WIND DATA REPORT

Cohasset

June 1st 2007 – May 31st 2008

Prepared for

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NOTICE AND ACKNOWLEDGEMENTS

This report was prepared by the Renewable Energy Research Laboratory (RERL) at the University of Massachusetts, Amherst in the course of performing work sponsored by the Renewable Energy Trust (RET), as administered by the Massachusetts Technology Collaborative (MTC). The opinions expressed in this report do not necessarily reflect those of MTC or the Commonwealth of Massachusetts, and reference to any specific product, service, process, or method does not constitute an implied or expressed recommendation or endorsement of it.

TABLE OF CONTENTS

TABLE OF FIGURES

EXECUTIVE SUMMARY

All the work presented in this Wind Data Report including installation and decommissioning of the meteorological tower and instrumentation, and the data analysis and reporting was performed by the Renewable Energy Research Laboratory (RERL) at the University of Massachusetts, Amherst.

The wind measurement station is installed on Turkey Hill in Cohasset, MA. Installed in May 2007, the wind monitoring station has been in operation for 12 months. The station consists of two anemometers each at 49 m (161 ft) and at 38 m (125 ft), one anemometer at 20 m (66 ft) and wind vanes at the same heights.

During the interval covered by this report, June 01 2007 – May 31 2008, the recorded mean wind speed was 5.28 m/s (11.81 mph) and the prevailing wind direction was from southwest. The gross data recovery percentage (the actual percentage of expected data received) was 100% and the net data recovery percentage (the percentage of expected data which passed all of the quality assurance tests) was 89.468%. Usually, the net data recovery percentage is over 90%. This relatively low percentage is due to the fact that one of the two wind speed sensors at the 49 m height malfunctioned.

Additional information about interpreting the data presented in this report can be found in the Fact Sheet, "Interpreting Your Wind Resource Data," produced by RERL and the Massachusetts Technology Collaborative (MTC). This document is found through the RERL website:

http://www.ceere.org/rerl/about_wind/RERL_Fact_Sheet_6_Wind_resource_interpretation.pdf

* 1 m/s = 2.237 mph.

SECTION 1 - Station Location

The location of the tower base is 42.23912° north, 70.85155° west. Relative to the Mean Low Water Level, the tower is mounted at a height of 41 m (134 ft).

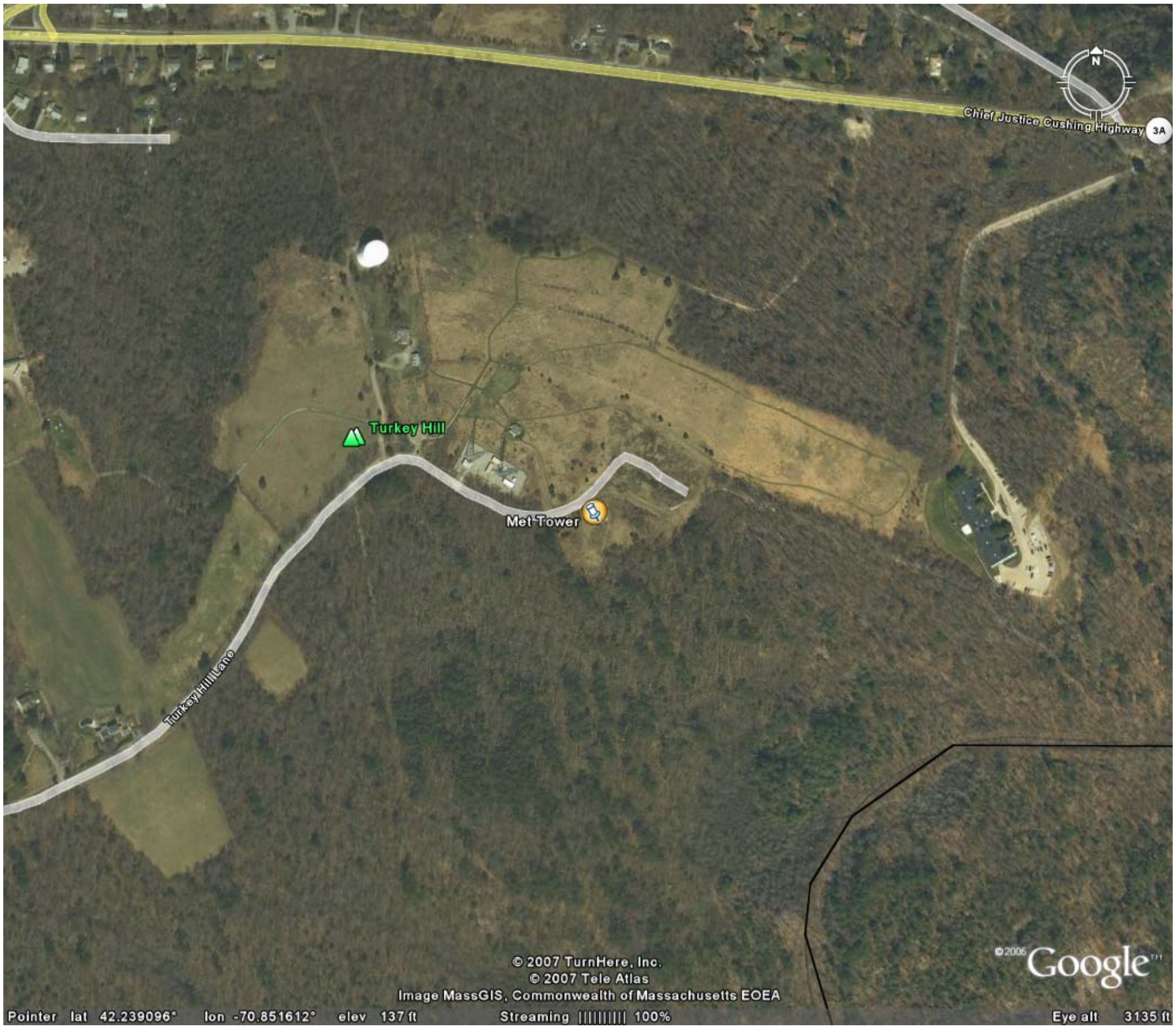

Figure 1 – Site location

SECTION 2 - Instrumentation and Equipment

The wind monitoring equipment is mounted on a met tower that is 164 feet tall, six inches in diameter, and held up by guy wires. This type of tower sits directly on the ground and no foundation is necessary. All the equipment comes from NRG Systems, and consists of the following items:

- Tower kit, height 50 m NRG tower
- Logger kit: NRG Symphonie Logger
- 5 - #40 Anemometers, standard calibration (Slope – 0.765 m/s, Offset – 0.350 m/s). One anemometer is located at 20 m (66 ft). Two anemometers are located at 38 m (125 ft) and two at 49 m (160 ft).
- 3 - #200P Wind direction vanes. The vanes are located at 20 m (66 ft), 38 m (125 ft), and 49 m (160 ft).
- 1 - #110S Temperature sensor located at 2 m (7 ft).

The data from the Symphonie logger is mailed to the University of Massachusetts, Amherst on a regular basis. The logger samples wind speed and direction once every two seconds. These samples are combined into 10-minute averages and are put into a binary file along with the standard deviation for each 10-minute interval. The binary files are converted to ASCII text files using the NRG software BaseStation®. These text files are then imported into a database software program where they are subjected to quality assurance tests prior to data usage.

SECTION 3 - Data Summary

A summary of the wind speeds and wind directions measured during the reporting period is included in Table 1. Table 1 includes the mean wind speeds measured at each measurement height, the maximum instantaneous wind speed measured at each measurement height and the prevailing wind direction measured at each measurement height. These values are provided for each month of the reporting period and for the whole reporting period.

Table 1. Wind Speed and Direction Data Summary

Date Height Units	Mean Wind Speed 49 m [m/s]	Max Wind Speed 49 m [m/s]	Prevailing Wind Direction 49 m	Mean Wind Speed 38 m [m/s]	Max Wind Speed 38 m [m/s]	Prevailing Wind Direction 38 m	Mean Wind Speed 20 m [m/s]	Max Wind Speed 20 m [m/s]	Prevailing Wind Direction 20 m
Jun 2007	4.99	10.71	NE	4.49	9.83	NE	3.15	7.82	SW
Jul 2007	4.5	14.01	SW	4.05	12.4	SW	2.14	9.26	N
Aug 2007	4.74	12.17	SW	4.3	11.23	SW	2.99	9.13	SW
Sep 2007	5.02	9.57	SW	4.54	8.62	SW	3.2	7.16	SW
Oct 2007	5.04	13.7	SW	4.52	12.39	SW	3.11	9.46	SW
Nov 2007	5.9	18.34	WNW	5.25	16.7	WNW	3.88	13.78	WNW
Dec 2007	5.38	15.56	WNW	4.62	14.22	WNW	3.21	11.73	WNW
Jan 2008	6.03	16.15	SW	5.3	14.86	SW	3.53	12.72	SW
Feb 2008	5.66	16.05	WNW	5.02	14.57	WNW	3.57	11.17	WNW
Mar 2008	6.26	17.22	WNW	5.62	14.15	WNW	4.24	11.8	WNW
Apr 2008	4.94	13.88	ENE	4.51	12.5	ENE	3.41	9.7	ENE
May 2008	5.54	13.87	SW	4.98	12.43	SW	3.63	10.58	SSW
Jun 2007 - May 2008	**5.28**	**18.34**	**SW**	**4.71**	**16.7**	**SW**	**3.3**	**13.78**	**SW**

Wind data statistics in the table are reported when more than 90% of the data during the reporting period are valid. In cases when a larger amount of data are missing, the percent of the available data that are used to determine the data statistics is noted.

No measurement of wind speed or direction can be perfectly accurate. Wind speed measurement errors occur due to anemometer manufacturing variability, anemometer calibration errors, the response of anemometers to turbulence and vertical air flow and due to air flows caused by the anemometer mounting system. Every effort is made to reduce the sources of these errors. Nevertheless, the values reported in this report have an expected uncertainty of about ± 2% or ± 0.2 m/s, whichever is greater. Wind direction measurement errors occur due to sensor measurement uncertainty, tower effects, boom alignment measurement errors and twisting of pipe sections during the raising of a pipe tower. Efforts are also made to reduce these errors, but the reported wind directions are estimated to have an uncertainty of +/- 5 degrees.

A summary of the turbulence intensity and mean wind shear measured at each measurement height during the reporting period is included in Table 2. These values are provided for each month of the reporting period and for the whole reporting period. Turbulence Intensity is calculated by dividing the standard deviation of the wind speed by the mean wind speed and is a measure of the gustiness of a wind resource. Lower turbulence results in lower mechanical loads on a wind turbine. Turbulence intensity varies with wind speed. The average turbulence intensity presented in Table 2 is the mean turbulence intensity when the wind speed at the highest measurement height is between 9.5 and 10.5 m/s.

Shear coefficients provide a measure of the change in wind speed with height. When data at multiple heights are available, shear coefficients, α, have been determined. They can be used in the following formula to estimate the average wind speed, $U(z)$, at height z, when the average wind speed, $U(z_r)$, at height z_r is known:

$$U(z)=U(z_r)\left(\frac{z}{z_r}\right)^{\alpha}$$

The change in wind speed with height is a very complicated relationship related to atmospheric conditions, wind speed, wind direction, time of day and time of year. This formula will not always provide the correct answer at any given site. Nevertheless the calculated shear coefficient, based on measurements at two heights, can be used to characterize the degree of increase in wind speed with height at a site.

The mean wind shear coefficient that is provided here is calculated based on the mean wind speeds in Table 1, where z_{high} and z_{low} are the heights of the higher and lower mean wind speeds used in the calculation and $U(z_{low})$ and $U(z_{high})$ are the mean wind speeds at the two heights.

$$\alpha = \log\left(\frac{U(z_{high})}{U(z_{low})}\right) \Big/ \log\left(\frac{z_{high}}{z_{low}}\right)$$

Table 2. Shear and Turbulence Intensity Data Summary

Date	Turbulence Intensity at 10 m/s	Turbulence Intensity at 10 m/s	Turbulence Intensity at 10 m/s	Mean Wind Shear Coefficient, α
Height Units	**49 m [-]**	**38 m [-]**	**20 m [-]**	**Between 49 m and 38 m [-]**
Jun 2007	0.19	0.22	0.33	0.42
Jul 2007	0.21	0.23	0.25	0.41
Aug 2007	0.19	0.21	0.31	0.38
Sep 2007	0.18	0.2	0.29	0.40
Oct 2007	0.2	0.21	0.32	0.43
Nov 2007	0.2	0.22	0.29	0.46
Dec 2007	0.19	0.21	0.32	0.60
Jan 2008	0.19	0.22	0.29	0.51
Feb 2008	0.21	0.24	0.34	0.47
Mar 2008	0.21	0.23	0.29	0.42
Apr 2008	0.21	0.23	0.29	0.36
May 2008	0.2	0.22	0.3	0.42
Jun 2007 - May 2008	**0.2**	**0.22**	**0.3**	**0.45**

SECTION 4- Long Term Estimate and Capacity Factor

Wind speed varies year by year and the mean obtained over the measurement period may be less or more compared to what is seen over a longer time period. Therefore, the use of the long term mean at the site is preferred when projecting the performance of a wind turbine. The long term mean at a site may be estimated by using the Measure-Correlate-Predict (MCP) method.

The MCP method correlates wind speed measurements at the target site to a reference site which collects data over the same period of time and has been collecting data for a much longer period. Based on this correlation, the reference wind speed data is used to predict long term mean at the site.

Long term data from Thompson Island between November 4th, 2001 and July 1st, 2008 is used as reference in the case of Cohasset. Correlation between the two sites are obtained from concurrent data between June 1st, 2007 and May 31st, 2008. The long term mean at Cohasset is estimated to be 5.5 m/s at 49 m with an uncertainty of 3% for the MCP process. This estimate may also be used to calculate the long term mean at different heights by using the mean wind shear at site and the equation described in the previous section. The long term mean wind speed at 70 m height is estimated at 6.46 m/s.

The capacity factor of a wind turbine at a given site depends on the hub height, wind speed distribution at the hub height, the wind turbine power curve and any assumptions about down time and losses due to wake effects from upwind wind turbines, etc. If the hub height wind speed is estimated from data at lower heights, then the capacity factor will also depend on the estimated wind shear and the wind speeds measured at lower heights. No simple estimate of capacity factor at a site could take all of these effects and choices into account. Nevertheless, an estimate of the capacity factor of a wind turbine at this site is provided here to help the reader understand the order of magnitude of the wind resource at this site.

The estimates assume a GE 1.5 sl turbine with a hub height of 80 m and the long term mean wind speed estimate at the highest measurement height and the mean wind shear at the site, in order to determine the mean hub height wind speed, in this case 6.86 m/s. The wind speed probability distribution is assumed to be given by a Rayleigh distribution. The average wind turbine power is then estimated from:

$$\overline{P_W} = \int_0^\infty P_W(U)p(U)dU$$

where $P_W(U)$ is the wind turbine power curve and $p(U)$ is the wind speed probability distribution. The capacity factor is then calculated from:

$$CF = \frac{\overline{P_W}}{P_{rated}}$$

where P_{rated} is the rated capacity of the turbine, i.e., 1500 kW. Based on this equation, the estimated average power of a wind turbine at this site would be 522.7 kW and the corresponding capacity factor would be about 34.8%

SECTION 5- Graphs

This report contains several types of wind data graphs. Unless otherwise noted, each graph represents data from one calendar year (June 2007 to May 2008). The following graphs are included:

- Time Series – 10-minute average wind speeds are plotted against time. This graph includes all of the collected data. The graph in Figure 2 represents data at 49 m.
- Wind Speed Distribution – A histogram plot giving the percentage of time that the wind is at a given wind speed. Figure 3 shows wind speeds ranged between 4 m/s (8.95 mph) and 5 m/s (11.2 mph) about 18% of the time and between 5 m/s (11.2

mph) and 6 m/s (13.42 mph) about another 19% of the time. The graph represents data at 49 m.

- Monthly Average – A plot of the monthly average wind speed over a 12-month period. This graph shows the trends in the wind speed over the whole period of data collection. This plot is shown on Figure 4 and represents data collected at 49 m.

- Diurnal – A plot of the average wind speed for each hour of the day. Figure 5 shows that the wind speed varied between 5.1 m/s (11.4 mph) and 5.5 m/s (12.3 mph) throughout the day on average and the highest wind speeds were recorded in the evening. The plot represents data collected at 49 m.

- Turbulence Intensity – A plot of turbulence intensity as a function of wind speed. Turbulence Intensity is calculated as the standard deviation of the wind speed divided by the wind speed and is a measure of the gustiness of a wind resource. Lower turbulence results in lower mechanical loads on a wind turbine. For Cohasset, the turbulence intensity was well within the acceptable range. This plot is shown as Figure 6. The plot represents data at 49 m.

- Wind Rose – A plot, by compass direction showing the percentage of time that the wind comes from a given direction and the average wind speed in that direction. The wind blew from the southwest approximately 13% of the time at an average speed of approximately 6.3 m/s (14.1 mph). This plot is shown on Figure 7 and represents data collected at 49 m.

Data for the wind speed histograms, monthly and diurnal average plots, and wind roses are included in APPENDIX B.

<u>Wind Speed Time Series</u>

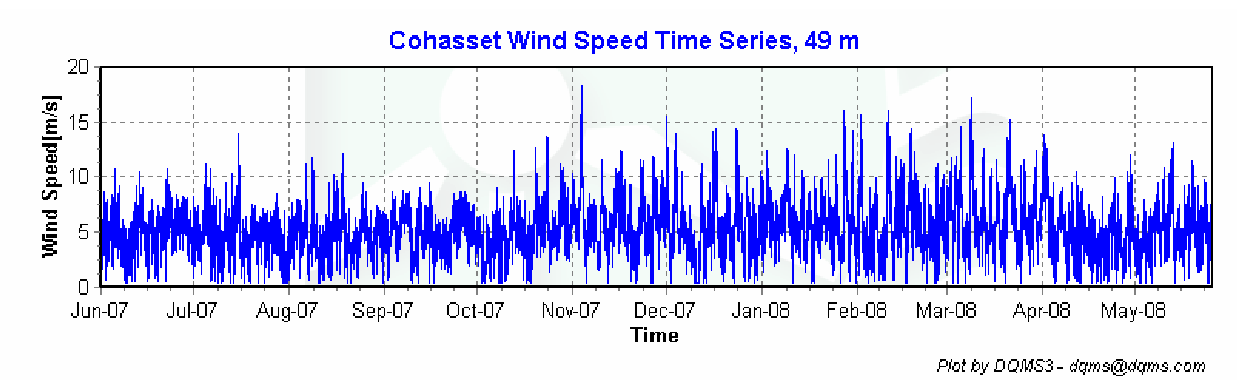

Figure 2 - Wind Speed Time Series, June 2007 – May 2008

Wind Speed Distributions

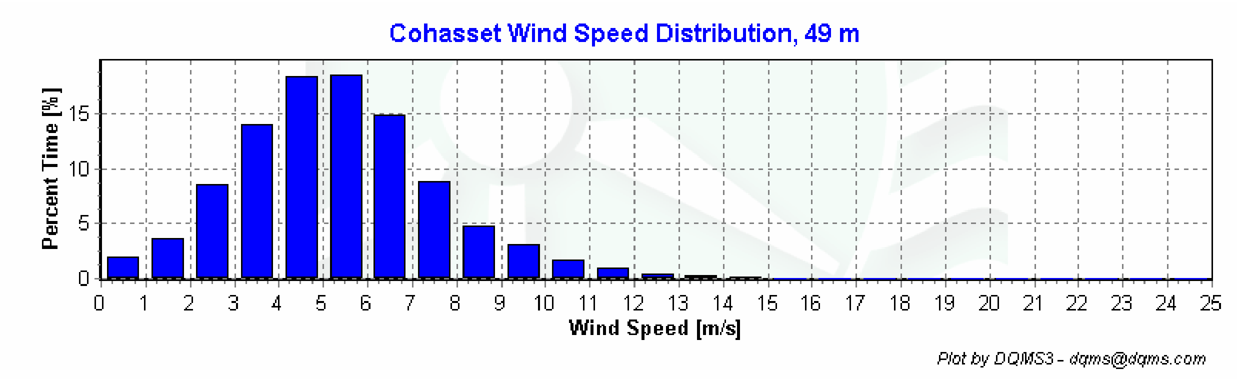

Figure 3 - Wind Speed Distribution, June 2007 – May 2008

Monthly Average Wind Speeds

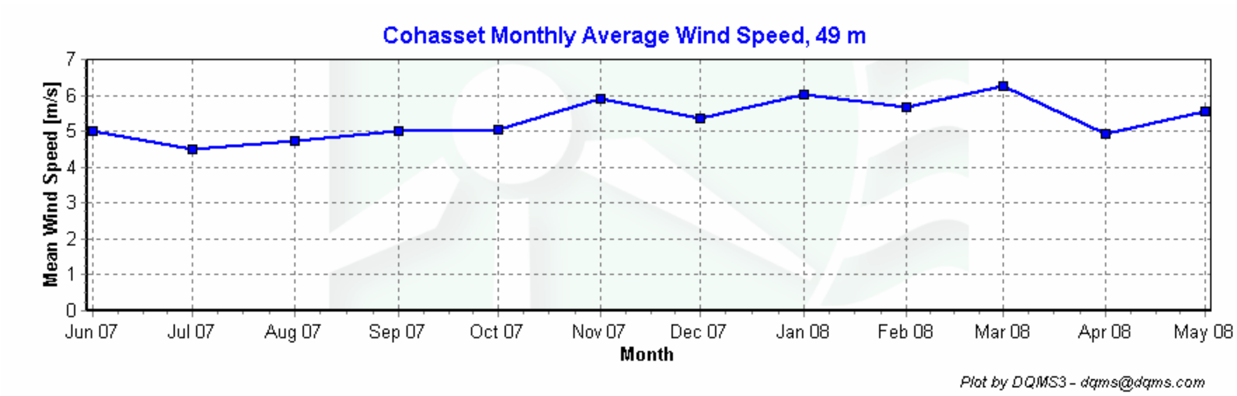

Figure 4 – Monthly Average Wind Speeds, June 2007 – May 2008

Diurnal Average Wind Speeds

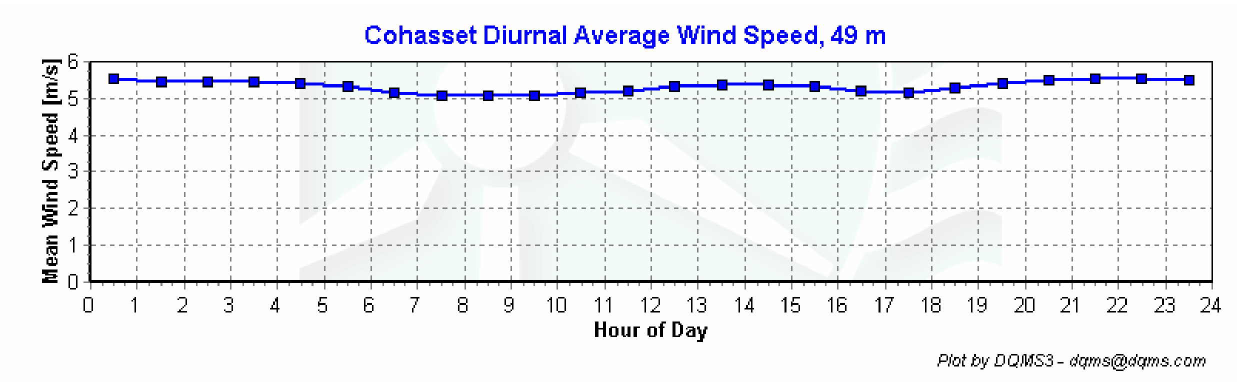

Figure 5 – Diurnal Average Wind Speeds, June 2007 – May 2008

Turbulence Intensities

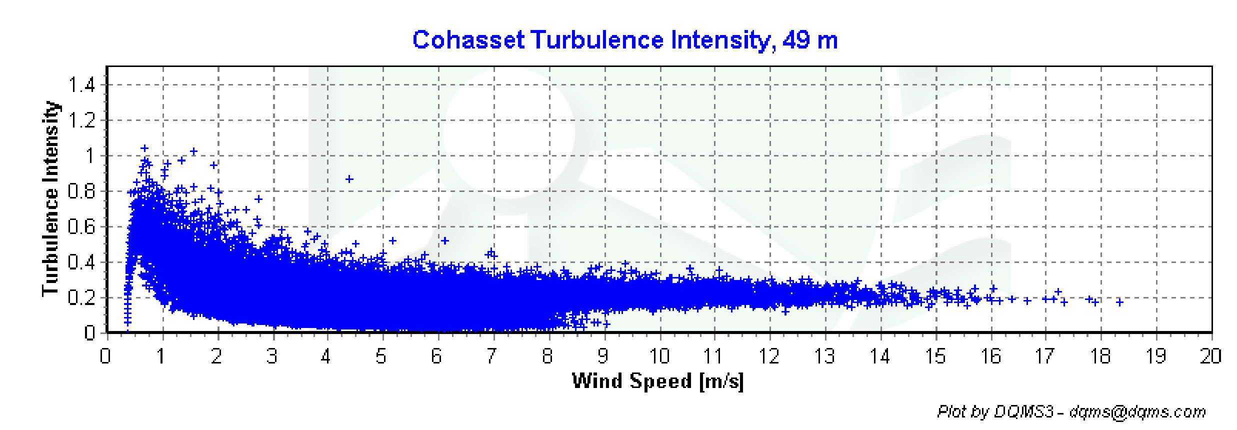

Figure 6 – Turbulence Intensities, June 2007 – May 2008

Wind Roses

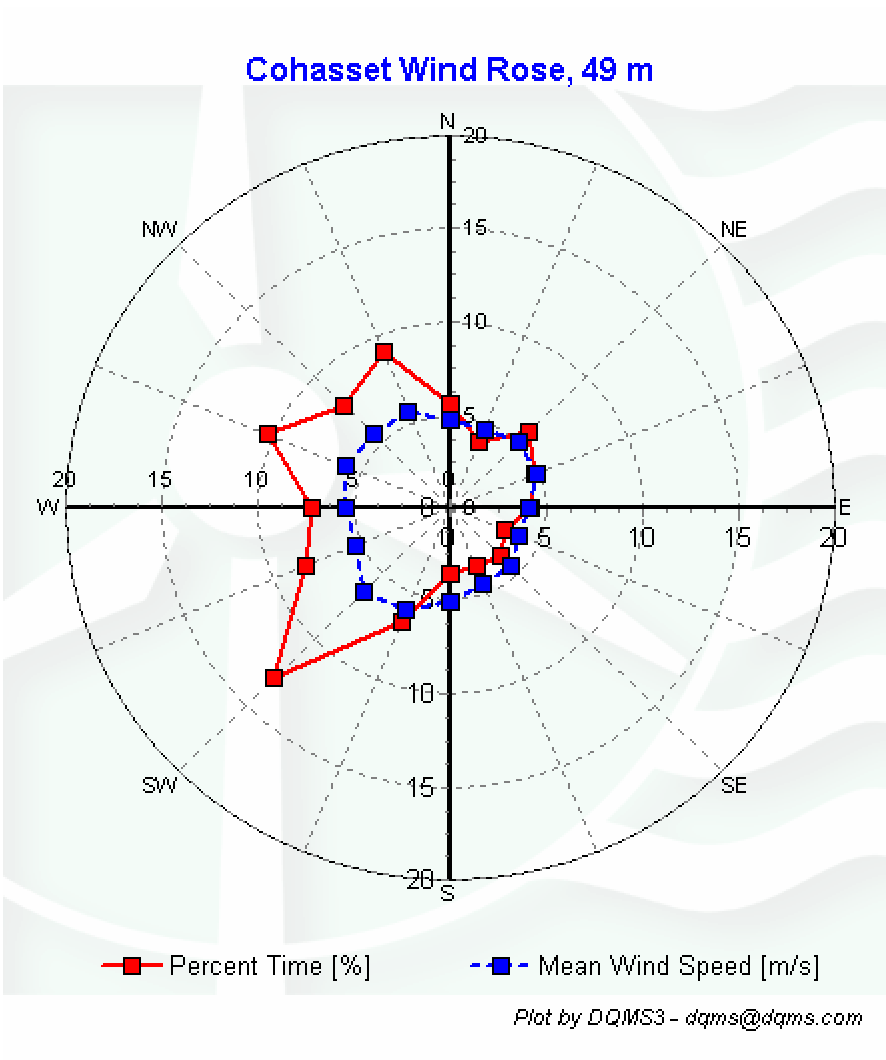

Figure 7 – Wind Rose, June 2007 – May 2008

SECTION 6 - Significant Meteorological Events

June of 2007 – May of 2008 experienced, on average, normal winds and precipitation. No major events are shown in the wind speed time series.

Source: http://www.erh.noaa.gov/box/MonthlyClimate2.shtml

SECTION 7 - Data Collection and Maintenance

The following maintenance/equipment problems occurred during the report period, and the following corrective actions taken:

- All sensors but one have been working without any problems since 11:00 am on May 25, 2007. One of the anemometers at the 49 m height was flagged for most of the time.
- No maintenance operations were performed.
- The tower was decommissioned on June 13th, 2008.

SECTION 8 - Data Recovery and Validation

All raw wind data are subjected to a series of tests and filters to weed out data that are faulty or corrupted. Definitions of these quality assurance (QA) controls are given below under Test Definitions and Sensor Statistics. These control filters were designed to automate the quality control process and used many of the previous hand-worked data sets made at UMass to affect a suitable emulation. The gross percentage of data recovered (ratio of the number of raw data points received to data points expected) and net percentage (ratio of raw data points which passed all QA control tests to data points expected) are shown below.

Gross Data Recovered [%]	100
Net Data Recovered [%]	89.468

Test Definitions

All raw data were subjected to a series of validation tests, as described below. The sensors tested and the parameters specific to each sensor are given in the Sensor Performance Report which is included in APPENDIX A. Data which were flagged as invalid were not included in the statistics presented in this report.

MinMax Test: All sensors are expected to report data values within a range specified by the sensor and logger manufacturers. If a value falls outside this range, it is flagged as invalid. A data value from the sensor listed in Test Field 1 (TF1) is flagged if it is less than Factor 1 (F1) or greater than Factor 2. This test has been applied to the following sensors (as applicable): wind speed, wind speed standard deviation, wind direction, temperature, and solar insolation.

$$F1 > TF1 > F2$$

MinMaxT Test: This is a MinMax test for wind direction standard deviation with different ranges applied for high and low wind speeds. A wind direction standard deviation data value (TF1) is flagged either if it is less than Factor 1, if the wind speed (TF2) is less than Factor 4 and the wind direction standard deviation is greater than Factor 2, or if the wind speed is greater than or equal to Factor 4 and the wind direction standard deviation is greater than Factor 3.

$$(TF1 < F1)$$
$$\text{or } (TF2 < F4 \text{ and } TF1 > F2)$$
$$\text{or } (TF2 \geq F4 \text{ and } TF1 > F3)$$

Icing Test: An icing event occurs when ice collects on a sensor and degrades its performance. Icing events are characterized by the simultaneous measurements of near-zero standard deviation of wind direction, non-zero wind speed, and near- or below-freezing temperatures. Wind speed, wind speed standard deviation, wind direction, and wind direction standard deviation data values are flagged if the wind direction standard deviation (CF1) is less than or equal to Factor 1 (F1), the wind speed (TF1) is greater than Factor 2 (F2), and the temperature (CF2) is less than Factor 3 (F3). To exit an icing event, the wind direction standard deviation must be greater than Factor 4.

$$CF1 \leq F1 \text{ and } TF1 > F2 \text{ and } CF2 < F3$$

CompareSensors Test: Where primary and redundant sensors are used, it is possible to determine when one of the sensors is not performing properly. For anemometers, poor performance is characterized by low data values. Therefore, if one sensor of the pair reports values significantly below the other, the low values are flagged. At low wind speeds (Test Fields 1 and 2 less than or equal to Factor 3) wind speed data are flagged if the absolute difference between the two wind speeds is greater than Factor 1. At high wind speeds (Test Fields 1 or 2 greater than Factor 3) wind speed data are flagged if the absolute value of the ratio of the two wind speeds is greater is greater than Factor 2.

$$[\ TF1 \leq F3 \text{ and } TF2 \leq F3 \text{ and } abs(TF1 - TF2) > F1\ ]$$
$$\text{or } [\ (TF1 > F3 \text{ or } TF2 > F3) \text{ and } (abs(1 - TF1 / TF2) > F2 \text{ or } abs(1 - TF2 / TF1) > F2)\ ]$$

Sensor Statistics

A summary of the results of the data collection and filtering are given in the Sensor Performance Report which is included in APPENDIX A. The following categories of information, tabulated for each sensor, are included in that report.

Expected Data Points: the total number of sample intervals between the start and end dates (inclusive).

Actual Data Points: the total number of data points recorded between the start and end dates.

% Data Recovered: the ratio of actual and expected data points (this is the *gross data recovered percentage*).

Hours Out of Range: total number of hours for which data were flagged according to MinMax and MinMaxT tests. These tests flag data which fall outside of an expected range.

Hours of Icing: total number of hours for which data were flagged according to Icing tests. This test uses the standard deviation of wind direction, air temperature, and wind speed to determine when sensor icing has occurred.

Hours of Fault: total number of hours for which data were flagged according to CompareSensors tests. These tests compare two sensors (e.g. primary and redundant anemometers installed at the same height) and flag data points where one sensor differs significantly from the other.

% Data Good: the filter results are subtracted from the gross data recovery percentage to yield the *net data recovered percentage*.

APPENDIX A - Sensor Performance Report

Test Definitions

Test Order	Test Field1	Test Field2	Test Field3	Calc Field1	Calc Field2	Calc Field3	TestType	Factor 1	Factor 2	Factor 3	Factor 4
1							TimeTest Insert				
3	Etmp2aDEGC						MinMax	-30	60		
4	EtmpSD2aDEGC						MinMax	-30	60		
10	Anem49aMS						MinMax	0	90		
11	Anem49bMS						MinMax	0	90		
12	Anem38aMS						MinMax	0	90		
13	Anem38bMS						MinMax	0	90		
14	Anem20aMS						MinMax	0	90		
20	AnemSD49aMS						MinMax	0	4		
21	AnemSD49bMS						MinMax	0	4		
22	AnemSD38aMS						MinMax	0	4		
23	AnemSD38bMS						MinMax	0	4		
24	AnemSD20aMS						MinMax	0	4		
30	Vane49aDEG						MinMax	0	359.9		
31	Vane38aDEG						MinMax	0	359.9		
32	Vane20aDEG						MinMax	0	359.9		
50	Turb49zNONE						MinMax	0	2		
51	Turb38zNONE						MinMax	0	2		
52	Turb20zNONE						MinMax	0	2		
60	Wshr0zNONE						MinMax	0	20		
70	Amax49aMS						MinMax	0	90		
71	Amin49aMS						MinMax	0	90		
72	Amax49bMS						MinMax	0	90		
73	Amin49bMS						MinMax	0	90		
74	Amax38aMS						MinMax	0	90		
75	Amin38aMS						MinMax	0	90		
76	Amax38bMS						MinMax	0	90		
77	Amin38bMS						MinMax	0	90		
78	Amax20aMS						MinMax	0	90		
79	Amin20aMS						MinMax	0	90		
80	Vmax49aDEGC						MinMax	0	359.9		
81	Vmin49aDEGC						MinMax	0	359.9		
82	Vmax38aDEGC						MinMax	0	359.9		
83	Vmin38aDEGC						MinMax	0	359.9		
84	Vmax20aDEGC						MinMax	0	359.9		
85	Vmin20aDEGC						MinMax	0	359.9		
200	VaneSD49aDEG	Anem49aMS					MinMaxT	0	100	100	10
201	VaneSD38aDEG	Anem38aMS					MinMaxT	0	100	100	10
202	VaneSD20aDEG	Anem20aMS					MinMaxT	0	100	100	10
300	Anem49aMS	AnemSD49aMS	Vane49aDEG	VaneSD49aDEG	Etmp2aDEGC		Icing	0.5	1	2	2
301	Anem49bMS	AnemSD49bMS	Vane49aDEG	VaneSD49aDEG	Etmp2aDEGC		Icing	0.5	1	2	2
302	Anem38aMS	AnemSD38aMS	Vane38aDEG	VaneSD38aDEG	Etmp2aDEGC		Icing	0.5	1	2	2
303	Anem20aMS	AnemSD20aMS	Vane20aDEG	VaneSD20aDEG	Etmp2aDEGC		Icing	0.5	1	2	2
400	Anem49aMS	Anem49bMS					CompareSensors	1	0.25	3	
401	Anem38aMS	Anem38bMS					CompareSensors	1	0.25	3	

Sensor Statistics

Sensor	Expected Data Points	Actual Data Points	% Data Recovered	Hours Out of Range	Hours of Icing	Hours of Fault	% Data Good
Anem49aMS	52705	52705	100	1	44.333	0	99.484
AnemSD49aMS	52705	52705	100	1	44.333	0	99.484
Anem49bMS	52705	52705	100	1.167	9.833	7532	14.13
AnemSD49bMS	52705	52705	100	1.167	9.833	7532	14.13
Anem38aMS	52705	52705	100	1.167	35.333	1.167	99.571
AnemSD38aMS	52705	52705	100	1.167	35.333	1.167	99.571
Anem38bMS	52705	52705	100	1.167	14.333	42.167	99.344
AnemSD38bMS	52705	52705	100	1.167	14.333	42.167	99.344
Anem20aMS	52705	52705	100	0.5	41.333	0	99.524
AnemSD20aMS	52705	52705	100	0.5	41.333	0	99.524
Vane49aDEG	52705	52705	100	2.333	44.333	0	99.469
VaneSD49aDEG	52705	52705	100	2.333	44.333	0	99.469
Vane38aDEG	52705	52705	100	2.667	35.5	0	99.566
VaneSD38aDEG	52705	52705	100	2.667	35.5	0	99.566
Vane20aDEG	52705	52705	100	2.333	41.333	0	99.503
VaneSD20aDEG	52705	52705	100	2.333	41.333	0	99.503
Etmp2aDEGC	52705	52705	100	945.167	0	0	89.24
EtmpSD2aDEGC	52705	52705	100	0	0	0	100
Total	**948690**	**948690**	**100**	**969.833**	**532.667**	**15150.67**	**89.468**

APPENDIX B - Plot Data

Wind Speed Distribution Data

Bin Center Wind Speed [m/s]	Percent of Time [%]
0.5	2.01
1.5	3.66
2.5	8.49
3.5	14.06
4.5	18.27
5.5	18.48
6.5	14.84
7.5	8.81
8.5	4.82
9.5	3.02
10.5	1.67
11.5	0.97
12.5	0.46
13.5	0.23
14.5	0.11
15.5	0.05
16.5	0.01
17.5	0.01
18.5	0
19.5	0
20.5	0
21.5	0
22.5	0
23.5	0
24.5	0

Monthly Average Wind Speed Data

Date	10 min Mean [m/s]
Jun 2007	4.99
Jul 2007	4.50
Aug 2007	4.74
Sep 2007	5.02
Oct 2007	5.04
Nov 2007	5.90
Dec 2007	5.38
Jan 2008	6.03
Feb 2008	5.66
Mar 2008	6.26
Apr 2008	4.94
May 2008	5.54

Diurnal Average Wind Speed Data

Hour of Day	Average Wind Speed [m/s]
0.5	5.52
1.5	5.45
2.5	5.46
3.5	5.44
4.5	5.42
5.5	5.31
6.5	5.15
7.5	5.08
8.5	5.06
9.5	5.06
10.5	5.16
11.5	5.21
12.5	5.34
13.5	5.35
14.5	5.38
15.5	5.34
16.5	5.21
17.5	5.17
18.5	5.3
19.5	5.42
20.5	5.48
21.5	5.54
22.5	5.54
23.5	5.51

Wind Rose Data

Direction	Percent Time [%]	Mean Wind Speed [m/s]
N	5.63	4.77
NNE	3.88	4.5
NE	5.78	5.07
ENE	4.77	4.86
E	4.21	4.04
ESE	3.08	3.79
SE	3.65	4.45
SSE	3.42	4.39
S	3.52	5.07
SSW	6.67	5.92
SW	12.91	6.31
WSW	8.17	5.35
W	7.2	5.4
WNW	10.31	5.86
NW	7.75	5.62
NNW	9.06	5.64