MASTER

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NETWORK WIND POWER OVER THE
PACIFIC NORTHWEST

prepared by

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DEPARTMENT OF ATMOSPHERIC SCIENCES

Submitted to

BONNEVILLE POWER ADMINISTRATION

Portland, Oregon

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1. INTRODUCTION AND CONCLUSIONS

Since 1975 the Bonneville Power Administration (BPA) has been sponsoring wind power research at Oregon State University. A feasibility study that initially concentrated on the wind power potential in the Columbia River Gorge has expanded to the BPA service area which covers Washington, Oregon, Idaho, western Montana and northern Nevada. Previous BPA reports have documented the progress of this research.

The objectives and conclusions of the investigations during the nine month period, December 1977-August 1978, are summarized below. The details of the research are contained in the rest of the report.

Objectives of the Research

The research conducted had the following objectives:

1. To locate, obtain, compile and analyze existing sources of wind data and to establish new data stations in locations with promising wind power potential.
2. To analyze the wind energy potential of a simulated network of wind turbine generators.
3. To measure the wind profile in the vertical with the TALA kite anemometer over various types of terrain.
4. To make a preliminary analysis of the governing forces that drive the wind over the Northwest.

Conclusions

1. The wind data that have been collected and analyzed indicated that strong and persistent winds occurred over many well exposed areas in the Northwest. The wind flow from January through March 1978 was about 10% lighter than normal over most of the region. Near normal flow was

experienced during the spring and summer although weaker than average winds (about 20%) were observed along the southern Oregon coast and southwest Oregon interior.

2. A network energy analysis using three different designs of megawatt sized wind turbine generators revealed that the turbine network using WTG B design machines had a higher annual capacity factor than the other two turbine networks.
3. A network sensitivity study indicated that wind data from four of six sites were most influential on system parameters. Ranked in overall importance were Cape Blanco, Oregon; Augspurgen Mountain, Washington; Goodnoe Hills, Washington; and Wells, Nevada.
4. Cut-out speeds of large megawatt sized turbines should be at least 60 mph to take advantage of the strong winds at Cape Blanco, Goodnoe Hills, and Kennewick.
5. Wind speed profile measurements up to 400 ft. at several prime potential wind power development areas indicated relatively little change of wind speed with height above the 100 ft. level. A noticeable exception was at Cape Blanco where a large wind shear was recorded in the lowest 200 ft.
6. Preliminary calibration studies on the TALA kite anemometer suggested a probable error of $\pm 2\%$.
7. Preliminary wind flow analysis indicated generally poor correlation between wind speed and pressure gradient over the mountainous terrain in the Northwest. More refined analysis should pinpoint the important variables governing the wind flow.

II. DATA COLLECTION AND ANALYSIS

Wind Data Stations

Climatological Wind Analysis for the Period
December 1977 - August 1978

Wind Data Stations

Wind data have been collected and analyzed from 74 locations in the Pacific Northwest. These stations are located on the map in Figure 1 and pertinent station data are listed in Tables 1a and 1b. Hourly data are available from 24 of the stations, four to six hourly data are available from 11 locations, and monthly wind speed averages are available from 38 stations. During the past nine months 13 new anemometer stations were established, wind data were collected from three Coast Guard stations, and 10 data stations were removed and relocated.

The wind summaries for these data stations are tabulated in Appendices A-D. Wind summaries consisting of wind rose analyses, diurnal speed analyses, effective power density and usable wind data, and speed frequency distribution data are listed for 13 of the stations. High wind summaries are also listed along with monthly wind speeds for most of the stations for the period December 1977 - August 1978. Other wind summaries are also contained in the Appendices.

Figure 1. Anemometer station locations.

Table 1a. Anemometer site data

	Station Elevation MSL(ft)	Anemometer Height(ft)	Period of Record	Remarks*		Station Elevation MSL(FT)	Anemometer Height(ft)	Period of Record	Remarks*
1. Gold Beach	720	40	8/76-current	5	19. Wasco Lookout	2346	100	9/77-9/78	1
2. Cape Blanco CGLS	200	20	1968-72 10/76-current	3	20. Seven Mile Bell	1840	40	3/77-current	4
3. Cape Blanco BPA	200	40	10/76-current	1	21. Ortley	1880	30	4/77-current	1
4. Cape Blanco Airport	200	50	2/76-2/78	1	22. Ortley Point	2040	30	4/77-current	4
5. Langlois Mtn.	1200	30	10/76-current	4	23. Sauter Ranch	1360	30	4/77-current	5,4
6. Leneve	607	120	8/76-current	4	24. Tygh Ridge	3083	50	10/76-4/78	5
7. Mt. Hebo	3149	40	11/77-current	1	25. Wasco	1800	30	9/76-current	4
8. McCulloch Peak	2200	30	5/76-2/78	4	26. Biggs	650	30	10/77-current	4
9. Prairie Mtn.	3200	50	7/76-current	4	27. Goldendale Bell	2000	40	10/77-current	4
		100	10/77-current	1	28. Shutler Flats	1200	40	9/76-current	4
10. Newberg Ridge	1530	60	8/77-current	4	29. Goodnoe Hills	2400	45	4/76-current	1
11. Corbett	960	27	1/77-1/78	4	30. Hurlburt Flats	603	50	9/76-current	5
12. Biddle Butte	1465	40	11/77-current	1	31. Boardman	320	30	12/76-current	1
13. Augspurger Mtn.	2880	60,150	12/76-1/78	1	32. Kennewick	2050	105	6/76-current	1
		40	4/75-4/78	1	33. Sunnyside	3000	45	4/76-3/78	1
		75	7/78-current	1				5/78-current	4
14. Wind Mtn.	960	40	6/76-current	4	34. Wanapum Dam	520	40	6/74-current	2
15. Mosier	640	23	2/77-current	4	35. Beverly	2320	60	12/76-5/78	5
16. Klickitat Ridge	1540	30	5/77-2/78	4	36. Royal Slope	1100	30	10/77-current	5
17. KCIV	3120	45	6/74-current	1	37. La Grande Haines	4000	30	10/77-2/78	4
18. Echelman Farm	2013	30	5/77-3/78	4	38. La Grande Elevator	3149	136	10/77-current	1

* Remarks

1. Hourly average velocities taken from strip charts.
2. Five minute average velocity observations taken hourly.
3. Velocity observations taken every four hours.
4. Monthly average speed data (wind run anemometer).
5. Wind spectrum analyzer data.
6. Six hour average velocities taken from strip charts.
7. Instantaneous hourly value.

Table 1b. Anemometer site data

	Station Elevation MSL(ft)	Anemometer Height	Period of Record	Remarks*		Station Elevation MSL(ft)	Anemometer Height(ft)	Period of Record	Remarks*
39. John Day Airport	3665	40	1/77-current	1	57. Mt. Baker	5040	30	1969-current	6
40. Coyote Hills	6700	35	9/76-current	4	58. Mission Ridge	6730	30	1970-current	6
41. Adel	6571	50	8/76-4/78	4	59. Sun Valley	9100	20	1968-current	6
			4/78-current	1					
42. Pequop Summit	7538	40	4/76-current	1	60. Jackson Hole	10300	30	1968-current	6
43. Wells West	6400	35	3/77-current	4	61. Bridger Bowl	8650	20	1968-current	6
44. Wendover	4237	30	10/77-current	4	62. Gresham	500	30	3/78-current	4
45. Columbia River Jetty	15	40	12/77-current	7	63. Vantage Farms	890	30	4/78-current	5
46. Prineville Airport	3246	30	3/78-current	1	64. Juniper Ranch	4200	30	6/78-current	4,5
47. Bend Airport	3452	30	2/78-current	1	65. Stinkingwater Pass	5000	30	6/78-current	4
48. Irrigon	300	30	2/78-current	4	66. Radio Hill	5800	30	6/78-current	4
49. Ashland	1300	30	12/77-current	4	67. Ruby Station	5700	60	6/78-current	4
50. Mt. Hood Meadows (Yellow Lift)	5916	40	2/78-current	4	68. Thunderbird Ranch	1000	30	7/78-current	4
51. La Grande Andrews	3149	50	10/77-11/77	4	69. Juniper Point	3100	100	8/78-current	1
52. La Grande Alicel	3149	30	10/77-11/77	4	70. Burdoin Mtn.	2000	40	5/78-current	1
53. Burns Butte	5307	35	12/76-current	4	71. Umatilla Lightship	surface	40	1970	3
54. Mt. Hood Meadows	6600	30	1975-current	6	72. Smith Island	30	30	1975	3
55. Crystal Mountain	6870	40	1968-current 1952-1961	6	73. Pt. Wilson	30	30	1975	3
56. Stevens Pass	5100	30	1968-current Nov-Apr 1952-61	6	74. Rattlesnake Mtn	3568	10	10/74-10/75 7/76-12/77	1

*Remarks:

1. Hourly average velocities taken from strip charts.
2. Five-minute average velocity observations taken hourly.
3. Velocity observations taken every four hours.
4. Monthly average speed data (wind run anemometer).
5. Wind spectrum analyzer data.
6. Six-hour average velocities taken from strip charts.
7. Instantaneous hourly value.

Climatological Wind Analysis for the Period
December 1977 - August 1978

Mean monthly wind speed data were gathered from several long-term data stations throughout the Pacific Northwest for the nine-month period, December 1977 - August 1978. These data along with data from several wind power data stations were compared to the long-term monthly averages to determine any significant departures from the climatological norm. Long-term data stations and the nearest wind power data stations are shown in Figure 2, and a mean monthly wind speed summary is tabulated in Table 2.

During the first half of December, persistent and strong south to southwest winds were common along the coast and mountainous area. Astoria, Sexton Summit, and Eugene all reported at least a 1.0 mph departure from the norm. The Coast Guard anemometer at Cape Blanco reported a much higher than normal wind speed (a departure of over 5 mph from the norm). However, a complete month of data was not available and the true average was probably 22 - 23 mph rather than 25.9 mph. The BPA anemometer has much better exposure to the flow from these directions than the Coast Guard anemometer. The wind power data stations along the coast and in the Coast Range reported moderate to strong flow, especially during the first half of the month.

Wind flow in the Columbia Gorge during December was also strong as west winds prevailed through the first half of the month. Portland's winds were over 3 mph higher than the normal while the flow at Pendleton exceeded the average by 1.2 mph.

Figure 2. Wind power data stations (solid stars) and the nearest long-term data stations (open stars).

The winds in northeastern Nevada appeared to be slightly stronger than normal especially during the first half of December as strong southwest winds prevailed. The somewhat sheltered Elko Airport reported almost a 1 mph higher than normal speed. Wind data from Pequop Summit were missing in December but the winds probably averaged 20 - 25 mph for the month.

During the latter part of December and in January, February, and March, storm movement frequently skirted south of Oregon and moved through central and northern California which resulted in numerous floods and high winds in that area. The winds along the northern Oregon coast were lighter than normal as east winds prevailed. Monthly departures from normal of wind speed at Astoria ranged from 1.0 to 1.5 mph.

Table 2. Mean monthly wind speeds (mph) at several national weather service and wind power data stations for the period 12/77-8/78. Long term averages are also given.

Station	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	AVG
Columbia River Jetty	16.6	13.5	11.9	11.0	11.2	M ²	M ²	8.7	9.2	11.9
Astoria	11.2	7.8	7.9	7.8	8.3	8.9	7.8	8.1	8.5	8.5
Astoria 1941-70	9.2	9.3	8.9	9.0	8.6	8.4	8.3	8.3	7.8	8.6
Cape Blanco BPA	26.2 ¹	25.4	25.2	19.8	25.9	21.3	14.5	20.2	19.4	22.0
Cape Blanco CGLS	25.9	18.6	21.5	13.8	18.4	16.7	11.5	14.7	12.5	17.1
Cape Blanco CGLS 1968-72	20.9	19.9	17.8	18.5	17.6	15.5	14.7	16.0	14.9	17.3
Prairie Mountain	17.8 ¹	17.6	27.9 ¹	17.8 ¹	13.8	24.7	8.4	7.0	17.9	15.6 ⁴
Eugene	9.1	7.0	7.3	6.8	7.8	7.5	7.2	7.4	7.8	7.5
Eugene 1941-70	7.7	8.3	7.9	8.6	7.7	7.4	7.4	8.0	7.5	7.8
Sexton Summit	14.4	13.2	13.0 ¹	8.8	10.2	10.4	7.6	9.5	9.0	10.7
Sexton Summit 1941-64	13.3	12.8	12.5	11.7	10.6	10.2	11.1	11.8	10.9	11.7
Augspurgen Mountain	19.6 ¹	M ²	M ²	M ²	13.2 ¹	M ²	M ²	21.6	16.8	18.5 ⁴
Portland	12.9	10.5	9.7	7.8	8.3	8.2	7.8	7.7	8.0	9.0
Portland 1941-70	9.6	10.0	8.9	8.4	7.2	6.9	7.0	7.5	7.1	8.1
Goodnoe Hills	15.3	6.7 ¹	M ²	15.0	17.6 ¹	M ²	19.8 ¹	17.6	18.2	16.0
Kennewick	20.5	12.7 ¹	12.9 ¹	16.0	19.6	16.9 ¹	18.5 ¹	16.3	13.7 ¹	16.7
Pendleton	9.7	7.1	7.8	8.0	10.7	13.5 ¹	M ²	M ²	M ²	9.5

¹Data recovery less than 85%

²Missing data (M)

³Computed from Dec-May data

⁴Probably not representative of the true annual average because of missing data.

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[illegible]¹Data recovery less than 85%²Missing data (M)³Computed from Dec-May data

⁴Probably not representative of the true annual average because of missing data

The wind flow at Eugene was also lighter than normal. Frequent high winds did occur along the southern Oregon coast as the storms moved into California. The BPA anemometer at Cape Blanco recorded average wind speeds exceeding 25 mph in January and February and recorded numerous occasions where the wind exceeded 50 mph as noted in the High Wind Summary (see Appendix D). Highest winds recorded were on 8 February when a 90 mph hourly average speed was recorded for a two hour period. Gusts exceeded the upper limit of the strip chart recorder (100 mph) and are estimated to have been in the 105 - 110 mph range. For the same day the southeast winds at Sexton Summit averaged over 19 mph for the day and the maximum speed recorded was 52 mph.

Southeasterly flow prevailed at Sexton Summit in January and February and was slightly stronger than normal. It appears that the winds along the southern Oregon coast were slightly stronger than normal although the Coast Guard anemometer reported a 1.3 mph lower than normal average in January. The reason for this is probably anemometer exposure. However, the February mean monthly wind speed at the Coast Guard station was about 4 mph higher than normal.

East winds were frequent through the Columbia Gorge in January and February which resulted in lighter winds at Goodnoe Hills and Kennewick. The wind flow at Portland was slightly stronger than normal as east to southeast winds prevailed. Wind data were not available from Augspurgen Mountain but it is estimated that the mean monthly wind speeds there during these two months probably averaged 13 - 15 mph as persistent and moderate east flow prevailed. The wind flow at Pendleton was also noticeably lighter than normal in January and February as the departure ranged from 1.1 - 1.3 mph.

It appears that the winds were fairly normal in the Wells area in January and February. The Pequop Summit anemometer recorded persistent westerly winds that averaged 20 mph. The Elko anemometer speeds for January and February were in close agreement with the climatological average.

The wind flow during March appeared to be slightly lighter than normal over the Northwest. Storms did not move through the region as often as normal which resulted in lighter winds along the coast and in the interior. All of the long-term data stations reported lighter winds than normal. Departures from normal along the coast ranged from 1.2 mph at Astoria to 4.7 mph at the Cape Blanco CGLS station. In the interior a 2.9 mph departure was noted at Sexton Summit, 1.8 mph at Eugene, 0.6 mph at Portland, 2.1 mph at Pendleton, and 1.2 mph at Elko.

During April and May fairly normal winds were experienced along the coast and in the Coast Range. The wind flow recorded at Portland was slightly stronger than normal during these two months as west to northwest winds prevailed. The prevailing southwest flow at Pendleton averaged near normal in April and probably slightly above normal in May. Only six days of wind data were available from Pendleton in May before the anemometer failed. The wind flow in northeast Nevada appeared to be near normal in April and May as recorded by the Elko anemometer.

Summer winds appeared to be near normal along the northern Oregon coast. The winds reported at Astoria agreed quite closely with the climatological norm. However, the prevailing north winds along the southern Oregon coast and in the Coast Range appeared to be lighter than normal. The Coast Guard station recorded 3.5 - 4.7 mph departures while those at Sexton Summit varied from 1.9 - 3.5 mph.

Near normal northwest flow was reported at the Portland Airport during the summer. The westerly flow through the Columbia Gorge appeared to be near the expected normal. Winds in northeast Nevada were near normal also. The Pequop Summit wind data averaged 12 - 14 mph during the period.

In summary, it appears that the wind flow was lighter than normal during the winter, especially from January through March. Spring and summer winds were close to normal over most of the Northwest. Significantly lighter than normal flow was recorded along the southwest Oregon coast and interior during the summer.

III. NETWORK WIND ENERGY ANALYSIS

Network WTG Study for Three Different
Designs of Turbines

WTG Network Sensitivity Study for
Six Potential WTG Development Areas

Effect of Cut-Out Speed on Annual
Energy Production

Network WTG Study for Three Different Designs of Turbines

The hourly power generated from a network composed of three different designs of wind turbine generators (WTGs) for the period December 1976 through November 1977 was calculated to determine how each network of WTGs performed. These designs are representative of various manufacturer's turbines and offer a reasonable range of performance characteristics. Wind data from six stations in the BPA service area shown in Figure 3 were used to determine the energy output at each station and for the network. The sea level/hub height performance curves were adjusted for the site anemometer height and station elevation as described in BPA Report 77-2. The energy output was investigated assuming a power law exponent, α , of 0.2. The array number and capacity are listed in Table 3.

All three turbine designs are large megawatt sized units, but their performance data vary significantly, as illustrated in Figures 4-6. The different designs are labeled WTG A, WTG B and WTG C. WTG A is a two-bladed upwind system with a hub height of 200 ft and a blade diameter of 300 ft. The rated speed varies from 28 mph for the 2.5 MW machine to 35 mph for the 4.5 MW turbine. The cut-out speed for this unit is 45 mph. WTG B is a two-bladed downwind system that has a hub height of 180 ft, a blade diameter of 260 ft, and a rated speed that varies from 27 mph for the 2.0 MW turbine to 34 mph for the 4.0 MW turbine. The cut-out speed is 60 mph. WTG C is a three-bladed upwind system with a hub height of 150 ft, a blade diameter of 165 ft and a rated speed that varies from 27 mph for the 1.0 MW WTG to 39 mph for the 3.0 MW WTG. This turbine has no cut-out speed.

The turbine size was chosen on the basis of the strength of the wind speed regime at each location. The stations' annual mean wind speeds are indicated in Table 3 and vary from 13.5 mph at KCIV to 18.1 at Cape

Blanco. In general, the maximum energy output of a WTG is achieved when the rated wind speed of the WTG approximately equals twice the annual mean wind speed, $\bar{V}$. The turbine sizes were chosen at each of these sites based on this rule of thumb. The number of WTG units at each site was determined from the land area availability and the spacing of the turbines in the wind flow regimes. These numbers are the same as those used in BPA Report 77-2. The total installed capacity for the 965-unit WTG network was 3022.5 MW for the WTG A array, 2540 MW for the WTG B array, and 2160 MW for the WTG C array.

The monthly and annual energy outputs and the capacity factors for the three different arrays are noted in Table 4. The monthly and annual energy outputs for the three simulated arrays cannot be compared directly with each other since the physical size and kilowatt rating of the different manufacturer's WTGs and thus the installed capacity at each site and for the network vary. However, the monthly and annual capacity factors do give a measure of how effectively the individual WTG designs are matched to the individual site wind regimes. The capacity factors were highest for the WTG B; the values varied from 0.24 to 0.48 and averaged 0.37. Next highest monthly capacity factors were found for the WTG A array where the values varied from 0.23 to 0.40 and averaged 0.33. Monthly capacity factors varied from 0.18 to 0.39 for the WTG C turbine and averaged 0.27.

The annual network energy output for the three arrays is illustrated in Table 5. The WTG B array performed with 50% of capacity nearly 31% of the time, while the WTG A machine performed at this level about 24% of the time. The WTG C array output equalled or exceeded 50% only 17% of the time. Full output rarely occurred for all three arrays while zero network output varied from 1.7 to 2.7% of the time.

It appears that the WTG B design provided the best match to the wind regime during the one-year test period as indicated by the highest

capacity factors. Although the WTG A cut-in speeds are the lowest of the three designs, the low cut-out speed, 45 mph, limited the ability of this array to produce power with winds in the 45 - 60 mph range which occur quite often at most of the six sites. Considering that the winds in this range generate full-rated power, the effect on the total energy generation capability is significant as described later in this section. In contrast, the shorter bladed WTG C design has a higher rated wind speed than the other two comparable sized designs and the generator appears to be oversized for the blade diameter for the given wind regimes.

Table 3. WTG array number and capacity.

Location	No. of WTGs	Unit Capacity (MW)			$\bar{V}$ (mph) ¹
		WTG A	WTG B	WTG C	
Augspurger Mountain	15	4.5	4.0	2.0	16.7
Columbia Hills (KCIV)	60	2.5	2.0	1.0	13.5
Goodnoe Hills	90	4.5	4.0	3.0	17.2
Kennewick	400	2.5	2.0	2.0	16.7
Cape Blanco	200	4.5	4.0	3.0	18.1
Wells	<u>200</u>	<u>2.5</u>	<u>2.0</u>	<u>2.0</u>	15.8
Network	965	3022.5	2540	2160	

1. Mean annual wind speed for the period Dec 1976 - Nov 1977.

Figure 3. WTG Network

Figure 4. WTG C Output Curve (Sea Level/Hub Height).

Figure 5. WTG A Output Curve (Sea Level/Hub Height)

Figure 6. WTG B Output Curve (Sea Level/Hub Height)

Table 4. Monthly and annual energy output (MWH) and capacity factors for a 965-unit WTG network made up of three different designs of WTGs.

	DEC76	JAN77	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	TOTAL
WTG A	565900 0.25	490900 0.23	708100 0.35	902200 0.40	678100 0.31	764300 0.33	811000 0.38	884800 0.38	850800 0.37	668900 0.32	732800 0.31	756800 0.37	8814600 0.33
WTG B	511800 0.28	436300 0.24	716800 0.42	906100 0.48	631700 0.35	732700 0.38	737500 0.41	768500 0.40	744400 0.38	647700 0.37	658900 0.35	769000 0.42	8252500 0.37
WTG C	317900 0.20	270000 0.18	509700 0.35	625500 0.39	367400 0.24	467000 0.29	399600 0.26	410500 0.25	438500 0.26	372100 0.25	411800 0.25	593300 0.37	5183400 0.27

Table 5. Network energy statistics for three different designs of WTGs. (ACF = Annual Capacity Factor)

	ZERO OUTPUT(%)	±50% OUTPUT(%)	FULL OUTPUT(%)	ACF	TOTAL INSTALLED CAPACITY(MW)	TOTAL ANNUAL ENERGY OUTPUT(MWH)
WTG A	1.7	23.9	0.0*	0.33	3022.5	8814600
WTG B	2.7	30.9	0.4	0.37	2540.0	8252500
WTG C	2.0	16.8	0.2	0.27	2160.0	5183400

*The actual value was 0.02. There were several occurrences when full network output would have been achieved except that winds at one or more of the sites exceeded the cut-out speed, 45 mph.

WTG Network Sensitivity Study for Six
Potential WTG Development Areas

The objective of this study was to determine the effect of different ratios of wind generators at the six sites shown in Figure 7 on several measures of system performance. The period of data used was from December 1976 to November 1977. Principle interest was in the relationship of the site output on the network output, termed synergistic effect. The identification of the best sites for different measures of performance was investigated. Placement costs and a limit on the number of generators at each site were not considered. Also, it was assumed that the wind year studied was 'typical.'

The missing data were extrapolated linearly between the means of equal periods before and after the missing periods. The power that could be potentially generated at a site was found from power/wind speed curve for a 3.5 MW design. The 3.5 MW size was chosen as a compromise between the 2.5 and 4.5 MW size of WTG A described in Figure 5.

The system was studied by running a series of simulations in which statistics on seventeen parameters were gathered on each run (see Table 6 for the parameters and abbreviations). Five of these characterized the system capacity available at least 60% of the time on an annual and seasonal basis. Others characterized the number and length of periods in which the system was at or below 25% capacity. The times between the low power periods were characterized as were the periods in which the system was at more than 75% capacity.

The results of the simulations were analyzed for the evidence of synergistic effects. Table 7 is a summary of this analysis. Each parameter is presented with the number of sites which most significantly affect the parameter. As can be seen, only two parameters, MXLL and AVTB,

Figure 7. Wind data stations.

show that the wind characteristics from three sites (i.e., a three-way interaction) are important. Most often the output of a single site is most important.

To reduce computation time and for clarity of the analysis, only eleven parameters were chosen for the derivation of regression relations. These regression relations enabled the relative importance of the contribution of different sites to a given statistic to be judged. The relation could also be used to estimate the combination of sites which would optimize this parameter. These relations were derived under the assumption that

Table 6. Identification of abbreviations and site numbers.

Site 1	KV	KCIV
Site 2	GH	Goodnoe Hills
Site 3	WL	Wells
Site 4	KN	Kennewick
Site 5	CB	Cape Blanco
Site 6	AG	Augspurger
OPT 1	% of system capacity obtained at least 60% of time (annually)	
OPT 2	% of system capacity obtained at least 60% of time (Spring)	
OPT 3	% of system capacity obtained at least 60% of time (Summer)	
OPT 4	% of system capacity obtained at least 60% of time (Fall)	
OPT 5	% of system capacity obtained at least 60% of time (Winter)	
TMWH	Total energy from system annually	
NMLL	Number of times system capacity less than 25%	
MXLL	Maximum length of period when system capacity less than 25%	
AVLL	Average length of period when system capacity less than 25%	
SDLL	Standard deviation of period when system capacity less than 25%	
MXTB	Maximum time between periods of less than 25% system capacity	
AVTB	Average time between periods of less than 25% system capacity	
SDTB	Standard deviation of time between periods less than 25% system capacity	
NMBUL	Number of periods above 75% system capacity	
MXUL	Maximum length of periods above 75% system capacity	
AVUL	Average length of periods above 75% system capacity	
SDUL	Standard deviation of periods above 75% system capacity	

Table 7. Condensed analysis of variance table.

Parameter*	Number of Significant First Order Effects	Number of Significant Second Order Effects	Number of Significant Third Order Effects
OPT 1	6	0	0
OPT 2	2	0	0
OPT 3	5	0	0
OPT 4	6	0	0
OPT 5	6	0	0
MWH	6	0	0
MXLL	6	1	1**
AVLL	6	4	0
SDLL	6	2	0
MXTB	3	2	0
AVTB	6	1	2**
SDTB	5	4	0
NMBUL	4	0	0
MXUL	3	2	0
AVUL	3	0	0
SDUL	2	0	0

* - See Table 6 for definitions of abbreviations

** - These are not uniquely identifiable, this is a minimum number

only one-way and two-way interactions were important. Table 8 gives the results of this analysis. This table shows that four of the six sites most influence the eleven parameters. The numbers given are the ranking and influence of each site, positive or negative, on the parameter. If duplicate rankings are present, this indicates an interaction between the two sites is important. As can be seen, four sites predominate in being influential in nearly all the parameters examined. These are Cape Blanco, Augspurgen, Wells, and Goodnoe Hills. Two sites, KCIV and Kennewick, are seldom major influences in measures of system performance. The equations used to estimate the parameters are listed in Table 9.

As was mentioned earlier, the equations obtained from the regression relations can be used to find the ratio of wind power generators at the sites which will tend to optimize the system performance as measured by a particular parameter. This is tabulated in Table 10, which also shows how the system performance measured by other parameters changes while optimizing for a particular parameter. This table consists of the eleven selected parameters for a particular ratio of wind generators. The ratio of each site is given in the table under the site name. These ratios were normalized to six. The underlined ratios are those of the sites which contribute most to the parameter being optimized. This is the first parameter listed. The values of the other parameters for this system arrangement are then given in the column below. From this table, one can see that when an effort is made to maximize the energy generated during the year (TMWH), much of the energy is generated during the summer when the system is at 60% capacity or better about 45% of the time,

Table 8. Ranking and influence of each site on the particular parameter.

Parameter	Sites					
	KCIV	Goodnoe Hills	Wells	Kennewick	Cape Blanco	Augspurger
OPT 1		4+	3+		1+	1+
OPT 2		1+	2-	3+	4-	3+
OPT 3	4+	3+			2+	1+
OPT 4		3+			1+, 4-	2+, 4-
OPT 5			3+	4+	1+, 4+	2+
TMWH		3+		4+	2+	1+
MXLL		4-	3-		1-, 4-	2-
AVLL		4-	2-		1-, 4-	3-
MXTB		4-	2-		1+, 3+, 4-	1+
AVTB		3-	2-	4+	1-, 3-	4+
AVUL		3-	1-, 2-, 3-	1-, 4-		

1. Numbers given are ranking of absolute magnitude of regression coefficients. A site with more than one rank indicates the interaction with another site of that rank. The sign after the number indicates the sign of the coefficient and therefore its influence on the parameter.

Table 9. Regression equations to estimate the various parameters.

Statistic	Regression Relation
OPT 1	$\approx 2.66CB + 1.76AG + .612WL + .326GH + 24.6$
OPT 2	$\approx 1.02GH - .609WL + .229(KN \times AG) - .305CB + 34.0$
OPT 3	$\approx 4.38AG + 4.11CB - 2.08GH + .871KV + 25.3$
OPT 4	$\approx 3.63CB + 2.14AG + .214GH - .16(CB \times AG) + 23.5$
OPT 5	$\approx 3.29CB + 2.61AG + 2.39WL + .182(KN \times CB) + 16.1$
TMWH	$\approx 5.08AG + 4.59CB + 3.00GH + .546KN + 46.1 \quad (\times 10^3)$
MXLL	$\approx -142.1CB - 77.2AG - 51.0WL - 27.9(GH \times CB) + 404.4$
AVLL	$\approx -3.41CB - 1.55WL - .670AG - .335(GH \times CB) + 31.1$
MXTB	$\approx 52.8(CB \times AG) - 56.1WL + 59.8CB - 32.7(GH \times CB) + 222.3$
AVTB	$\approx -4.57CB - 3.07WL - .765(GH \times CB) + .394(KN \times AG) + 25.6$
AVUL	$\approx -.114(WL \times KN) - .286WL - .173(GH \times WL) - .212KN + 2.52$

Use the equations to estimate parameters in the following steps:

- 1) give site ratios (CB, AG, WL, etc.) in integers e.g. (KV, GH, WL, KN, CB, AG) = (1, 2, 2, 1, 2, 1)
- 2) normalize to 6 (e.g. $Wt_i^1 = (Wt_i / \sum_{i=1}^6 Wt_i) \times 6$) (KV, GH, WL, KN, CB, AG) = (.857, 1.714, 1.714, .857, 1.714, .857)
- 3) the Wt values are used for individual sites in the equations e.g., $TMWH = 5.08 (.857) + 4.59 (1.714) + 3.0 (1.714) + .546 (.857) + 46.1 = 63.9 \times 10^3$
- 4) for interaction terms (e.g., $CB \times AG$), set them equal to 1 if both are at a "high" level and 0 otherwise (e.g., if $CB = 2$; $AG = 2$ at step 1 - then $(CB \times AG) = 1$; if $CB = 2$ and $AG = 1$ at step 1; then $(CB \times AG) = 0$)

Note: These equations are a linear approximation to a non-linear surface and as such have a limited range of validity. They are best used to estimate the relative rather than the absolute magnitudes of the effects.

Table 10. Value of selected parameters and optimization ratios.

Optimizing for:	Value	KV	GH	WL	KN	CB	AG
OPT 1	33.19	.138	.438	.701	.138	<u>2.877</u>	<u>1.759</u>
OPT 2	30.64						
OPT 3	43.93						
OPT 4	33.17						
OPT 5	27.50						
TMWH	69414						
MXLL	54						
AVLL	5.60						
MXTB	313						
AVTB	15.8						
AVUL	3.57						
OPT 2	34.87	.982	<u>1.974</u>	.274	.982	.806	.982
OPT 1	29.15						
OPT 3	37.31						
OPT 4	28.60						
OPT 5	21.32						
TMWH	61328						
MXLL	53						
AVLL	5.34						
MXTB	273						
AVTB	15.7						
AVUL	3.2						

Table 10..(Cont.) Value of selected parameters and optimization ratios.

Optimizing for:	Value	KV	GH	WL	KN	CB	AG
OPT 3	45.47	.144	.171	.144	.144	<u>3.542</u>	1.857
OPT 1	32.16						
OPT 2	28.04						
OPT 4	32.66						
OPT 5	23.51						
TMWH	72432						
MXLL	56						
AVLL	6.3						
MXTB	3.3						
AVTB	17.0						
AVUL	4.7						
OPT 5	29.48	.092	.092	<u>1.56</u>	.092	<u>2.31</u>	<u>1.85</u>
OPT 1	33.44						
OPT 2	31.37						
OPT 3	41.04						
OPT 4	31.95						
TMWH	66417						
MXLL	84						
AVLL	5.5						
MXTB	281						
AVTB	16.1						
AVUL	2.8						

Table 10.(Cont.) Value of selected parameters and optimization ratios.

Optimizing for:	Value	KV	GH	WL	KN	CB	AG
TMWH	72178	.034	1.396	.034	.034	<u>2.137</u>	<u>2.364</u>
OPT 1	34.50						
OPT 2	34.38						
OPT 3	44.86						
OPT 4	35.39						
OPT 5	26.52						
MXLL	53						
AVLL	5.2						
MXTB	293						
AVTB	15.5						
AVUL	3.8						

(OPT 5). By trying to generate more energy in the winter one can get 60% or better capacity about 38% of the time with an 8% reduction in energy generated and a 4% reduction in the summer capacity factor. This is accomplished by increasing the proportion of generators at Wells and decreasing the proportion at Goodnoe Hills.

A second method of comparing the changes in system parameters when one is used for optimization is illustrated in Figures 8 - 14. Figures 8 - 10 are the capacity factor curves (percent time versus percent capacity). The percent capacity achieved 60% of the time or more is marked on these curves. This point constitutes the OPT 1 (on an annual basis) and OPT 5 (on a winter season basis) parameters. The graph A on each Figure (8 - 10) is for a system in which OPT 1 was chosen for optimization. Graph B on each figure is for a system in which OPT 5 was chosen for optimization. Similarly, graph C on each figure corresponds to total annual energy, TMWH, and graph D corresponds to AVTB (average time between low power levels). Figures 8, 9, and 10 are the annual, summer season, and winter season curves respectively. The summer season includes the months from June through August and the winter season covers the months from December through February.

Figures 11, 12, and 13 are the diurnal capacity factor curves on an annual, summer season, and winter season basis. Three curves appear on each graph. Each gives the percent of time that at least a given capacity is obtained by hour of day. The capacity factors shown are 25%, 50%, and 75%. The A, B, C, and D graphs are again the ones obtained for systems optimized on different parameters.

Figure 14 is a set of curves for the four different systems which represents the percent of time the period of less than 25% capacity of

Figure 8. Annual capacity factor curves for the optimization of OPT 1, (A), optimization of OPT 5, (B), optimization of TMWH, (C), and optimization of AVTB, (D).

Figure 9. Summer capacity factor curves for the optimization of OPT 1, (A), optimization of OPT 5, (B), optimization of TMWH, (C), and optimization of AVTB, (D).

Figure 10. Winter capacity factor curves for the optimization of OPT 1, (A), optimization of OPT 5, (B), optimization of TMWH, (C), and optimization of AVTB, (D).

Figure 11. Annual diurnal capacity factor curves for the optimization of OPT 1, (A), optimization of OPT 5, (B), optimization of TMWH, (C), and optimization of AVTB, (D).

Figure 12. Summer diurnal capacity factor curves for the optimization of OPT 1, (A), optimization of OPT 5, (B), optimization of TMWH, (C), and optimization of AVTB, (D).

Figure 13. Winter diurnal capacity factor curves for the optimization of OPT 1, (A), optimization of OPT 5, (B), optimization of TMWH, (C), and optimization of AVTB, (D).

Figure 14. Percent of time the period of less than 25% capacity of a given length occurred for the optimization of OPT 1, (A), optimization of OPT 5, (B), optimization of TMWH, (C), and optimization of AVTB, (D).

given length occurred. From these curves one can determine what percent of the time a low power period of, say, 24 hours in length occurred.

Figures 8 - 10 present another way of looking at the system in order to understand what parameters would be most beneficial to optimize. Each of the four parameters chosen for optimization corresponds to choosing a particular graph from this set. In optimizing for this parameter, one is trying to get the best performance curve on the corresponding graph. For example, the parameter OPT 1 corresponds to Figures 8 - 10. Optimizing for this parameter is equivalent to saying the best performance curve in this graph is one in which the marked point has the highest value. The optimization for OPT 5 is similar in effect but for Figures 8 - 10.

Optimizing for total energy, TMWH, is equivalent to maximizing the area under the curve in Figure 8C, while optimizing for AVTB is seen in Figure 14D as moving the entire curve in toward the axis. This would reduce the probability of longer lower power periods.

The entire set of seven figures contrasts the four systems under different optimizations and time periods. The most striking aspect of these figures is the effect of optimizing for AVTB. Figure 14D shows that this optimization reduces the frequency of low power periods of most lengths. For example, periods of low power (less than 25% installed capacity) of 1 - 2 hours are reduced from around 5% in the other systems to about 2%. However, in most every other measure of system performance in Figures 8 - 13, this system is the least desirable. In effect the reduction of low power periods is achieved at the cost of overall energy output.

On the other hand, choosing to optimize the total energy obtained from the system (graphs C) doesn't appear to be markedly worse than strategies A or B. The main effect of this approach is that a larger proportion of the power is generated during the summer season.

Summary

A wind turbine generator (WTG) network consisting of WTG units placed at six widely spaced sites in the Pacific Northwest was looked at with respect to the optimization of several system parameters. These parameters included the percent of system capacity on an annual and seasonal basis, the total annual energy output, the percent of time the network output was less than 25%, and the percent of time the network output exceeded 75%. The relative importance of each site as it contributed to a given parameter was examined.

It was discovered that the interaction between three or more sites was not significant to the optimization of the system parameters. Most often the wind characteristics at a single site had the most influence on a given parameter, although two-way interactions were also common. Four sites were most influential on the system parameters. Ranked on the overall importance are Cape Blanco, Augspurgen, Goodnoe Hills, and Wells. Kennewick and KCIV had little effect on the parameters.

The ratio of WTG units at each site in the six station network was determined to optimize the system performance. It was determined that to optimize the percent of system capacity obtained at least 60% of the time on an annual basis, more WTG units should be placed at Cape Blanco, Augspurgen Mountain, and Wells in the ratio of 2.9, 1.8, and 0.7. The ratios at KCIV, Goodnoe, and Kennewick were 0.1, 0.4, and 0.1 respectively. The ratios were normalized to add up to six. To optimize this parameter during the summer the ratios at Cape Blanco and Augspurgen should be 3.5 and 1.9 respectively, while those at the other four sites are each less than 0.2. To optimize this parameter during the winter, the ratios at Cape Blanco, Augspurgen, and Wells should be 2.3, 1.9, and 1.6 respectively, while those at the other three sites are each below 0.1. The ratios at Augspurgen Mountain, Cape Blanco, and

Goodnoe Hills should be 2.4, 2.1, and 1.4 respectively to optimize the total annual energy output, while those at the other three stations are each near 0.03.

A sensitivity analysis to determine the effect of varying the ratios of WTGs at each site on the change from the optimum or nominal in OPT 1, OPT 5, and TMWH is illustrated in Figures 15 - 17. As can be seen in the three figures the only significant change occurs by varying the generating capacity at Cape Blanco when considering OPT 1. A 15% reduction in the proportion of the generating capacity at Cape Blanco results in about a 0.6% reduction from nominal as shown in Figure 15. A 15% increase in the proportion of generating capacity at Cape Blanco results in about a 2% increase in the nominal in OPT 1. The sensitivity plots for OPT 5 and TMWH (Figures 16 and 17) indicate little effect in changing the proportion of generating capacity $\pm 15\%$ at all six sites.

Figure 15. Sensitivity plot for OPT 1, percent of system capacity obtained at least 60% of the time annually. The Kennewick influence was not significant so the curve was not plotted for clarity. (WL - Wells, GH - Goodnoe Hills, AM - Augspurger Mtn, KC - KCIV, CB - Cape Blanco). The base value of OPT 1 is 33.2%.

Figure 16. Sensitivity plot for OPT 5, percent of generating capacity obtained at least 60% of the time during the winter. The Kennewick and Goodnoe Hills influence was not significant so their curves were not plotted for clarity. The base value of OPT 5 is 29.5%.

Figure 17. Sensitivity plot for TMWH, total energy from the system annually. The Kennewick and Wells influence was not significant so their curves were not plotted for clarity. The base value of TMWH is 72178 MWH for the six station 21.0 MW network.

Effect of Cut-Out Speed on Annual Energy Production

The performance curves for the numerous large megawatt sized wind turbine generators (WTGs) now being designed and built vary greatly. Considerable attention has been placed by the designers on the influence of cut-in and rated speeds, but little on that of cut-out speeds. Many recent designs have concentrated on large diameter (300 ft. plus) blades and lower cut-in and rated speeds to capture most of the available energy at 'typical' wind power sites. However, the wind speed distribution data used have often been assumed rather than actual data from good potential wind power sites.

Using the extensive wind data base that BPA now has, the effect of cut-out speed on the annual energy production of wind turbines has been investigated. The wind speed distributions for the one year period December 76 - November 77 for the six potential WTG development areas in Table 11 were used to determine the megawatt hours gained by changing the cut-out speed from 45 mph to 60 mph. The 2.5 and 4.5 MW WTG performance data for WTG A in Figure 5 were used in the preparation of Table 11. The sea level performance curve for the WTG was modified for each site based on site anemometer height and site elevation. Anemometer height data were adjusted to the 200 ft. hub height speed using the power law coefficient $\alpha = 0.2$. The density adjustment was made according to the cube root of the ratio of the sea level air density to the site air density.

Table E1. Potential WTG farm areas using the WTG A performance data and installed capacity.

Site	Site Anem. Height (ft.)	Site Elevation (ft. MSL)	No. of WTGs	Size (MW)	Total Installed Capacity (MW)
Augspurger Mtn.	40	2880	15	4.5	67.5
Columbia Hills	45	3120	60	2.5	150.0
Goodnoe Hills	45	2400	90	4.5	405.0
Kennewick	105	2050	400	2.5	1000.0
Cape Blanco	40	200	200	4.5	900.0
Wells	40	7538	<u>200</u>	2.5	<u>500.0</u>
Network			965		3022.5

Table 12 lists the number of hours when the cut-out wind speed at the hub height equalled or exceeded 60 mph for the six stations. Other pertinent information is also given such as the average number of hours for the year where $v \geq 60$ mph based on a full year of data (8760 obs). Also listed in Table 12 are the maximum one hour average wind speed and mean wind speed for the one year period. Cut-out wind speeds at Cape Blanco were noted for 283 actual hours while the other stations experienced many fewer cut-out hours.

Similar data are shown in Table 13 for a cut-out speed of 45 mph at hub height. The wind blew at 45 mph and above for many hours, the highest number being at Cape Blanco with 811 hours and Goodnoe Hills with 668 hours. It is felt that better exposure of the KCIV anemometer would probably result in corresponding hours in the 200 - 400 range.

The effect on the potential energy production for this one year period for a 965 unit WTG network by reducing the cut-out speed from 60 mph to 45 mph is very significant. Table 14 indicates the number of hours where the hub height winds were in the 45 - 60 mph range and Table 15 shows the corresponding potential energy lost. Approximately 15% or over 1.3 million megawatt hours of energy could have been produced in the 45 - 60 mph range. The most significant losses were at Goodnoe Hills, Cape Blanco and Kennewick. The energy generation potential was also noticeably reduced at Augspurger Mountain and Wells. If the cut-out speed were changed from 45 to 60 mph the annual energy production would increase from 8.8 to 10.1 million megawatt hours.

A similar, and more conservative analysis assuming that there was no wind speed change with height (i.e. $\alpha = 0.0$) revealed that the energy production for the same network for the Dec. 76 - Nov. 77 period was considerably less. The results are shown in Table 16 and indicate that the network energy production was about 6.5 million MWH for a cut-out speed of 45 mph compared to 7.0 million MWH for a cut-out speed of 60 mph. The loss was over 450,000 MWH or about 7% of the annual energy output compared to the 1.3 million MWH or 15% loss indicated in Table 15.

Table 12. The number of hours of cut-out wind speeds
(> 60 mph) at six potential WTG sites.
(Data Period 12/76 - 11/77)

Station	Total Observations	Actual Hours $\bar{V}_{HH} \geq 60$	% Frequency	Expected Avg Hours/Year ¹	Maximum 1 HR $\bar{V}$ (mph) ²	Annual $\bar{V}$ (mph) ²
Augspurger Mtn.	7753	21	.3	24	97	16.7
Columbia Hills	7020	0	0	0	42	13.5
Goodnoe Hills	8092	59	.7	64	70	17.2
Kennewick	8154	31	.4	33	71	16.7
Cape Blanco BPA	7902	283	3.6	314	76	18.1
Wells	6045	26	.4	38	60	15.8

1. 8760 hour observation base
2. Wind speed, mph, at the site anemometer height.

Table 13. The number of hours of cut-out wind speeds
(> 45 mph) at six potential WTG sites.
(Data Period 12/76 - 11/77)

Station	Total Observations	Actual Hours $\bar{V}_{HH} \geq 45$	% Frequency	Expected Avg Hours/Year ¹	Maximum 1 HR $\bar{V}$ (mph) ²	Annual $\bar{V}$ (mph) ²
Augspurger Mtn.	7753	213	2.7	241	97	16.7
Columbia Hills	7020	13	.2	16	42	13.5
Goodnoe Hills	8092	668	8.3	723	70	17.2
Kennewick	8154	374	4.6	402	71	16.7
Cape Blanco, BPA	7902	811	10.3	899	76	18.1
Wells	6045	201	3.3	285	60	15.8

1. 8760 hours observation base.

2. Wind speed at the site anemometer height.

Table 14. Frequency of occurrence of hub height wind speeds in the 45 - 60 mph range.
(Data Period 12/76 - 11/77)

Station	Total Observations	Actual Hours $45 \leq \bar{V}_{HH} < 60$	% Frequency	Expected Avg Hours/Year ¹
Augspurgen Mtn.	7753	192	2.5	217
Columbia Hills	7020	13	.2	16
Goodnoe Hills	8092	609	7.5	659
Kennebec	8154	343	4.2	369
Cape Blanco BPA	7902	528	6.7	585
Wells	6045	175	2.9	247

1. 8760 hours observation base

Table 15. Annual network energy production of a Boeing WTG array assuming an $\alpha = 0.2$.

Site	No. of WTGs and size	Annual Energy Production (MWH) for Cut-out 45 mph	Annual Energy Production (MWH) for Cut-out 60 mph	Difference	
				MWH	%
Augspur Mtn.	15 - 4.5 MW	205400	219800	14400	7.0
Columbia Hills	60 - 2.5 MW	459000	461300	2300	0.5
Goodnoe Hills	90 - 4.5 MW	1104800	1395300	290500	26.3
Kennewick	400 - 2.5 MW	2815900	3186500	370600	13.2
Cape Blanco	200 - 4.5 MW	2730800	3260700	529900	19.4
Wells	200 - 2.5 MW	<u>1498700</u>	<u>1623600</u>	<u>124900</u>	<u>8.3</u>
Network	965 WTGs	8814600	10147200	1332600	15.1

1.. The % difference was calculated by dividing the MWH difference by the annual energy produced for a cut-out of 45 mph.

In summary, the annual energy lost by limiting the cut-out speed to 45 mph is significant whether considering a modest increase in wind speed with height ($\alpha=0.2$) or no wind speed change with height ($\alpha=0.0$). The terrain and roughness characteristics will vary from site to site, resulting in differences in wind profiles in the vertical; for the six potential sites the winds at rotor hub height are probably those for α values lying between 0.0 and 0.2. Thus it appears that the actual annual energy losses may lie between 7 and 15% for the network and that the most significant losses would probably be at Goodnoe Hills, Kennewick and Cape Blanco. It might be more cost effective to design WTCs with a cut-out speed of 60 mph for these three sites to capture the usable energy on the high end of the wind speed spectrum rather than trying to design the turbines for lower rated and cut-in speeds.

Table 16. Annual network energy production of the WTG A array assuming an $\alpha = 0.0$.

Site	No. of WTGs and size	Annual Energy Production (MWH) for Cut-out 45 mph	Annual Energy Production (MWH) for Cut-out 60 mph	Differencel	
				MWH	%
Augspurgen Mtn.	15 - 4.5 MW	96000	96300	300	.3
Columbia Hills	60 - 2.5 MW	217900	217900	0	0
Goodnoe Hills	90 - 4.5 MW	837100	864300	27200	3.2
Kennewick	400 - 2.5 MW	2550000	2729200	179200	7.0
Cape Blanco	200 - 4.5 MW	1738100	1959600	221500	12.7
Wells	200 - 2.5 MW	<u>1054500</u>	<u>1083600</u>	<u>29100</u>	<u>2.8</u>
Network	965 WTGs	6493600	6950900	457300	7.0

1. The % difference was calculated by dividing the MWH difference by the annual energy produced for a cut-out of 45 mph.

7

IV. WIND SPEED PROFILE STUDIES

Wind Speed Profile Measurements

Kite Anemometer Calibration

Wind Speed Profile Measurements

Kite anemometer measurements were taken at several locations during the past year. Diagrams illustrating the wind speed profiles at eight potential wind power areas are presented below. Two areas were investigated along the Oregon coast at Yaquina Head and Cape Blanco, and six were investigated in the Columbia River Gorge. Measurements were made every fifteen seconds for a five-minute period at each level. The mean, variance, and standard deviation of the wind speed for each five minute interval were calculated. From this information the turbulence intensity value, defined as the ratio of the standard deviation to the mean wind speed, was determined at each level and is noted next to each measured point of the speed profile in each of the figures. This quantity is a measure of gustiness which exerts stresses of varying amounts on a wind turbine rotor and its supporting tower: values less than 0.10 occur in stable, smooth flow; those between 0.10 and 0.20 are representative of moderately turbulent flow, and higher values characterize very turbulent flow. In general, turbulence intensity values usually decrease with height due to the decrease in effect of surface roughness, which creates low level turbulence, and the general increase in wind speed with height. Most of the profiles taken followed this pattern although there were a few noticeable differences. It should be noted that these profiles were only a sampling of the air flow on a particular day and may not represent the average structure of the air mass motion. More samples will have to be taken under prevailing flow conditions on a seasonal basis to more accurately estimate the wind speed change with height over the span of a wind turbine generator blade which may extend to 400 ft.

The kite anemometer has been calibrated against conventional anemometers in the field and there has been close agreement, within 2%. Calibration

results from testing against the anemometers on a 300 m tower near Denver, Colorado, and other tower data are contained in the next section.

Cape Blanco

Kite anemometer wind speed measurements were taken at the Cape Blanco Airport shown in Figure 18 on 22 Nov. 1977 under strong south southwest flow, the prevailing flow during the winter. There was a noticeable change of wind speed with height from the 55 ft level to the 230 ft level (from 17 to 34 mph) as indicated in Figure 19. The resulting α value (the power law exponent) between these two levels was 0.48. The change from the 230 to the 320 ft level was not as great, 34 to 38 mph. The effect of the surface roughness, about a 40 ft high, dense tree canopy over the Cape Blanco headland, is to significantly reduce the strength of the wind near the canopy. Turbulence values were also noticeably greater near the canopy than higher up, say above the 230 ft level. Wind speed data taken at the 55 ft level from the anemometer at the airport agreed well with the kite measurements. The anemometer recorded a 17 mph average wind while the kite anemometer recorded a 17.4 mph average. For the same time period the BPA anemometer on the well exposed tip of the headland of Cape Blanco recorded south southwest winds at 28 mph. More testing will be done under north and south flow to determine the shear in the boundary layer close to the tree canopy where the WTGs may be installed.

Figure 18. Topography map of the Cape Blanco area and the measurement site, A.

Figure 19. Wind speed profile at the Cape Blanco Airport on 22 November 1977 (1300-1330 PST). The Cape Blanco Airport anemometer reading is noted at A and the Cape Blanco BPA anemometer reading is noted at B.

Yaquina Head

Three kite anemometer soundings were made in March 1978 at the west end of Yaquina Head (see Figure 20). Two profiles were taken under north flow and one under south flow. The measurements made on 18 March are shown in Figure 21 and reveal a speed maximum at 100 ft. This maximum resulted from an acceleration of the north wind flow over the coastal headland. Turbulence intensity values were low varying between 0.02 and 0.05 and reflect the relative smoothness of the topography and the ocean surface around it. The power law exponent α between the 33 and 160-ft levels was -0.02. The wind direction varied with altitude and there was a 25° shear between the 160 and 330 ft levels. The directions for the 33, 66, 100, 160, and 330 ft levels were 345, 355, 340, 340, and 005 degrees respectively.

On 19 March wind measurements were taken under northwest winds. Maximum winds were recorded at the 33 and 160 ft levels, the latter being the most pronounced maximum. Turbulence intensity values were low, varying between 0.02 and 0.03. The power law value α between the 33 and 160 ft levels was 0.05. The wind direction measured at the first four levels was 310° , while that at the 330 ft level was 335° (see Figure 22).

South wind flow was measured over the headland on 22 March as shown in Figure 23. The wind speed generally increased with height through the 330 ft level, although a relative speed minimum occurred at the 66 ft level which probably was due to local terrain-induced acceleration of the flow below this level. A power law exponent of 0.12 was calculated from the 33 to 160 ft level. The flow was very smooth at all levels as indicated by the turbulence intensity values which varied from 0.02 - 0.03. The wind direction was relatively constant averaging 155° for the first three levels and 160° for the last two levels.

Figure 20. Yaquina Head topography map showing the measurement site, A.

Figure 21. Wind speed profile at Yaquina Head on 18 March 1978. (1500 - 1600 PST)

Figure 22. Wind speed profile at Yaquina Head on 19 March 1978. (1400 - 1500 PST)

Figure 23. Wind speed profile at Yaquina Head on 22 March 1978. (1120 - 1220 PST)

Mosier

Wind speed profile measurements were also made on 4 May 1978 at the Mosier anemometer site shown in Figure 24. There was a noticeable decrease in wind speed with height from the 50 to 100 ft level (see Figure 25). The 40 ft high wind-run anemometer recorded west winds at 31 mph while those recorded by the kite anemometer at the 50 ft level were 32 mph. It appears that there was a wind speed maximum near the 50 ft level due to the influence of local terrain. The turbulence intensity values were moderate, in the 0.12 to 0.18 range. There was a noticeable wind speed change with height from the 100 to 200 ft level which corresponded to an α value of 0.26. The winds were 270° in direction at all levels.

Figure 24. Topography map of Mosier showing the speed profile measurement site, A.

Figure 25. Wind speed profile at Mosier on 4 May 1978 (1110 - 1145 PST)

KCIV

Kite anemometer measurements were taken at the KCIV anemometer site and at a ridge point about 3 miles west of KCIV on 13 Oct 1977. This area is depicted on the topographic map in Figure 26. The wind profile at this ridge point, A, indicated a maximum speed zone near the 50 ft level and also at the 300 ft level, as noted in Figure 27. The former speed-up under a moderate west wind was caused by the local terrain enhancement of the flow in the immediate area of the knoll along the ridge top. The other maximum is probably due to the larger scale terrain-induced enhancement of the flow by the sloping ridge line which lowers to the west about 600 ft in two miles. The wind speed at the 500 ft level was 24.6 compared to 26.0 at the 400 ft level. Also, turbulence intensity values were quite low above 100 ft.

While 50 ft winds at this ridge point were 18.5 mph, the wind recorded by the KCIV anemometer at the 45 ft level was 8 mph. Kite wind measurements taken next to the KCIV anemometer, site B in Figure 26, indicated fairly steady flow at the 150, 200, and 300 ft levels as shown in Figure 28. The KCIV anemometer recorded a 9 mph average speed, too light to fly the kite on a stable basis. However, there were strong enough winds at the 150 ft level to successfully fly the kite anemometer. The flow at the 200 and 300 ft levels was not as strong as, and slightly more turbulent than, that recorded west of KCIV at site A. It appears from these limited data that the ridge top west of KCIV has much better wind exposure and stronger flow.

Figure 26. Topography map of the KCIV area showing the speed profile measurement sites A, west of KCIV, and B, KCIV.

Figure 27. Wind speed profile at the knoll west of KCIV, A in Figure 24 (1020 - 1110 PST). The KCIV anemometer reading is noted at point B.

Figure 28. Wind speed profile at KCIV (1215 - 1240 PST). The KCIV anemometer reading is noted at Point B.

Goodnoe Hills

Speed profile measurements were made on 21 September 1978 at Goodnoe Hills about 0.25 miles north of the present anemometer (see Figure 29). Moderate winds (290°) were recorded at the four measurement heights from 50 - 350 ft as noted in Figure 30. The wind speed did not change significantly with height. The speed increase from the 50 to 150 ft level was 1.2 mph which gives a power law exponent α of 0.13. The wind flow was fairly smooth as evidenced by turbulence intensity values which ranged from 0.06 - 0.12.

After the morning testing (0900 to 0930 PST) the kite was flown next to the Goodnoe Hills anemometer at 1000 PST. However, winds were much lighter and very gusty and were blowing up the steep hillside from the south southwest direction which prohibited the use of the kite. Surface heating had begun on the steep south slope, and the air flow at this location was being influenced by the large eddies that were moving up the slope. It is interesting to note that merely 0.25 miles away on the top of the ridge crest the flow was totally different being much stronger and relatively non-turbulent.

Figure 29. Topography map showing the speed profile measurement location A and the Goodnoe Hills anemometer site, B.

Figure 30. Wind speed profile at Goodnoe Hills on 21 September 1978 (0900 - 0930 PST)

Juniper Point

Three kite soundings have been taken at Juniper Point under different flow conditions as noted in Figures 32 - 34. The location is shown in Figure 31. On 25 April, very steady north winds were measured from 50 to 300 ft (see Figure 32). There was very little wind speed change with height with a slight decrease in the lowest 200 ft being noted. Turbulence intensity values were relatively low, averaging about 0.08.

On 18 July, measurements were taken at the 70, 150, and 250 ft levels under west northwest flow, 300° , (see Figure 33). The winds at all levels were very steady, and turbulence intensity values were low, 0.03 to 0.04. The wind speed decreased with height in the lowest 150 ft from 18.6 mph at the 70 ft level to 17.4 at the 150 ft level. The wind increased to 18.1 mph at the 250 ft level.

Kite anemometer data were also taken on 18 August with west southwest winds (250°) at the 100, 200, and 300 ft levels. The results are shown in Figure 34. The wind speed at the lower two levels remained the same, 21.8 mph, and decreased to 19.8 at the upper level. Winds were gustier than in the two previous kite soundings and turbulence intensity values varied from 0.10 to 0.16. The kite anemometer reading at the 100 ft level, 21.8 mph, agreed quite closely with the wind speed recorded by the tower anemometer at the same level; the tower measurement was 22.1 mph.

Figure 31. Topography map showing the speed profile measurement location, A.

Figure 32. Wind speed profile at Juniper Point on 25 April 1978 (1130 - 1200 PST)

Figure 33. Wind speed profile at Juniper Point on 18 July 1978 (1945 - 2010 PST)

Figure 34. Wind speed profile at Juniper Point on 18 August 1978 (1115 - 1145 PST)

Kennewick

Kite anemometer measurements were taken on two days in September next to the BPA anemometer at the Kennewick substation. This anemometer is located on the east end of the Horse Heaven Hills; its location is shown in Figure 35. Southwesterly flow (220°) was common on both days, but was much stronger on the 15th. The 14 September sounding is shown in Figure 36 and indicates a significant change of wind speed with height from the 5 to 40 ft level, from 15.0 to 19.9 mph. The change in speed from the 40 to 105 ft level was slight, from 19.9 to 20.5 mph, and winds at the 200 and 300 ft levels were 19.4 and 19.7 mph respectively. The power law exponent, α , between 40 and 105 ft was .03. The maximum winds occurred in the lowest 100 ft. The winds were very steady at all levels as turbulence intensity values varied between 0.02 and 0.06. Unfortunately, wind data from the BPA anemometer were not available at this time to cross check against the kite readings.

The next morning the southwest wind was much stronger, averaging over 29 mph at the surface (wind-run anemometer). There was a more noticeable increase in speed from the 40 to 105 ft level, a 3.1 mph difference, as noted in Figure 37. The corresponding power law exponent, α , was .10. A wind speed maximum occurred between the 100 and 200 ft level as wind speeds averaged about 35 mph, decreasing to nearly 32 mph at the 300 ft level. The wind flow again was very steady as turbulence intensity values varied between 0.05 and 0.06. The tower anemometer at the 105 ft level recorded a wind speed of 34.5 while the kite recorded a speed of 35.3 mph, a 2% difference.

Figure 35. Topography map showing the speed profile measurement location, A.

Figure 36. Wind speed profile at Kennewick on 14 September 1978 (1720 - 1800 PST). The wind-run speed is noted at B.

Figure 37. Wind speed profile at Kennewick on 15 September 1978 (0810 - 0840 PST). The wind-run speed is noted at B.

Seven Mile Ridge

Seven wind profiles were taken along the top of Seven Mile Ridge and on the east slope on 17 Aug 78 under 20 to 30 mph west winds. The profile locations are noted in Figure 38. Location numbers 1 and 7 were next to the Ortley anemometer and the now standing 150 ft BPA meteorological tower. The wind profiles at the six locations are displayed in Figures 39 - 44. The wind speed from the Ortley strip chart recording anemometer that is mounted on a 30 ft mast is noted on each profile. In general the west wind recorded by the Ortley anemometer increased from 22 mph at 1140 PST to 30 mph at 1700 PST and decreased to 25 mph by 1800 PST.

The profiles at all locations showed winds increasing with height through the 250 ft level. An estimated wind speed profile for the Ortley anemometer locations (1 and 7) is superimposed on the speed profiles at locations 2 through 6. It is assumed that this is the representative profile for location 1 during the same time the other kite anemometer measurements were taken. The Ortley anemometer site had the strongest winds of the six locations. The wind profile strengthened and became more uniform as noted from the differences in the profiles in Figures 38 and 44. There was a more noticeable change in wind speed from the 30 ft level to the 50 ft level and there was very little change of speed from the 150 to 350 ft level as noted in Figure 39. The flow was also very stable at location 1 with turbulence intensity values varying from 0.04 to 0.08. The wind direction remained constant, 260° at all levels.

The wind speed profile was also very uniform at Ortley Point, location 2 (see Figure 38). Relatively steady winds were noted above 100 ft as turbulence intensity values varied from 0.05 to 0.08. The surface roughness of the area resulted in gustier winds at the 50 ft level. The Ortley Point wind-run anemometer mounted on a 30 ft mast read 21 mph. The wind direction at all levels was 250° except at 350 ft, where the direction was more westerly (270°).

Location 3 was on the west slope of Seven Mile Ridge and just east of a 20 ft high oak tree canopy. Winds were too light and variable at 50 ft due to the roughness of the tree canopy to operate the kite, so the first level of measurements was at 100 ft. The winds were still gusty but stronger. The wind direction varied from 220 to 260° and the wind speed turbulence intensity value was 0.16 as noted in Figure 41. There was a noticeable wind speed increase with height from the 100 to 150 ft levels where the speed increased from 21.0 to 24.0 mph. There was little change in the wind speed above 150 ft, but the flow was more turbulent than that recorded at locations 1 and 2. The wind direction averaged about 260° at the 150 ft level and 270° at the upper two levels.

The next kite anemometer sounding was taken at the Seven Mile Bell wind-run anemometer station (location 4) between 3:00 and 3:30 PM PST. The wind speed increased with height from the 50 to 150 ft level as indicated in Figure 42. The power law value, α , corresponding to this 4.3 mph increase was 0.14. Maximum winds occurred between the 150 and 250 ft levels and a decrease in wind speed was noted at the 350 ft level. The wind profile was very similar to the extrapolated (estimated) profile at the Ortley anemometer site, location 1, for the same time period. The turbulence intensity values varied from 0.06 to 0.11 and were highest at the upper two levels. The wind direction at the lower two levels was 270° and that at the upper two levels was 260°.

The kite anemometer sounding taken next to the wind-run anemometer at Sauter's Ranch, location 5, indicated a gradual wind speed increase with height (see Figure 43). The calculated α value from the 50 to 150 ft level was 0.05. The winds were considerably lighter than those measured on top of the ridge at Ortley. The turbulence intensity values varied between 0.09

and 0.14 and generally decreased with height. There was a 20° wind direction change between the lower and upper levels. The wind directions at the 50, 150, 250, and 350 ft levels were 240° , 245° , 250° , and 260° respectively.

Next, an attempt was made to fly the kite at location 6A just south of the Wasco Lookout. The winds were too strong, however, gusting well above 50 mph, to fly the kite anemometer. A wind profile was taken further south and on top of the ridge in an open meadow, location 6B. There the wind speed also increased gradually with height, up to the 250 ft level in a manner similar to that observed at location 5 (see Figure 44). There was a noticeable increase in speed, from 22.1 to 28.8 mph, from the 250 to 350 ft level. Turbulence intensity values varied from 0.07 to 0.14, generally being highest below 250 ft. The wind direction fluctuated considerably in the lowest 150 ft and averaged 260° ; at the upper two levels it was steadier and averaged 250° .

The final wind profile was taken back at the Ortley anemometer, location 7, between 6:55 and 7:20 PM, PST. The west wind averaged 260° at all levels and increased in speed with height between the 50 and 150 ft levels, remaining fairly constant between 150 and 250 ft as indicated in Figure 45. The speed decreased slightly at the 350 ft level. The power law exponent was 0.08 between the first two levels. Turbulence intensity values were low, varying from 0.04 to 0.08. The wind flow was much stronger at the lower two levels than in the previous run at 11:30 PM. There was also a more noticeable difference between the Ortley 30 ft anemometer reading of 25 mph and the kite 50 ft reading of 29 mph than that observed during the noon run.

In summary, the numerous kite anemometer measurements taken over the Seven Mile Ridge area on this day indicated noticeable differences in wind speed profiles up to the 350 ft level. The strongest flow occurred

at location 1, the Ortley anemometer site. The wind speed profiles were fairly similar in shape at all three sounding locations in the Ortley area (locations 1 to 3) and at location 4 (Seven Mile Bell), where a speed maximum occurred between the 150 and 350 ft levels. The wind profiles at Sauter's Ranch and south of the Wasco Lookout were similar in shape, increasing in the speed with height at all levels.

These profiles are a sampling only of the wind flow over this portion of Seven Mile Ridge and should not be construed as being the typical speed profiles at these locations. More testing with the versatile kite anemometer will describe in a reliable manner the three dimensional flow over this ridge.

Figure 38. Topography map of Seven Mile Ridge showing the speed profile measurement locations, 1 - 7, and the wind direction.

Figure 39. Wind speed profile at location 1 (1130 - 1200 PST). The Ortley anemometer speed is noted at A.

Figure 40. Wind speed profile at location 2 (1240 - 1300 PST). The Ortley anemometer speed is noted at A and the Ortley Pt. anemometer speed at B.

Figure 41. Wind speed profile at location 3 (1355 - 1420 PST). The Ortley anemometer speed is noted at A.

Figure 42. Wind speed profile at location 4 (1500 - 1530 PST). The Ortley anemometer speed is noted at A.

Figure 43. Wind speed profile at location 5 (1635 - 1700 PST). The Ortley anemometer speed is noted at A.

Figure 44. Wind speed profile at location 6 (1730 - 1805 PST). The Ortley anemometer speed is noted at A.

Figure 45. Wind speed profile at location 7 (1855 - 1920 PST). The Ortley anemometer speed is noted at A.

Kite Anemometer Calibration

The kite anemometer has been flown next to several anemometers to check its accuracy. The operation of both the hand-held spring scale and the analog system with a recording strain guage have been tested. These preliminary results are listed in Table 17 and indicate an overall accuracy of 1.7%. The manufacturer claims a 2% accuracy for the analog recording system. Greater error resulted with the spring scale measurements than with the recording strain guage system. The sampling times varied from 3 to 10 minutes and it appears that, as would be expected, accurate and representative measurements of the mean flow are obtained with a longer sampling time. Further measurements will be made with both the spring scale and recording strain guage system as well as with the recently acquired micro processor unit to test the accuracy of this wind measuring system at various wind speeds, altitudes, and sampling times.

Table 17. Preliminary calibration results for the spring scale and analog kite anemometer.

Location	Sampling time (min)	Altitude (ft)	Type of Recorder	Kite Speed (mph)	Anem. Speed (mph)	Percent Accuracy
Cape Blanco	5	55	Spring Scale	17.4	17.0	+2.4
Juniper Pt.	5	100	Spring Scale	21.8	22.1	-1.4
Kennewick	5	105	Spring Scale	35.3	34.5	+2.3
Erie Colorado	10	330	Analog	19.0	18.9	+ .5
"	3	660	Analog	26.2	26.7	-1.9
Mean (regardless of sign)						1.7

V. WIND FLOW ANALYSIS

Preliminary Pacific Northwest Wind Flow Analysis

Preliminary Pacific Northwest Wind Flow Analysis

1. Introduction

The subject of this section is preliminary research on wind flow analysis for the Pacific Northwest. The character of the work so far accomplished has necessitated a rather narrow approach to this broad topic; however, the groundwork for a more general examination of the problem has been laid.

In the free atmosphere, the relationship between the wind and the existing pressure distribution, the geostrophic wind equation, is valid to a very useful degree:

$$V_g = \frac{1}{f\rho} \left| \nabla P \right| \quad (1)$$

where V_g is the geostrophic wind speed, $f = 2\Omega \sin \phi$, Ω is the angular velocity of the earth, ϕ is latitude, ρ is density, and $\left| \nabla P \right|$ is the magnitude of the horizontal gradient of pressure. Because the density varies relatively slowly in space and time and the variability of f is small over a limited range of latitudes, we may rewrite (1) as

$$V_g = k \left| \nabla P \right|, \quad (2)$$

where $k = \frac{1}{f\rho}$. The wind speed is thus proportional to the magnitude of the pressure gradient.

This simple result may be applied near the ground with some success over flat terrain (e.g. the ocean), provided account is taken of the decrease of the wind speed caused by frictional effects. Practical applications are discussed by Petterssen (1956) among others. He suggests that the ratio of actual speed to geostrophic speed is approximately 0.7 for smooth land with a wind speed of about 14 mph and that the ratio decreases to 0.5 or less at higher speeds.

Godske (1957) suggests a ratio of about 0.4 illustrating the uncertainty of the result. Furthermore, it is well known that great departures from any average or typical value of this ratio are common. Nevertheless, as a starting point for our study we have chosen to test the relationship between the wind speeds observed at selected locations in the Pacific Northwest and the magnitude of the horizontal pressure gradient.

2. Method

The horizontal pressure gradient is given by

$$\nabla P = \frac{\partial P}{\partial x} \hat{i} + \frac{\partial P}{\partial y} \hat{j} \quad (3)$$

where x and y are distances and $\hat{i}$ and $\hat{j}$ are unit vectors in the eastward and northward directions, respectively. The magnitude of the gradient is given by

$$|\nabla P| = \left[\left(\frac{\partial P}{\partial x} \right)^2 + \left(\frac{\partial P}{\partial y} \right)^2 \right]^{1/2} \quad (4)$$

The derivations in (4) must, in practice, be replaced by finite differences to obtain

$$|\nabla P| = \left[\left(\frac{\Delta P}{\Delta x} \right)^2 + \left(\frac{\Delta P}{\Delta y} \right)^2 \right]^{1/2} \quad (5)$$

The validity of (5) as a replacement for (4) depends on how smoothly the pressure varies in the horizontal and on how small Δx and Δy are. In general, the smaller the distance increments, the better the finite differences will approximate the derivatives. However, we are not justified in making Δx and Δy smaller than a typical distance between reporting stations. For the purposes of this study we have taken a value of about 200 km (120 mi).

In order to facilitate the application of (5), the pressure data must be interpreted from the irregularly spaced weather stations to a regular grid of points. The grid used in this study is a one degree

latitude by one degree longitude array of points which is shown together with the weather station locations in Figure 46. In addition to the stations shown, there are occasionally available pressure observations from mobile ships which are within the area covered by the grid. It should be noted, however, that the data coverage is generally poor off the coast.

The procedure used to perform the interpolation from stations to grid is a slightly modified version of a method developed by Barnes (1975). The details will not be discussed here, but it should be kept in mind that the method cannot perform well without adequate data. Furthermore, any variation of pressure on a scale smaller than the spacing of the grid points will be removed by the analysis.

The analysis is begun by entering the pressure data taken from teletype data collections into an HP calculator. The calculator plots the observations on a map for checking purposes; following checking, the pressures are stored together with station locations and fed into the interpolation program. Grid point pressure values are plotted on a map and stored for use by the gradient computation program. Finally the magnitude of the pressure gradient is plotted on a map. The results of these computations for two cases are discussed on the following section.

3. Results

The observed wind speeds for 1600 PST, 3 March 1978 are shown in Figure 47, plotted as a function of the magnitude of the pressure gradient. The winds are taken from all weather stations for which observations were available in Washington, Oregon, northern California, and northern Nevada. The pressure gradients are derived from the application of the numerical interpolation scheme. There is a fair correlation between wind speed and pressure gradient although there is substantial scattering of points. Multiplication of the pressure gradient by 1.7 gives the geostrophic

Figure 46. Weather Station Locations

Figure 47. Pressure gradient versus wind speed (3 March 1978, 1600 PST).

wind speed. The ratio of observed speed to geostrophic speed is found to be about 0.3 for this case.

A second example illustrates the need for a much more complete analysis. The sea level pressure field for 1600 PST, 11 April 1978 is shown by the solid lines in Figure 48. The isobars have been constructed manually, based on the grid point pressures obtained from the numerical interpolation. A north - south trough of low pressure approximately bisects Washington and Oregon with high pressure building in from the west. This trough is associated with an eastward moving front. The dashed lines in the same figure represent the magnitude of the pressure gradient which reaches maximum values in the area west of the trough. The high pressure gradient regions are areas of expected moderate to strong winds.

The surface winds at all available regular weather stations, together with the winds at five wind energy stations (indicated by underlining), are combined with pressure gradients in Figure 47. The result indicates great scatter of the points and generally poor correlation between wind speed and pressure gradient.

4. Direction of future work.

Three reasons for the poor correlation between wind speed and pressure gradient are suggested:

- a) The pressure field may have been overly smoothed by the computer analysis.
- b) Because of highly localized effects such as channeling of the flow, the correlation at one time over a large, inhomogeneous area may be poor in spite of a basically sound physical relationship.

Figure 48. Sea level pressure field for 11 April 1978, 1600 PST (solid lines). Dashed lines represent the magnitude of the pressure gradient.

Figure 49. Pressure gradient versus wind speed (11 April 1978, 1600 PST). The circled value indicates a duplicate data point.

- c) Such important physical processes as the vertical transfer of momentum and the effects of temporal variation of the pressure field have not been taken into account.

Three methods of improving the analysis are thus proposed:

- a) The pressure analysis program can readily be adjusted to cause less smoothing: however, such an adjustment requires an improved set of pressure data. We shall, therefore, obtain pressures for all stations in the area rather than the relatively limited sample used in this study.
- b) The correlation between wind and pressure gradient will be examined using a time series of observations at selected stations combined with corresponding pressure gradients. In this way a relationship tailored to each station with individual topographic peculiarities will be developed.
- c) All available surface and upper-air data including barograms and rawinsonde observations will be combined in a detailed case study of two or three carefully selected cases. This will facilitate analysis of the basic factors in addition to pressure gradient which influence the wind speed.

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APPENDIX A

Monthly Mean Wind Speed Summaries

Table A-1. Monthly mean wind speed summary (mph) for the period 12/77 - 8/78.

Station	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	AVG
Cape Blanco BPA	26.2	25.4	25.2	19.8 ¹	25.9 ¹	21.3 ¹	14.5	20.2 ¹	19.4 ¹	22.0
Cape Blanco CGLS	25.9 ¹	18.6	21.5	13.8	18.4	16.7	11.5	14.7	12.5	17.1
Cape Blanco Airport	10.2	11.2 ¹	11.8 ¹			System Removed				11.1 ¹
Gold Beach	F	F	11.6	F	13.4	13.9	8.0	12.8	11.0	11.8
Langlois Mountain	F	18.9	17.6	13.1	16.8	12.4	11.6	14.3	12.4	14.6
Leneve	11.9	9.4	8.6	8.0	9.8	11.9	8.9	11.0	12.1	10.2
Ashland	14.8	10.0	8.2	6.1	7.1	5.9	6.2	5.9	3.6	7.5
McCulloch Park	13.0	11.0				System Removed				12.0
Prairie Mountain	17.8 ¹	17.6	27.9 ¹	17.8 ¹	13.8 ¹	M	M	7.0	17.9	17.1
Mt. Hebo	14.3 ¹	F	F	F	14.8 ¹	16.4 ¹	F	F	F	15.2
Columbia River Jetty	16.6	13.5	11.9	11.0	11.2	F	F	8.7	9.2	11.9
Newberg Ridge	13.8	10.2	7.8	10.0	8.4	7.5	6.8	M	M	9.2
Corbett	18.7	19.3				System Removed				19.0
Gresham				3.7	3.6	2.5	3.2	2.5	3.2	3.1
Biddle Butte	16.5 ¹	F	F	F	F	10.6 ¹	8.4 ¹	6.5 ¹	M	10.5 ¹
Wind Mountain	14.2	10.0	8.8	9.5	11.0	13.4	14.2	M	M	11.6
Mt. Hood Meadows			10.0	8.7	10.3	11.8	9.6	6.7	8.5	9.4
Burdoin Mountain						7.8	4.6 ¹	7.5 ¹	8.5 ¹	7.1 ¹

¹ Data recovery less than 85% M - Missing data, F - System failure, E - Estimated speed

Table A-1 (Cont.). Monthly mean wind speed summary (mph) for the period 12/77 - 8/78.

Station	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	AVG
Augspurger Mountain	19.6 ¹	F	F	F	13.2 ¹	F	F	21.6	16.8	17.2
Mosier					11.7	14.0	12.9	12.9	M	12.9
Ortley	F	F	15.9 ¹	20.1 ¹	12.8 ¹	14.6	9.1 ¹	15.7 ¹	14.6 ¹	15.2
Ortley Point	E14.0	E12.0	E13.0	12.0	16.8	15.8	19.3	19.7	16.6	15.5
Seven Mile Bell	E15.0	E13.0	E14.0	13.6	16.9	20.5	21.7	21.0	16.0	16.9
Sauter's Ranch	7.8	5.7	6.2	F	F	F	F	22.8	F	
Thunderbird Ranch								7.6	7.3	7.5
Eshelman Farm	9.1	4.8	5.6	6.7	F	F	F	F	F	6.6
Wasco Lookout	23.4 ¹	11.3 ¹	8.5 ¹			System Removed				14.4 ¹
KCIV	15.4 ¹	13.4 ¹	14.0	13.5 ¹	15.3	17.2	15.1 ¹	15.0 ¹	M	15.0
Goldendale Bell	F	5.5	9.7	11.8	E14.0	19.6	18.3	18.3	16.4	14.2
Wasco	9.5	6.7	7.8	10.2	12.8	13.3	12.6	12.8	12.1	10.9
Biggs	10.2	5.8	6.8	9.7	11.8	E17.0	17.0	14.5	M	11.6
Juniper Point									22.4	22.4
Goodnoe Hills	15.3	6.7 ¹	F	15.0	17.6 ¹	F	19.8 ¹	17.6	18.2	16.0
Shutler Flats	8.2	7.0	7.7	10.8	12.1	13.0	12.2	12.5	12.5	10.7
Irrigon			3.7	6.2	E8.0	9.2	5.4	5.5	7.8	6.5
Hurlburt Flats	4.1	6.5	7.3	9.4	14.2	13.4	11.8	8.8	9.1	9.4
Boardman 130 ft.	8.0	3.9	5.5	7.0	9.9	11.3	M	9.4	M	7.9

¹ Data recovery less than 85%. M - Missing data, F - System failure, E - Estimated speed.

Table A-1 (Cont.). Monthly mean wind speed summary (mph) for the period 12/77 - 8/78.

Station	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	AVG
Kennewick	20.5	12.7 ¹	12.9 ¹	16.0	19.6	16.9 ¹	18.5 ¹	16.3	13.7 ¹	16.7
Sunnyside	15.8	10.8	10.1 ¹	12.7 ¹	17.3 ¹	15.0 ¹	15.8	12.8	14.9	13.9
Wanapum Dam	9.1	7.6	7.5	9.7	12.9	M	M	13.4	13.2	10.0
Vantage Farms								14.0	9.2	11.6
La Grande	16.6 ¹	16.7	14.8 ¹	11.2	M	M	M	M	M	14.8 ¹
Haines	7.8	7.2	F	F	F	F	F	F	14.0	9.7 ¹
John Day Airport	11.5	8.2	12.5 ¹	F	10.9	13.7 ¹				11.4
Burns Butte						16.0	12.9	11.8	12.7	13.4
Juniper Ranch							7.4	5.9	M	6.7
Stinkingwater Pass							7.0	7.0	M	7.0
Coyote Hills	E24.0	14.0	16.3	16.3	20.3	15.7	13.8	11.8	12.5	16.1
Adel	24.1	14.6	14.6	14.6	16.8 ¹	15.8	11.0	12.7 ¹	9.5	14.8
Prineville Airport					6.2 ¹	F	5.2 ¹	4.9	5.2 ¹	5.4 ¹
Bend Airport			4.7 ¹	3.6 ¹	F	F	F	F	F	4.1 ¹
Pequop Summit (Wells)	F	20.1	19.9	14.6	15.8	18.9 ¹	M	M	M	17.9
Wells West	16.0	12.5	13.0	10.3	M	M	M	M	M	13.0
Wendover			5.2	2.5	M	M	M	M	M	3.9
Radio Hill							M	M	M	
Ruby Station							M	M	M	

1 Data recovery less than 85%. M - Missing data, F - System failure, E - Estimated speed

Table A-2. Mean monthly wind speed summary (mph).

Station	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	AVG
Pt. Wilson 1975	11.3	12.4	12.9	11.2	10.4	10.6	9.4	10.1	8.1	11.6	14.6	11.8	11.2
Umatilla Lightship 1970	20.7	17.0	19.1	18.2	10.6	9.1	20.5	19.8	16.4	18.9	22.5	27.7	18.4
Smith Island 1975	14.5	14.4	13.8	11.6	10.7	11.0	10.4	10.1	6.7	13.6	16.6	12.2	12.1
Mt. Hood Meadows 1977-78	12.7	12.5										14.6	13.3
Sun Valley 1977-78	11.4	10.0	8.4									12.8	10.5
Bridger Bowl 1977-78	14.8	15.8	14.4									17.1	15.5
Mt. Baker 1977-78	5.4	7.3	9.6	12.1								9.7	9.0
Crystal Mountain 1977-78	16.4	14.1	12.8									16.2	14.8
Stevens Pass 1977-78	7.3	7.5	7.7	8.7							12.4	9.1	8.8
Mission Ridge 1977-78	9.0	7.2	7.5									10.5	8.6
Rattlesnake Mtn. 12/76-11/77	5.7 ¹	11.0 ¹	22.1	17.7	19.1	13.9	12.4	15.8	15.1	15.7	25.3	19.6 ¹	16.9
Jackson Hole 1977-78	16.7	19.3	15.2									23.0	18.5

¹ Data recovery less than 85%.

Table A-3. Monthly wind speed frequency distributions for the Spectrum Analyzer stations.

Station	Date	SPEED CLASS (mph)									
		<u>0-7</u>	<u>8-9</u>	<u>10-11</u>	<u>12-13</u>	<u>14-15</u>	<u>16-17</u>	<u>18-19</u>	<u>20-40</u>	<u>41-59</u>	<u>60+</u>
Vantage Farms	4/1 - 5/4	34.1	8.8	8.6	8.0	7.2	7.2	6.2	19.7	.1	0
	5/4 - 6/12	31.7	10.2	9.5	9.2	9.2	8.6	6.5	15.0	.0	0
Mosier		<u>0-10</u>	<u>11-12</u>	<u>13-14</u>	<u>15-16</u>	<u>17-18</u>	<u>19-20</u>	<u>21-22</u>	<u>23-24</u>	<u>25-26</u>	<u>27+</u>
	4/27 - 6/7	56.0	8.8	8.4	7.7	6.5	5.2	3.3	1.6	.8	1.6
	6/7 - 8/8	23.1	7.9	8.9	9.2	8.9	7.7	5.5	3.7	2.1	2.0
Sauter's Ranch		<u>0-7</u>	<u>8-9</u>	<u>10-11</u>	<u>12-13</u>	<u>14-15</u>	<u>16-17</u>	<u>18-19</u>	<u>20-40</u>	<u>41-59</u>	<u>60+</u>
	2/28 - 4/20	5.0	8.6	8.0	6.3	4.8	4.0	3.3	13.6	.4	0
	4/20 - 5/24	21.7	3.6	3.2	4.0	4.6	5.8	6.3	47.1	3.6	0
	5/24 - 8/3	21.8	4.6	3.5	2.9	2.7	3.2	3.5	51.3	6.4	0

Table A-4. Monthly wind speed frequency distributions for the Spectrum Analyzer stations.
 Aeolian odometer averages when available are also indicated.

SPEED CLASS (mph)

Station	Date	<u>0-7</u>	<u>8-9</u>	<u>10-11</u>	<u>12-13</u>	<u>14-15</u>	<u>16-17</u>	<u>18-19</u>	<u>20-21</u>	<u>22-69</u>	<u>70+</u>	<u>Aeolian $\bar{V}$</u>
Juniper Ranch	6/6 - 6/29	51.6	12.9	9.1	5.8	4.2	3.2	2.4	2.0	8.9	0	7.4
	6/29 - 7/27	61.2	11.1	6.8	4.6	3.4	.3	2.3	2.1	8.2	0	5.9
		<u>0-7</u>	<u>8-9</u>	<u>10-11</u>	<u>12-13</u>	<u>14-15</u>	<u>16-17</u>	<u>18-19</u>	<u>20-40</u>	<u>41-59</u>	<u>60+</u>	<u>Aeolian $\bar{V}$</u>
Hurlburt Flats	4/1 - 5/1	44.7	11.3	10.6	9.6	7.6	7.0	6.2	3.0	.1	0	14.2
	5/1 - 5/31	33.2	10.1	10.3	8.6	7.5	6.4	5.8	18.1	0	0	13.4
	5/31 - 7/5	39.1	9.4	10.2	9.5	9.8	8.0	5.7	8.4	.0	0	11.8
	7/5 - 8/1	59.6	7.7	7.5	5.8	5.1	4.3	4.2	5.8	.0	0	8.8
	8/1 - 9/5	59.0	9.2	8.5	7.2	5.3	4.0	2.9	4.0	0	0	9.1
		<u>0-7</u>	<u>8-9</u>	<u>10-11</u>	<u>12-13</u>	<u>14-15</u>	<u>16-17</u>	<u>18-19</u>	<u>20-40</u>	<u>41-59</u>	<u>60+</u>	
Beverly	4/11 - 5/4	20.4	11.5	11.9	11.1	10.8	9.4	7.5	16.8	.6	0	
	5/4 - 5/17	21.1	14.9	15.9	13.6	10.4	7.5	5.7	10.8	0	0	

Table A-5. Monthly wind speed frequency distributions for the Spectrum Analyzer sites. Aeolian odometer averages when available are also indicated.

Station	Date	SPEED CLASS (mph)										Aeolian Avg.
		0-7	8-9	10-11	12-13	14-15	16-17	18-19	20-40	41-59	60+	
Beverly	11/25 - 1/10/78	32.4	13.2	12.0	10.4	7.6	6.0	4.7	12.8	.8	-	
	1/10 - 3/15/78	41.0	13.7	12.5	10.3	7.7	5.9	4.0	4.8	-	-	
Tygh Ridge	1/26 - 3/1/78	95.7	1.4	1.0	0.9	0.5	0.2	0.1	0.1	-	-	1.0
	3/1 - 3/31/78	96.9	1.3	0.8	0.4	0.3	0.2	0.1	0.1	-	-	0.5
Sauter's Ranch	11/17 - 12/31/77	57.9	8.8	11.0	7.4	3.5	2.4	2.2	6.8	-	-	7.1
	12/31 - 1/31/78	61.9	7.1	5.9	4.8	3.4	2.6	2.1	11.6	4.7	-	5.2
	1/31 - 2/28/78	72.5	3.3	5.4	3.6	3.5	3.5	2.7	5.5	-	-	5.6
Hurlburt Flats	12/1 - 1/5/78	72.0	9.3	6.5	4.8	3.0	1.4	0.6	2.3	0.1	-	3.7
	1/5 - 2/1/78	68.5	11.5	7.3	4.4	2.8	1.8	1.2	2.6	-	-	5.9
	2/1 - 3/1/78	66.5	7.5	7.7	5.9	4.2	3.4	2.3	2.5	-	-	6.6
	3/1 - 4/1/78	57.3	8.2	6.6	5.9	5.4	3.7	3.4	9.4	-	-	8.5
Royal Slope	12/1 - 1/4/78	72.0	6.6	4.2	3.9	3.4	2.1	1.6	6.2	0.1	-	
	1/4 - 2/8/78	67.1	6.0	4.1	4.9	5.9	5.4	3.5	3.2	-	-	
	2/8 - 3/1/78	69.2	7.2	13.2	4.7	3.2	1.4	0.6	0.5	-	-	

APPENDIX B

Wind Roses, Diurnal Speed Tables, Power Density Tables,
and Wind Speed Frequency Distributions

Table B-1. Wind rose for Cape Blanco BPA (Dec 77 - Aug 78).

WIND ROSES RUN 11/04/78 FOR CAPE BLANCO BPA

ALL DATA -- 4537 OBSERVATIONS

	WIND SPEED (MPH)																TOTAL	MEAN SPEED
DIP	0 TO 3	3 TO 6	6 TO 9	9 TO 12	12 TO 15	15 TO 18	18 TO 21	21 TO 24	24 TO 27	27 TO 30	30 TO 33	33 TO 36	36 TO 39	39 TO 42	42			
N	.1	.5	.9	1.0	.9	.7	1.4	.8	1.4	.9	.6	.1	.1	.0	.0	9.5	18.6	
NNE	.2	.6	1.9	1.7	2.3	2.9	5.4	1.7	3.6	2.0	1.4	.6	.6	.2	.0	25.0	19.6	
NE	.1	.2	.7	.4	.6	.4	.5	.1	.2	.2	.3	.0	.1	.0	.0	3.8	15.0	
NENE	.1	.3	.7	.2	.0	.0	.9	.0	.0	.0	.0	.0	.0	.0	.0	1.4	6.5	
E	.3	.3	.9	.5	.2	.4	.1	.0	.0	.0	.0	.0	.0	.0	.0	2.8	9.1	
ESE	.2	.3	.5	.4	.2	.2	.2	.0	.0	.0	.0	.0	.0	.0	.0	2.2	8.8	
SE	.2	.3	.2	.4	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	1.2	8.9	
SSE	.2	.7	1.4	1.4	1.1	1.4	3.5	1.4	3.7	1.5	2.2	.0	2.2	.1	.3	18.2	15.6	
S	.2	.7	1.1	1.4	1.2	1.4	3.2	1.4	2.7	1.5	2.8	1.0	2.4	1.3	8.9	31.3	31.1	
SSW	.1	.4	.9	.9	.2	.4	1.0	.2	.7	.6	.8	.2	.7	.6	1.1	9.8	25.0	
WSW	.1	.2	.2	.1	.0	.0	.9	.1	.4	.1	.1	.0	.0	.0	.0	2.9	16.9	
W	.1	.2	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.6	6.8	
WNW	.1	.2	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.6	6.8	
NW	.0	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.4	7.1	
NNW	.0	.1	.6	.3	.3	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	1.5	7.1	
CALM	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1	.0	
TOTAL	2.3	5.4	11.2	8.6	7.4	7.4	13.4	4.5	9.5	5.4	6.3	2.0	4.1	2.2	10.4	100.0		

Table B-2. Power density and usable wind summary for Cape Blanco BPA.

POWER GENERATED FOR 1 PERIODS.
POWER GIVEN IN WATTS/METER SQUARED.

VELOCITY RANGE FOR THIS RUN 4 TO 50

DEC TO AUG

	MEAN POWER	TOTAL POWER	NO. DATA PTS. WITHIN RANGE	NO. DATA PTS. BELOW	NO. DATA PTS. ABOVE	PERCENT TIME WITHIN RANGE	MEAN VELOC. WITHIN RANGE	MEAN VELOC. ALL OBSERV.
DEC	1.49766E 03	6.63499E 05	446	105	74	70.91	25.0	26.2
JAN	1.59347E 03	8.83158E 05	558	117	69	75.00	25.4	25.4
FEB	1.65981E 03	8.63114E 05	520	91	50	78.67	25.1	25.2
MAR	1.09640E 03	2.42305E 05	221	32	0	87.35	21.9	19.8
APR	1.22943E 03	3.43012E 05	270	5	14	93.62	24.6	25.9
MAY	9.02970E 02	1.83865E 05	227	16	0	93.42	22.5	21.3
JUNE	8.73748E 02	2.14158E 05	573	146	0	79.69	17.1	14.5
JULY	7.06461E 02	3.56137E 05	501	50	0	90.93	21.8	20.2
AUG	9.17590E 02	3.14833E 05	343	84	12	78.13	21.5	19.4
PERIOD TOTAL	1.10907E 03	4.06804E 05	3669	646	223	80.85	22.7	22.0

Table B-3. Diurnal wind speed summary for Cape Blanco BPA.

AVERAGE HOURLY VELOCITY FOR 1 PERIODS:
VELOCITY GIVEN IN MPH.

VELOCITY RANGE FOR THIS RUN 0 TO 99

DEC TO AUG

MON	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	TOTAL	AV
DEC	27.5	27.4	26.1	27.4	29.8	29.3	27.3	26.3	24.4	25.5	26.0	27.3	26.9	26.5	25.8	25.0	25.4	24.2	23.8	24.5	24.2	24.3	26.2	26.8	26.16	
JAN	26.4	26.4	25.7	25.1	23.7	22.3	21.2	20.7	21.5	21.3	24.1	27.7	28.1	28.2	27.6	26.3	25.3	25.0	26.0	26.0	27.6	27.7	27.3	27.5	25.36	
FEB	23.7	24.6	25.8	25.4	26.8	26.1	26.1	26.9	28.8	28.4	27.9	28.6	28.9	27.6	26.8	25.0	23.0	22.1	21.9	20.5	21.4	22.1	22.6	22.3	25.18	
MAR	21.3	20.3	19.8	19.4	19.4	19.8	19.4	19.2	18.9	19.4	20.2	19.8	20.2	20.0	20.5	19.5	19.3	20.9	20.0	20.2	19.3	18.5	19.6	19.6	19.77	
APR	25.2	24.0	23.2	22.5	20.5	20.8	20.8	22.2	22.9	25.4	29.5	29.6	30.4	30.7	29.8	30.0	26.3	27.5	27.8	25.7	26.3	28.0	27.7	27.2	25.89	
MAY	19.9	20.3	20.6	19.4	18.6	19.4	19.6	19.2	20.2	23.7	22.3	23.4	24.1	22.4	22.8	23.0	23.7	22.9	22.6	22.0	20.6	20.6	19.2	18.9	21.33	
JUNE	14.1	13.3	12.8	13.3	12.5	12.3	13.2	13.5	13.9	15.5	15.5	15.5	15.1	16.1	15.8	15.9	16.8	17.4	15.4	15.5	14.9	14.2	13.1	13.3	14.53	
JULY	18.3	18.1	18.3	18.2	18.3	18.5	17.7	17.2	17.6	18.5	20.3	21.2	21.9	23.0	23.4	22.7	23.3	23.0	22.5	21.5	21.0	20.5	20.0	20.0	20.21	
AUG	19.4	20.3	20.8	19.9	19.7	18.8	17.2	18.2	18.9	19.8	21.1	22.5	20.3	18.7	19.1	17.9	18.4	19.5	18.7	19.3	19.5	19.4	19.1	18.6	19.38	
TOT																										
AVE	21.8	21.8	21.6	21.5	21.5	21.1	20.5	20.6	21.0	21.8	22.8	24.0	24.0	23.8	23.5	22.7	22.4	22.3	21.8	21.6	21.7	21.7	21.6	21.7	22.03	

NO. OBSERVATIONS PER MONTH

DEC 629 JAN 744 FEB 661 MAR 253 APR 298 MAY 243 JUNE 719 JULY 551 AUG 439

TOTAL 4537

Table B-4. Wind speed distribution for Cape Blanco BPA.

AVERAGE WIND VELOCITY FOR TIME PERIOD -- 22.0				
WIND VELOCITY FREQUENCY - MPH				
TOTAL HOURS OBSERVED -- 4537				
WINDSPEED	HOURS/PERIOD	RELATIVE FREQUENCY	CUMULATIVE HOURS	CUMULATIVE RELATIVE FREQUENCY
0	9	.110	4537	100.000
1	31	.643	4532	99.890
2	67	1.477	4501	99.207
3	31	.643	4434	97.730
4	162	3.571	4403	97.047
5	54	1.190	4241	93.476
6	241	5.312	4187	92.286
7	55	1.212	3946	86.974
8	214	4.717	3491	75.762
9	30	.661	3677	81.045
10	298	6.568	3647	80.384
11	62	1.367	3349	73.815
12	140	3.046	3247	72.449
13	57	1.256	3147	69.363
14	139	3.064	3090	68.107
15	52	1.146	2951	65.043
16	227	5.003	2499	55.097
17	55	1.212	2672	58.894
18	220	4.849	2617	57.681
19	55	1.212	2397	52.832
20	332	7.310	2342	51.620
21	44	.970	2010	44.302
22	105	2.314	1966	43.333
23	63	1.364	1861	41.018
24	165	3.637	1804	39.850
25	74	1.631	1643	36.213
26	190	4.188	1569	34.582
27	55	1.212	1379	30.395
28	164	3.615	1324	29.182
29	27	.595	1160	25.568
30	203	4.474	1133	24.972
31	26	.573	930	20.498
32	48	1.274	904	19.925
33	15	.331	846	18.647
34	61	1.345	831	18.316
35	13	.287	770	16.972
36	103	2.270	757	16.685
37	10	.220	654	14.415
38	72	1.587	644	14.194
39	9	.194	572	12.607
40	89	1.962	563	12.409
41	2	.044	474	10.447
42	22	.485	472	10.403
43	9	.194	450	9.914
44	26	.573	441	9.720
45	5	.110	415	9.147
46	59	1.300	410	9.037
47	6	.132	351	7.736
48	59	1.300	345	7.604
49	63	1.349	286	6.304
50	2	.044	223	4.915
51	14	.309	221	4.871
52	9	.198	207	4.562
53	10	.220	198	4.364
54	28	.617	180	4.044
55	17	.375	160	3.527
56	5	.110	143	3.152
57	22	.485	130	2.942
58	24	.517	116	2.557
59	5	.110	88	1.940
60	1	.022	83	1.829
61	10	.220	82	1.807
62	16	.353	72	1.547
63	8	.176	56	1.234
64	2	.044	48	1.058
65	7	.154	46	1.014
66	2	.044	39	.860
67	17	.375	37	.816
68	1	.022	20	.441
69	4	.088	19	.419
70	3	.066	15	.331
71	5	.110	12	.264
72	2	.044	7	.154
73	2	.044	5	.110
74	1	.022	3	.066
75	2	.044	2	.044

Table B-5. Wind rose for Prairie Mtn. (Dec 77 - Aug 78).

WIND ROSES RUN 11/09/78 FOR PRAIRIE MTN

ALL DATA -- 2708 OBSERVATIONS

DIR	WIND SPEED (MPH)																TOTAL	MEAN SPEED
	0	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45		
N	1.8	7.8	5.3	4.1	2.6	1.2	1.3	.4	.4	.1	.7	.0	.1	.2	.2	.2	26.3	9.9
NNE	.0	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.2	5.0
NE	.8	4.7	2.9	2.1	1.4	2.1	2.2	.5	1.0	.4	.7	.0	.2	.4	.7	.2	20.2	14.3
NENE	.9	.3	.7	.3	.1	.3	.3	.0	.1	.0	.1	.0	.1	.1	.2	.1	3.3	14.0
E	.1	1.4	.8	.8	.7	.2	.2	.1	.4	.0	.2	.0	.2	.0	.6	.0	6.8	14.3
ESE	1.5	1.2	.6	.4	.7	.4	1.0	.2	.7	.3	.4	.1	.2	.0	.0	.0	7.8	12.0
SE	.9	.5	.1	.6	.4	.5	.2	.1	.1	.0	.2	.1	.1	.0	.0	.0	3.6	10.9
SSE	1.2	2.1	.9	1.5	.8	.2	.3	.0	.0	.1	.3	.1	.2	.2	.1	.1	8.7	11.2
SSW	.6	.6	.5	.4	.3	.7	.5	.0	.2	.0	1.1	.2	.2	.1	.2	.1	6.1	20.5
SW	.1	.3	.3	.3	.1	.1	.2	.1	.1	.1	.3	.1	.2	.4	1.7	.0	6.4	25.8
WSW	.2	.5	.7	.5	.2	.1	.3	.1	.1	.1	.1	.0	.0	.1	.0	.0	2.4	14.9
W	.2	.2	.3	.4	.1	.1	.1	.0	.0	.0	.1	.0	.0	.0	.0	.0	2.3	11.1
WNW	.2	.3	.3	.4	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	1.3	10.9
NW	.0	.2	.2	.2	.1	.1	.2	.1	.1	.1	.0	.0	.0	.0	.0	.0	1.9	11.2
NNW	.0	.2	.2	.2	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.4	6.0
CALM	.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.4	.0
TOTAL	9.2	21.3	14.3	12.6	8.3	7.4	7.8	1.8	4.0	1.3	4.5	.6	1.6	1.5	3.7	100.0		

Table B-6. Power density and usable wind summary for Prairie Mtn.

POWER GENERATED FOR 1 PERIODS:
POWER GIVEN IN WATTS/METER SQUARED.

VELOCITY RANGE FOR THIS RUN 8 TO 50

DEC TO AUG

	MEAN POWER - - -	TOTAL POWER	NO. DATA PTS. WITHIN RANGE	NO. DATA PTS. BELOW	NO. DATA PTS. ABOVE	PERCENT TIME WITHIN RANGE	MEAN VELOC. WITHIN RANGE	MEAN VELOC. ALL OBSVS.
DEC	4.88189E 02	3.95433E 04	81	3	0	96.43	18.2	17.0
JAN	6.46565E 02	3.58843E 05	555	81	0	87.26	19.7	17.6
FEB	1.49879E 03	2.95262E 05	197	6	0	97.04	28.5	27.9
MAR	5.66855E 02	1.10537E 05	195	47	0	80.58	18.0	15.6
APR	4.08928E 02	2.14687E 05	525	101	0	83.87	16.6	14.4
MAY	1.59390E 03	9.99374E 05	627	64	24	87.69	25.6	24.7
JUNE	1.66453E 02	5.22664E 04	314	365	0	46.24	12.9	8.4
JULY	1.40042E 02	3.78113E 04	270	510	0	34.62	12.4	7.0
AUG	5.49210E 02	3.77307E 05	687	51	0	93.09	18.9	17.9
PERIOD-TOTAL	7.20264E 02	2.48563E 06	3451	1228	24	73.38	19.3	15.5

Table B-7. Diurnal wind speed summary for Prairie Mtn.

AVERAGE HOURLY VELOCITY FOR 1 PERIODS:
VELOCITY GIVEN IN MPH.

VELOCITY RANGE FOR THIS RUN 0 TO 99

DEC TO AUG

MON	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	TOTAL	AV			
DEC	18.8	16.8	17.5	18.0	19.3	19.8	18.8	18.8	19.8	14.8	15.5	14.3	19.0	18.7	19.3	18.0	17.3	18.3	16.7	19.0	17.3	18.0	18.3	18.3	17.76				
JAN	18.8	18.1	18.1	17.9	17.5	17.2	16.8	17.9	17.8	16.9	17.1	16.2	17.3	17.7	17.3	17.9	17.0	17.1	18.1	17.6	17.8	18.5	17.8	18.1	17.61				
FEB	24.7	23.8	24.8	25.8	27.1	26.2	28.3	28.8	28.0	28.5	28.5	29.0	29.9	29.7	31.4	30.5	28.9	30.5	27.4	28.3	27.8	29.3	28.8	25.0	27.85				
MAR	17.6	16.4	15.6	16.9	18.2	16.7	16.4	16.2	17.6	15.4	15.6	12.6	12.1	13.5	13.3	13.8	12.9	13.6	15.6	15.8	17.6	18.2	17.5	16.5	15.57				
APR	14.6	13.1	13.0	12.9	12.8	13.0	13.4	13.0	11.0	11.8	11.8	12.7	12.8	14.0	15.5	16.4	16.0	16.6	17.3	16.6	16.5	16.8	16.2	16.3	14.38				
MAY	28.2	26.5	24.5	24.9	24.7	25.4	25.3	23.3	21.3	18.2	18.0	20.8	19.2	20.9	22.5	24.4	25.7	25.6	27.5	28.7	28.9	29.2	28.8	28.9	24.68				
JUNE	10.5	10.1	9.5	8.7	8.6	8.5	7.1	6.7	6.2	5.9	5.7	6.1	6.8	7.1	7.6	7.9	8.4	8.5	9.5	10.4	10.5	10.9	10.1	10.5	8.39				
JULY	8.8	8.2	8.2	8.4	8.8	8.0	7.2	6.1	5.3	4.7	4.2	4.4	5.3	5.7	5.6	6.4	6.4	6.6	7.4	7.3	8.2	8.9	8.6	8.6	6.96				
AUG	21.0	20.2	19.1	18.9	20.2	19.4	18.4	16.9	16.0	14.9	14.2	15.2	15.8	16.0	16.2	16.7	17.1	18.0	18.1	18.9	18.9	19.8	19.8	20.4	17.94				
TOT	17.2	16.5	15.9	16.0	16.2	15.9	15.4	14.7	13.8	12.8	12.6	13.1	13.6	14.3	14.8	15.5	15.5	15.9	16.7	16.9	17.2	17.8	17.4	17.4	15.55				
NO. OBSERVATIONS PER MONTH																													
DEC	84	JAN	636	FEB	203	MAR	242	APR	626	MAY	715	JUNE	679	JULY	780	AUG	738											TOTAL	4703

Table B-8. Wind speed distribution for Prairie Mtn.

DEC 1 1977 TO AUG 31 1978

AVERAGE WIND VELOCITY FOR TIME PERIOD -- 15.5

WIND VELOCITY FREQUENCY -- MPH
TOTAL HOURS OBSERVED -- 4703

WIND SPD	HOURS/ PERIOD	RELATIVE FREQUENCY	CUMULATIVE HOURS	CUMULATIVE RELATIVE FREQUENCY
0	12	.255	4703	100.000
1	53	1.127	4691	99.745
2	259	5.507	4638	98.618
3	111	2.360	4379	93.111
4	234	4.976	4268	90.751
5	248	5.273	4034	85.775
6	205	4.359	3786	80.502
7	106	2.254	3581	76.143
8	213	4.529	3475	73.889
9	24	.510	3262	69.360
10	556	11.822	3238	68.850
11	2	.043	2682	57.027
12	297	6.315	2680	56.985
13	22	.468	2383	50.670
14	167	3.551	2361	50.202
15	188	3.997	2194	46.651
16	182	3.870	2006	42.654
17	72	1.531	1824	38.784
18	191	4.061	1752	37.253
19	2	.043	1561	33.192
20	396	8.420	1559	33.149
22	133	2.828	1163	24.729
23	3	.064	1030	21.901
24	84	1.796	1027	21.837
25	72	1.531	943	20.051
26	143	3.041	871	18.520
27	21	.447	728	15.479
28	83	1.765	707	15.033
30	250	5.316	624	13.268
32	45	.957	374	7.952
33	4	.085	329	6.996
34	26	.553	325	6.910
35	18	.383	299	6.358
36	68	1.446	281	5.975
37	5	.106	213	4.529
38	26	.553	208	4.423
40	61	1.297	182	3.870
42	7	.149	121	2.573
44	7	.149	114	2.424
45	16	.340	107	2.275
46	15	.319	91	1.935
48	19	.404	76	1.616
50	37	.702	57	1.212
52	1	.021	24	.510
54	1	.021	23	.489
55	10	.213	22	.468
58	2	.043	12	.255
60	4	.085	10	.213
62	2	.043	6	.128
64	2	.043	4	.085
65	2	.043	2	.043

Table B-9. Wind rose summary for the Columbia River Jetty (Dec 77 - Aug 78).

WIND ROSES RUN 11/03/78 FOR COLUMBIA RIVER JETTY. ALL DATA -- 4427 OBSERVATIONS

DIR	0 TO 3	3 TO 6	6 TO 9	9 TO 12	12 TO 15	15 TO 18	18 TO 21	21 TO 24	24 TO 27	27 TO 30	30 TO 33	33 TO 36	36 TO 39	39 TO 42	> 42	TOTAL	MEAN SPEED
N	.2	1.2	1.2	.9	.7	.4	.2	.1	.0	.0	.0	.0	.0	.0	.0	4.9	9.3
NNE	.3	.7	.2	.2	.2	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	1.3	6.9
NNE	.1	.3	.3	.2	.2	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	1.4	10.6
NNE	.3	.3	1.2	2.2	2.2	2.2	1.3	1.2	.6	.1	.0	.0	.0	.0	.0	13.3	14.9
NNE	.3	1.2	1.2	1.2	2.2	2.2	1.3	1.0	.4	.1	.0	.0	.0	.0	.0	14.0	12.2
NNE	.2	.6	.6	.8	.7	.6	.8	.1	.2	.1	.0	.0	.0	.0	.0	4.8	11.6
NNE	.1	.2	.2	.1	.3	.1	.3	.2	.2	.1	.0	.0	.0	.0	.0	1.5	12.9
NNE	.1	.2	.2	.1	.3	.1	.3	.2	.2	.1	.0	.0	.0	.0	.0	5.5	18.2
NNE	.6	1.2	2.8	3.6	2.7	1.6	1.2	1.4	.8	.3	.1	.2	.1	.1	.0	15.6	13.8
NNE	.1	.6	.4	.7	.3	.2	.2	.1	.3	.1	.0	.0	.0	.0	.0	4.7	10.2
NNE	.2	1.0	1.1	1.1	.3	.1	.2	.1	.2	.1	.0	.0	.0	.0	.0	2.0	11.3
NNE	.3	1.1	3.0	2.5	1.4	.4	.7	.2	.1	.0	.0	.0	.0	.0	.0	4.3	9.4
NNE	.3	1.1	2.5	2.4	1.4	.7	.4	.1	.3	.0	.0	.0	.0	.0	.0	3.1	9.4
NNE	.1	1.2	1.1	.8	.5	.3	.2	.0	.0	.0	.0	.0	.0	.0	.0	2.6	10.5
NNE	.1	.9	.8	.3	.3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	4.3	8.8
CALM	.3	.9	.8	.3	.3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	4.2	11.0	19.0	26.3	14.9	10.8	7.2	5.8	3.4	1.8	.6	.6	.1	.2	.1	100.0	

Table B-10. Power density and usable wind summary for the Columbia River Jetty.

POWER GENERATED FOR 1 PERIODS.
POWER GIVEN IN WATTS/METER SQUARED.

VELOCITY RANGE FOR THIS RUN 8 TO 50

DEC TO AUG

	MEAN POWER - - - TOTAL POWER	NO. DATA PTS. WITHIN RANGE	NO. DATA PTS. BELOW	NO. DATA PTS. ABOVE	PTS. 50	MEAN VELOC. WITHIN RANGE	PERCENT TIME WITHIN RANGE
DEC	6.75509E 02	4.37730E 05	648	54	3	20.1	91.91
JAN	3.69315E 02	2.32668E 05	630	68	0	16.7	90.26
FEB	3.92248E 02	1.96908E 05	502	153	0	16.4	76.64
MAR	4.13794E 02	2.11449E 05	511	230	0	16.3	68.96
APR	3.07529E 02	1.68526E 05	548	164	0	15.4	76.97
JULY	1.30035E 02	5.90358E 04	454	197	0	12.1	69.74
AUG	2.38707E 02	7.08959E 04	297	164	0	14.3	64.43
PERIOD TOTAL	3.83625E 02	1.37721E 06	3590	1030	3	16.2	77.66

Table B-11. Diurnal wind speed summary for the Columbia River Jetty.

AVERAGE HOURLY VELOCITY FOR 1 PERIODS.
VELOCITY GIVEN IN MPH.

VELOCITY RANGE FOR THIS RUN 0 TO 99

DEC TO AUG

MON	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	TOTAL	AV
DEC	16.3	18.0	18.1	18.7	18.7	19.1	18.4	18.9	18.6	19.6	19.0	17.6	21.4	20.1	20.0	19.8	20.5	20.6	20.0	19.0	20.1	19.1	18.7	19.1	19.1	19.1
JAN	15.8	15.6	15.8	15.4	15.7	15.3	15.7	16.1	15.6	15.8	16.5	16.3	15.5	15.2	15.2	15.0	14.2	14.4	15.0	15.4	16.0	16.3	15.3	16.4	15.56	
FEB	13.4	13.4	14.3	14.0	13.6	13.5	12.7	13.7	13.1	13.8	14.8	13.9	13.6	14.3	14.6	16.1	16.0	14.7	12.8	12.9	12.2	13.0	11.7	12.3	13.70	
MAR	12.0	11.5	11.1	11.2	11.2	10.9	11.1	11.2	11.8	12.2	12.2	11.6	13.1	14.4	14.7	15.7	16.7	15.0	14.0	14.2	12.3	11.8	11.6	12.4	12.67	
APR	11.0	11.1	10.3	10.3	11.1	11.2	12.6	11.6	12.2	12.4	14.1	14.8	16.1	15.7	15.6	15.1	14.5	14.9	13.7	13.9	13.0	11.6	11.6	12.2	12.94	
JULY	8.8	8.2	8.8	8.3	7.5	7.3	7.7	8.1	8.1	9.2	10.6	10.7	11.9	12.1	12.6	12.1	12.2	12.3	11.6	11.2	10.6	10.3	10.2	9.6	9.99	
AUG	7.8	8.4	9.2	8.4	7.3	7.5	7.0	8.6	8.3	9.6	12.1	12.2	11.6	15.9	13.9	15.7	13.7	13.7	13.3	12.1	11.5	10.9	9.4	10.5	10.56	
TOT																										
AVE	12.3	12.5	12.7	12.6	12.4	12.4	12.5	12.8	12.8	13.5	14.3	14.0	14.9	15.4	15.4	15.7	15.5	15.2	14.4	14.2	13.8	13.4	12.9	13.4	13.69	
NO. OBSERVATIONS PER MONTH																										
DEC	705	JAN	698	FEB	655	MAR	741	APR	712	MAY	0	JUNE	0	JULY	651	AUG	461								TOTAL	4623

Table B-12. Wind speed distribution for the Columbia River Jetty.

DEC 1 1977 TO AUG 21 1978

AVERAGE WIND VELOCITY FOR TIME PERIOD -- 13.6

WIND VELOCITY FREQUENCY - MPH
TOTAL HOURS OBSERVED -- 4648

INDSPD	HOURS/ PERIOD	RELATIVE FREQUENCY	CUMULATIVE HOURS	CUMULATIVE RELATIVE FREQUENCY
0	60	1.291	4648	100.000
1	67	1.441	4588	98.709
2	94	2.022	4521	97.268
3	153	3.292	4427	95.245
5	143	3.937	4274	91.954
6	223	4.798	4091	88.016
7	275	5.917	3868	83.219
8	311	6.691	3593	77.302
9	297	6.390	3282	70.611
10	303	6.519	2985	64.221
12	328	7.057	2682	57.702
13	306	6.583	2354	50.645
14	255	5.701	2048	44.062
15	203	4.367	1783	38.361
16	177	3.808	1580	33.993
17	170	3.657	1403	30.185
18	170	3.657	1233	26.528
20	156	3.356	1063	22.870
21	132	2.840	907	19.514
22	115	2.560	775	16.674
23	86	1.850	656	14.114
24	95	2.044	570	12.263
25	88	1.893	475	10.219
26	82	1.764	387	8.326
28	72	1.549	305	6.562
29	51	1.097	233	5.013
30	32	.688	182	3.916
31	36	.775	150	3.227
32	24	.516	114	2.453
33	20	.430	90	1.936
35	8	.172	70	1.506
36	9	.194	62	1.334
37	8	.172	53	1.140
38	10	.215	45	.968
39	11	.237	35	.753
40	5	.108	24	.516
41	2	.043	19	.409
43	2	.043	17	.366
44	2	.043	15	.323
45	6	.129	13	.280
46	2	.043	7	.151
47	1	.022	5	.108
49	1	.022	4	.086
51	1	.022	3	.065
52	1	.022	2	.043
54	1	.022	1	.022

Table B-13. Wind rose summary for Augspurgen Mtn. (Dec 77 - Aug 78).

WIND ROSES RUN 11/14/78 FOR AUGSPURGER MTN													ALL DATA -- 2025 OBSERVATIONS				
	0	3	6	9	12	15	18	21	24	27	30	33	36	39	42	TOTAL	MEAN SPEED
DIR	TO 3	TO 6	TO 9	TO 12	TO 15	TO 18	TO 21	TO 24	TO 27	TO 30	TO 33	TO 36	TO 39	TO 42			
N	0	.1	.0	0	0	0	0	0	0	0	0	0	0	0	0	.1	4.7
NNE	.1	.8	.3	.8	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	2.2	7.8
NNE	.1	.8	.3	.8	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	2.2	7.8
NNE	.4	.9	1.1	2.7	2.4	1.4	.4	.0	.1	.2	.2	.3	.0	.0	.0	6.9	12.1
E	.1	.2	.5	.3	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	1.4	7.4
ESE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1	3.5
ESE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	5.0
SSE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.2	8.2
SSW	.3	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1	4.7
SSW	.0	.1	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.8	4.9
WSW	.1	.8	1.1	1.1	3.0	5.8	11.4	5.0	8.0	4.4	5.9	1.8	2.7	1.6	1.6	57.6	11.9
W	.1	1.2	2.4	2.0	2.0	3.5	2.7	.9	1.9	.5	.5	.3	.0	.0	.0	18.7	23.0
WNW	.0	.0	.0	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.6	8.8
NNW	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1	17.0
CALM	.8	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	5.0
TOTAL	2.4	5.5	7.9	11.2	9.2	12.2	15.1	6.2	9.9	5.1	6.7	2.4	2.8	1.7	1.7	100.0	0

Table B-14. Power density and usable wind summary for Augspurgen Mtn.

POWER GENERATED FOR 1 PERIODS.
POWER GIVEN IN WATTS/METER SQUARED.

VELOCITY RANGE FOR THIS RUN 8 TO 50

DEC TO AUG

	MEAN POWER - -	TOTAL POWER	NO. DATA PTS. WITHIN RANGE	NO. DATA PTS. BELOW 8	NO. DATA PTS. ABOVE 50	PERCENT TIME WITHIN RANGE	MEAN VELOC. WITHIN RANGE	MEAN VELOC. ALL OBSERV.
DEC	9.22085E 02	3.88198E 05	421	50	0	89.38	21.4	19.6
APR	2.75162E 02	4.87037E 04	177	39	0	81.94	15.0	13.2
JULY	1.05728E 03	5.81836E 05	550	61	0	90.02	23.5	21.6
AUG	5.64306E 02	3.47048E 05	615	128	0	82.77	19.3	16.8
PERIOD TOTAL	7.74694E 02	1.36579E 06	1763	278	0	86.38	20.7	18.5

Table B-15. Diurnal wind speed summary for Augspurger Mtn.

AVERAGE HOURLY VELOCITY FOR 1 PERIODS.
VELOCITY GIVEN IN MPH.

VELOCITY RANGE FOR THIS RUN 0 TO 99

DEC TO AUG

[illegible]

Table B-16. Wind speed distribution for Augspurger Mtn.

AVERAGE WIND VELOCITY FOR TIME PERIOD -- 18.5

WIND VELOCITY FREQUENCY - MPH
TOTAL HOURS OBSERVED -- 2041

WINDSPD	HOURS/ PERIOD	RELATIVE FREQUENCY	CUMULATIVE HOURS	CUMULATIVE RELATIVE FREQUENCY
0	16	.784	2041	100.000
1	13	.637	2025	99.216
2	21	1.029	2012	98.579
3	29	1.421	1991	97.550
4	44	2.156	1962	96.129
5	50	2.450	1918	93.974
6	52	2.548	1868	91.524
7	53	2.597	1816	88.976
8	57	2.793	1763	86.379
9	53	2.597	1706	83.586
10	119	5.830	1653	80.900
11	55	2.695	1534	75.159
12	76	3.724	1479	72.464
13	51	2.499	1403	68.741
14	59	2.891	1352	66.242
15	115	5.634	1293	63.351
16	90	3.920	1178	57.717
17	53	2.597	1098	53.797
18	85	4.165	1045	51.200
19	55	2.695	960	47.036
20	165	8.084	905	44.341
21	33	1.617	740	36.257
22	62	3.038	707	34.640
23	31	1.519	645	31.602
24	46	2.254	614	30.093
25	89	4.361	568	27.829
26	66	3.234	479	23.469
27	26	1.274	413	20.235
28	47	2.303	387	18.961
29	39	1.970	340	16.659
30	100	4.900	319	15.189
31	13	.637	210	10.289
32	22	1.078	197	9.652
33	17	.833	175	8.574
34	15	.735	158	7.741
35	17	.833	143	7.006
36	35	1.715	126	6.173
37	1	.040	91	4.459
38	21	1.029	90	4.410
39	4	.196	69	3.381
40	29	1.421	65	3.185
41	2	.098	36	1.764
42	2	.098	34	1.666
43	1	.040	32	1.568
44	3	.147	31	1.519
45	1	.040	28	1.372
46	12	.588	27	1.323
48	8	.392	15	.735
50	7	.343	7	.343

Table B-17. Wind rose summary for Ortley (Feb 78 - Aug 78).

WIND ROSES RUN 11/06/78 FOR ORTLEY																ALL DATA -- 2513 OBSERVATIONS			
	WIND SPEED (MPH)																		
	0	3	6	9	12	15	18	21	24	27	30	33	36	39	42				
DIR	TO 3	TO 6	TO 9	TO 12	TO 15	TO 18	TO 21	TO 24	TO 27	TO 30	TO 33	TO 36	TO 39	TO 42	42	TOTAL	MEAN SPEED		
N	.1	.1	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.4	4.4		
NNE	.0	.1	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.3	6.9		
NNE	.0	.1	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.3	7.7		
NNE	.0	.1	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.3	8.9		
NNE	.0	.1	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.3	9.5		
NNE	.0	.1	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.3	9.1		
NNE	.0	.1	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.3	8.3		
NNE	.0	.1	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.3	9.1		
NNE	.0	.1	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.3	8.5		
NNE	.0	.1	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.3	11.0		
NNE	.0	.1	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.3	11.1		
NNE	.0	.1	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.3	14.9		
NNE	.0	.1	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.3	15.6		
NNE	.0	.1	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.3	17.3		
NNE	.0	.1	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.3	18.1		
NNE	.0	.1	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.3	14.8		
NNE	.0	.1	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.3	.9		
TOTAL	3.8	4.4	12.4	12.8	17.5	14.9	17.1	4.2	6.3	2.0	3.0	.6	.4	.1	.1	100.0	.		

Table B-18. Power density and usable wind summary for Ortley.

POWER GENERATED FOR 1 PERIODS:
POWER GIVEN IN WATTS/METER SQUARED.

VELOCITY RANGE FOR THIS RUN 8 TO 50

FEB TO AUG

	MEAN POWER - - - TOTAL POWER	NO. DATA PTS. WITHIN RANGE	NO. DATA PTS. BELOW 8	NO. DATA PTS. ABOVE 50	PERCENT TIME WITHIN RANGE	MEAN VELOC. WITHIN RANGE	MEAN VELOC. ALL OBSERV.	
FEB	3.86938E 02	1.07956E 05	279	31	0	90.00	17.1	15.9
MAR	6.83053E 02	3.35379E 05	491	5	0	98.99	20.2	20.1
APP	4.77617E 02	1.75285E 05	367	173	0	67.96	17.4	12.8
MAY	3.59491E 02	2.14975E 05	598	130	0	82.14	16.7	14.6
JUNF	7.23030E 01	6.36266E 03	88	44	0	66.67	10.7	9.1
JULY	2.91800E 02	9.36678E 04	321	25	0	92.77	16.5	15.7
AUG	2.61893E 02	8.79959E 04	336	43	0	88.65	15.7	14.6
PERIOD TOTAL	4.11944E 02	1.02162E 06	2480	451	0	84.61	17.2	15.2

Table B-19. Diurnal wind speed summary for Ortley.

AVERAGE HOURLY VELOCITY FOR 1 PERIODS.
VELOCITY GIVEN IN MPH.

VELOCITY RANGE FOR THIS RUN 0 TO 99

FEB TO AUG

MON	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	TOTAL	AV
FEB	17.2	16.9	16.5	16.0	16.2	15.5	15.7	15.2	15.2	16.1	16.6	16.8	17.3	17.3	16.8	17.1	14.8	14.4	13.2	13.8	14.2	15.1	16.9	17.2	15.91	
MAR	13.8	18.6	18.1	18.3	18.1	18.2	18.4	18.3	17.7	18.3	19.4	20.3	21.7	22.4	22.7	22.9	22.0	21.7	20.7	20.0	20.1	21.3	20.3	20.8	20.06	
APR	12.5	12.8	12.2	12.3	11.2	10.6	9.5	10.3	10.4	12.0	12.3	12.0	13.9	14.6	15.9	15.6	15.4	15.1	14.8	14.0	13.1	13.4	12.2	11.1	12.78	
MAY	14.3	14.8	13.9	13.7	13.4	12.5	12.2	12.4	12.8	13.2	13.4	14.7	15.8	16.4	16.9	16.9	16.6	16.3	15.8	15.8	15.1	14.8	14.6	14.3	14.62	
JUNE	9.7	10.0	10.2	10.2	10.0	10.2	10.0	9.8	9.2	8.5	8.5	9.0	8.6	8.8	8.4	7.0	6.8	7.4	8.0	8.6	9.0	9.8	10.2	10.6	9.14	
JULY	15.9	15.8	15.3	15.1	14.9	14.9	14.9	14.4	14.2	14.2	14.7	14.6	15.1	15.7	15.8	16.3	17.3	17.3	17.5	17.6	16.9	16.3	16.2	15.9	15.73	
AUG	14.4	14.5	13.8	13.9	13.4	13.4	13.4	13.6	13.7	13.7	13.5	14.5	15.3	15.6	15.9	15.8	15.8	15.9	15.5	14.9	15.2	15.4	15.1	15.1	14.63	
TOT																										
AVE	15.2	15.1	14.5	14.5	14.1	13.7	13.4	13.5	13.5	14.1	14.4	15.1	16.2	16.7	17.1	17.1	16.7	16.5	16.0	15.8	15.5	15.8	15.5	15.3	15.22	

NO. OBSERVATIONS PER MONTH

FEB 310 MAR 496 APR 540 MAY 728 JUNE 132 JULY 346 AUG 379

TOTAL 2931

Table B-20. Wind speed distribution for Ortley.

FEB 9 1978 TO AUG 18 1978

AVERAGE WIND VELOCITY FOR TIME PERIOD -- 15.2

WIND VELOCITY FREQUENCY -- MPH
TOTAL HOURS OBSERVED -- 2931

WINDSPD	HOURS/ PERIOD	RELATIVE FREQUENCY	CUMULATIVE HOURS	CUMULATIVE RELATIVE FREQUENCY
0	40	1.365	2931	100.000
1	2	.068	2891	98.635
2	66	2.252	2825	96.383
3	11	.375	2814	96.008
4	81	2.764	2733	93.244
5	37	1.262	2696	91.982
6	156	5.322	2540	86.660
7	58	1.979	2482	84.681
8	137	4.674	2345	79.907
9	41	1.399	2304	78.508
10	294	10.031	2010	68.579
11	24	.819	1984	67.760
12	201	6.858	1783	60.802
13	54	1.842	1729	58.960
14	243	8.291	1486	50.699
15	104	3.548	1382	47.151
16	210	7.165	1172	39.986
17	92	3.139	1080	36.847
18	208	7.097	872	29.751
19	55	1.876	817	27.874
20	255	8.700	562	19.174
21	19	.648	543	18.526
22	98	3.344	445	15.183
23	19	.648	426	14.534
24	92	3.139	334	11.395
25	22	.751	312	10.645
26	88	3.002	224	7.642
27	4	.136	220	7.506
28	57	1.945	163	5.561
29	1	.034	162	5.527
30	95	3.241	67	2.286
32	13	.444	54	1.842
34	12	.409	42	1.433
35	8	.273	34	1.160
36	16	.546	18	.614
38	3	.102	15	.512
40	9	.307	6	.205
44	3	.102	3	.102
46	3	.102		

Table B-21. Wind rose summary for KCIV (Dec 77 - Jul 78).

WIND ROSES RUN 11/03/78 FOR KCIV

ALL DATA -- 1666 OBSERVATIONS

	0	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	TOTAL	MEAN SPEED
DIP	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10		
N	.1	.1	.3	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	1.8	7.6
NNE	.1	.1	.3	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	1.3	11.1
NNE	.1	.1	.3	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	1.3	11.1
NNE	.1	.1	.3	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	1.3	11.1
E	.1	.1	.3	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	1.3	11.1
ESE	.1	.1	.3	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	1.3	11.1
SE	.1	.1	.3	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	1.3	11.1
SSE	.1	.1	.3	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	1.3	11.1
SSW	.1	.1	.3	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	1.3	11.1
SSW	.1	.1	.3	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	1.3	11.1
SW	.1	.1	.3	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	1.3	11.1
WSW	.1	.1	.3	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	1.3	11.1
W	.1	.1	.3	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	1.3	11.1
WNW	.1	.1	.3	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	1.3	11.1
NW	.1	.1	.3	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	1.3	11.1
NNW	.1	.1	.3	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	1.3	11.1
CALM	.1	.1	.3	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	1.3	11.1
TOTAL	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	100.0	

Table B-22. Power density and usable wind summary for KCIV.

POWER GENERATED FOR 1 PERIODS.
POWER GIVEN IN WATTS/METER SQUARED.

VELOCITY RANGE FOR THIS RUN 8 TO 50

DEC TO AUG

	MEAN POWER - - - TOTAL POWER	NO. DATA PTS. WITHIN RANGE	NO. DATA PTS. BELOW	NO. DATA PTS. ABOVE	PTS. 50	PERCENT TIME WITHIN RANGE	MEAN VELOC. WITHIN RANGE	MEAN VELOC. ALL OBSERV.
DEC	4.58369E 02	1.63034E 05	362	65	0	84.78	17.4	15.4
JAN	3.27466E 02	9.23453E 04	282	80	0	77.90	15.7	13.3
FEB	3.06265E 02	1.59258E 05	520	89	0	85.39	15.5	14.0
MAR	2.95832E 02	1.23066E 05	416	88	0	82.54	15.4	13.5
APR	3.85334E 02	2.16558E 05	562	77	0	87.95	16.7	15.3
MAY	3.98562E 02	2.50350E 05	641	28	0	95.81	17.7	17.2
JUNE	2.80378E 02	1.34301E 05	479	35	0	93.19	15.8	15.0
JULY	2.82977E 02	1.58750E 05	561	90	0	86.18	15.9	14.4
PERIOD TOTAL	3.39436E 02	1.29766E 06	3223	552	0	87.38	16.3	14.9

Table B-23. Diurnal wind speed summary for KCIV.

AVERAGE HOURLY VELOCITY FOR 1 PERIODS.
VELOCITY GIVEN IN MPH.

VELOCITY RANGE FOR THIS RUN 0 TO 99

DEC TO AUG

MON	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	TOTAL	AV
DEC	17.1	16.9	15.9	15.7	15.2	15.4	15.3	14.6	14.2	13.7	14.0	14.8	15.3	16.0	15.6	15.9	16.6	15.4	14.9	15.2	15.6	15.5	15.0	15.7	15.41	
JAN	12.7	12.2	12.7	13.1	14.3	14.4	14.0	14.1	14.4	14.1	13.9	14.3	13.7	13.9	13.3	12.5	12.8	12.7	12.4	13.1	12.9	12.0	12.7	13.1	13.30	
FEB	13.1	13.0	12.6	13.1	13.9	15.0	16.1	16.1	14.8	14.3	14.7	14.2	13.8	13.9	13.5	13.3	13.7	13.3	13.2	14.0	14.7	14.1	13.4	13.8	13.98	
MAR	15.0	15.0	15.0	15.0	15.7	15.0	14.0	13.9	13.3	13.2	12.6	12.6	12.4	13.0	12.7	12.8	13.1	13.5	13.5	13.1	12.9	12.7	12.4	12.5	13.54	
APR	13.9	14.7	15.3	15.5	15.4	14.8	14.9	14.7	14.5	14.7	15.7	16.2	16.0	16.1	16.3	16.2	16.9	16.1	15.6	15.2	15.4	14.6	14.4	14.8	15.33	
MAY	18.1	16.8	16.3	16.1	15.1	14.9	14.9	14.9	15.6	15.1	16.1	16.0	17.1	17.3	17.9	17.7	18.6	19.1	19.4	19.7	19.0	19.0	18.6	18.5	17.16	
JUNE	15.3	15.2	15.2	15.1	14.3	14.0	13.5	13.0	12.0	12.6	13.4	13.6	14.9	15.4	15.5	15.3	16.5	16.9	17.8	17.8	16.5	16.3	15.8	15.3	15.04	
JULY	15.3	15.3	14.7	14.4	13.8	13.8	13.1	12.3	11.2	11.2	11.5	12.1	12.7	12.7	13.4	14.7	15.4	16.5	17.4	17.5	17.7	17.6	16.9	15.9	14.41	
101 AVE	15.2	15.0	14.3	14.8	14.7	14.6	14.5	14.2	13.8	13.6	14.0	14.3	14.6	14.8	14.9	14.9	15.6	15.7	15.8	15.9	15.8	15.4	15.1	15.1	14.88	

NO. OBSERVATIONS PER MONTH

DEC 427 JAN 362 FEB 609 MAR 504 APR 639 MAY 669 JUNE 514 JULY 651 AUG 0

TOTAL 4375

Table B-24. Wind speed distribution for KCIV.

DEC 1 1977 TO JULY 29 1978
AVERAGE WIND VELOCITY FOR TIME PERIOD -- 14.9
WIND VELOCITY FREQUENCY - MPH
TOTAL HOURS OBSERVED -- 4375

WINDSPD	HOURS/ PERIOD	RELATIVE FREQUENCY	CUMULATIVE HOURS	CUMULATIVE RELATIVE FREQUENCY
0	10	.229	4375	100.000
1	18	.411	4365	99.771
2	51	1.166	4347	99.360
3	15	.343	4296	98.194
4	120	2.743	4281	97.851
5	15	.343	4161	95.109
6	291	6.651	4146	94.766
7	32	.731	3855	88.114
8	307	7.017	3823	87.383
9	32	.731	3516	80.366
10	560	12.800	3484	79.634
11	52	1.189	2924	66.834
12	255	5.829	2872	65.646
13	47	1.074	2617	59.817
14	297	6.789	2570	58.743
15	49	1.120	2273	51.954
16	600	13.714	2224	50.834
17	50	1.143	1624	37.120
18	500	11.429	1574	35.977
19	37	.846	1074	24.549
20	180	4.686	1037	23.703
21	28	.640	657	15.017
22	63	1.440	629	14.377
23	27	.617	566	12.937
24	108	2.469	539	12.320
25	21	.480	431	9.851
26	243	5.554	410	9.371
27	13	.297	167	3.817
28	38	.869	154	3.520
29	4	.091	116	2.651
30	52	1.189	112	2.560
31	2	.046	60	1.371
32	12	.274	58	1.326
33	3	.069	46	1.051
34	17	.389	43	.983
35	6	.137	26	.594
36	12	.274	20	.457
38	5	.114	8	.183
40	3	.069	3	.069

Table B-25. Wind rose summary for Goodnoc Hills (Dec 77 - Aug 78).

WIND POSSES RUN 11/06/78 FOR GOODNOE HILLS

ALL DATA -- 3843 OBSERVATIONS

	0	3	6	9	12	15	18	21	24	27	30	33	36	39	42	TOTAL	MEAN SPEED
DIR	TO 3	TO 6	TO 9	TO 12	TO 15	TO 18	TO 21	TO 24	TO 27	TO 30	TO 33	TO 36	TO 39	TO 42			
N	.2	.2	.7	.5	.4	.5	.6	.1	.2	.1	.2	.1	.1	.0	.3	4.4	18.0
NNE	.3	.1	.1	.5	.1	.2	.0	.0	.0	.1	.0	.0	.0	.0	.0	1.4	9.9
NF	.1	.1	.1	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.5	9.4
ENE	.1	.1	.3	.2	.2	.1	.1	.1	.1	.0	.0	.0	.0	.0	.0	1.1	12.0
E	.1	.3	.7	.3	.5	.6	.3	.0	.1	.0	.0	.0	.0	.0	.0	3.5	11.6
ESE	.2	.3	.4	.3	.4	.3	.1	.0	.0	.0	.0	.0	.0	.0	.0	2.8	9.4
SE	.4	.3	.3	.3	.4	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0	6.1	8.5
SSE	.5	.5	.3	.7	.5	.4	.2	.0	.0	.0	.0	.0	.0	.0	.0	7.7	7.6
SW	1.1	2.3	2.9	.3	.5	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	3.2	5.6
SSW	.5	1.1	1.1	.3	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	1.5	7.2
WSW	.2	.5	.5	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	2.7	7.4
W	.3	.6	1.0	.7	.2	.1	.0	.0	.1	.2	.3	.0	.0	.1	.1	9.6	15.1
WNW	.6	.7	1.7	1.0	1.0	1.5	1.1	.4	.7	.2	.3	.1	.3	.2	.5	9.7	19.3
NW	.4	.3	1.2	.7	.3	1.4	1.3	1.1	3.4	2.0	1.9	1.0	.9	.3	.7	17.6	24.5
NNW	.2	.2	.4	.6	.9	1.5	3.7	3.0	1.9	1.9	1.2	1.4	.6	.3	.6	21.8	23.1
CALM	.9	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	100.0	0
TOTAL	10.2	8.9	14.8	8.4	7.4	9.1	10.0	4.4	8.8	4.7	4.8	2.5	3.0	.9	2.2		

Table B-26. Power density and usable wind summary for Goodnoe Hills.

POWER GENERATED FOR 1 PERIODS.
POWER GIVEN IN WATTS/METER SQUARED.

VELOCITY RANGE FOR THIS RUN 8 TO 50

DEC TO AUG

	MEAN POWER - - - TOTAL POWER	NO. DATA PTS. WITHIN RANGE	NO. DATA PTS. BELOW	NO. DATA PTS. ABOVE	PERCENT TIME WITHIN RANGE	MEAN VELOC. WITHIN RANGE	MEAN VELOC. ALL OBSERV.
DEC	1.21825E 03	4.73897E 05	389	329	26	52.28	15.3
JAN	6.66746E 02	6.80081E 04	102	236	0	30.14	6.7
MAR	6.31698E 02	2.92471E 05	463	175	0	72.57	15.0
APR	9.34109E 02	2.97047E 05	318	102	0	75.71	17.6
JUNE	8.45501E 02	1.52190E 05	180	26	0	87.38	19.8
JULY	6.67760E 02	4.08669E 05	612	127	2	82.59	17.6
AUG	6.68734E 02	4.40027E 05	658	98	0	87.04	18.2
PERIOD TOTAL	7.83361E 02	2.13231E 06	2722	1093	28	70.83	16.0

Table B-27. Diurnal wind speed summary for Goodnoe Hills.

AVERAGE HOURLY VELOCITY FOR 1 PERIODS.
VELOCITY GIVEN IN MPH.

VELOCITY RANGE FOR THIS RUN 0 TO 99

DEC TO AUG

MON	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	TOTAL	AV
DEC	14.1	14.0	13.6	15.3	14.6	14.6	14.6	14.3	14.4	15.7	16.0	15.4	15.5	15.8	17.3	17.6	16.1	16.4	16.7	15.7	16.1	14.7	14.0	15.1	15.32	
JAN	5.3	4.6	5.1	5.6	5.9	5.9	6.1	6.1	7.9	7.4	6.3	6.5	7.9	9.0	9.7	8.1	10.1	8.7	7.6	5.1	6.5	5.8	5.1	4.6	6.70	
MAR	17.9	17.5	16.2	15.1	14.8	14.8	13.7	12.7	10.5	10.6	10.7	11.0	11.4	12.6	13.9	16.1	17.0	17.3	17.5	17.1	18.2	18.3	17.4	17.5	15.00	
APR	16.6	15.6	16.8	16.7	16.0	16.0	13.8	14.4	15.3	14.8	14.8	15.6	17.1	17.5	18.5	20.9	21.6	21.8	22.6	23.4	20.9	20.4	18.0	15.6	17.63	
JUNE	24.7	21.9	22.0	22.1	21.9	20.9	17.6	16.0	16.7	16.8	16.4	18.6	20.0	19.4	19.1	18.4	18.6	17.3	19.5	21.6	21.9	20.0	20.3	22.0	19.77	
JULY	21.2	20.9	21.0	19.7	18.8	16.8	15.1	13.4	12.2	11.4	11.5	12.2	13.5	14.0	15.4	17.9	18.6	19.1	21.0	23.3	22.1	22.0	21.3	20.3	17.61	
AUG	18.6	19.2	19.7	19.9	20.9	20.5	20.6	19.2	17.9	18.1	17.6	17.8	17.8	17.8	18.6	18.3	18.0	17.2	16.6	15.8	16.0	16.7	17.4	17.5	18.22	
TOT AVE	17.0	16.7	16.7	16.7	16.5	16.0	15.0	14.2	13.7	13.7	13.6	13.9	14.6	15.1	16.2	17.1	17.3	17.1	17.5	17.6	17.6	17.2	16.7	16.5	16.01	

NO. OBSERVATIONS PER MONTH
DEC 744 JAN 338 FEB 0 MAR 638 APR 428 MAY 0 JUNE 206 JULY 741 AUG 744

TOTAL 3843

Table B-28. Wind speed distribution for Goodnoe Hills.

DEC 1 1977 TO AUG 31 1978

AVERAGE WIND VELOCITY FOR TIME PERIOD -- 16.0

WIND VELOCITY FREQUENCY - MPH
TOTAL HOURS OBSERVED -- 3843

WINDSPD	HOURS/ PERION	RELATIVE FREQUENCY	CUMULATIVE HOURS	CUMULATIVE RELATIVE FREQUENCY
0	188	4.892	3843	100.000
1	71	1.848	3655	95.108
2	133	3.461	3584	93.260
3	71	1.848	3451	89.800
4	189	4.918	3380	87.952
5	81	2.108	3191	83.034
6	271	7.052	3110	80.926
7	89	2.316	2839	73.875
8	207	5.386	2750	71.559
9	47	1.223	2543	66.172
10	232	6.037	2496	64.949
11	42	1.093	2264	58.912
12	110	2.862	2222	57.819
13	53	1.379	2112	54.957
14	121	3.149	2059	53.578
15	68	1.769	1938	50.429
16	231	6.011	1870	48.660
17	51	1.327	1639	42.649
18	147	3.825	1588	41.322
19	39	1.015	1441	37.497
20	198	5.152	1402	36.482
21	25	.651	1204	31.330
22	118	3.071	1179	30.679
23	26	.677	1051	27.609
24	110	2.862	1035	26.932
25	37	.963	925	24.070
26	192	4.996	888	23.107
27	47	1.223	696	18.111
28	110	2.862	649	16.888
29	22	.572	539	14.026
30	133	3.461	517	13.453
31	11	.286	384	9.992
32	41	1.067	373	9.706
33	19	.494	332	8.639
34	62	1.613	313	8.145
35	16	.416	251	6.531
36	72	1.874	235	6.115
37	12	.312	163	4.241
38	31	.807	151	3.929
39	4	.104	120	3.123
40	30	.781	116	3.018
41	1	.026	86	2.238
42	7	.182	85	2.212
43	4	.104	78	2.030
44	10	.260	74	1.926
45	5	.130	64	1.665
46	11	.286	59	1.535
48	6	.156	48	1.249
50	14	.364	42	1.093
51	1	.026	28	.729
54	2	.052	27	.703
55	8	.208	25	.651
58	2	.052	17	.442
60	10	.260	15	.390
62	1	.026	5	.130
64	1	.026	4	.104
65	3	.078	3	.078

Table B-31. Diurnal wind speed summary for Kennewick.

AVERAGE HOURLY VELOCITY FOR 1 PERIODS.
VELOCITY GIVEN IN MPH.

VELOCITY RANGE FOR THIS RUN 0 TO 99

DEC TO AUG

MON	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	TOTAL	AV			
DEC	18.8	18.4	18.5	19.4	20.0	19.9	20.4	21.8	21.7	20.8	21.3	21.8	21.8	21.1	21.5	21.6	21.1	20.7	20.9	21.4	20.8	20.5	19.3	18.7	---	20.51			
JAN	12.2	13.1	12.7	12.2	11.8	11.3	11.5	11.5	11.7	12.1	12.4	11.7	12.7	13.6	13.6	13.9	12.8	13.3	13.7	13.5	13.6	13.3	13.0	12.7		12.66			
FEB	12.6	12.2	12.4	12.6	12.5	12.9	12.5	12.8	12.9	12.8	13.0	12.7	12.7	13.0	12.3	13.1	12.7	13.5	13.8	14.0	13.9	13.6	13.1	12.1		12.91			
MAR	17.2	18.1	16.9	16.9	15.2	16.9	16.6	15.8	16.3	14.7	17.4	19.6	17.6	17.7	15.9	15.1	14.6	14.1	14.5	13.6	14.5	14.4	14.8	15.5		15.98			
APR	19.0	18.8	19.2	19.4	18.8	18.8	18.9	19.4	19.2	20.2	20.1	20.2	20.4	20.8	20.3	20.5	21.0	20.7	20.2	19.1	18.3	19.3	18.9	19.6		19.63			
MAY	17.3	18.2	17.8	16.2	17.0	17.4	15.8	15.1	15.0	15.9	17.3	16.5	16.5	18.0	18.8	17.0	18.0	16.0	17.5	17.8	15.5	16.0	16.9	18.3		16.91			
JUNE	18.6	18.3	18.0	17.5	16.9	17.5	17.4	16.9	17.4	17.9	17.0	18.7	17.8	17.7	17.8	18.2	18.8	19.9	20.1	20.0	19.9	20.8	20.9	19.2		18.48			
JULY	16.3	16.7	16.5	17.4	17.7	17.4	17.1	16.6	17.1	16.3	16.6	15.7	15.8	16.6	16.5	17.0	15.5	15.5	13.9	14.0	14.9	16.9	16.9	16.6		16.32			
AUG	14.6	14.6	14.6	14.8	14.6	14.0	13.8	13.2	14.0	12.0	11.3	11.3	11.6	12.9	12.4	12.4	12.2	12.2	13.3	14.7	15.6	15.8	16.4	16.0		13.71			
TOT																													
AVE	16.5	16.6	16.4	16.6	16.3	16.5	16.4	16.5	16.7	16.4	16.9	17.1	16.9	17.3	16.9	17.0	16.7	16.6	16.6	16.5	16.5	16.9	16.7	16.5		16.66			
NO. OBSERVATIONS PER MONTH																													
DEC	744	JAN	578	FEB	541	MAR	707	APR	709	MAY	198	JUNE	398	JULY	744	AUG	225											TOTAL	4844

DEC 1 1977 TO AUG 10 1978

AVERAGE WIND VELOCITY FOR TIME PERIOD -- 16.7

WIND VELOCITY FREQUENCY - MPH TOTAL HOURS OBSERVED -- 4844				
WINDSPD	HOURS/ PERIOD	RELATIVE FREQUENCY	CUMULATIVE HOURS	CUMULATIVE RELATIVE FREQUENCY
0	27	.557	4844	100.000
1	22	.454	4817	99.443
2	150	3.097	4795	98.988
3	60	1.239	4645	95.892
4	148	3.055	4595	94.653
5	118	2.436	4437	91.598
6	379	7.824	4319	89.162
7	21	.434	3940	81.338
8	457	9.434	3919	80.904
9	33	.681	3462	71.470
10	599	12.366	3429	70.789
11	13	.268	2830	58.423
12	270	5.574	2817	58.154
13	17	.351	2547	52.581
14	200	4.129	2530	52.230
15	69	1.424	2330	48.101
16	374	7.721	2261	46.676
17	6	.124	1887	38.955
18	295	6.090	1881	38.832
19	13	.268	1586	32.742
20	284	5.863	1573	32.473
21	2	.041	1289	26.610
22	70	1.631	1287	26.569
23	2	.041	1208	24.938
24	110	2.271	1206	24.897
25	21	.434	1096	22.626
26	207	4.273	1075	22.192
27	2	.041	868	17.919
28	148	3.055	966	17.878
29	24	.495	718	14.822
30	185	3.819	694	14.327
31	7	.145	509	10.508
32	57	1.177	502	10.363
33	4	.083	465	9.187
34	58	1.197	441	9.104
35	10	.206	383	7.907
36	102	2.106	373	7.700
38	35	.723	271	5.595
40	58	1.197	236	4.872
42	15	.310	178	3.675
43	1	.021	163	3.365
44	10	.206	162	3.344
45	3	.062	152	3.138
46	35	.723	149	3.076
48	11	.227	114	2.353
50	25	.516	103	2.126
54	5	.103	78	1.610
55	10	.206	73	1.507
56	22	.454	63	1.301
58	11	.227	41	.846
60	8	.165	30	.619
62	7	.145	22	.454
63	2	.041	15	.310
64	2	.041	13	.268
66	1	.021	11	.227
68	6	.124	10	.206
70	1	.021	4	.083
72	1	.021	3	.062
82	2	.041	2	.041

Table B-33. Wind rose summary for Sunnyside (Dec 77 - May 78).

WIND ROSES FOR 11/03/78 FOR SUNNYSIDE

ALL DATA -- 2216 OBSERVATIONS

	0	3	6	9	12	15	18	21	24	27	30	33	36	39	42	TOTAL	MEAN SPEED
DIP	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10		
N	.2	.3	1.0	.7	.6	.8	1.5	.2	.7	.4	.2	.0	.0	.7	.0	6.3	16.2
NNE	.5	.5	2.2	4.7	1.0	1.7	2.5	.2	.1	.0	.0	.0	.0	.0	.0	13.6	12.0
NNE	.3	.3	1.0	.3	.0	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0	2.1	7.5
ENE	.7	.6	2.1	1.3	.6	.7	.5	.0	.0	.0	.0	.0	.0	.0	.0	6.7	9.1
ESE	.5	.6	2.3	1.3	.3	.9	.0	.0	.0	.0	.0	.0	.0	.0	.0	6.5	9.1
SSE	.1	.6	2.3	1.5	1.1	.4	1.0	.1	.7	.0	.0	.0	.0	.0	.0	1.8	5.8
SSE	.3	1.0	2.0	1.5	.6	.6	.4	.2	.9	.2	.1	.1	.1	.0	.4	10.5	11.7
S	.3	.6	1.0	.6	.2	.3	.7	.0	.1	.1	.2	.0	.1	.0	.1	4.5	14.5
SSW	.6	.3	2.0	.4	.6	.3	.8	.0	.2	.4	.6	.1	.1	.0	.3	7.1	18.6
SW	.1	.1	.6	.3	.3	.5	.4	.0	.1	.1	.1	.0	.0	.0	.0	1.7	20.9
WSW	.6	.1	.9	.9	.3	.8	.0	.1	.6	.1	.3	.0	.0	.0	.2	5.9	16.9
W	.5	.4	1.4	1.2	1.5	1.7	1.8	.1	.5	.3	.3	.0	.1	.1	.0	10.1	14.0
WNW	.4	.0	.8	.6	.1	.3	.5	.2	.6	.0	.1	.0	.0	.0	.1	4.6	14.4
NW	.9	.1	.3	.2	.1	.1	.5	.2	.6	.2	.1	.0	.0	.0	.0	2.3	9.7
NNW	.4	.3	.5	.6	.1	.1	.1	.0	.2	.0	.0	.0	.0	.0	.0	.1	9.0
CALM	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1	.0
TOTAL	6.3	6.6	21.0	21.2	8.0	9.1	12.1	1.5	5.8	1.3	2.5	.6	2.0	.7	1.2	100.0	

Table B-34. Power density and usable wind summary for Sunnyside.

POWER GENERATED FOR 1 PERIODS.
POWER GIVEN IN WATTS/METER SQUARED.

VELOCITY RANGE FOR THIS RUN 9 TO 50

DEC TO MAY

	MEAN POWER - - - TOTAL POWER	NO. DATA PTS. WITHIN RANGE	NO. DATA PTS. BELOW	NO. DATA PTS. ABOVE	PERCENT TIME WITHIN RANGE	MEAN VELOC. WITHIN RANGE	MEAN VELOC. ALL OBSERV.
DEC	7.98816E 02	4.32958E 05	542	202	0	72.85	20.0
JAN	2.76577E 02	1.34417E 05	486	199	0	70.95	13.7
FEB	1.00785E 02	2.92277E 03	29	10	0	74.36	11.7
MAR	2.63194E 02	1.00540E 05	382	129	6	73.89	14.4
APR	4.48394E 02	6.68108E 04	149	9	0	94.30	18.0
MAY	3.11344E 02	3.11344E 04	100	5	0	95.24	15.5
PERIOD TOTAL	4.55440E 02	7.68783E 05	1688	554	6	75.09	16.3

Table B-35. Diurnal wind speed summary for Sunnyside.

AVERAGE HOURLY VELOCITY FOR 1 PERIODS.
VELOCITY GIVEN IN MPH.

VELOCITY RANGE FOR THIS RUN 0 TO 99

DEC TO MAY

MON	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	TOTAL	AV
DEC	16.5	15.7	14.9	14.9	14.9	14.6	14.2	15.0	15.3	16.1	16.5	15.9	15.9	15.6	15.6	15.6	16.3	16.5	16.5	16.0	15.9	15.9	16.4	17.2	15.78	
JAN	10.0	10.0	9.6	10.0	10.7	10.8	11.6	11.7	11.7	12.0	11.4	11.4	11.4	11.1	11.2	10.7	10.9	10.7	10.5	10.4	10.4	11.0	10.3	10.0	10.81	
FEB	10.0	12.0	16.0	16.0	12.0	10.0	10.0	12.0	12.0	11.0	11.0	9.0	8.0	7.0	8.0	8.0	7.0	5.0	6.0	9.0	9.0	14.0	15.0	14.0	10.05	
MAR	14.5	14.4	11.2	11.4	15.2	15.3	14.5	14.3	13.3	12.5	14.1	13.5	12.1	11.4	11.2	11.7	11.0	11.1	11.6	12.1	11.9	12.1	12.0	11.1	12.67	
APR	16.7	16.3	14.0	16.3	17.3	16.7	16.3	17.7	18.7	17.0	16.3	16.6	16.7	19.1	18.9	21.4	24.0	22.0	18.3	16.3	16.6	15.7	12.9	12.6	17.30	
MAY	15.6	15.6	15.6	19.2	20.8	19.2	18.0	14.4	13.2	11.5	13.0	12.5	16.0	16.0	14.5	13.0	13.5	14.5	14.5	15.0	11.5	12.5	13.5	13.0	15.01	
TOT AVE	13.9	13.6	12.4	12.9	14.1	13.9	13.8	13.9	14.1	13.7	14.1	13.7	13.6	13.4	13.3	13.4	13.7	13.6	13.4	13.3	13.1	13.3	13.1	13.1	13.52	

NO. OBSERVATIONS PER MONTH

DEC 744 JAN 685 FEB 39 MAR 517 APR 159 MAY 105

TOTAL 2248

Table B-36. Wind speed distribution for Sunnyside.

DEC 1 1977 TO MAY 5 1978

AVERAGE WIND VELOCITY FOR TIME PERIOD -- 13.5

WIND VELOCITY FREQUENCY - MPH
TOTAL HOURS OBSERVED -- 2249

WINDSPD	HOURS/ PERIOD	RELATIVE FREQUENCY	CUMULATIVE HOURS	CUMULATIVE RELATIVE FREQUENCY
0	2	.049	2248	100.000
1	16	.712	2246	99.911
2	123	5.472	2230	99.199
3	5	.222	2107	93.728
4	144	6.406	2102	93.505
6	264	11.744	1958	97.100
8	212	9.431	1694	75.356
9	1	.044	1482	65.925
10	472	20.996	1481	65.881
12	85	3.781	1009	44.884
14	96	4.270	924	41.103
16	204	9.075	828	36.833
18	115	5.116	624	27.758
20	155	6.895	509	22.642
22	32	1.423	354	15.747
23	1	.044	322	14.324
24	47	2.091	321	14.279
26	83	3.692	274	12.189
28	40	1.779	191	8.496
30	51	2.269	151	6.717
32	5	.222	100	4.448
34	9	.400	95	4.226
36	31	1.379	86	3.826
38	13	.578	55	2.447
40	14	.623	42	1.868
41	1	.044	28	1.246
42	3	.133	27	1.201
43	1	.044	24	1.068
44	1	.044	23	1.023
45	2	.089	22	.979
46	13	.578	20	.890
48	1	.044	7	.311
63	2	.089	6	.267
80	3	.133	4	.178
93	1	.044	1	.044

Table B-37. Wind rose summary for Wanapum Dam (Dec 77 - Aug 78).

WIND ROSES RUN 11/03/78 FOR WANAPUM DAM											ALL DATA -- 4448 OBSERVATIONS				
DIR	WIND SPEED (MPH)										TOTAL	MEAN SPEED			
	0	3	6	9	12	15	18	21	24	27					
	10	10	10	10	10	10	10	10	10	10					
	3	6	9	12	15	18	21	24	27	30					
N	.9	1.2	5.7	1.1	1.7	.7	.4	.1	.1	.0	0	8.2			
NNE	.4	1.3	1.3	.2	.2	.1	.1	.0	.0	.0	0	6.2			
NE	.6	.9	.6	.2	.1	.0	.0	.0	.0	.0	0	5.2			
NENE	.5	.7	.4	.2	.1	.0	.0	.0	.0	.0	0	4.3			
ESE	.6	.6	.3	.1	.9	.0	.0	.0	.0	.0	0	3.3			
SE	.2	.5	.2	.0	.0	.0	.0	.0	.0	.0	0	4.6			
SSE	.5	1.3	1.0	.2	.0	.0	.0	.0	.0	.0	0	5.3			
SSW	.4	.8	.4	.1	.1	.0	.1	.0	.0	.0	0	5.1			
SW	.3	.2	.1	.1	.1	.1	.3	.0	.0	.0	0	3.5			
WSW	.2	.1	.1	.2	.1	.1	.7	.1	.2	.3	0	11.1			
W	.6	.3	.4	.1	.5	.1	.3	.1	.2	.1	.5	15.1			
WNW	.7	2.7	3.7	2.0	2.1	2.0	2.6	2.0	2.3	1.3	.6	27.4			
NW	.7	2.6	3.1	1.1	.7	.9	.8	.4	.2	.5	.1	11.5			
NNW	.8	2.2	2.1	.0	.3	.1	.1	.0	.1	.0	.0	6.9			
CALM	1.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	17.3			
TOTAL	11.1	21.9	24.1	12.4	7.1	4.4	5.8	2.6	3.1	1.7	1.1	100.0			

Table B-38. Power density and usable wind summary for Wanapum Dam.

POWER GENERATED FOR 1 PERIODS.
POWER GIVEN IN WATTS/METER SQUARED.

VELOCITY RANGE FOR THIS RUN 8 TO 50

DEC TO AUG

	MEAN POWER - - -	TOTAL POWER	NO. DATA PTS. WITHIN RANGE	NO. DATA PTS. BELOW	NO. DATA PTS. ABOVE	PERCENT TIME WITHIN RANGE	MEAN VELOC. WITHIN RANGE	MEAN VELOC. ALL OBSERV.
DEC	2.85013E 02	1.13720E 05	399	340	0	53.99	13.8	9.1
JAN	1.76616E 02	4.96292E 04	281	425	0	39.80	12.4	7.2
FEB	1.31541E 02	3.40691E 04	259	426	0	37.81	11.7	7.0
MAR	3.64313E 02	1.19495E 05	328	388	0	45.81	15.1	9.2
APR	7.44215E 02	1.51076E 05	203	150	0	57.51	19.0	12.7
JULY	7.75635E 02	3.12581E 05	403	332	2	54.68	21.1	13.4
AUG	6.88358E 02	2.73278E 05	397	338	1	53.94	20.1	12.7
PERIOD TOTAL	4.64250E 02	1.05385E 06	2270	2399	3	48.59	16.4	10.0

Table B-39. Diurnal wind speed summary for Wanapum Dam.

AVERAGE HOURLY VELOCITY FOR 1 PERIODS:
VELOCITY GIVEN IN MPH.

VELOCITY RANGE FOR THIS RUN 0 TO 99

DEC TO AUG

MON	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	TOTAL	AV			
DEC	9.1	9.0	8.6	8.8	6.8	6.5	8.0	8.4	10.1	9.9	10.5	10.5	11.0	10.1	9.5	10.1	9.3	9.5	7.5	8.7	9.0	9.4	10.3	8.9	9.14				
JAN	7.9	8.5	8.8	8.0	7.4	7.0	6.8	5.8	7.4	5.7	6.0	6.1	6.3	6.0	5.6	6.4	7.2	8.6	8.4	8.6	7.6	7.6	6.8	7.6	7.19				
FEB	5.7	6.6	6.3	5.6	6.3	6.1	6.2	5.5	6.0	5.1	7.7	8.0	8.4	9.0	8.6	8.5	6.8	7.2	8.1	8.1	8.1	6.5	6.2	7.4	6.99				
MAR	8.8	9.7	8.9	8.4	7.5	6.4	7.3	9.0	9.2	9.7	9.2	9.4	10.6	8.9	10.5	9.4	10.5	9.8	9.4	10.8	10.3	9.6	8.4	8.9	9.19				
APR	10.5	9.9	10.2	8.1	7.9	9.1	9.7	10.5	13.1	13.4	12.6	15.5	14.7	12.2	12.6	15.1	15.7	15.7	16.9	15.6	16.2	14.1	13.3	12.3	12.69				
JULY	18.4	16.0	15.8	13.7	12.8	11.6	10.1	9.3	9.8	9.0	10.5	9.0	7.5	7.9	8.8	10.6	11.7	12.2	16.9	16.9	20.1	22.8	19.7	19.0	13.36				
AUG	15.4	14.2	12.6	13.1	10.7	11.2	11.2	9.7	9.6	9.0	8.0	7.4	7.2	9.3	10.3	12.3	12.0	14.8	16.5	17.0	19.0	19.3	17.5	16.8	12.68				
TOT AVE	10.9	10.7	10.2	9.5	8.5	8.2	8.4	8.2	9.0	8.5	9.0	9.0	9.0	8.8	9.2	10.0	10.1	10.8	11.6	12.0	12.8	12.9	11.8	11.5	10.03				
NO. OBSERVATIONS PER MONTH																													
DEC	739	JAN	706	FEB	672	MAR	716	APR	353	MAY	0	JUNE	0	JULY	737	AUG	736											TOTAL	4672

Table B-40. Wind speed distribution for Wanapum Dam.

DEC 1 1977 TO AUG 31 1978

AVERAGE WIND VELOCITY FOR TIME PERIOD -- 10.0

WIND VELOCITY FREQUENCY - MPH
TOTAL HOURS OBSERVED -- 4672

WINDSPD	HOURS/ PERIOD	RELATIVE FREQUENCY	CUMULATIVE HOURS	CUMULATIVE RELATIVE FREQUENCY
0	290	6.207	4672	100.000
1	135	2.870	4342	93.793
2	228	4.880	4247	90.903
3	252	5.394	4019	86.023
4	450	9.632	3767	80.629
5	284	6.079	3317	70.997
6	495	10.595	3033	64.919
7	265	5.672	2538	54.324
8	336	7.192	2273	48.652
9	121	2.590	1937	41.460
10	385	8.241	1816	38.870
11	60	1.284	1431	30.629
12	146	3.125	1371	29.345
13	58	1.241	1225	26.220
14	120	2.568	1167	24.979
15	58	1.241	1047	22.410
16	97	2.076	949	21.169
17	43	.920	892	19.092
18	106	2.269	849	18.172
19	28	.599	743	15.903
20	124	2.654	715	15.304
21	14	.300	591	12.650
22	77	1.648	577	12.350
23	25	.535	500	10.702
24	59	1.263	475	10.167
25	37	.792	416	8.904
26	49	1.049	379	8.112
27	12	.257	330	7.063
28	58	1.241	318	6.807
29	6	.128	260	5.565
30	89	1.905	254	5.437
31	5	.107	165	3.532
32	46	.985	160	3.425
33	10	.214	114	2.440
34	20	.428	104	2.226
35	8	.171	84	1.798
36	20	.428	76	1.627
37	4	.086	56	1.199
38	8	.171	52	1.113
39	1	.021	44	.942
40	20	.428	43	.920
41	2	.043	23	.892
42	12	.257	21	.849
44	3	.064	9	.193
45	1	.021	6	.128
46	1	.021	5	.107
48	1	.021	4	.086
52	1	.021	3	.064
54	1	.021	2	.043
58	1	.021	1	.021

Table B-41. Wind rose summary for Rattlesnake Mtn. (Dec 76 - Dec 77).

WIND ROSES RUN 06/13/79 FOR RATTLESNAKE MTN HAYTELLE

ALL DATA -- 1862 OBSERVATIONS

	WIND SPEED (MPH)																TOTAL	MEAN SPEED
DIF	0 10	3 10	6 10	9 10	12 10	15 10	18 10	21 10	24 10	27 10	30 10	33 10	36 10	39 10	42 10	45 10		
N	.1	.2	1.6	1.6	.4	.6	.5	0	.2	.2	.1	0	.1	0	0	0	6.0	12.6
NNE	.1	.4	1.5	1.1	.7	1.1	.9	.1	.4	.3	.3	.1	.2	0	.2	0	7.0	15.6
NNE	0	0	1.5	.2	.1	.2	.2	.1	.2	0	0	0	0	0	0	0	1.4	13.5
NNE	.2	.4	1.3	.6	.3	.5	.3	.2	.3	.1	0	0	0	0	0	0	4.0	11.9
ENE	.2	.4	1.1	1.6	1.3	1.5	.5	.0	.2	.1	.1	.6	.3	.1	0	0	5.8	13.9
ESE	.1	.1	1.2	1.7	1.7	.3	.5	.1	.1	.0	.1	.0	.0	0	0	0	4.4	11.6
ESE	.1	.1	.3	.9	.4	.3	.5	.9	.3	.0	.2	.0	.2	.1	0	0	3.4	16.8
SE	.1	.1	1.1	1.0	1.3	1.0	1.9	.1	1.7	.2	.5	.1	.5	.1	.2	0	10.2	19.9
SSE	.1	.2	2.3	1.7	.4	1.7	.3	.0	.1	.5	.3	.1	.8	.1	0	0	12.1	16.3
SSW	.2	.2	1.3	1.3	1.3	.3	.5	.6	1.9	.3	.3	.8	.8	.5	.4	0	12.7	21.3
WSW	0	0	.3	.3	.2	.6	.5	.2	.3	.2	.3	.0	.0	.0	0	0	3.0	18.8
WSW	.1	.2	.9	1.2	.1	.3	.5	.1	.1	.1	.3	.0	.0	.0	0	0	3.8	11.8
W	0	.2	.9	1.4	.7	.9	1.0	.2	.3	.1	.4	.0	.1	.1	0	0	6.2	15.4
WNW	.3	.3	1.9	1.1	.5	.5	.5	.1	.2	.1	.3	.0	.0	.0	0	0	5.6	11.6
NW	0	.1	.2	.5	.2	.4	.2	.0	.1	.1	.1	.1	.0	.0	0	0	2.3	12.3
NW	.2	.2	1.2	2.0	1.6	1.4	1.2	.1	.9	.2	.4	.2	.2	.0	0	0	9.8	15.6
CALM	1.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.3	0
TOTAL	2.8	3.7	18.0	13.0	9.4	11.1	14.8	1.9	7.8	2.1	3.8	1.1	3.2	1.0	.8	0	100.0	

Table B-42. Power density and usable wind summary for Rattlesnake Mtn.

POWER GENERATED FOR 1 PERIODS.
POWER GIVEN IN WATTS/METER SQUARED.

VELOCITY RANGE FOR THIS RUN 8 TO 50

DEC TO NOV

	MEAN POWER - - -	TOTAL POWER	NO. DATA PTS. WITHIN RANGE	NO. DATA PTS. BELOW 8	NO. DATA PTS. ABOVE 50	PERCENT TIME WITHIN RANGE	MEAN VELOC. WITHIN RANGE	MEAN VELOC. ALL OBSERV.
DEC	7.51520E 02	3.03614E 05	404	33	0	92.45	20.9	19.6
JAN	7.03423E 01	3.02472E 03	43	115	0	27.22	10.4	5.7
FEB	5.56368E 02	1.14055E 05	205	173	0	54.23	18.2	11.0
MAR	1.23546E 03	6.68383E 05	541	65	9	87.97	23.5	22.1
APR	6.14719E 02	3.31948E 05	540	104	13	82.19	19.0	17.7
MAY	9.64996E 02	5.47153E 05	567	110	8	82.77	21.3	19.1
JUNE	3.73124E 02	1.84696E 05	495	188	7	71.74	16.6	13.9
JULY	3.18492E 02	1.64342E 05	516	217	0	70.40	15.5	12.4
AUG	5.58454E 02	3.48475E 05	624	128	1	82.87	17.9	15.8
SEPT	6.00970E 02	3.27529E 05	545	162	3	76.76	17.8	15.1
OCT	5.24154E 02	3.18686E 05	608	96	1	86.24	17.3	15.7
NOV	1.51209E 03	8.58863E 05	568	64	35	85.16	25.5	25.3
PERIOD TOTAL	7.37406E 02	4.17077E 06	5656	1455	77	78.69	19.4	16.8

Table B-43. Diurnal wind speed summary for Rattlesnake Mtn. (Dec 76 - Dec 77).

AVERAGE HOURLY VELOCITY FOR 1 PERIODS.
VELOCITY GIVEN IN MPH.

VELOCITY RANGE FOR THIS RUN 0 TO 99

DEC TO NOV

MON	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	TOTAL	AV	
DEC	18.1	18.7	19.1	20.6	20.6	20.8	20.6	20.4	20.7	20.6	20.1	19.3	19.2	19.6	19.7	19.1	19.2	19.6	19.7	18.8	18.3	19.7	19.5	19.4		19.62	
JAN	6.3	5.7	6.7	6.7	6.8	7.2	6.8	5.8	5.8	4.3	5.6	4.9	4.6	5.1	4.4	3.7	4.1	4.6	5.4	5.6	6.1	6.4	6.9	8.1		5.71	
FEB	10.4	9.3	9.8	10.5	11.4	12.1	11.7	13.3	12.9	14.4	10.4	11.2	10.2	10.2	11.0	12.5	11.5	12.6	9.9	11.2	10.6	10.0	9.3	8.9		11.05	
MAR	21.0	22.4	21.3	21.5	19.0	21.8	18.9	22.0	22.8	23.0	23.2	22.3	21.5	21.8	23.7	23.5	23.7	23.1	22.5	22.2	22.6	22.0	21.8	21.7		22.06	
APR	19.9	20.0	20.1	19.5	17.6	16.6	16.0	15.4	16.1	16.6	19.0	19.0	19.5	18.9	18.3	16.7	16.8	15.9	14.9	15.3	16.2	17.5	18.1	20.5		17.68	
MAY	17.8	19.1	19.8	19.7	18.9	18.5	17.9	17.6	17.4	16.7	17.7	17.8	18.3	19.4	18.3	20.3	21.0	21.6	21.1	20.2	19.7	20.3	20.0	19.6		19.13	
JUNE	14.4	13.0	14.9	14.0	14.7	14.2	12.5	12.7	11.9	12.1	12.5	12.0	12.6	15.1	12.7	13.4	14.1	13.9	15.0	15.8	15.1	16.5	15.3	13.4		13.85	
JULY	13.4	12.8	13.1	12.8	12.1	12.3	11.8	11.0	12.0	12.7	12.2	12.5	12.3	11.7	12.1	11.6	10.9	10.8	10.7	10.9	12.6	15.4	15.2	14.1		12.38	
AUG	14.3	14.9	15.8	15.9	16.4	16.9	17.1	16.8	16.5	16.7	16.6	16.7	15.1	15.3	15.3	14.9	15.4	15.5	16.0	15.0	15.4	15.9	15.3	14.9		15.77	
SEPT	15.7	15.7	15.1	14.7	13.2	13.0	13.2	13.4	13.6	13.6	17.0	16.5	16.0	16.1	14.7	16.0	15.3	14.8	15.7	16.3	15.5	16.0	15.5	14.9		15.07	
OCT	15.6	14.5	14.4	14.1	14.9	14.9	15.4	15.3	14.7	14.5	15.4	15.2	16.2	16.0	15.2	16.8	16.6	17.3	17.4	17.3	15.9	15.9	16.9	16.4		15.70	
NOV	26.0	26.8	26.7	25.1	24.7	24.0	23.6	22.4	21.9	24.5	25.7	27.4	25.9	25.8	26.4	26.3	25.8	24.8	22.7	23.1	26.5	26.0	27.4	27.7		25.29	
TOT																											
AVE	16.9	16.9	17.2	17.0	16.5	16.6	16.1	16.1	16.1	16.4	17.1	17.1	16.8	17.0	16.7	17.0	17.0	16.9	16.7	16.7	17.0	17.6	17.6	17.3		16.84	
NO. OBSERVATIONS PER MONTH																											
DEC	477	JAN	158	FEB	378	MAR	615	APR	657	MAY	685	JUNE	690	JULY	733	AUG	743	SEPT	710	OCT	705	NOV	667	TOTAL	7188		

Table B-44. Wind speed distribution for Rattlesnake Mtn. (Dec 76 - Dec 77).

DEC 6 1976 TO DEC 21 1977

AVERAGE WIND VELOCITY FOR TIME PERIOD -- 16.8

WIND VELOCITY FREQUENCY - MPH
TOTAL HOURS OBSERVED -- 7184

WINDSPD	HOURS/ PERIOD	RELATIVE FREQUENCY	CUMULATIVE HOURS	CUMULATIVE RELATIVE FREQUENCY
0	75	.348	7188	100.000
1	76	1.857	7163	99.652
2	196	2.699	7087	98.595
3	81	1.127	6893	95.496
4	272	3.784	6812	94.769
5	95	1.322	6540	90.985
6	569	7.916	6445	89.663
7	143	1.989	5876	81.747
8	459	6.386	5733	79.758
9	54	.807	5274	73.372
10	774	10.768	5216	72.565
11	28	.390	4442	61.797
12	334	4.647	4414	61.408
13	95	1.322	4080	56.761
14	338	4.702	3945	55.440
15	89	1.238	3647	50.737
16	595	8.278	3558	49.499
17	120	1.669	2963	41.221
18	331	4.605	2883	39.552
19	28	.390	2512	34.947
20	523	7.276	2484	34.558
21	17	.237	1961	27.282
22	154	2.198	1944	27.045
23	53	.737	1786	24.847
24	142	1.976	1733	24.110
25	55	.765	1591	22.134
26	351	4.883	1536	21.369
27	45	.626	1189	16.446
28	141	2.518	1140	15.860
29	7	.097	959	13.342
30	209	2.928	952	13.244
31	2	.028	743	10.337
32	40	.556	741	10.309
33	19	.264	701	9.752
34	59	.821	682	9.488
35	21	.292	623	8.667
36	169	2.351	602	8.375
37	21	.292	433	6.024
38	60	.815	412	5.732
39	1	.014	352	4.897
40	94	1.302	351	4.883
41	2	.028	257	3.575
42	9	.125	255	3.548
43	10	.139	246	3.422
44	18	.250	236	3.283
45	14	.195	218	3.033
46	65	.904	204	2.838
47	6	.083	139	1.934
48	24	.334	133	1.850
49	1	.014	109	1.516
50	31	.431	108	1.503
51	1	.014	77	1.071
52	2	.028	76	1.057
53	3	.042	74	1.029
54	3	.042	71	.988
55	18	.250	68	.946
56	8	.111	50	.696
57	1	.014	42	.584
58	2	.028	41	.570
60	16	.223	39	.543
61	3	.042	23	.320
62	2	.028	20	.278
65	3	.042	18	.250
66	1	.014	15	.209
68	2	.028	14	.195
70	5	.070	12	.167
72	2	.028	7	.097
74	2	.028	5	.070
76	1	.014	3	.042
78	1	.014	2	.028
82	1	.014	1	.014

Table B-45. Wind rose summary for Adel (Apr 78 - Aug 78).

WIND ROSES RUN 11/04/78 FOR ADEL										ALL DATA -- 1356 OBSERVATIONS									
	0	3	6	9	12	15	18	21	24	27	30	33	36	39	42	TOTAL	MEAN SPEED		
DIR	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10				
	3	6	9	12	15	18	21	24	27	30	33	36	39	42	42				
N	.2	.6	.7	.8	.3	.3	.4	.2	0	0	0	0	0	0	0	3.3	10.0		
NNE	.5	.9	1.0	1.0	.4	.7	.4	.1	.3	.1	0	.1	0	0	0	5.2	10.4		
NE	.1	.5	.6	1.0	1.1	.7	.5	0	.3	0	0	0	0	0	0	4.9	12.1		
ENE	.4	.8	1.5	1.1	.3	.4	.3	.1	.1	.1	0	0	0	0	0	6.1	9.0		
ESE	1.2	2.1	2.9	1.3	.5	.7	.3	.2	.6	.3	0	0	0	0	0	10.6	7.8		
ESE	.2	.5	2.4	.9	.2	.2	.2	0	0	.1	0	0	0	0	0	4.3	7.8		
SE	.3	.3	.3	.1	.2	.2	.2	0	.2	0	0	0	0	0	0	1.6	11.5		
SSE	.4	.2	.9	.8	.2	.4	.2	0	0	0	0	0	0	0	0	3.0	9.1		
SSW	.3	.4	.6	.4	.1	.3	.5	0	.1	.5	.5	.1	0	0	0	3.1	16.1		
SW	.2	.1	.9	1.0	.7	1.6	1.3	.3	.8	.2	.3	.0	.2	0	0	4.8	13.1		
WSW	.4	.3	.9	1.5	1.6	2.0	2.1	.3	1.0	.4	.2	.1	.2	0	0	7.8	17.2		
W	.3	.3	1.0	1.9	1.6	3.0	3.1	.9	.6	.3	.7	.3	.1	0	0	11.3	16.3		
WNW	.4	.6	.7	.8	1.1	.9	1.3	0	.6	.4	.3	0	.1	0	0	5.9	12.5		
NW	.4	.2	.2	.2	.5	.7	1.8	.3	1.3	.5	.3	0	0	0	0	5.9	19.7		
NNW	.5	.4	1.5	.6	.6	.8	1.8	.5	.4	0	.1	0	.1	0	0	7.3	14.0		
CALM	1.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.2	0		
TOTAL	7.3	8.8	16.5	14.3	10.4	13.4	15.2	2.9	5.9	2.7	2.2	.3	.3	0	0	100.0			

Table B-46. Power density and usable wind summary for Adel.

POWER GENERATED FOR 1 PERIODS.
POWER GIVEN IN WATTS/METER SQUARED.

VELOCITY RANGE FOR THIS RUN A TO 50

APR TO AUG

	MEAN POWER	TOTAL POWER	NO. DATA PTS. WITHIN RANGE	NO. DATA PTS. BELOW	NO. DATA PTS. ABOVE	PERCENT TIME WITHIN RANGE	MEAN VELOC. WITHIN RANGE	MEAN VELOC. ALL OBSERV.
APR	3.78996E 02	2.76667E 04	73	3	0	96.05	17.2	16.8
MAY	4.51503E 02	2.54648E 05	564	95	0	85.58	17.8	15.8
JUNE	2.55968E 02	3.67733E 04	339	150	0	69.07	14.5	11.0
JULY	3.08152E 02	1.18947E 05	386	144	0	72.83	16.0	12.7
AUG	1.61399E 02	1.36907E 04	122	72	0	61.00	12.7	9.5
PERIOD TOTAL	3.42133E 02	5.07725E 05	1484	479	0	75.60	16.1	13.2

Table B-47. Diurnal wind speed summary for Adel.

AVERAGE HOURLY VELOCITY FOR 1 PERIODS.
VELOCITY GIVEN IN MPH.

VELOCITY RANGE FOR THIS RUN 0 TO 99

APR TO AUG

MON	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	TOTAL	AV
APR	16.7	18.0	20.0	20.0	20.0	21.3	21.3	18.0	13.3	11.3	14.0	16.0	15.7	16.0	18.0	16.7	12.7	13.5	14.5	15.0	16.0	18.0	20.0	19.3	16.76	
MAY	15.5	14.8	14.2	13.6	12.0	11.1	10.7	11.3	12.8	14.4	14.0	15.0	16.4	17.7	18.7	19.5	19.9	18.6	18.1	18.1	18.6	18.6	17.4	17.0	15.80	
JUNE	10.7	9.7	9.8	8.7	8.2	7.9	7.9	9.2	10.7	11.3	11.5	12.1	12.6	12.7	12.6	12.4	13.5	13.2	11.9	11.5	12.1	12.1	12.4	10.9	11.05	
JULY	18.8	18.1	14.0	10.5	8.9	7.6	5.9	4.1	4.4	5.1	7.1	9.5	11.5	11.5	13.2	13.5	14.6	15.0	15.6	15.8	17.3	20.3	21.1	20.2	12.72	
AUG	12.6	10.1	7.0	6.0	5.8	5.7	5.9	4.0	4.8	4.8	5.9	6.8	8.4	10.1	9.3	10.3	11.1	15.6	15.0	13.4	15.9	14.5	16.3	11.9	9.51	
TOT																										
AVE	14.8	13.9	12.4	10.9	9.8	9.1	8.6	8.3	9.2	10.0	10.7	12.0	13.3	13.9	14.7	15.0	15.7	15.7	15.4	15.3	16.3	17.1	17.2	16.0	13.16	

NO. OBSERVATIONS PER MONTH

APR 76 MAY 659 JUNE 498 JULY 530 AUG 200

TOTAL 1963

Table B-48. Wind speed distribution for Adel.

APR 24 1978 TO AUG 9 1978

AVERAGE WIND VELOCITY FOR TIME PERIOD -- 13.2

WIND VELOCITY FREQUENCY - MPH
TOTAL HOURS OBSERVED -- 1963

WINDSPO	HOURS/ PERIOD	RELATIVE FREQUENCY	CUMULATIVE HOURS	CUMULATIVE RELATIVE FREQUENCY
0	24	1.223	1963	100.000
1	27	1.375	1939	98.777
2	94	4.789	1912	97.402
3	42	2.140	1818	92.613
4	103	5.247	1776	90.474
5	28	1.426	1673	85.227
6	129	6.521	1645	83.800
7	33	1.681	1517	77.280
8	162	8.253	1484	75.599
9	50	2.547	1322	67.346
10	214	10.902	1272	64.799
11	16	.815	1058	53.897
12	72	3.664	1042	53.082
13	33	1.681	970	49.414
14	94	4.992	937	47.733
15	28	1.426	839	42.741
16	207	10.545	811	41.314
17	28	1.426	604	30.769
18	111	5.655	576	29.343
19	20	1.019	465	23.688
20	167	8.507	445	22.669
21	8	.408	278	14.162
22	38	1.936	270	13.754
23	10	.509	232	11.819
24	52	2.649	222	11.309
25	8	.408	170	8.660
26	55	2.802	162	8.253
27	2	.102	107	5.451
28	49	2.496	105	5.349
29	2	.102	56	2.853
30	36	1.834	54	2.751
32	7	.357	18	.917
34	5	.255	11	.560
36	6	.306	6	.306

Table B-49. Wind rose summary for La Grande (Dec 77 - Aug 78).

WIND ROSES RUN 11/15/78 FOR LAGRANDE ELEVATOR

ALL DATA -- 3042 OBSERVATIONS

DIR	WIND SPEED (MPH)																TOTAL	MEAN SPEED
	0 TO 3	3 TO 6	6 TO 9	9 TO 12	12 TO 15	15 TO 18	18 TO 21	21 TO 24	24 TO 27	27 TO 30	30 TO 33	33 TO 36	36 TO 39	39 TO 42	42 TO 45	45 TO 48		
N	1.2	3.6	3.4	1.0	1.1	.4	.6	0	0	0	.0	0	0	0	0	0	12.3	7.5
NNE	.1	.0	.2	.3	.0	.0	.0	0	.0	0	0	0	0	0	0	0	.7	8.8
NE	.0	.1	.1	.1	.0	0	.1	0	0	0	0	0	0	0	0	0	.5	9.2
NENE	.1	.1	.0	.0	.0	0	0	0	0	0	0	0	0	0	0	0	.2	3.8
E	.8	1.1	.2	.1	.1	0	.2	0	0	0	0	0	0	0	0	0	2.3	4.0
ESE	.2	.7	.5	.3	.1	.1	.2	0	0	0	0	0	0	0	0	0	2.1	7.7
SE	.2	.7	1.9	2.3	1.0	.4	1.1	.1	.2	.1	.1	.1	.0	.1	.2	.2	8.4	12.5
SSE	.4	.6	1.0	3.1	1.7	1.5	6.7	.5	2.6	1.3	.1	.2	.4	.2	.2	.2	23.1	19.5
S	.9	1.4	1.4	1.7	1.7	.7	2.8	.4	.9	.3	.9	.1	.1	.0	.0	.0	13.3	14.8
SSW	.2	.4	.2	.3	.2	.2	.1	0	0	0	0	0	0	0	0	0	1.6	8.9
SW	1.2	.9	.5	.2	.1	.0	0	0	0	0	0	0	0	0	0	0	2.9	4.0
WSW	.1	.2	.2	.0	.0	0	0	0	0	0	0	0	0	0	0	0	.5	4.9
W	1.5	2.1	.7	.5	.1	.0	.0	0	.0	0	0	0	0	0	0	0	4.9	4.7
WNW	.2	1.1	.5	.3	.1	.2	.5	0	0	0	0	0	0	0	0	0	3.4	8.9
NW	.9	3.6	1.9	2.4	1.3	1.4	2.7	.0	.2	0	0	0	0	0	0	0	14.4	10.4
NNW	.5	2.6	1.5	.9	1.2	.7	1.7	.1	.1	0	0	0	0	0	0	0	9.3	10.2
CALM	.3	.0	.0	.0	.0	.0	.0	0	0	0	0	0	0	0	0	0	.3	0
TOTAL	8.8	18.9	14.3	14.6	8.9	5.8	16.4	1.1	4.0	1.6	3.9	.5	.5	.2	.3	.3	100.0	

Table B-50. Power density and usable wind summary for La Grande.

POWER GENERATED FOR 1 PERIODS.
POWER GIVEN IN WATTS/METER SQUARED.

VELOCITY RANGE FOR THIS RUN 8 TO 50

DEC TO AUG

	MEAN POWER - - -	TOTAL POWER	NO. DATA PTS. WITHIN RANGE	NO. DATA PTS. BELOW	NO. DATA PTS. ABOVE	PERCENT TIME WITHIN RANGE	MEAN VELOC. WITHIN RANGE	MEAN VELOC. ALL OBSRVS.
DEC	9.12361E 02	1.75173E 05	102	72	0	72.73	21.1	16.6
JAN	5.87425E 02	2.91363E 05	466	125	0	79.87	19.3	16.3
FEB	4.98065E 02	1.55396E 05	312	97	0	76.28	18.5	15.2
MAR	3.24085E 02	7.74564E 04	239	110	0	68.48	16.0	12.1
APR	1.70917E 02	9.19531E 04	538	152	0	77.97	13.2	11.3
MAY	2.37737E 02	3.01927E 04	127	12	0	91.37	15.5	14.6
JULY	5.05739E 01	1.46664E 03	29	526	0	5.23	9.4	4.0
AUG	2.80320E 01	2.80320E 01	1	53	0	1.85	8.0	3.7
PERIOD TOTAL	4.25558E 02	8.23029E 05	1934	1147	0	62.77	16.8	12.1

Table B-51. Diurnal wind speed summary for La Grande.

AVERAGE HOURLY VELOCITY FOR 1 PERIODS.
VELOCITY GIVEN IN MPH.

VELOCITY RANGE FOR THIS RUN 0 TO 99

DEC TO AUG																													
MON	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	TOTAL	AV			
DEC	20.8	18.6	18.4	14.7	17.8	17.8	19.3	18.9	18.5	18.5	18.0	17.8	18.4	17.1	16.9	14.5	13.6	12.6	11.5	12.7	15.1	14.5	13.8	14.5	16.61				
JAN	15.6	15.1	14.7	14.4	14.4	15.5	15.2	15.6	15.3	17.1	18.1	17.6	17.6	17.9	18.3	17.9	17.3	17.0	17.3	16.3	15.7	15.6	16.1	16.1	16.29				
FEB	16.0	16.6	14.2	14.9	13.5	14.8	14.6	14.0	14.1	14.9	15.6	16.4	16.5	16.7	15.6	15.6	16.1	15.1	15.1	13.9	13.4	14.4	15.6	15.8	15.17				
MAR	8.9	9.4	9.6	9.7	10.1	12.1	11.0	11.7	11.4	11.9	12.1	11.7	14.0	15.1	13.4	13.9	13.9	14.1	13.4	13.1	13.9	13.8	11.4	10.6	12.10				
APR	10.0	10.3	9.4	9.6	9.6	10.9	11.4	10.6	10.7	11.6	11.9	12.3	13.1	13.3	13.6	13.6	12.7	11.9	10.6	11.3	10.8	10.8	10.8	9.7	11.26				
MAY	12.0	13.0	13.0	12.0	14.3	13.7	14.0	15.3	13.7	14.7	13.0	14.0	14.7	16.3	16.7	18.3	16.7	16.3	17.1	16.0	12.4	14.4	13.6	13.6	14.56				
JULY	3.6	3.7	3.4	2.9	3.2	2.7	2.3	2.4	2.8	3.6	4.0	4.1	4.3	4.3	4.6	5.2	5.3	5.0	6.0	5.2	5.3	4.8	4.3	3.9	4.03				
AUG	4.3	3.7	4.3	4.0	3.0	3.3	1.5	2.0	2.0	2.5	2.0	2.0	4.0	4.5	5.0	4.0	9.0	5.5	4.5	6.0	5.0	3.5	4.0	4.0	3.74				
TOT AVE	11.6	11.5	10.9	10.9	10.8	11.6	11.6	11.5	11.5	12.4	12.7	12.9	13.3	13.6	13.4	13.4	13.0	12.6	12.3	11.9	11.8	11.8	11.6	11.2	12.06				
NO. OBSERVATIONS PER MONTH																													
DEC	264	JAN	621	FEB	469	MAR	349	APR	690	MAY	139	JUNE	0	JULY	555	AUG	54											TOTAL	3081

Table B-52. Wind speed distribution for La Grande.

DEC 21 1977 TO AUG 5 1978

AVERAGE WIND VELOCITY FOR TIME PERIOD -- 11.9

WIND VELOCITY FREQUENCY - MPH

TOTAL HOURS OBSERVED -- 3128

WINDSPEED	HOURS/ PERIOD	RELATIVE FREQUENCY	CUMULATIVE HOURS	CUMULATIVE RELATIVE FREQUENCY
0	9	.288	3128	100.000
1	45	1.439	3119	99.712
2	230	7.353	3074	98.274
3	141	4.508	2944	90.921
4	323	10.326	2703	86.413
5	142	4.540	2380	76.087
6	269	8.600	2238	71.547
7	35	1.119	1969	62.948
8	148	4.731	1934	61.829
9	8	.256	1786	57.097
10	446	14.258	1778	56.841
11	3	.096	1332	42.583
12	167	5.339	1329	42.487
13	1	.032	1162	37.148
14	105	3.357	1161	37.116
15	6	.192	1056	33.768
16	173	5.531	1050	33.568
17	1	.032	877	28.037
18	136	4.348	876	28.005
20	370	11.829	740	23.657
22	32	1.023	370	11.829
24	41	1.311	338	10.806
26	82	2.621	297	9.495
28	50	1.598	215	6.873
30	109	3.485	165	5.275
32	10	.320	56	1.790
34	13	.416	46	1.471
35	1	.032	33	1.055
36	10	.320	32	1.023
38	5	.160	22	.703
40	7	.224	17	.543
44	1	.032	10	.320
45	2	.064	9	.288
46	5	.160	7	.224
48	2	.064	2	.064

WIND ROSES RUN 11/09/78 FOR JOHN DAY AIRPORT

ALL DATA -- 8064 OBSERVATIONS

DIR	WIND SPEED (MPH)																TOTAL	MEAN SPEED
	0 3	3 6	6 9	9 12	12 15	15 18	18 21	21 24	24 27	27 30	30 33	33 36	36 39	39 42	42			
N	.5	.3	.5	.1	.2	.0	.0	0	0	0	0	0	0	0	0	1.6	6.1	
NNE	.2	.2	.4	.1	.0	.0	.0	0	0	0	0	0	0	0	0	1.0	5.1	
NE	.2	.2	.1	.1	.0	.0	.0	0	0	0	0	0	0	0	0	.6	4.5	
ENE	1.5	1.1	.6	.2	.2	.0	.0	0	0	0	0	0	0	0	0	5.0	6.0	
ESE	.2	.5	.2	.6	.1	.0	.0	0	0	0	0	.0	0	0	0	15.4	6.2	
SE	.2	.5	.2	.6	.1	.0	.0	0	0	0	0	0	0	0	0	8.4	6.0	
SSE	.4	.3	.6	.4	.1	.6	.5	0	.8	.0	.0	0	0	0	0	4.9	7.3	
SSW	.4	.3	.3	.3	.6	.6	.7	.2	.2	.0	.0	0	0	0	0	5.8	10.7	
WSW	.4	.2	.5	.4	.5	.5	.4	.1	.1	.0	.0	0	0	0	0	4.4	13.3	
WSW	.9	.6	.3	.6	.2	.2	.3	.1	.2	.0	.0	0	0	0	0	2.0	11.7	
WSW	.9	.6	.3	.6	.2	.2	.3	.1	.2	.0	.0	0	0	0	0	2.0	9.9	
MNW	1.0	1.0	.2	.9	1.1	2.2	1.3	.3	.0	.0	.2	.1	0	0	0	10.9	11.4	
MNW	.0	.0	.3	.9	.5	.2	.3	.0	.0	.0	.0	.0	0	0	0	2.8	8.9	
MNW	.6	.6	.4	.6	.5	.4	.5	.1	.0	.0	0	0	0	0	0	3.8	11.0	
GALM	.7	.6	.0	.0	.6	.4	.1	.0	.0	.0	0	0	0	0	0	1.7	8.5	
TOTAL	9.9	18.8	32.0	14.4	9.0	6.6	5.2	1.0	1.9	.4	.6	.1	.1	.0	.0	100.0		

POWER GENERATED FOR 1 PERIODS:
POWER GIVEN IN WATTS/METER SQUARED.

VELOCITY RANGE FOR THIS RUN 0 TO 50

JAN TO AUG		MEAN POWER - - - TOTAL POWER	NO. DATA PTS. WITHIN RANGE	NO. DATA PTS. BELOW	NO. DATA PTS. ABOVE	PERCENT TIME WITHIN RANGE	MEAN VELOC. WITHIN RANGE	MEAN VELOC. ALL OBSRVS.
JAN	2.07084E 02	7.77484E 04	374	871	0	30.04	12.3	6.6
FEB	2.12029E 02	2.35353E 04	111	225	0	33.04	13.8	7.5
MAR	3.30713E 02	1.34269E 05	406	269	0	60.15	15.9	11.3
APR	1.97507E 02	1.43588E 05	727	568	0	56.14	13.3	9.5
MAY	1.81777E 02	8.79802E 04	484	409	0	54.20	13.3	9.1
JUNE	1.25474E 02	4.51706E 04	360	381	0	48.58	11.5	7.7
JULY	1.49073E 02	6.02257E 04	404	286	0	58.55	12.4	8.8
AUG	1.11213E 02	4.82666E 04	434	310	0	58.33	11.3	8.5
PERIOD TOTAL	1.88116E 02	6.20784E 05	3300	3319	0	49.86	12.9	8.6

Table B-55. Diurnal wind speed summary for John Day Airport (Jan 77 - May 78).

AVERAGE HOURLY VELOCITY FOR 1 PERIODS:
VELOCITY GIVEN IN MPH.

VELOCITY RANGE FOR THIS RUN 0 TO 99

JAN TO AUG.

MON	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	TOTAL	AV
JAN	7.1	7.2	7.2	7.0	6.9	6.1	6.0	5.6	6.2	6.2	6.1	6.1	6.3	6.4	6.5	7.5	6.2	5.8	6.3	6.7	7.1	6.9	7.0	7.4	6.60	
FEB	7.7	7.2	7.9	6.7	6.4	7.8	6.8	6.7	6.8	9.5	9.5	7.4	7.9	8.0	8.3	7.3	6.9	6.1	8.0	8.6	7.4	6.8	6.6	7.4	7.49	
MAR	11.1	10.8	11.2	10.1	9.9	8.9	10.0	9.9	12.2	12.0	12.6	13.4	14.6	14.7	14.1	12.7	10.8	10.3	10.1	9.7	9.7	10.3	11.2	10.6	11.32	
APR	8.4	8.8	8.6	8.1	7.7	7.6	8.1	8.1	9.0	9.9	10.5	11.7	12.1	12.2	12.4	12.7	11.6	11.4	9.0	8.2	8.4	8.2	7.6	7.4	9.51	
MAY	7.5	7.0	6.4	6.8	6.9	8.0	8.6	9.4	9.3	10.1	10.9	10.9	11.9	12.3	13.2	12.3	12.6	10.5	8.8	7.6	6.7	7.1	7.2	7.8	9.14	
JUNE	5.6	5.5	5.7	5.3	4.8	4.6	4.8	5.7	6.2	7.0	7.7	8.7	10.2	11.7	11.0	11.4	11.8	12.2	10.5	8.1	7.5	7.3	7.2	5.2	7.74	
JULY	6.9	6.5	7.3	7.2	6.4	6.1	5.1	5.0	6.8	7.4	8.8	10.2	10.8	11.7	12.6	13.8	14.3	13.7	12.4	9.4	8.6	8.4	7.1	6.8	8.85	
AUG	7.0	7.1	6.7	6.9	7.8	7.6	6.8	6.4	6.8	7.6	8.0	9.2	9.9	11.0	12.1	11.5	12.0	12.4	11.9	9.1	7.4	7.0	6.5	6.5	8.55	
TOT																										
AVE	7.6	7.6	7.6	7.3	7.1	7.0	7.0	7.1	7.9	8.6	9.1	9.7	10.4	10.9	11.2	11.2	10.7	10.3	9.4	8.2	7.8	7.8	7.7	7.4	8.62	

NO. OBSERVATIONS PER MONTH

JAN 1245 FEB 336 MAR 675 APR 1295 MAY 893 JUNE 741 JULY 690 AUG 744

TOTAL 6619

Table B-56. Wind speed distribution for John Day Airport.

JAN 6 1977 TO MAY 7 1978

AVERAGE WIND VELOCITY FOR TIME PERIOD -- 8.7

WIND VELOCITY FREQUENCY - MPH
TOTAL HOURS OBSERVED -- 8616

WIND SPD	HOURS/ PERIOD	RELATIVE FREQUENCY	CUMULATIVE HOURS	CUMULATIVE RELATIVE FREQUENCY
0	141	1.636	8616	100.000
1	209	2.426	8475	98.364
2	529	6.140	8266	95.938
3	346	4.016	7737	89.798
4	916	10.631	7391	85.782
5	421	4.896	6475	75.151
6	1323	15.355	6054	70.265
7	373	4.329	4731	54.909
8	1016	11.792	4358	50.580
9	230	2.669	3342	38.788
10	924	10.724	3112	36.119
11	76	.882	2188	25.395
12	306	3.552	2112	24.513
13	94	1.091	1806	20.961
14	360	4.178	1712	19.870
15	123	1.428	1352	15.692
16	356	4.109	1229	14.264
17	77	.894	875	10.156
18	193	2.240	798	9.262
19	35	.406	605	7.022
20	217	2.519	570	6.616
21	24	.279	353	4.097
22	50	.580	329	3.818
23	12	.139	279	3.238
24	56	.643	267	3.099
25	34	.395	203	2.356
26	65	.754	169	1.961
27	11	.128	104	1.297
28	19	.221	93	1.079
29	3	.035	74	.859
30	33	.383	71	.824
31	4	.046	38	.441
32	9	.104	34	.395
33	2	.023	25	.290
34	7	.081	23	.267
35	4	.046	16	.186
36	6	.070	12	.139
40	2	.023	6	.070
45	2	.023	4	.046
50	2	.023	2	.023

Table B-57. Wind rose summary for Pequop Summit (Jan 78 - Jul 78).

WIND ROSES RUN 11/15/78 FOR PEQUOP SUMMIT

ALL DATA -- 3572 OBSERVATIONS

	WIND SPEED (MPH)																	
DIR	0	3	6	9	12	15	18	21	24	27	30	33	36	39	42	42	TOTAL	MEAN SPEED
N	.1	.3	.1	1.1	.5	.2	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	2.6	11.3
NNE	.1	.3	.1	.2	.1	.0	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.9	8.5
NE	.0	.1	.0	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.3	7.9
NENE	.2	.3	.2	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	1.0	7.0
E	.1	.8	2.0	1.4	.9	1.3	.5	.0	.0	.0	.0	.0	.0	.0	.0	.0	7.0	10.8
ESE	.1	.3	.4	.7	.2	.3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	1.9	9.3
SE	.0	.0	.2	1.3	1.4	1.6	.8	.1	.0	.0	.0	.0	.0	.0	.0	.0	5.5	13.7
SSE	.1	.3	.3	1.3	.9	1.0	.8	.0	.1	.0	.0	.0	.0	.0	.0	.0	5.2	12.4
S	.1	.2	.3	1.3	.9	.6	.3	.0	.1	.0	.0	.0	.0	.0	.0	.0	3.8	12.2
SSW	.0	.3	.4	1.3	.9	1.2	.6	.1	.5	.1	.0	.0	.0	.0	.0	.0	5.4	14.8
SW	.0	.0	.3	.8	.8	1.6	.6	.3	1.4	.4	.7	.7	.2	.0	.3	.3	10.1	21.4
WSW	.1	.1	.8	1.7	1.4	2.6	.8	.2	.8	.2	.3	.1	.0	.1	.0	.0	10.7	16.0
W	.2	.6	.4	2.4	3.0	2.8	3.1	.8	1.7	.4	1.3	.5	.9	.3	1.0	.0	19.5	20.2
WNW	.2	.3	.4	1.6	1.5	2.7	3.4	.9	1.2	1.7	1.7	.4	1.2	.6	.6	.6	20.6	22.4
NW	.1	.2	.1	.5	.5	.5	.5	.1	.2	.1	.1	.0	.1	.3	.0	.0	3.2	18.1
NNW	.1	.2	.4	.5	.3	.3	.1	.0	.2	.1	.1	.0	.1	.0	.0	.0	2.4	14.1
CALM	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	1.3	4.3	6.8	16.3	13.4	16.8	15.7	2.5	8.2	3.1	4.3	1.7	2.4	1.3	1.8	1.8	100.0	

Table B-58. Power density and usable wind summary for Pequop Summit.

POWER GENERATED FOR 1 PERIODS.
POWER GIVEN IN WATTS/METER SQUARE.

VELOCITY RANGE FOR THIS RUN 8 TO 50

DEC. TO AUG.

	MEAN POWER - - - TOTAL POWER	NO. DATA PTS. WITHIN RANGE	NO. DATA PTS. BELOW 8	NO. DATA PTS. ABOVE 50	PERCENT TIME WITHIN RANGE	MEAN VELOC. WITHIN RANGE	MEAN VELOC. ALL OBSERV.
JAN	8.83112E 02 4.75997E 05	539	25	0	95.57	20.7	20.0
FEB	8.09241E 02 5.18724E 05	641	28	3	95.39	20.3	19.9
MAR	5.74407E 02 2.89352E 05	502	242	0	67.47	18.6	14.6
APR	5.13209E 02 3.04333E 05	593	124	3	82.36	17.8	15.8
MAY	4.92709E 02 1.82795E 05	371	33	1	91.60	18.3	17.3
JUNE	3.76073E 02 2.34669E 05	624	93	1	86.91	15.8	14.4
JULY	2.46941E 02 1.16803E 05	473	134	0	77.92	14.1	11.9
PERIOD TOTAL	5.66838E 02 2.12167E 06	3743	679	8	84.49	18.0	16.1

Table B-59. Diurnal wind speed summary for Pequop Summit.

AVERAGE HOURLY VELOCITY FOR 1 PERIODS.
VELOCITY GIVEN IN MPH.

VELOCITY RANGE FOR THIS RUN 0 TO 99

DEC TO AUG

MON	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	TOTAL	AV
JAN	20.3	18.5	18.8	18.9	15.4	18.0	17.5	17.4	18.3	16.8	19.0	19.8	20.8	21.1	22.8	22.7	21.4	22.0	20.5	20.5	20.3	19.7	20.5	21.1	19.99	
FEB	20.1	19.4	19.0	18.1	18.3	17.1	16.1	16.6	18.4	19.6	20.3	21.4	21.1	20.8	20.8	21.7	21.0	21.3	22.0	22.1	20.6	20.4	20.4	20.6	19.89	
MAR	13.9	13.3	13.3	13.5	12.6	12.8	13.3	14.3	14.9	14.7	16.0	17.5	16.2	16.2	16.8	15.9	15.0	14.4	14.4	14.4	14.6	14.0	14.1	14.2	14.60	
APR	14.6	14.4	13.4	13.3	12.2	11.6	14.0	15.9	17.0	17.5	17.5	18.2	18.8	19.3	19.2	18.0	16.9	15.8	15.8	16.1	15.7	15.4	15.2	14.5	15.84	
MAY	16.5	15.6	15.4	15.2	13.8	13.9	14.2	15.5	15.7	16.9	17.1	17.6	18.9	18.2	19.8	20.8	20.1	20.5	20.6	18.4	18.2	19.4	16.3	15.8	17.27	
JUNE	14.2	14.6	13.9	13.8	12.8	11.4	11.9	12.2	13.5	13.8	16.1	15.0	14.4	15.6	16.6	16.1	17.5	17.1	15.0	13.7	14.1	14.4	14.5	14.3	14.42	
JULY	11.9	11.6	10.2	8.7	7.2	6.5	6.6	7.0	8.4	9.5	10.8	10.7	12.4	13.4	14.7	16.0	17.2	17.0	17.2	15.4	15.0	14.2	13.2	12.7	11.94	
TOT AVE	15.8	15.2	14.7	14.3	13.5	13.0	13.3	14.1	15.2	15.9	16.7	17.2	17.4	17.7	18.5	18.5	18.2	18.0	17.6	17.0	16.8	16.5	16.2	16.1	16.14	

NO. OBSERVATIONS PER MONTH

DEC 0 JAN 564 FEB 672 MAR 744 APR 720 MAY 405 JUNE 718 JULY 607 AUG 0

TOTAL 4430

Table B-60. Wind speed distribution for Pequop Summit.

JAN 8 1978 TO JULY 26 1978

AVERAGE WIND VELOCITY FOR TIME PERIOD -- 16.1

WIND VELOCITY FREQUENCY -- MPH

TOTAL HOURS OBSERVED -- 6430

WINDSPEED	HOURS/ PERIOD	RELATIVE FREQUENCY	CUMULATIVE HOURS	CUMULATIVE RELATIVE FREQUENCY
1	16	.346	4049	100.000
2	40	.988	4035	99.654
3	19	.469	3995	98.666
4	57	1.408	3976	98.197
5	106	2.618	3919	96.789
6	57	2.326	3813	94.171
7	51	1.269	3716	91.776
8	140	3.458	3665	90.516
9	54	1.314	3525	87.059
10	637	15.732	3471	85.725
11	24	.593	2934	69.993
12	265	6.545	2910	69.400
13	27	.667	2545	62.855
14	240	5.927	2518	62.188
15	267	6.594	2278	56.261
16	296	7.310	2011	49.667
17	111	2.741	1715	42.356
18	293	5.014	1604	39.615
19	19	.465	1401	34.601
20	422	10.422	1383	34.157
21	3	.074	961	23.714
22	86	2.124	958	23.660
23	7	.173	972	21.536
24	71	1.754	865	21.363
25	86	2.124	794	19.610
26	152	3.754	708	17.486
27	42	1.037	556	13.732
28	64	1.581	514	12.634
29	8	.198	450	11.114
30	127	3.137	442	10.916
31	1	.025	315	7.740
32	40	.988	314	7.755
34	46	1.136	274	6.767
35	24	.593	228	5.631
36	50	1.235	204	5.038
37	6	.148	154	3.803
38	32	.790	148	3.655
40	68	1.185	116	2.865
42	7	.173	68	1.679
43	2	.049	61	1.507
44	6	.148	59	1.457
45	4	.099	53	1.309
46	25	.617	49	1.210
48	7	.173	24	.593
50	9	.222	17	.420
52	2	.049	8	.198
54	2	.049	6	.148
55	1	.025	4	.099
56	1	.025	3	.074
58	1	.025	2	.049
60	1	.025	1	.025

APPENDIX C

Wind Rose Summaries

Table C-1. Wind rose summary for Umatilla Lightship (1970).

WIND ROSES RUN 09/25/78 FOR UNIT 15

ALL DATA -- 2140 OBSERVATIONS

DIR	WIND SPEED (KNOTS)																TOTAL	MEAN SPEED
	0	10	11	12	13	14	15	16	17	18	19	20	44	2				
	10	10	10	10	10	10	10	10	10	10	10	10	10	0	0			
N	1.9	.6	.1	.1	.0	.0	.6	.0	.0	.1	.0	.7	0	0	0	4.4	11.5	
NNW	.6	.5	.0	.1	.0	.0	.6	.0	.0	.0	.0	.3	0	0	0	2.2	12.3	
NNE	.9	.9	.0	.1	.0	.0	.6	.0	.0	.0	.0	.7	0	0	0	3.1	13.2	
E	.8	.6	.0	.3	.0	.0	.6	.0	.0	.0	.0	.6	0	0	0	3.1	13.4	
ESE	1.7	1.6	.1	.4	.1	.0	1.4	.1	.0	.2	.1	2.1	0	0	0	7.8	14.6	
SE	1.1	.6	.0	.2	.1	.0	1.1	.0	.1	.1	.2	1.2	0	0	0	4.7	14.6	
SSE	.8	.8	.1	.1	.0	.0	.9	.0	.1	.3	.0	2.0	0	.1	0	5.4	17.9	
SSW	1.3	1.1	.0	.3	.2	.1	.7	.0	.1	.3	.0	4.1	0	.2	0	8.6	19.8	
SW	1.4	.9	.0	.3	.2	.1	1.7	.1	.1	.3	.1	5.8	0	.5	0	11.9	20.6	
WSW	.9	.5	.0	.3	.0	.1	.7	.0	.0	.1	.0	1.7	0	.1	0	4.6	16.0	
W	.6	.6	.0	.2	.1	.0	.7	.0	.0	.0	.0	1.7	0	.0	0	4.0	17.8	
WNW	1.4	.5	.0	.2	.0	.1	.9	.0	.0	.0	.0	1.9	0	.1	0	5.1	16.1	
NW	2.0	1.3	.2	.6	.1	.0	1.8	.0	.0	.4	.4	2.2	0	.1	0	10.8	16.4	
NNW	1.7	.9	.2	.7	.4	.0	1.7	.0	.3	.1	.0	2.6	0	.0	0	8.7	15.4	
NW	1.5	1.0	.3	.7	.0	.0	1.1	.1	.2	.1	.0	3.2	0	.0	0	8.0	16.3	
NNW	1.7	.6	.0	.4	.1	.1	.9	.0	.1	.0	.0	1.7	0	.0	0	5.7	14.3	
CALM	2.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	1.7	0	.0	0	2.0	14.3	
TOTAL	22.6	12.9	1.3	4.7	1.5	.8	15.9	.6	1.7	2.2	.6	31.9	0	1.2	0	100.0	16.0	

Table C-2. Wind rose summary for Smith Island (1975).

WIND ROSES RUN 09/25/78 FOR SMITH IS

ALL DATA -- 2187 OBSERVATIONS

DIR	WIND SPEED (KNOTS)																40 10	≥ 10	TOTAL	MEAN SPEED
	0 10	10 11	11 12	12 13	13 14	14 15	15 16	16 17	17 18	18 19	19 20	20 24								
N	2.0	.7	.0	.7	.1	.0	.2	.0	.0	.2	.0	.2	.0	.0	0	4.3	10.0			
NNF	.6	.2	.1	.2	.0	.0	.1	.0	.0	.0	.0	.1	.0	.0	.0	1.5	10.9			
NNE	1.6	.5	.0	.3	.0	.1	.2	.0	.0	.0	.0	.0	.0	.0	.0	2.8	8.8			
E	.9	.4	.0	.1	.0	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	1.5	9.0			
ESE	1.8	.3	.0	.3	.0	.1	.9	.0	.0	.0	.0	.0	.0	.0	.0	2.5	8.2			
SE	1.1	1.0	.0	.6	.1	.3	.7	.0	.1	.5	.0	1.2	.0	.0	.0	5.7	14.2			
SSE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	10.0			
SSW	5.0	3.0	.1	1.5	.2	.3	2.2	.5	.2	1.1	.0	5.4	.0	.0	.0	20.7	14.5			
SW	4.0	.5	.0	.4	.0	.0	.1	.0	.0	.1	.0	.0	.0	.0	.0	5.0	7.4			
WSW	3.2	.7	.0	.6	.2	.3	.7	.0	.0	.0	.0	.0	.0	.0	.0	5.3	8.8			
W	6.5	2.4	.1	1.4	.2	.7	2.3	.0	.1	.0	.0	1.2	.0	.0	.0	15.8	11.0			
WNW	3.7	1.4	.0	.9	.1	.3	1.4	.1	.1	.1	.0	1.4	.0	.0	.0	10.5	10.5			
NW	5.0	1.1	.0	.6	.1	.2	1.1	.0	.1	.0	.0	1.4	.0	.0	.0	10.5	11.7			
NNW	1.2	.5	.0	.2	.1	.0	.0	.0	.0	.0	.0	.3	.0	.0	.0	2.4	10.3			
NW	1.6	.5	.0	.0	.0	.1	.2	.0	.1	.2	.0	.2	.0	.0	.0	2.9	10.2			
NNW	1.2	.7	.0	.3	.0	.0	.4	.0	.1	.1	.0	.2	.0	.0	.0	3.2	10.9			
CALM	7.9	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	7.9	.0			
TOTAL	47.2	13.9	.4	7.7	1.4	3.2	8.6	.8	.9	4.4	.2	11.3	.0	.0	.0	100.0	10.5			

Table C-3. Wind rose summary for Pt. Wilson (1975).

WIND ROSES RUN 09/25/78 FOR PT WILSON

ALL DATA -- 2909 OBSERVATIONS

DIR	WIND SPEED (KNOTS)																46 TO 0	2 0	TOTAL	MEAN SPEED
	0 TO 10	10 TO 11	11 TO 12	12 TO 13	13 TO 14	14 TO 15	15 TO 16	16 TO 17	17 TO 18	18 TO 19	19 TO 20	20 TO 44								
N	.7	.7	.0	.2	.0	.1	.1	.1	.0	.1	.0	.3	0	0	0	2.3	11.8			
NNW	1.0	.2	.0	.1	.0	.0	.0	.0	.0	.0	.0	.0	0	0	0	1.4	8.0			
NNE	.9	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	0	0	0	1.0	6.7			
E	.2	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	0	0	0	.4	9.0			
ESE	.3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	0	0	0	.4	7.6			
ESE	1.2	.4	.0	.0	.0	.1	.1	.0	.0	.0	.0	.4	0	.0	0	2.6	10.7			
SSE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	0	.0	0	.0	.0			
SSW	.8	.1	.7	1.8	.4	1.3	2.6	.8	.6	.9	.3	5.7	0	.0	0	28.7	12.7			
SW	.3	.1	.0	.1	.0	.0	.0	.0	.0	.0	.0	.1	0	.0	0	1.2	8.6			
WSW	.3	.1	.0	.1	.0	.0	.0	.1	.0	.0	.0	.1	0	.0	0	.7	10.2			
W	.5	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	0	.0	0	.5	9.1			
WNW	.5	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	0	.0	0	.7	8.0			
NW	3.6	2.6	.6	1.3	.3	.2	2.2	.4	.2	.3	.0	.9	0	.0	0	12.1	11.8			
NNW	8.8	5.0	.7	1.8	.7	.6	1.5	.4	.2	.3	.1	1.7	0	.0	0	21.8	10.9			
NW	5.3	1.5	.2	.5	.0	.1	.2	.1	.0	.1	.0	.5	0	.0	0	8.9	9.1			
NNW	1.2	.8	.1	.4	.1	.1	.3	.1	.0	.1	.0	.6	0	.0	0	3.9	12.1			
CALM	14.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	0	.0	0	14.2	.0			
TOTAL	48.5	15.9	2.4	6.0	1.6	2.4	7.4	2.1	1.1	1.4	.5	10.3	0	.0	0	100.0	9.7			

Table C-4. Wind rose summary for Mt. Hood Meadows (Dec 77 - Feb 78).

WIND ROSES RUN 10/02/78 FOR MT HOOD MEADOWS												ALL DATA -- 308 OBSERVATIONS				
DIR	0	10	11	12	13	14	WIND SPEED (MPH)				18	19	20	44	TOTAL	MEAN SPEED
	10	10	10	10	10	10	15	16	17	18	19	20	20	44		
N	1.9	1.6	0	0	0	0	.3	0	0	0	0	0	0	0	3.9	7.9
NNE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NE	3.6	2.3	0	0	0	0	0	0	0	0	0	0	.3	0	6.2	7.6
ENE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
E	1.9	1.6	0	0	0	0	1.0	0	0	0	0	0	.3	0	4.9	7.9
ESE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SSE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SSW	0	.6	0	0	0	0	.5	0	0	0	0	0	0	0	1.6	16.0
SW	8.8	14.9	0	0	0	0	17.2	.3	0	0	0	0	20.3	0	61.4	14.8
WSW	.6	.6	0	0	0	0	.4	0	0	0	0	0	.6	0	2.3	13.6
W	2.6	4.9	0	0	0	0	3.6	0	0	0	0	0	2.6	0	13.6	12.7
WNW	0	.6	0	0	0	0	.3	0	0	0	0	0	0	0	1.0	11.7
NW	1.6	.6	0	0	0	0	.3	0	0	0	0	0	0	0	2.6	7.5
NNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CALM	2.6	0	0	0	0	0	0	0	0	0	0	0	0	0	2.6	0
TOTAL	23.7	27.9	0	0	0	0	23.7	.3	0	0	0	0	24.4	0	100.0	13.0

Table C-5. Wind rose summary for Crystal Mtn. (Dec 77 - Mar 78).

WIND ROSES RUN 09/25/78 FOR CRYSTAL MTN													ALL DATA -- 454 OBSERVATIONS			
DIR	0	10	11	12	13	14	WIND SPEED (MPH)				18	19	20	44	TOTAL	MEAN SPEED
	10	10	10	10	10	10	15	16	17	18	19	20	20	44		
N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NNE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NE	0	0	.2	0	0	0	0	0	0	0	0	0	.2	0	.4	20.5
ENE	.4	0	0	0	0	0	0	0	0	0	0	0	.2	0	1.1	13.4
E	.7	.2	.2	.7	0	.2	0	0	0	.4	0	0	7.3	0	11.7	21.5
ESE	.2	.2	.2	.2	0	0	.4	.2	1.1	.7	.2	.2	1.3	0	4.0	20.6
SE	.2	.4	0	0	0	0	.2	.2	.2	.2	.2	.2	.4	0	2.6	16.0
SSE	.4	0	0	0	0	0	.2	.2	.2	.2	.2	.2	.4	0	2.0	15.2
SSW	1.8	.2	.4	0	0	0	.2	.2	.2	.2	1.3	.4	5.1	0	9.9	18.1
SW	1.8	.7	.4	.4	.9	.9	.7	.4	.4	.2	.2	.2	2.4	0	9.7	15.0
WSW	3.1	1.1	.2	.4	.4	.2	1.1	.2	.2	.2	.2	.2	2.4	0	9.7	14.6
W	5.9	1.3	.2	.9	.4	.2	1.3	.4	.4	.4	.2	.2	2.6	0	16.2	12.7
WNW	11.9	2.6	.9	1.4	.9	1.1	1.7	.4	.4	.7	.4	.4	5.1	0	26.1	12.0
NW	1.8	.9	0	.2	.4	0	.2	.2	.2	.2	.2	.2	1.3	0	9.1	10.9
NNW	1.3	0	0	0	0	0	.2	.2	.2	.2	.2	.2	0	0	2.9	7.7
CALM	.2	.4	0	0	0	0	0	0	0	0	0	0	0	0	.4	0
TOTAL	30.2	7.9	3.1	4.4	3.1	4.0	5.5	3.5	2.6	4.4	1.4	1.4	29.1	0	100.0	14.8

Table C-6. Wind rose summary for Mt. Baker (Dec 77 - Apr 78).

WIND ROSES RUN 09/25/78 FOR MT BAKER											ALL DATA -- 298 OBSERVATIONS					
DIR	WIND SPEED (MPH)										TOTAL	MEAN SPEED				
	0	10	11	12	13	14	15	16	17	18						
	10	10	10	10	10	10	10	10	10	10	20	44	0	0		
N	1.7	0	0	0	0	0	0	0	0	0	0	0	0	1.7		
NNE	2.0	0	0	0	0	0	.3	0	0	0	0	0	0	2.3		
NF	.7	0	0	0	0	0	0	0	0	0	0	0	0	.7		
ENE	3.4	0	0	0	0	0	0	0	.3	0	0	0	0	3.7		
E	4.7	.3	0	0	0	0	.3	0	0	0	0	0	0	5.4		
ESE	2.0	0	0	0	0	0	0	0	0	0	0	0	0	2.0		
SE	4.0	.7	.3	1.9	.3	0	.3	0	.3	0	0	0	0	7.0		
SSE	14.4	6.4	.3	1.7	1.3	1.3	3.4	1.0	.3	1.0	.7	.7	0	32.6		
SSW	19.1	1.0	1.0	0	.3	.3	1.1	.7	1.0	1.7	.9	1.0	0	29.5		
SW	1.3	0	0	0	0	0	0	0	0	0	0	0	0	1.3		
WSW	.3	0	0	0	0	0	0	0	0	0	0	0	0	.3		
W	0	0	0	0	.3	0	0	0	0	.3	0	0	0	.7		
WNW	.3	0	0	0	0	0	0	0	0	0	0	0	0	.7		
NW	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
NNW	.3	0	0	0	0	0	0	0	0	0	0	0	0	.3		
CALM	11.7	0	0	0	0	0	0	0	0	0	0	0	0	11.7		
TOTAL	66.1	8.4	1.7	2.7	2.7	1.7	5.7	1.7	2.0	3.0	.7	.7	1.7	100.0		

Table C-7. Wind rose summary for Sun Valley (Dec 77 - Mar 78).

WIND ROSES RUN 10/07/78 FOR SUN VALLEY												ALL DATA -- 450 OBSERVATIONS				
	WIND SPEED (MPH)															
	0	10	11	12	13	14	15	16	17	18	19	20	44	Σ	TOTAL	MEAN SPEED
DIR	10	10	10	10	10	10	10	10	10	10	10	10	10	0		
	10	11	12	13	14	15	16	17	18	19	20	44	0			
N	.9	0	.2	.2	.7	.2	0	.2	0	.9	0	0	0	0	3.3	12.6
NNF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NNE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
E	.2	0	.9	0	0	0	0	0	0	0	0	0	0	0	2.2	9.0
ESE	0	0	.2	0	.2	0	0	0	0	0	0	0	0	0	1.4	17.4
SE	.2	.2	.2	.2	.2	0	0	0	.4	0	.2	.4	0	0	2.9	17.0
SSE	0	0	.2	0	.2	0	0	0	0	0	0	0	0	0	2.2	15.7
S	5.8	1.1	.4	.7	1.3	.7	0	.2	.4	.2	.2	1.1	0	0	12.4	10.9
SSW	1.6	1.3	.9	1.1	.8	.2	0	.2	0	0	0	1.8	0	0	5.3	11.5
SW	7.3	2.2	0	.4	.4	.2	.2	.2	.4	.4	.4	1.1	0	0	15.3	10.2
WSW	17.3	2.2	1.1	.6	.4	.2	.2	.4	.4	.7	.2	1.1	0	0	34.9	9.2
W	33.9	1.7	.7	.4	.4	.2	.7	.9	.9	1.1	.2	0	0	0	38.8	11.8
WNW	33.9	.9	1.6	.2	.9	.2	.2	.2	.4	.4	.4	0	0	0	44.4	10.3
NW	33.9	.2	.6	.3	.9	.2	1.1	.4	.4	.9	.4	1.6	0	0	46.0	12.1
NNW	33.9	0	0	0	0	0	0	0	0	0	0	0	0	0	33.9	0.0
CALM	33.9	0	0	0	0	0	0	0	0	0	0	0	0	0	33.9	0.0
TOTAL	64.9	8.2	6.6	6.7	5.3	3.1	4.4	3.1	3.3	4.7	1.6	8.2	0	0	100.0	10.5

Table C-8. Wind rose summary for Jackson Hole (Dec 77 - Mar 78).

WIND ROSES RUN 09/25/78 FOR JACKSON HOLE										ALL DATA -- 354 OBSERVATIONS							
DIR	WIND SPEED (MPH)										14	19	20	44	%	TOTAL	MEAN SPEED
	0	10	11	12	13	14	15	16	17	18							
	0	10	11	12	13	14	15	16	17	18	19	20	44				
N	.3	0	0	0	0	0	0	0	.3	0	0	.3	1.4	0	0	2.2	
NNNE	.8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	.8	
NNE	0	0	0	.3	0	0	0	0	0	0	0	0	0	0	0	.6	
ENE	.8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	.8	
ESE	.3	0	.3	0	0	0	0	0	0	0	0	0	0	0	0	.6	
E	0	0	.3	0	0	0	0	0	0	0	0	0	0	0	0	.3	
SSE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
SSSE	.3	.3	0	0	0	0	0	0	.3	0	.3	0	0	0	0	1.4	
SSW	1.4	0	.6	.6	.8	.3	.3	.3	0	.3	0	0	1.7	0	0	.9	
WSW	2.0	1.1	.9	.8	.9	.6	.8	.8	0	.6	0	0	1.7	0	0	.7	
WS	1.4	1.6	.3	.3	0	0	0	0	.3	0	.6	1.1	2.0	0	0	16.0	
W	2.0	1.0	1.6	.8	1.4	.8	.8	1.1	1.4	.3	.3	2.0	0	0	0	15.1	
WNW	1.0	1.0	.6	.8	.8	2.0	2.2	2.2	1.1	2.2	1.1	1.4	0	0	0	30.4	
NW	1.7	.8	0	.6	1.4	.3	.3	.3	1.4	1.7	.3	1.9	0	0	0	12.6	
NNW	.8	.6	0	.6	.3	.3	.6	.6	.3	.6	.3	2.8	0	0	0	7.3	
NN	.8	1.1	0	.3	.3	0	.6	.6	.3	0	.3	2.8	0	0	0	7.0	
CALM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
TOTAL	13.7	7.8	3.6	5.0	6.1	4.2	5.6	4.5	6.1	6.4	2.5	34.4	0	0	100.0	17.0	

Table C-9. Wind rose summary for Bridger Bowl (Dec 77 - Mar 78).

WIND ROSES RUN 09/26/78 FOR BRIDGER BOWL										ALL DATA -- 448 OBSERVATIONS				
DIR	WIND SPEED (MPH)						18 TO 19	19 TO 20	20 TO 44	44 TO 9	9 TO 2	TOTAL	MEAN SPEED	
	0 TO 10	10 TO 11	11 TO 12	12 TO 13	13 TO 14	14 TO 15								
N	0	0	0	.2	0	0	0	0	0	0	0	.2	12.0	
NNNE	0	0	0	0	0	0	0	0	0	0	0	0	0	
NNE	0	0	0	0	0	0	0	0	0	0	0	0	0	
NENE	0	0	0	0	0	0	0	0	0	0	0	0	0	
E	.7	1.3	0	.2	.2	0	.9	0	.2	4.2	0	7.8	20.1	
ESE	.2	0	0	0	0	0	0	0	0	0	0	0	5.0	
ESE	0	0	0	0	0	0	0	0	0	0	0	0	0	
SE	1.1	.7	0	.2	0	0	0	0	0	.2	0	.4	15.5	
SE	.2	0	0	0	0	0	0	0	0	0	0	0	0	
SSW	0	0	0	0	0	0	0	0	0	0	0	0	0	
SSW	0	0	0	0	0	0	0	0	0	0	0	0	0	
WSW	7.8	9.4	0	0	0	0	0	0	0	0	0	2.0	7.9	
WSW	0	0	0	0	0	0	0	0	0	0	0	0	0	
W	1.4	2.0	.2	5.4	.9	1.6	.2	1.3	4.0	.2	22.8	1.3	7.0	
WNW	.2	0	0	0	.7	.2	.4	0	0	0	0	65.8	15.9	
WNW	0	0	0	0	0	0	0	0	0	0	0	20.8	16.0	
NNW	0	0	0	0	0	0	0	0	0	0	0	.2	10.0	
CALM	0	0	0	0	0	0	0	0	0	0	0	0	0	
TOTAL	12.7	11.4	.9	6.0	1.8	1.1	20.5	.7	1.6	6.3	.2	14.8	100.0	

	0	3	6	9	12	15	18	WIND SPEED (MPH)	24	27	30	33	36	39	>	TOTAL	MEAN SPEED
DIR	TO 3	TO 6	TO 9	TO 12	TO 15	TO 18	TO 21	TO 24	TO 27	TO 30	TO 33	TO 36	TO 39	TO 42	42		
N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NNE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NF	0	0	0	.1	0	0	0	0	0	0	0	0	0	0	0	0	0
NNE	0	0	0	.1	0	0	0	0	0	0	0	0	0	0	0	0	0
E	.3	5.5	19.3	17.9	2.6	1.3	.6	0	0	0	0	0	0	0	0	47.5	8.0
ENE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SSE	0	.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SSE	0	.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SSS	0	.3	.6	.4	0	0	0	0	0	0	0	0	0	0	0	0	0
SSW	0	1.0	5.7	1.0	1.4	.1	0	0	0	0	0	0	0	0	0	1.3	5.5
SW	0	1.0	4.1	3.6	1.7	1.0	.3	.4	0	0	0	0	0	0	0	7.7	7.6
WSW	0	1.6	6.8	6.5	4.1	1.7	1.4	.3	.1	0	.1	.1	0	0	0	12.2	10.0
NNN	0	1.0	1.7	1.6	.1	.1	0	0	.9	0	0	0	0	0	0	22.9	10.7
NNW	0	.1	0	0	0	0	0	0	0	0	0	0	0	0	0	4.6	7.9
NW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	.1	4.0
NNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CALM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	.3	11.7	30.0	32.2	9.0	4.3	2.3	.7	.1	0	.1	.1	0	0	0	100.0	9.0

ALL DATA -- 690 OBSERVATIONS

APPENDIX D

High Wind Summaries

WIND VELOCITY OBSERVATIONS WHEN HOURLY MEAN (99 MAX) WIND
SPEED EQUALED OR EXCEEDED 50 MPH.

STATION	CAPE	BLANCO	BPA						
2	DEC	1977	1400	PST	52	MPH	190	DEGREES	
2	DEC	1977	1500	PST	50	MPH	190	DEGREES	
2	DEC	1977	1600	PST	52	MPH	190	DEGREES	
2	DEC	1977	1700	PST	55	MPH	190	DEGREES	
2	DEC	1977	1800	PST	55	MPH	190	DEGREES	
2	DEC	1977	1900	PST	54	MPH	190	DEGREES	
2	DEC	1977	2000	PST	56	MPH	190	DEGREES	
2	DEC	1977	2100	PST	55	MPH	190	DEGREES	
2	DEC	1977	2200	PST	55	MPH	190	DEGREES	
2	DEC	1977	2300	PST	52	MPH	190	DEGREES	
3	DEC	1977	100	PST	53	MPH	180	DEGREES	
10	DEC	1977	1100	PST	50	MPH	180	DEGREES	
10	DEC	1977	1200	PST	57	MPH	180	DEGREES	
10	DEC	1977	1300	PST	64	MPH	180	DEGREES	
10	DEC	1977	1400	PST	64	MPH	180	DEGREES	
10	DEC	1977	1500	PST	66	MPH	180	DEGREES	
10	DEC	1977	1600	PST	68	MPH	180	DEGREES	
10	DEC	1977	1700	PST	73	MPH	180	DEGREES	
10	DEC	1977	1800	PST	66	MPH	180	DEGREES	
10	DEC	1977	1900	PST	60	MPH	180	DEGREES	
10	DEC	1977	2000	PST	57	MPH	180	DEGREES	
10	DEC	1977	2100	PST	62	MPH	180	DEGREES	
10	DEC	1977	2200	PST	65	MPH	180	DEGREES	
10	DEC	1977	2300	PST	64	MPH	180	DEGREES	
10	DEC	1977	2400	PST	64	MPH	180	DEGREES	
11	DEC	1977	100	PST	62	MPH	180	DEGREES	
11	DEC	1977	200	PST	64	MPH	180	DEGREES	
11	DEC	1977	300	PST	65	MPH	180	DEGREES	
11	DEC	1977	400	PST	64	MPH	180	DEGREES	
11	DEC	1977	500	PST	57	MPH	180	DEGREES	
11	DEC	1977	600	PST	55	MPH	180	DEGREES	
12	DEC	1977	1100	PST	50	MPH	180	DEGREES	
12	DEC	1977	1200	PST	56	MPH	180	DEGREES	
12	DEC	1977	1300	PST	58	MPH	180	DEGREES	
12	DEC	1977	1400	PST	65	MPH	180	DEGREES	
12	DEC	1977	1500	PST	67	MPH	180	DEGREES	
12	DEC	1977	1600	PST	68	MPH	180	DEGREES	
12	DEC	1977	1700	PST	70	MPH	180	DEGREES	
12	DEC	1977	1800	PST	76	MPH	180	DEGREES	
12	DEC	1977	1900	PST	76	MPH	190	DEGREES	
12	DEC	1977	2000	PST	74	MPH	180	DEGREES	
12	DEC	1977	2100	PST	74	MPH	180	DEGREES	
12	DEC	1977	2200	PST	70	MPH	180	DEGREES	
12	DEC	1977	2300	PST	70	MPH	180	DEGREES	
12	DEC	1977	2400	PST	65	MPH	180	DEGREES	
13	DEC	1977	100	PST	65	MPH	180	DEGREES	
13	DEC	1977	200	PST	67	MPH	180	DEGREES	
13	DEC	1977	300	PST	69	MPH	180	DEGREES	
13	DEC	1977	400	PST	70	MPH	180	DEGREES	
13	DEC	1977	500	PST	72	MPH	180	DEGREES	
13	DEC	1977	600	PST	73	MPH	180	DEGREES	
13	DEC	1977	700	PST	66	MPH	180	DEGREES	
13	DEC	1977	800	PST	69	MPH	180	DEGREES	
13	DEC	1977	900	PST	74	MPH	180	DEGREES	
13	DEC	1977	1000	PST	73	MPH	180	DEGREES	
13	DEC	1977	1100	PST	73	MPH	180	DEGREES	
13	DEC	1977	1200	PST	63	MPH	180	DEGREES	
13	DEC	1977	1300	PST	54	MPH	180	DEGREES	
13	DEC	1977	2300	PST	53	MPH	180	DEGREES	
13	DEC	1977	2400	PST	52	MPH	180	DEGREES	
14	DEC	1977	100	PST	54	MPH	180	DEGREES	
14	DEC	1977	200	PST	52	MPH	180	DEGREES	
14	DEC	1977	300	PST	58	MPH	180	DEGREES	
14	DEC	1977	400	PST	58	MPH	180	DEGREES	
14	DEC	1977	500	PST	62	MPH	190	DEGREES	
14	DEC	1977	600	PST	56	MPH	190	DEGREES	
14	DEC	1977	700	PST	55	MPH	190	DEGREES	
14	DEC	1977	1900	PST	50	MPH	180	DEGREES	
14	DEC	1977	2000	PST	64	MPH	180	DEGREES	
14	DEC	1977	2300	PST	50	MPH	210	DEGREES	
14	DEC	1977	2400	PST	50	MPH	210	DEGREES	

Cape Blanco (cont.)

15	DEC	1977	100	PST	55	MPH	210	DEGREES
15	DEC	1977	200	PST	55	MPH	210	DEGREES
16	DEC	1977	100	PST	52	MPH	180	DEGREES
16	DEC	1977	500	PST	56	MPH	180	DEGREES
16	DEC	1977	600	PST	53	MPH	180	DEGREES
16	DEC	1977	700	PST	51	MPH	180	DEGREES
16	DEC	1977	800	PST	50	MPH	180	DEGREES
16	DEC	1977	1000	PST	53	MPH	180	DEGREES
16	DEC	1977	1300	PST	57	MPH	180	DEGREES
16	DEC	1977	1400	PST	58	MPH	180	DEGREES
23	DEC	1977	200	PST	56	MPH	170	DEGREES
23	DEC	1977	300	PST	57	MPH	180	DEGREES
23	DEC	1977	400	PST	55	MPH	180	DEGREES
23	DEC	1977	1300	PST	53	MPH	180	DEGREES
2	JAN	1978	1500	PST	53	MPH	180	DEGREES
2	JAN	1978	2000	PST	52	MPH	180	DEGREES
2	JAN	1978	2200	PST	51	MPH	180	DEGREES
2	JAN	1978	2300	PST	50	MPH	180	DEGREES
2	JAN	1978	2400	PST	52	MPH	180	DEGREES
3	JAN	1978	300	PST	54	MPH	180	DEGREES
3	JAN	1978	400	PST	54	MPH	180	DEGREES
3	JAN	1978	500	PST	53	MPH	180	DEGREES
3	JAN	1978	600	PST	50	MPH	180	DEGREES
3	JAN	1978	700	PST	52	MPH	180	DEGREES
3	JAN	1978	800	PST	53	MPH	180	DEGREES
3	JAN	1978	900	PST	56	MPH	180	DEGREES
3	JAN	1978	1000	PST	52	MPH	180	DEGREES
3	JAN	1978	1100	PST	53	MPH	180	DEGREES
3	JAN	1978	1200	PST	54	MPH	180	DEGREES
3	JAN	1978	1300	PST	54	MPH	180	DEGREES
3	JAN	1978	1400	PST	55	MPH	180	DEGREES
4	JAN	1978	1200	PST	50	MPH	200	DEGREES
4	JAN	1978	1300	PST	50	MPH	180	DEGREES
4	JAN	1978	1400	PST	56	MPH	180	DEGREES
4	JAN	1978	1500	PST	70	MPH	180	DEGREES
4	JAN	1978	1600	PST	70	MPH	180	DEGREES
4	JAN	1978	1700	PST	70	MPH	160	DEGREES
4	JAN	1978	1800	PST	70	MPH	180	DEGREES
4	JAN	1978	1900	PST	70	MPH	200	DEGREES
4	JAN	1978	2000	PST	60	MPH	200	DEGREES
4	JAN	1978	2100	PST	60	MPH	200	DEGREES
4	JAN	1978	2200	PST	65	MPH	180	DEGREES
4	JAN	1978	2300	PST	65	MPH	180	DEGREES
4	JAN	1978	2400	PST	68	MPH	180	DEGREES
5	JAN	1978	100	PST	66	MPH	200	DEGREES
5	JAN	1978	200	PST	68	MPH	200	DEGREES
5	JAN	1978	300	PST	70	MPH	200	DEGREES
5	JAN	1978	400	PST	76	MPH	200	DEGREES
5	JAN	1978	500	PST	76	MPH	200	DEGREES
5	JAN	1978	600	PST	70	MPH	200	DEGREES
5	JAN	1978	700	PST	65	MPH	200	DEGREES
5	JAN	1978	800	PST	55	MPH	210	DEGREES
5	JAN	1978	900	PST	55	MPH	200	DEGREES
5	JAN	1978	1000	PST	55	MPH	210	DEGREES
5	JAN	1978	1100	PST	50	MPH	200	DEGREES
5	JAN	1978	1200	PST	50	MPH	200	DEGREES
5	JAN	1978	1300	PST	60	MPH	200	DEGREES
5	JAN	1978	1400	PST	55	MPH	200	DEGREES
5	JAN	1978	1500	PST	55	MPH	200	DEGREES
7	JAN	1978	900	PST	50	MPH	180	DEGREES
7	JAN	1978	1200	PST	50	MPH	180	DEGREES
7	JAN	1978	1300	PST	50	MPH	180	DEGREES
7	JAN	1978	1400	PST	50	MPH	180	DEGREES
7	JAN	1978	1500	PST	50	MPH	180	DEGREES
8	JAN	1978	300	PST	50	MPH	180	DEGREES
8	JAN	1978	400	PST	56	MPH	180	DEGREES
8	JAN	1978	500	PST	52	MPH	180	DEGREES
8	JAN	1978	600	PST	50	MPH	180	DEGREES
8	JAN	1978	2100	PST	50	MPH	200	DEGREES
11	JAN	1978	1200	PST	50	MPH	180	DEGREES

Cape Blanco (cont.)

13	JAN	1978	1600	PST	65	MPH	200	DEG	REF
13	JAN	1978	1700	PST	55	MPH	180	DEG	REF
13	JAN	1978	1800	PST	55	MPH	180	DEG	REF
13	JAN	1978	1900	PST	50	MPH	180	DEG	REF
13	JAN	1978	2000	PST	55	MPH	180	DEG	REF
13	JAN	1978	2100	PST	55	MPH	180	DEG	REF
13	JAN	1978	2200	PST	60	MPH	180	DEG	REF
13	JAN	1978	2300	PST	60	MPH	180	DEG	REF
13	JAN	1978	2400	PST	55	MPH	180	DEG	REF
14	JAN	1978	1000	PST	60	MPH	180	DEG	REF
14	JAN	1978	1200	PST	50	MPH	180	DEG	REF
15	JAN	1978	1200	PST	58	MPH	180	DEG	REF
15	JAN	1978	1300	PST	60	MPH	180	DEG	REF
15	JAN	1978	1400	PST	58	MPH	200	DEG	REF
15	JAN	1978	1500	PST	56	MPH	200	DEG	REF
15	JAN	1978	1900	PST	50	MPH	210	DEG	REF
15	JAN	1978	2000	PST	60	MPH	200	DEG	REF
15	JAN	1978	2100	PST	70	MPH	180	DEG	REF
15	JAN	1978	2200	PST	60	MPH	180	DEG	REF
15	JAN	1978	2300	PST	58	MPH	180	DEG	REF
15	JAN	1978	2400	PST	60	MPH	180	DEG	REF
16	JAN	1978	1000	PST	70	MPH	180	DEG	REF
16	JAN	1978	2000	PST	68	MPH	200	DEG	REF
16	JAN	1978	3000	PST	66	MPH	180	DEG	REF
16	JAN	1978	4000	PST	66	MPH	180	DEG	REF
16	JAN	1978	5000	PST	64	MPH	180	DEG	REF
18	JAN	1978	1100	PST	60	MPH	180	DEG	REF
18	JAN	1978	1200	PST	58	MPH	180	DEG	REF
18	JAN	1978	1300	PST	50	MPH	180	DEG	REF
18	JAN	1978	1400	PST	50	MPH	180	DEG	REF
18	JAN	1978	1500	PST	56	MPH	180	DEG	REF
18	JAN	1978	1600	PST	56	MPH	180	DEG	REF
18	JAN	1978	1700	PST	58	MPH	180	DEG	REF
18	JAN	1978	1900	PST	50	MPH	180	DEG	REF
18	JAN	1978	2400	PST	50	MPH	180	DEG	REF
1	FEB	1978	1000	PST	50	MPH	180	DEG	REF
1	FEB	1978	2000	PST	60	MPH	180	DEG	REF
1	FEB	1978	3000	PST	70	MPH	180	DEG	REF
1	FEB	1978	4000	PST	70	MPH	180	DEG	REF
1	FEB	1978	5000	PST	70	MPH	190	DEG	REF
2	FEB	1978	1000	PST	50	MPH	180	DEG	REF
2	FEB	1978	1100	PST	50	MPH	180	DEG	REF
2	FEB	1978	1200	PST	52	MPH	180	DEG	REF
3	FEB	1978	1000	PST	50	MPH	180	DEG	REF
5	FEB	1978	8000	PST	50	MPH	180	DEG	REF
5	FEB	1978	9000	PST	60	MPH	180	DEG	REF
5	FEB	1978	10000	PST	56	MPH	180	DEG	REF
5	FEB	1978	16000	PST	50	MPH	180	DEG	REF
5	FEB	1978	17000	PST	50	MPH	180	DEG	REF
5	FEB	1978	18000	PST	50	MPH	180	DEG	REF
5	FEB	1978	22000	PST	58	MPH	180	DEG	REF
5	FEB	1978	23000	PST	58	MPH	180	DEG	REF
5	FEB	1978	24000	PST	58	MPH	180	DEG	REF
5	FEB	1978	1000	PST	50	MPH	180	DEG	REF
5	FEB	1978	3000	PST	50	MPH	180	DEG	REF
5	FEB	1978	4000	PST	50	MPH	180	DEG	REF
5	FEB	1978	5000	PST	50	MPH	180	DEG	REF
5	FEB	1978	6000	PST	55	MPH	180	DEG	REF
5	FEB	1978	7000	PST	65	MPH	180	DEG	REF
5	FEB	1978	8000	PST	65	MPH	160	DEG	REF
5	FEB	1978	9000	PST	64	MPH	160	DEG	REF
5	FEB	1978	10000	PST	50	MPH	180	DEG	REF
5	FEB	1978	11000	PST	55	MPH	180	DEG	REF
5	FEB	1978	12000	PST	55	MPH	180	DEG	REF
5	FEB	1978	13000	PST	58	MPH	180	DEG	REF
5	FEB	1978	14000	PST	58	MPH	180	DEG	REF
5	FEB	1978	15000	PST	50	MPH	180	DEG	REF
5	FEB	1978	17000	PST	50	MPH	180	DEG	REF
5	FEB	1978	21000	PST	55	MPH	180	DEG	REF
5	FEB	1978	22000	PST	58	MPH	180	DEG	REF
5	FEB	1978	23000	PST	65	MPH	180	DEG	REF
5	FEB	1978	24000	PST	60	MPH	180	DEG	REF

Cape Blanco (cont.)

7	FEB	1978	100	PST	55	MPH	180	DEGREES
7	FEB	1978	200	PST	50	MPH	160	DEGREES
7	FEB	1978	300	PST	65	MPH	180	DEGREES
7	FEB	1978	400	PST	70	MPH	160	DEGREES
7	FEB	1978	500	PST	65	MPH	160	DEGREES
7	FEB	1978	600	PST	76	MPH	180	DEGREES
7	FEB	1978	700	PST	65	MPH	180	DEGREES
8	FEB	1978	300	PST	56	MPH	180	DEGREES
8	FEB	1978	400	PST	56	MPH	180	DEGREES
8	FEB	1978	500	PST	65	MPH	180	DEGREES
8	FEB	1978	600	PST	58	MPH	180	DEGREES
8	FEB	1978	700	PST	50	MPH	160	DEGREES
8	FEB	1978	800	PST	55	MPH	160	DEGREES
8	FEB	1978	900	PST	68	MPH	160	DEGREES
8	FEB	1978	1000	PST	73	MPH	180	DEGREES
8	FEB	1978	1100	PST	80	MPH	180	DEGREES
8	FEB	1978	1200	PST	85	MPH	180	DEGREES
8	FEB	1978	1300	PST	90	MPH	180	DEGREES
8	FEB	1978	1400	PST	90	MPH	180	DEGREES
8	FEB	1978	1500	PST	80	MPH	180	DEGREES
8	FEB	1978	1600	PST	60	MPH	180	DEGREES
12	FEB	1978	800	PST	60	MPH	160	DEGREES
12	FEB	1978	900	PST	78	MPH	180	DEGREES
12	FEB	1978	1000	PST	68	MPH	180	DEGREES
12	FEB	1978	1100	PST	50	MPH	180	DEGREES
12	FEB	1978	1200	PST	50	MPH	180	DEGREES
14	FEB	1978	1000	PST	50	MPH	180	DEGREES
14	FEB	1978	1100	PST	58	MPH	180	DEGREES
14	FEB	1978	1200	PST	58	MPH	180	DEGREES
14	FEB	1978	1300	PST	58	MPH	180	DEGREES
16	FEB	1978	800	PST	58	MPH	180	DEGREES
16	FEB	1978	900	PST	54	MPH	180	DEGREES
24	FEB	1978	900	PST	52	MPH	180	DEGREES
24	FEB	1978	1800	PST	50	MPH	180	DEGREES
24	FEB	1978	1900	PST	50	MPH	180	DEGREES
24	FEB	1978	2000	PST	50	MPH	180	DEGREES
24	FEB	1978	2100	PST	50	MPH	180	DEGREES
24	FEB	1978	2200	PST	50	MPH	180	DEGREES
24	FEB	1978	2300	PST	50	MPH	180	DEGREES
24	MAR	1978	1200	PST	50	MPH	180	DEGREES
2	APR	1978	2400	PST	50	MPH	180	DEGREES
3	APR	1978	200	PST	50	MPH	180	DEGREES
3	APR	1978	300	PST	50	MPH	180	DEGREES
3	APR	1978	400	PST	50	MPH	180	DEGREES
3	APR	1978	500	PST	50	MPH	180	DEGREES
3	APR	1978	600	PST	52	MPH	180	DEGREES
3	APR	1978	700	PST	50	MPH	180	DEGREES
3	APR	1978	800	PST	54	MPH	180	DEGREES
3	APR	1978	900	PST	60	MPH	180	DEGREES
3	APR	1978	1000	PST	60	MPH	200	DEGREES
3	APR	1978	1100	PST	60	MPH	200	DEGREES
3	APR	1978	1200	PST	55	MPH	180	DEGREES
3	APR	1978	1300	PST	55	MPH	200	DEGREES
3	APR	1978	1400	PST	56	MPH	200	DEGREES
3	APR	1978	1500	PST	60	MPH	200	DEGREES
3	APR	1978	1600	PST	56	MPH	180	DEGREES
4	APR	1978	2200	PST	56	MPH	200	DEGREES
4	APR	1978	2300	PST	66	MPH	200	DEGREES
4	APR	1978	2400	PST	60	MPH	200	DEGREES
5	APR	1978	100	PST	64	MPH	200	DEGREES
23	AUG	1978	1700	PST	50	MPH	180	DEGREES
23	AUG	1978	1800	PST	54	MPH	180	DEGREES
23	AUG	1978	1900	PST	58	MPH	180	DEGREES
23	AUG	1978	2000	PST	60	MPH	180	DEGREES
23	AUG	1978	2100	PST	62	MPH	180	DEGREES
23	AUG	1978	2200	PST	66	MPH	180	DEGREES
23	AUG	1978	2300	PST	60	MPH	180	DEGREES
23	AUG	1978	2400	PST	58	MPH	180	DEGREES
24	AUG	1978	100	PST	60	MPH	180	DEGREES
24	AUG	1978	200	PST	62	MPH	180	DEGREES
24	AUG	1978	300	PST	60	MPH	180	DEGREES
24	AUG	1978	400	PST	60	MPH	180	DEGREES
24	AUG	1978	500	PST	60	MPH	180	DEGREES

STATION AUGSPURGER MTN BPA							
1	DEC	1977	1200 PST	50	MPH	240	DEGREES
1	DEC	1977	1300 PST	50	MPH	240	DEGREES
1	DEC	1977	1400 PST	50	MPH	240	DEGREES
1	DEC	1977	1500 PST	50	MPH	240	DEGREES
1	DEC	1977	1600 PST	50	MPH	240	DEGREES
15	DEC	1977	1500 PST	50	MPH	240	DEGREES
15	DEC	1977	1600 PST	50	MPH	240	DEGREES

STATION GOODNOE HILLS							
2	DEC	1977	400 PST	50	MPH	290	DEGREES
2	DEC	1977	500 PST	62	MPH	290	DEGREES
2	DEC	1977	600 PST	60	MPH	290	DEGREES
2	DEC	1977	700 PST	50	MPH	280	DEGREES
2	DEC	1977	900 PST	50	MPH	290	DEGREES
2	DEC	1977	1000 PST	55	MPH	290	DEGREES
2	DEC	1977	1100 PST	55	MPH	290	DEGREES
2	DEC	1977	1200 PST	50	MPH	290	DEGREES
3	DEC	1977	1100 PST	50	MPH	300	DEGREES
3	DEC	1977	1300 PST	55	MPH	300	DEGREES
3	DEC	1977	1400 PST	60	MPH	320	DEGREES
3	DEC	1977	1500 PST	60	MPH	320	DEGREES
3	DEC	1977	1600 PST	60	MPH	320	DEGREES
3	DEC	1977	1700 PST	60	MPH	320	DEGREES
3	DEC	1977	1800 PST	65	MPH	320	DEGREES
3	DEC	1977	1900 PST	65	MPH	320	DEGREES
3	DEC	1977	2000 PST	65	MPH	320	DEGREES
3	DEC	1977	2100 PST	64	MPH	320	DEGREES
3	DEC	1977	2200 PST	60	MPH	320	DEGREES
3	DEC	1977	2300 PST	60	MPH	320	DEGREES
4	DEC	1977	2400 PST	50	MPH	320	DEGREES
4	DEC	1977	100 PST	50	MPH	320	DEGREES
4	DEC	1977	200 PST	55	MPH	320	DEGREES
4	DEC	1977	300 PST	60	MPH	320	DEGREES
4	DEC	1977	400 PST	60	MPH	330	DEGREES
4	DEC	1977	500 PST	58	MPH	320	DEGREES
4	DEC	1977	600 PST	58	MPH	330	DEGREES
4	DEC	1977	700 PST	60	MPH	350	DEGREES
4	DEC	1977	800 PST	54	MPH	360	DEGREES
4	DEC	1977	900 PST	50	MPH	360	DEGREES
6	DEC	1977	1000 PST	50	MPH	270	DEGREES
6	DEC	1977	1100 PST	55	MPH	360	DEGREES
6	DEC	1977	2400 PST	55	MPH	340	DEGREES
7	DEC	1977	100 PST	55	MPH	340	DEGREES
7	DEC	1977	400 PST	55	MPH	360	DEGREES
7	DEC	1977	700 PST	50	MPH	360	DEGREES
15	DEC	1977	1500 PST	50	MPH	290	DEGREES
10	APR	1978	2000 PST	50	MPH	320	DEGREES
16	APR	1978	300 PST	50	MPH	330	DEGREES
15	JULY	1978	1800 PST	50	MPH	320	DEGREES
15	JULY	1978	1900 PST	54	MPH	330	DEGREES
15	JULY	1978	2000 PST	51	MPH	330	DEGREES

STATION JOHN DAY AIRPORT							
6	DEC	1977	300 PST	50	MPH	200	DEGREES
21	JAN	1978	1600 PST	50	MPH	999	DEGREES

STATION PRAIRIE MTN

7	FEB	1978	500	PST	50	MPH	999	DEGREES
30	APR	1978	700	PST	50	MPH	180	DEGREES
3	MAY	1978	2000	PST	50	MPH	360	DEGREES
5	MAY	1978	2200	PST	55	MPH	50	DEGREES
5	MAY	1978	2300	PST	54	MPH	50	DEGREES
5	MAY	1978	2400	PST	50	MPH	50	DEGREES
6	MAY	1978	2400	PST	50	MPH	50	DEGREES
10	MAY	1978	1900	PST	55	MPH	230	DEGREES
10	MAY	1978	2000	PST	50	MPH	230	DEGREES
10	MAY	1978	2100	PST	50	MPH	230	DEGREES
12	MAY	1978	1600	PST	50	MPH	200	DEGREES
12	MAY	1978	1700	PST	55	MPH	220	DEGREES
12	MAY	1978	1800	PST	50	MPH	220	DEGREES
12	MAY	1978	1900	PST	60	MPH	230	DEGREES
12	MAY	1978	2000	PST	62	MPH	230	DEGREES
12	MAY	1978	2100	PST	64	MPH	230	DEGREES
12	MAY	1978	2200	PST	60	MPH	220	DEGREES
12	MAY	1978	2300	PST	50	MPH	220	DEGREES
12	MAY	1978	2400	PST	52	MPH	230	DEGREES
13	MAY	1978	700	PST	50	MPH	230	DEGREES
13	MAY	1978	900	PST	55	MPH	220	DEGREES
13	MAY	1978	1100	PST	50	MPH	230	DEGREES
13	MAY	1978	1200	PST	62	MPH	230	DEGREES
13	MAY	1978	1500	PST	55	MPH	230	DEGREES
13	MAY	1978	1600	PST	50	MPH	220	DEGREES
13	MAY	1978	1700	PST	50	MPH	220	DEGREES
13	MAY	1978	1900	PST	50	MPH	220	DEGREES
13	MAY	1978	2000	PST	55	MPH	230	DEGREES
13	MAY	1978	2100	PST	50	MPH	230	DEGREES
13	MAY	1978	2200	PST	50	MPH	230	DEGREES
13	MAY	1978	2300	PST	50	MPH	230	DEGREES
13	MAY	1978	2400	PST	50	MPH	230	DEGREES
14	MAY	1978	100	PST	50	MPH	230	DEGREES
14	MAY	1978	300	PST	50	MPH	230	DEGREES
14	MAY	1978	400	PST	50	MPH	220	DEGREES
14	MAY	1978	500	PST	55	MPH	230	DEGREES
14	MAY	1978	600	PST	50	MPH	220	DEGREES
14	MAY	1978	700	PST	60	MPH	220	DEGREES
14	MAY	1978	800	PST	65	MPH	220	DEGREES
14	MAY	1978	900	PST	50	MPH	220	DEGREES
17	MAY	1978	2200	PST	55	MPH	40	DEGREES
17	MAY	1978	2300	PST	50	MPH	40	DEGREES
17	MAY	1978	2400	PST	50	MPH	50	DEGREES
18	MAY	1978	300	PST	50	MPH	80	DEGREES
18	MAY	1978	400	PST	58	MPH	90	DEGREES
18	MAY	1978	500	PST	50	MPH	80	DEGREES
18	MAY	1978	600	PST	50	MPH	90	DEGREES
18	MAY	1978	700	PST	50	MPH	90	DEGREES
18	MAY	1978	2000	PST	50	MPH	70	DEGREES
18	MAY	1978	2100	PST	50	MPH	80	DEGREES
18	MAY	1978	2200	PST	50	MPH	90	DEGREES
29	MAY	1978	2400	PST	55	MPH	50	DEGREES
30	MAY	1978	100	PST	55	MPH	50	DEGREES
30	MAY	1978	200	PST	58	MPH	50	DEGREES
30	MAY	1978	300	PST	65	MPH	50	DEGREES
30	MAY	1978	400	PST	64	MPH	50	DEGREES
30	MAY	1978	500	PST	60	MPH	50	DEGREES

STATION WANAPUM DAM

15	JULY	1978	2200	PST	52	MPH	260	DEGREES
15	JULY	1978	2300	PST	58	MPH	270	DEGREES
4	AUG	1978	2400	PST	54	MPH	250	DEGREES

STATION SUNNYSIDE

5	MAR	1978	100	PST	80	MPH	200	DEGREES
5	MAR	1978	200	PST	80	MPH	210	DEGREES
5	MAR	1978	500	PST	80	MPH	200	DEGREES
5	MAR	1978	600	PST	83	MPH	300	DEGREES
5	MAR	1978	700	PST	63	MPH	200	DEGREES
5	MAR	1978	800	PST	63	MPH	200	DEGREES

STATION	KENNEWICK							
1	DEC	1977	1000	PST	50	MPH	200	DEGREES
1	DEC	1977	1100	PST	50	MPH	200	DEGREES
1	DEC	1977	1200	PST	55	MPH	200	DEGREES
1	DEC	1977	1300	PST	56	MPH	200	DEGREES
1	DEC	1977	1400	PST	56	MPH	200	DEGREES
1	DEC	1977	1500	PST	58	MPH	200	DEGREES
1	DEC	1977	1600	PST	60	MPH	200	DEGREES
1	DEC	1977	1700	PST	60	MPH	200	DEGREES
1	DEC	1977	1800	PST	60	MPH	200	DEGREES
1	DEC	1977	1900	PST	58	MPH	200	DEGREES
1	DEC	1977	2000	PST	58	MPH	200	DEGREES
1	DEC	1977	2100	PST	60	MPH	210	DEGREES
1	DEC	1977	2200	PST	60	MPH	210	DEGREES
1	DEC	1977	2300	PST	56	MPH	210	DEGREES
1	DEC	1977	2400	PST	56	MPH	210	DEGREES
2	DEC	1977	100	PST	56	MPH	210	DEGREES
2	DEC	1977	200	PST	56	MPH	210	DEGREES
2	DEC	1977	300	PST	56	MPH	210	DEGREES
2	DEC	1977	400	PST	56	MPH	210	DEGREES
2	DEC	1977	500	PST	58	MPH	210	DEGREES
2	DEC	1977	600	PST	60	MPH	210	DEGREES
2	DEC	1977	700	PST	60	MPH	210	DEGREES
2	DEC	1977	800	PST	58	MPH	210	DEGREES
2	DEC	1977	900	PST	55	MPH	210	DEGREES
2	DEC	1977	1000	PST	50	MPH	210	DEGREES
2	DEC	1977	1100	PST	50	MPH	210	DEGREES
2	DEC	1977	1300	PST	55	MPH	210	DEGREES
2	DEC	1977	1400	PST	55	MPH	210	DEGREES
2	DEC	1977	1500	PST	55	MPH	210	DEGREES
2	DEC	1977	1600	PST	54	MPH	210	DEGREES
2	DEC	1977	1700	PST	50	MPH	210	DEGREES
2	DEC	1977	1800	PST	50	MPH	210	DEGREES
2	DEC	1977	1900	PST	55	MPH	200	DEGREES
2	DEC	1977	2000	PST	55	MPH	200	DEGREES
2	DEC	1977	2100	PST	50	MPH	200	DEGREES
2	DEC	1977	2300	PST	50	MPH	210	DEGREES
3	DEC	1977	1100	PST	50	MPH	210	DEGREES
3	DEC	1977	1200	PST	50	MPH	210	DEGREES
3	DEC	1977	1300	PST	50	MPH	210	DEGREES
6	DEC	1977	1800	PST	50	MPH	210	DEGREES
6	DEC	1977	1900	PST	58	MPH	210	DEGREES
6	DEC	1977	2000	PST	68	MPH	210	DEGREES
11	DEC	1977	1300	PST	50	MPH	200	DEGREES
11	DEC	1977	1400	PST	50	MPH	200	DEGREES
11	DEC	1977	1500	PST	50	MPH	200	DEGREES
11	DEC	1977	1600	PST	56	MPH	210	DEGREES
11	DEC	1977	1700	PST	56	MPH	210	DEGREES
11	DEC	1977	1800	PST	56	MPH	210	DEGREES
12	DEC	1977	400	PST	50	MPH	200	DEGREES
13	DEC	1977	1800	PST	50	MPH	210	DEGREES
13	DEC	1977	1900	PST	55	MPH	210	DEGREES
13	DEC	1977	2000	PST	56	MPH	210	DEGREES
14	DEC	1977	1200	PST	50	MPH	200	DEGREES
15	DEC	1977	800	PST	64	MPH	200	DEGREES
15	DEC	1977	900	PST	60	MPH	200	DEGREES
15	DEC	1977	1000	PST	58	MPH	200	DEGREES
15	DEC	1977	1100	PST	58	MPH	200	DEGREES
15	DEC	1977	1200	PST	56	MPH	200	DEGREES
15	DEC	1977	1300	PST	56	MPH	200	DEGREES
15	DEC	1977	1400	PST	56	MPH	200	DEGREES
15	DEC	1977	1500	PST	64	MPH	200	DEGREES
15	DEC	1977	1600	PST	72	MPH	200	DEGREES

Kennewick (cont.)

15	DEC	1977	1700	PST	58	MPH	200	DEGREES
15	DEC	1977	1800	PST	70	MPH	210	DEGREES
15	DEC	1977	1900	PST	68	MPH	210	DEGREES
15	DEC	1977	2000	PST	68	MPH	210	DEGREES
15	DEC	1977	2100	PST	68	MPH	210	DEGREES
15	DEC	1977	2200	PST	66	MPH	210	DEGREES
15	DEC	1977	2300	PST	58	MPH	210	DEGREES
15	DEC	1977	2400	PST	50	MPH	210	DEGREES
13	MAR	1978	900	PST	54	MPH	210	DEGREES
13	MAR	1978	1000	PST	56	MPH	210	DEGREES
13	MAR	1978	1100	PST	50	MPH	210	DEGREES
13	MAR	1978	1200	PST	54	MPH	210	DEGREES
13	MAR	1978	1300	PST	56	MPH	210	DEGREES
13	MAR	1978	1400	PST	56	MPH	210	DEGREES
13	MAR	1978	1500	PST	50	MPH	210	DEGREES
26	MAR	1978	100	PST	62	MPH	10	DEGREES
26	MAR	1978	200	PST	82	MPH	10	DEGREES
26	MAR	1978	400	PST	82	MPH	20	DEGREES
26	MAR	1978	600	PST	62	MPH	20	DEGREES
26	MAR	1978	700	PST	62	MPH	20	DEGREES
26	MAR	1978	800	PST	62	MPH	20	DEGREES
26	MAR	1978	900	PST	62	MPH	10	DEGREES
26	MAR	1978	1100	PST	62	MPH	10	DEGREES
26	MAR	1978	1200	PST	62	MPH	10	DEGREES
10	APR	1978	2200	PST	55	MPH	320	DEGREES
10	APR	1978	2300	PST	50	MPH	320	DEGREES
16	APR	1978	1000	PST	50	MPH	300	DEGREES
16	APR	1978	1100	PST	55	MPH	300	DEGREES
16	APR	1978	1200	PST	58	MPH	300	DEGREES
16	APR	1978	1300	PST	58	MPH	310	DEGREES
16	APR	1978	1400	PST	58	MPH	310	DEGREES
16	APR	1978	1500	PST	50	MPH	310	DEGREES
21	APR	1978	1300	PST	54	MPH	310	DEGREES
21	APR	1978	1400	PST	54	MPH	320	DEGREES
22	APR	1978	2400	PST	63	MPH	320	DEGREES
16	JULY	1978	100	PST	56	MPH	210	DEGREES
16	JULY	1978	200	PST	56	MPH	210	DEGREES
16	JULY	1978	300	PST	56	MPH	210	DEGREES
16	JULY	1978	400	PST	56	MPH	210	DEGREES
16	JULY	1978	500	PST	50	MPH	210	DEGREES
16	JULY	1978	1100	PST	63	MPH	220	DEGREES

STATION PEQUOP SUMMIT

24	JAN	1978	1400	PST	50	MPH	290	DEGREES
24	JAN	1978	1500	PST	50	MPH	280	DEGREES
7	FEB	1978	2100	PST	50	MPH	270	DEGREES
7	FEB	1978	2300	PST	56	MPH	270	DEGREES
7	FEB	1978	2400	PST	58	MPH	270	DEGREES
8	FEB	1978	100	PST	55	MPH	270	DEGREES
8	FEB	1978	300	PST	50	MPH	280	DEGREES
8	FEB	1978	400	PST	50	MPH	280	DEGREES
8	FEB	1978	500	PST	50	MPH	280	DEGREES
16	APR	1978	900	PST	54	MPH	220	DEGREES
16	APR	1978	1000	PST	52	MPH	220	DEGREES
16	APR	1978	1100	PST	54	MPH	230	DEGREES
16	APR	1978	1200	PST	50	MPH	220	DEGREES
16	APR	1978	1300	PST	50	MPH	220	DEGREES
9	JUNE	1978	1100	PST	60	MPH	260	DEGREES
11	JUNE	1978	500	PST	50	MPH	280	DEGREES

Rattlesnake Mtn. (cont.)

14	NOV	1977	100	PST	55	MPH	999	DEGREES
14	NOV	1977	1200	PST	50	MPH	999	DEGREES
15	NOV	1977	1200	PST	56	MPH	999	DEGREES
15	NOV	1977	1300	PST	50	MPH	999	DEGREES
15	NOV	1977	1400	PST	55	MPH	999	DEGREES
15	NOV	1977	1500	PST	65	MPH	999	DEGREES
15	NOV	1977	1600	PST	66	MPH	999	DEGREES
15	NOV	1977	1700	PST	60	MPH	999	DEGREES
15	NOV	1977	1800	PST	55	MPH	999	DEGREES
15	NOV	1977	2200	PST	50	MPH	999	DEGREES
15	NOV	1977	2400	PST	50	MPH	999	DEGREES
16	NOV	1977	100	PST	58	MPH	999	DEGREES
16	NOV	1977	200	PST	50	MPH	999	DEGREES
19	NOV	1977	200	PST	50	MPH	999	DEGREES
19	NOV	1977	300	PST	54	MPH	999	DEGREES
19	NOV	1977	400	PST	56	MPH	999	DEGREES
19	NOV	1977	500	PST	56	MPH	999	DEGREES
19	NOV	1977	600	PST	56	MPH	999	DEGREES
19	NOV	1977	700	PST	56	MPH	999	DEGREES
19	NOV	1977	800	PST	55	MPH	999	DEGREES
19	NOV	1977	900	PST	54	MPH	999	DEGREES
19	NOV	1977	1000	PST	55	MPH	999	DEGREES
19	NOV	1977	1100	PST	50	MPH	999	DEGREES
23	NOV	1977	2300	PST	70	MPH	999	DEGREES
23	NOV	1977	2400	PST	60	MPH	999	DEGREES
29	NOV	1977	100	PST	60	MPH	999	DEGREES
29	NOV	1977	200	PST	60	MPH	999	DEGREES
29	NOV	1977	300	PST	55	MPH	999	DEGREES
26	NOV	1977	300	PST	60	MPH	999	DEGREES
28	NOV	1977	1800	PST	50	MPH	999	DEGREES
28	NOV	1977	1900	PST	50	MPH	999	DEGREES
28	NOV	1977	2000	PST	50	MPH	999	DEGREES
28	NOV	1977	2100	PST	50	MPH	999	DEGREES
28	NOV	1977	2200	PST	55	MPH	999	DEGREES
29	NOV	1977	400	PST	60	MPH	999	DEGREES
29	NOV	1977	500	PST	74	MPH	999	DEGREES
29	NOV	1977	600	PST	65	MPH	999	DEGREES
29	NOV	1977	700	PST	70	MPH	999	DEGREES

WIND VELOCITY OBSERVATIONS WHEN HOURLY MEAN (99 MAX) WIND
SPEED EQUALLED OR EXCEEDED 43 KNOT. OUTPUT FOR 1 STATIONS

STATION COLUMBIA RIVER JETTY

8	DEC	1977	1300	PST	45	KNOT	190	DEGREES
15	DEC	1977	1300	PST	47	KNOT	350	DEGREES
15	DEC	1977	1400	PST	44	KNOT	250	DEGREES
15	DEC	1977	1500	PST	43	KNOT	350	DEGREES

STATION	WASCO	LOOKOUT							
2	DECO	1977	200	PST	53	MPH	999	DEGREES	
2	DECO	1977	500	PST	55	MPH	999	DEGREES	
2	DECO	1977	600	PST	63	MPH		DEGREES	
2	DECO	1977	700	PST	63	MPH		DEGREES	
2	DECO	1977	800	PST	55	MPH		DEGREES	
2	DECO	1977	900	PST	58	MPH		DEGREES	
2	DECO	1977	1000	PST	54	MPH		DEGREES	
2	DECO	1977	1100	PST	55	MPH		DEGREES	
2	DECO	1977	1200	PST	53	MPH		DEGREES	