Winter Composite (December, January, February) Wind Rose.

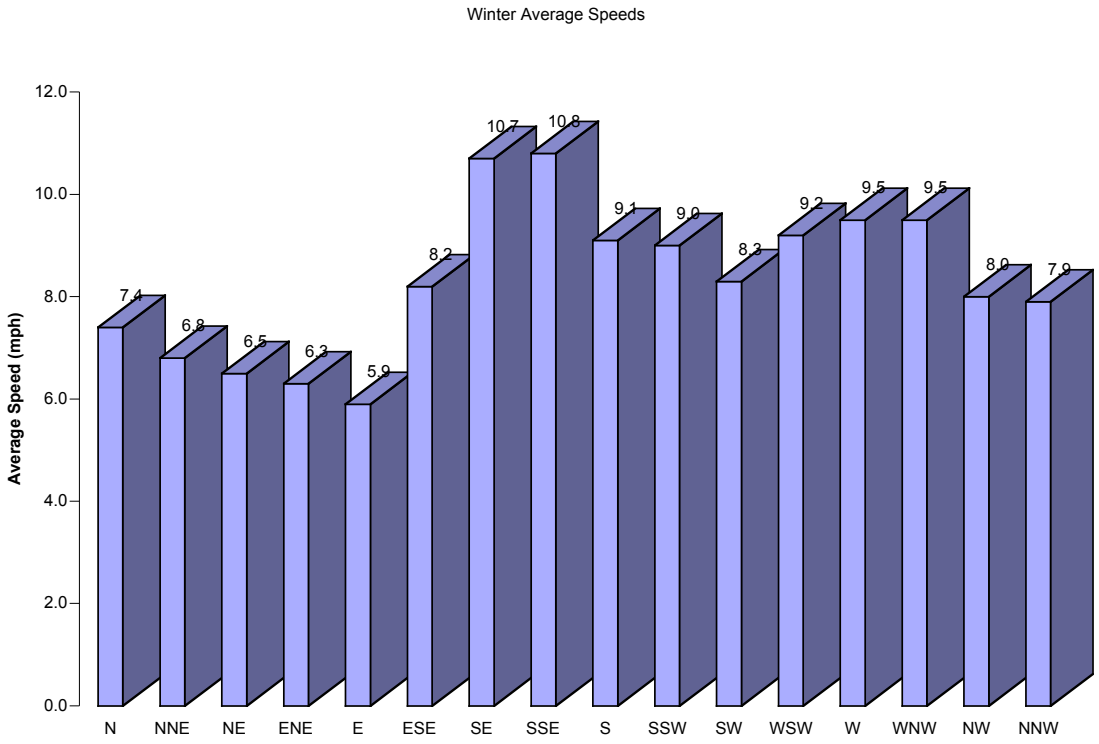

Figure 3(b): Winter Average Wind Speeds (mph) for each direction shown in Fig 3(a)

iii. Spring and Fall Wind Information

Spring wind information at the site during the period can be estimated from Fig. 4(a) and 4(b) and 5(a) and 5(b), the spring and fall wind roses and wind speed histogram sfor KNGZ. While cool season storm systems still bring a good frequency of southeast winds to the area early in the spring and late in the fall, the dominance of the summer pattern begins to emerge in April and May and still are persistent in September and the early part of October. This is reflected in the return to dominance of the westerly winds (in Figs. 4(a) and 5(a)) but the appearance of relatively strong speeds in the east-southeast, southeast and south-southeast directions. Another maximum in wind speeds and in direction frequency occurs in the north direction, probably due to the occasional occurrences of offshore (Diablo) winds in the late spring, and, particularly, early fall.

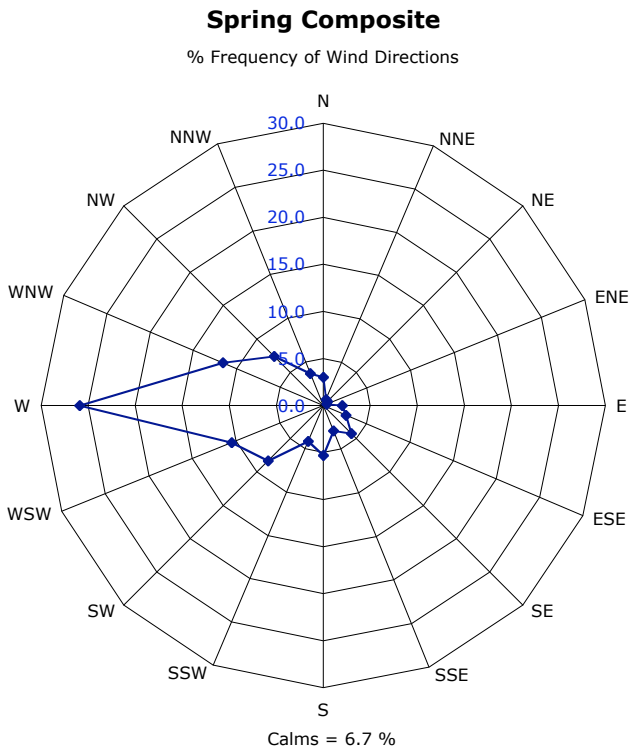

Figure 4(a): As in Fig 1(a) except for Spring Composite (March, April, May) Wind Rose.

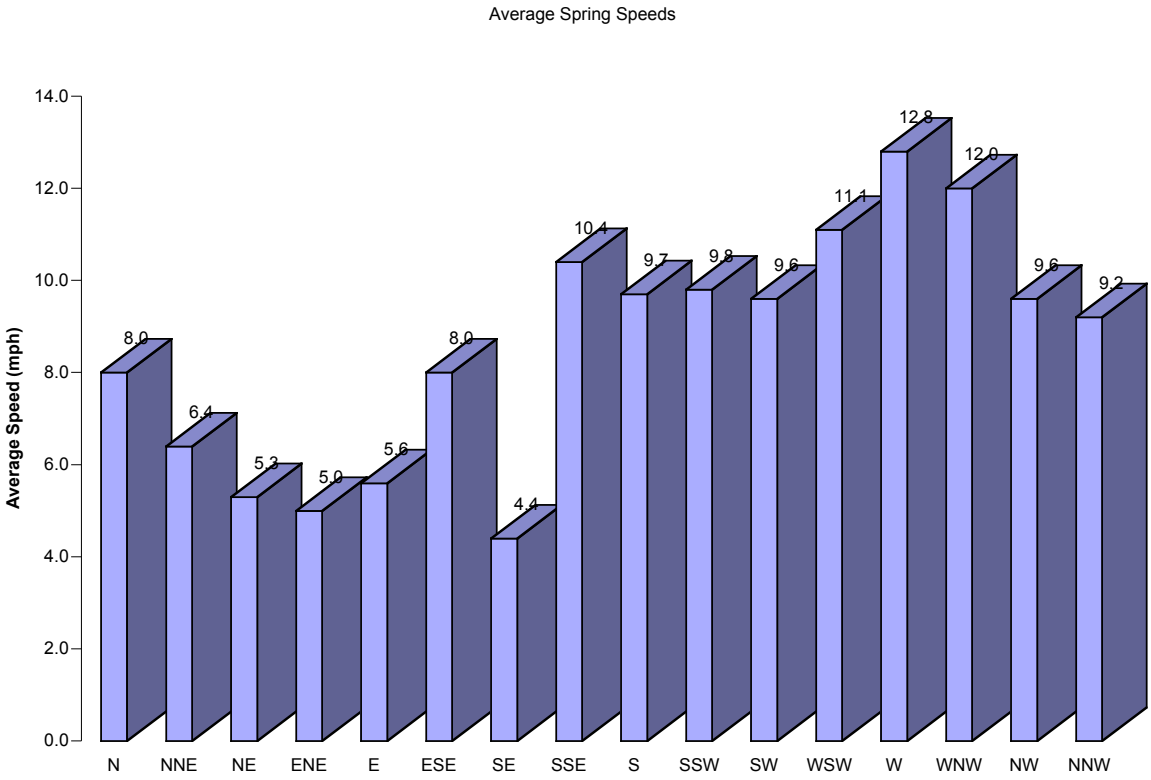

Figure 4(b): Spring Average Wind Speeds (mph) for each direction shown in Fig 4(a)

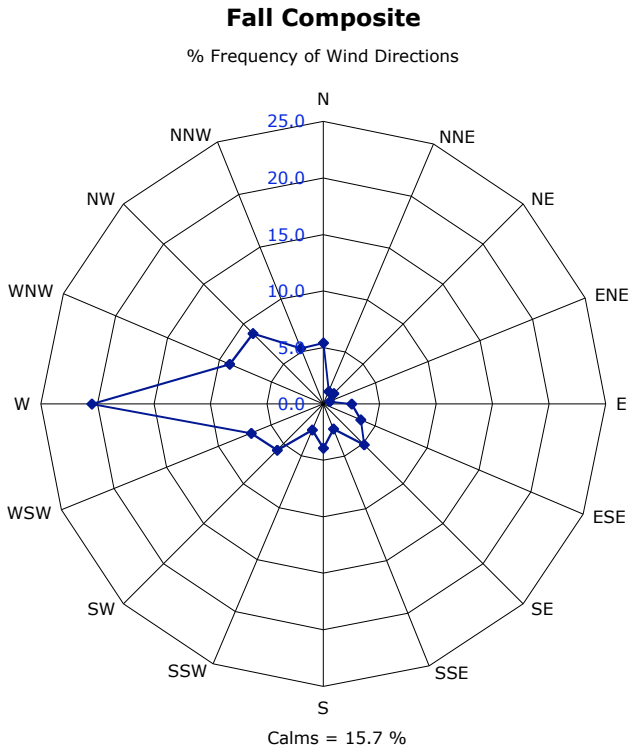

Figure 5(a): As in Fig 1(a) except for Fall Composite (September, October, November) Wind Rose.

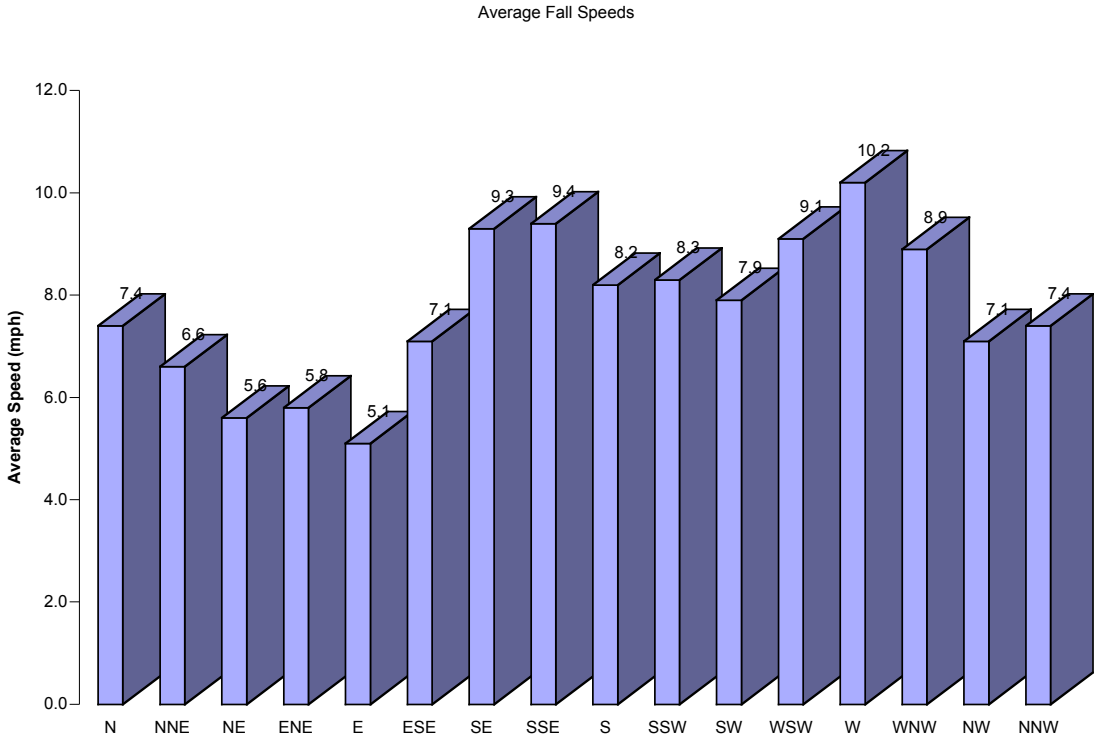

Figure 5(b): Spring Average Wind Speeds (mph) for each direction shown in Fig 5(a)

F. Rainfall Information

The monthly rainfall information for the site can be assumed to be similar to the rainfall for the Berkeley site, as explained above. This information is included in Table 1.

Table 1 gives the monthly rainfall for each month in the calender year for the period 1950-1970. The consultant has also included the annual total and the monthly and annual averages for this period for comparsion purposes.

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
1950	8.73	2.93	3.00	1.01	0.50	0.02	0.01	0.00	0.00	3.28	7.42	6.67	33.57
1951	5.03	2.58	1.53	1.24	0.94	0.02	0.00	0.48	0.06	1.70	4.82	9.58	27.98
1952	8.92	2.47	4.81	1.27	0.25	0.74	0.00	0.00	0.00	0.07	2.34	9.28	30.15
1953	4.70	0.00	2.80	2.91	0.53	0.34	0.00	0.08	0.00	0.49	2.16	0.71	14.72
1954	3.67	2.95	4.20	1.18	0.13	0.25	0.00	0.27	0.00	0.14	2.98	6.07	21.84
1955	5.46	1.24	0.43	1.84	0.20	0.00	0.00	0.00	0.03	0.05	2.23	15.04	26.52
1956	7.23	3.54	0.03	1.90	1.06	0.00	0.00	0.00	0.25	2.48	0.05	0.26	16.80
1957	2.81	4.06	3.34	1.65	3.56	0.06	0.00	0.00	1.64	2.94	0.52	3.78	24.36
1958	5.48	9.14	7.06	6.06	0.29	0.24	0.00	0.04	0.10	0.31	0.16	1.42	30.30
1959	4.69	4.63	0.58	0.36	0.03	0.00	0.00	0.00	2.62	0.04	0.00	1.54	14.49
1960	3.96	3.56	2.44	1.05	1.00	0.00	0.00	0.00	0.00	0.33	3.89	1.39	17.62
1961	2.73	1.38	3.14	1.11	0.76	0.00	0.00	0.12	0.36	0.12	4.50	2.45	16.67
1962	1.92	8.83	2.92	0.66	0.00	0.00	0.00	0.12	0.41	7.05	0.94	3.50	26.35
1963	4.84	3.10	3.51	5.97	0.53	0.08	0.00	0.06	0.10	1.61	3.38	0.60	23.78
1964	4.96	0.16	2.21	0.05	0.32	0.76	0.00	0.01	0.00	1.28	3.63	8.27	21.65
1965	4.53	0.88	2.10	3.79	0.00	0.00	0.02	0.18	0.00	0.17	5.77	3.56	21.00
1966	4.76	3.38	0.67	0.73	0.16	0.12	0.09	0.17	0.13	0.00	4.92	4.48	19.61
1967	10.34	0.35	5.60	5.73	0.07	1.21	0.00	0.00	0.02	0.56	1.56	2.23	27.67
1968	6.16	3.04	3.84	0.44	0.23	0.00	0.00	0.55	0.00	0.81	2.89	5.13	23.09
1969	9.22	8.76	1.44	2.46	0.00	0.03	0.00	0.00	0.00	2.12	1.43	8.47	33.93
1970	11.14	1.85	1.71	0.00	0.00	0.56	0.00	0.00	0.00	0.94	7.79	7.52	31.51
Mean	5.78	3.28	2.73	1.97	0.50	0.21	0.01	0.10	0.27	1.26	3.02	4.85	23.98

Table 1. Monthly and Annual Rainfall, 1950-1970, for Berkeley, CA (Earth Sciences Building, UCB)