LONG TERM SITE
WIND DATA ANNUAL REPORT

Mass Turnpike Authority
Blandford, MA

July 1, 2012 – June 30, 2013

Prepared for

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NOTICE AND ACKNOWLEDGEMENTS

This report was prepared by the Wind Energy Center (WEC) at the University of Massachusetts, Amherst in the course of performing work sponsored by the Renewable Energy Trust (RET), as administered by the Massachusetts Clean Energy Center (MassCEC). 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.

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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 Wind Energy Center (WEC) at the University of Massachusetts, Amherst.

Two anemometers and one wind vane are mounted each at the 60 m (197 ft) tower height and at the 40 m (131 ft) tower height and a temperature sensor is installed near the base of the tower. On August 16th, 2012 the temperature sensor was replaced and on November 16th, 2012 the cellular modem was replaced.

During the period covered by this annual report, July, 2012 – June, 2013, the mean recorded wind speed at 60 m was 5.20 m/s (11.63 mph*). The annual average wind speed for this year is similar to annual average wind speeds at the site in previous years. The prevailing wind direction during the monitoring period was from the West-Northwest. The average turbulence intensity measured at wind speeds near 10 m/s at 60 m was 0.2085. The gross data recovery percentage (the actual percentage of expected data received) was 99.86% and the net data recovery percentage (the percentage of expected data which passed all of the quality assurance tests) was 97.55%.

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

http://www.umass.edu/windenergy/publications/published/communityWindFactSheets/RERL_Fact_Sheet_6_Wind_resource_interpretation.pdf

* 1 m/s = 2.237 mph.

SECTION 1 - Station Location

This update summarizes the quarterly data results for the Blandford monitoring site in Blandford, MA. Site coordinates are 42-13-22.8 North, 72-58-4.8 West per the WGS84 standard (the World Geodetic System 1984, an international standard for absolute localization with earthly coordinates). The site is located on the MTA tower in Blandford, MA. The picture below shows the location of the tower, with the red circle indicating the location of the tower base.

Figure 1 - Site Location

Terrain

The site is located at a highway maintenance facility. The highway runs from Northwest to Southeast providing a clearing. Some buildings and a parking lot containing trucks and equipment is located to the West of the tower and a small building is located to the Southeast of the tower. There are trees lining the highway edges.

SECTION 2 - Instrumentation and Equipment

The wind monitoring equipment is mounted on an 80 m (262 ft) lattice communications tower. The wind monitoring equipment comes from several vendors and consists of the following items:

- NRG Symphonie data logger and I-pack cellular modem
- 3 – NRG Max 40 anemometer, std calibration (Slope – 0.765 m/s, offset – 0.35 m/s) 2 are located at 40m (131.2 ft) and 1 is located at 60 m (196.85 ft)
- 1 – Risoe # 6803 calibrated cup anemometer located at 60 m (196.85 ft) (Slope 0.62643 m/s, offset 0.21002 m/s)
- 2 – NRG #200P Wind direction vane. One vane is located at 60 m (196.85 ft) , the other vane is located at 40m (131.2 ft)
- NRG 110S temperature sensor located near the base of the tower

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

	Month	Mean Wind Speed [m/s]	NDR [%]	Max Wind Speed [m/s]	NDR [%]	Prevailing Direction [deg]	NDR [%]
60 m	12-Jul	4.352	100	11.94	100	WNW	96.93
	12-Aug	4.264	100	10.35	100	SW	99.37
	12-Sep	4.656	100	12.59	100	WNW	100
	12-Oct	5.256	100	18.29	100	W	100
	12-Nov	5.13	98.33	14.98	98.33	WNW	94.51
	12-Dec	5.644	100	19.12	100	WNW	89.85
	13-Jan	5.774	100	16.69	100	WNW	95.45
	13-Feb	6.01	100	17.52	100	W	92.58
	13-Mar	6.053	100	15.57	100	WNW	98.92
	13-Apr	5.446	100	14.74	100	WNW	94.51
	13-May	4.825	100	11.81	100	W	99.57
	13-Jun	5.077	100	11.02	100	W	100
	FY 2013	5.202	99.86	19.12	99.86	WNW	96.84
40 m	12-Jul	3.503	98.84	10.52	98.84	WNW	98.61
	12-Aug	3.34	99.51	8.87	99.51	SW	99.48
	12-Sep	3.732	100	10.95	100	WNW	100
	12-Oct	4.364	100	16.98	100	W	100
	12-Nov	4.464	95.81	13.39	95.81	WNW	95.74
	12-Dec	5.184	89.47	17.42	89.47	WNW	89.47
	13-Jan	4.945	99.6	15.07	99.6	WNW	99.15
	13-Feb	5.499	89.71	15.4	89.71	W	89.61
	13-Mar	5.356	99.66	13.73	99.66	WNW	99.57
	13-Apr	4.973	94.84	13.11	94.84	WNW	94.81
	13-May	4.194	99.96	10.45	99.96	W	99.96
	13-Jun	4.327	100	9.97	100	SW	100
	FY 2013	4.467	97.34	17.42	97.34	WNW	97.26

Wind data statistics in the table are reported when more than 90% of the data during the reporting period that are valid. In cases when a large amount of data is 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 each measurement height is between 10 and 11 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

	Month	TI at 10 m/s [-]	NDR [%]	Mean Wind Shear Coefficient Between 60 and 40 meters [-]	NDR [%]
60 m	12-Jul	0.1133	99.57	0.5351	98.84
	12-Aug	0.1281	99.31	0.6022	99.51
	12-Sep	0.1401	98.61	0.5454	100.00
	12-Oct	0.1478	99.35	0.4585	100.00
	12-Nov	0.1219	99.65	0.3427	95.81
	12-Dec	0.1349	97.51	0.2098	89.47
	13-Jan	0.1373	96.82	0.3822	99.60
	13-Feb	0.1219	92.66	0.2192	89.71
	Mar-13	0.1304	96.03	0.3016	99.66
	Apr-13	0.1254	95.83	0.2241	94.84
	13-May	0.133	99.98	0.3456	99.96
	13-Jun	0.1347	100	0.3944	100.00
	FY 2013	0.2085	99.86	0.3755	97.34
40 m	12-Jul	0.128	99.31		
	12-Aug	0.1603	98.3		
	12-Sep	0.1531	98.87		
	12-Oct	0.1614	98.97		
	12-Nov	0.135	99.63		
	12-Dec	0.1449	97.22		
	13-Jan	0.1451	96.08		
	13-Feb	0.1199	94.05		
	13-Mar	0.1179	99.87		
	13-Apr	0.1353	95.35		
	13-May	0.1313	99.13		
	13-Jun	0.1716	99.54		
	FY 2013	0.223	97.34		

The seasonal Average wind shear is given in Table 3. Table 4 gives the average night and day time wind shear values. Day time is defined as 6 AM to 6 PM with night time being all other times. The average directional wind shear is given in Table 5. The average directional wind shear is calculated by placing the wind shears in bins and calculating the average for each bin. The bin centers are the directional sectors listed in Table 5. For instance, the directional sector

of 0 is the average of all wind shear values when the wind direction is between 347.75° and 12.25°.

Table 3. Seasonal Average Wind Shear

	Mean Wind Shear Coefficient Between 60 and 40 meters [-]	NDR [%]
Jul - Sep 2012	0.561	99.45
Oct - Dec 2012	0.337	95.09
Jan - Mar 2013	0.301	96.32
Apr - Jun 2013	0.321	98.27

Table 4. Day and Night Time Wind Shear Averages

	Mean Wind Shear Coefficient Between 60 and 40 meters [-]
Day	0.338
Night	0.588

Table 5. Average Directional Wind Shear

Direction Sector [deg]	Mean Wind Shear Coefficient Between 60 and 40 meters [-]
0	0.566
22.5	0.538
45	0.872
67.5	0.963
90	0.568
112.5	0.528
135	0.461
157.5	-0.160
180	0.306
202.5	0.703
225	0.604
247.5	0.542
270	0.409
292.5	0.336
315	0.366
337.5	0.543

SECTION 4- Graphs

This report contains several types of wind data graphs. Unless otherwise noted, each graph represents data from 1 quarter (3 months). Each quarterly graph corresponds to a quarter of fiscal year 2013: Quarter 1 (July 2012-September 2012), Quarter 2 (October 2012 to December 2012), Quarter 3 (January 2013 – March 2013), or Quarter 4 (April 2013 – June 2013). The following graphs are included:

- Time Series – 10-minute average wind speeds are plotted against time.
- Wind Speed Distribution – A histogram plot giving the percentage of time that the wind is at a given wind speed.
- Monthly Average – A plot of the monthly average wind speed over the three-month period. This graph shows the trends in the wind speed over the year.
- Diurnal – A plot of the average wind speed for each hour of the day.

- 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.

- 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.

- Annual Average Wind Speed – A plot of the annual average wind speed at the site for each fiscal year.

With regard to the Blandford MTA site, the following observations are noted.

- Time Series – The winds were primarily less than 15 m/s during the monitoring period.

- Wind Speed Distribution – The wind speed distributions show that the most common wind speed is typically around 4 or 5 m/s at the site.

- Monthly Average – The winter months show higher average wind speeds than the summer months.

- Diurnal – A plot of the average wind speed for each hour of the day.

- Turbulence Intensity – In each quarter turbulence intensities for high wind speeds generally stay below 0.3

- Wind Rose – The wind direction data varied during each of the four quarters but the prevailing wind directions were from the West and the West-Northwest directions.

- Annual Average Wind Speed – The annual average wind speed at the site has consistently been between 5 and 6 m/s. The average wind speed in 2013 was similar to the average wind speeds in the previous years.

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

Wind Speed Time Series

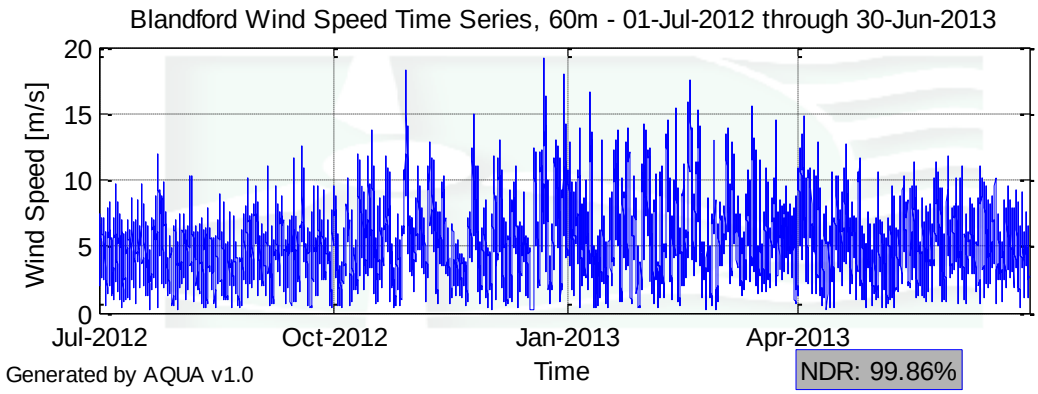

Figure 2 – Wind Speed Time Series

Wind Speed Distributions

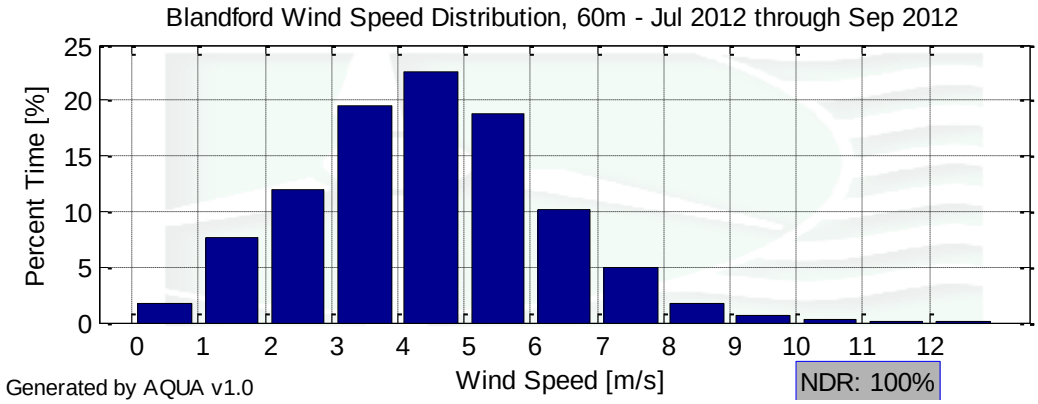

Figure 3a – Wind Speed Distribution Jul 2012 – Sep 2012

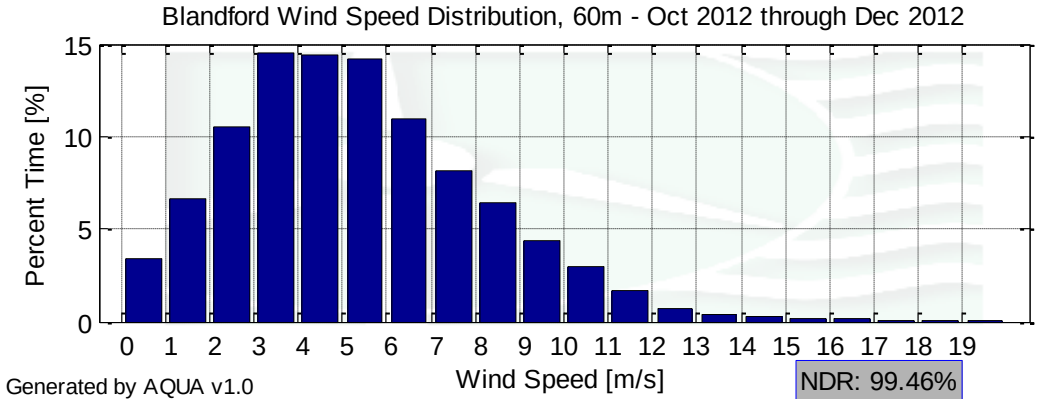

Figure 3b – Wind Speed Distribution Oct 2012 – Dec 2012

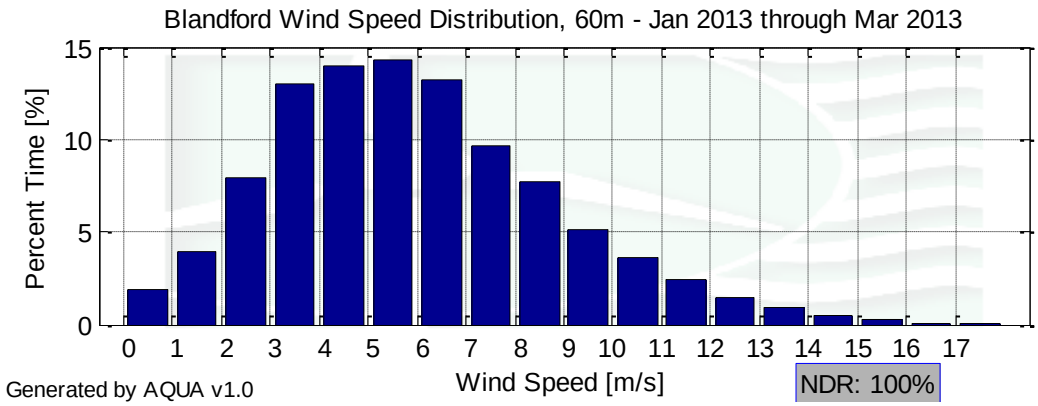

Figure 3c – Wind Speed Distribution Jan 2013 – Mar 2013

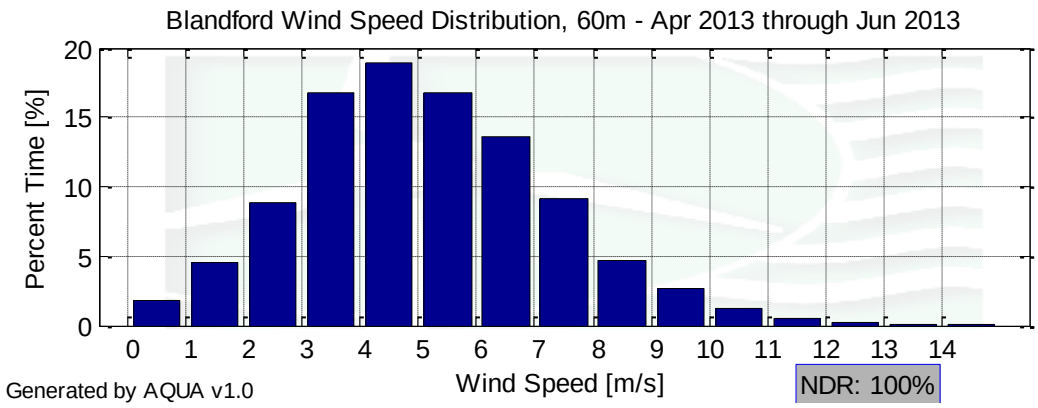

Figure 3d – Wind Speed Distribution Apr 2013 – Jun 2013

Monthly Average Wind Speeds

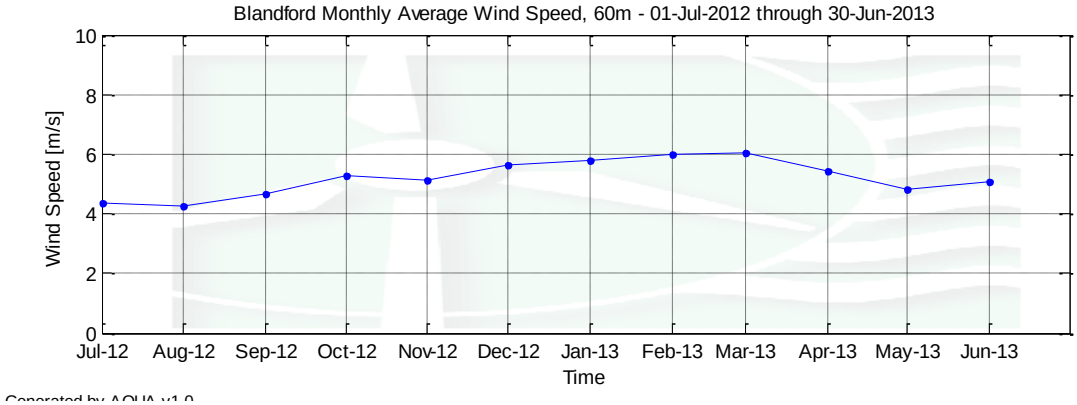

Figure 4 – Monthly Average Wind Speed

Diurnal Average Wind Speeds

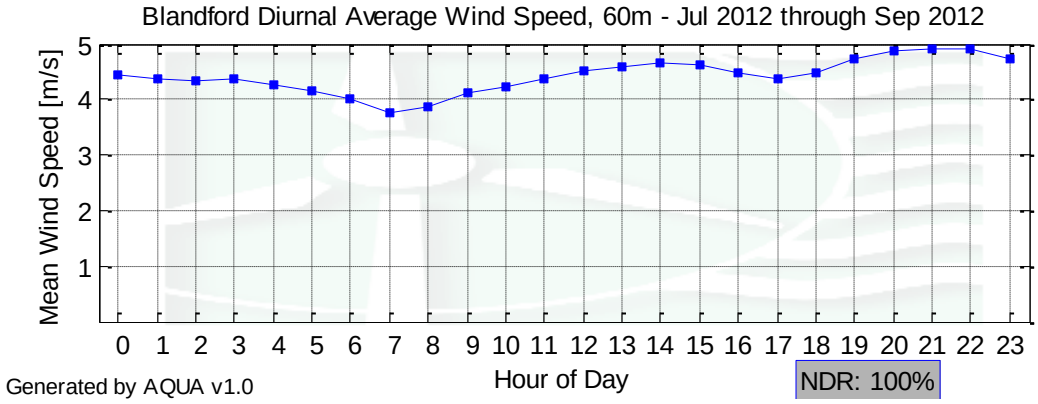

Figure 5a – Diurnal Average Wind Speeds Jul 2012 – Sep 2012

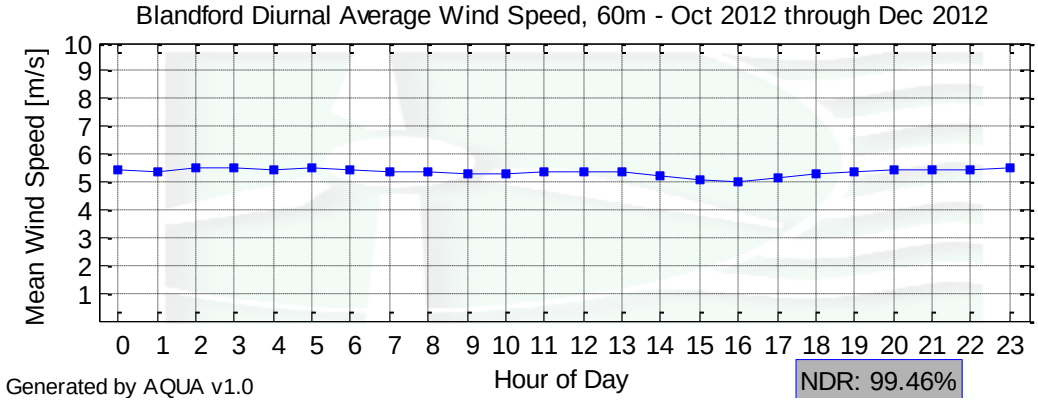

Figure 5b – Diurnal Average Wind Speeds Oct 2012 – Dec 2012

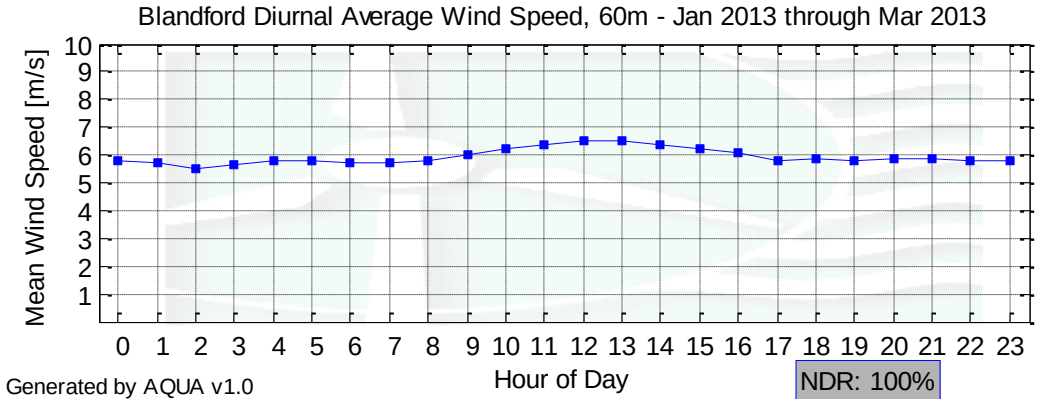

Figure 5c – Diurnal Average Wind Speeds Jan 2013 – Mar 2013

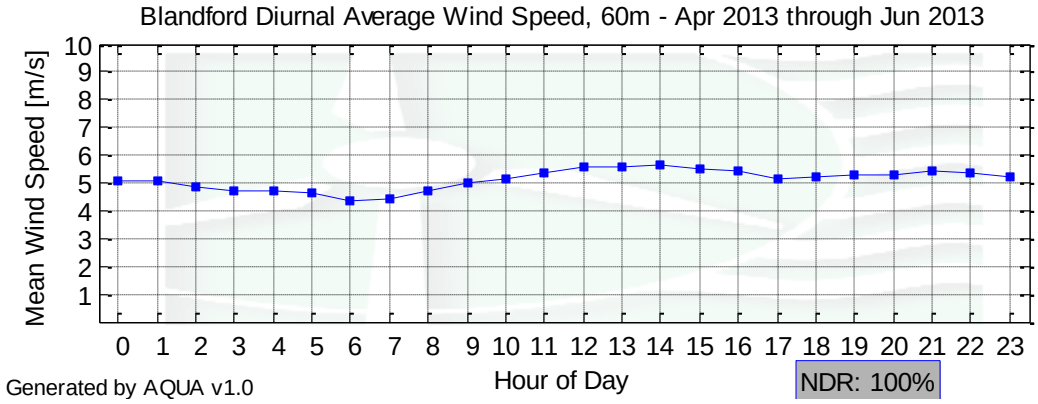

Figure 5d – Diurnal Average Wind Speeds Apr 2013 – Jun 2013

Turbulence Intensities

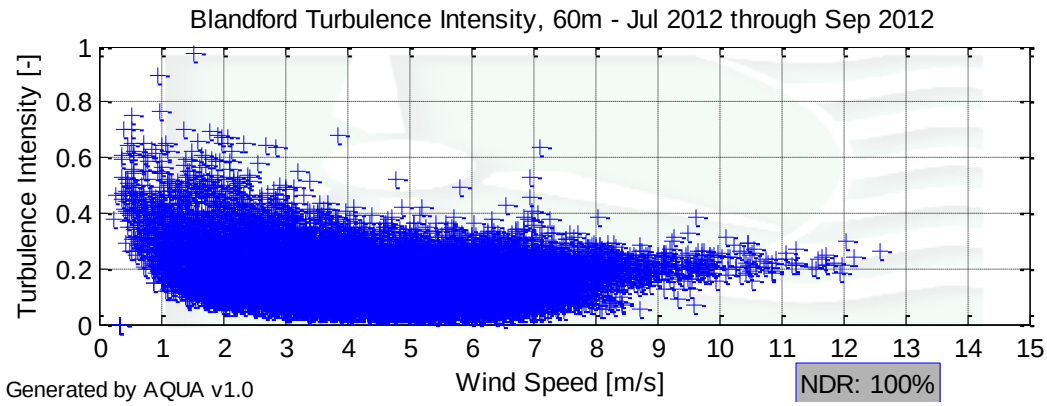

Figure 6a – Turbulence Intensity Jul 2012 – Sep 2012

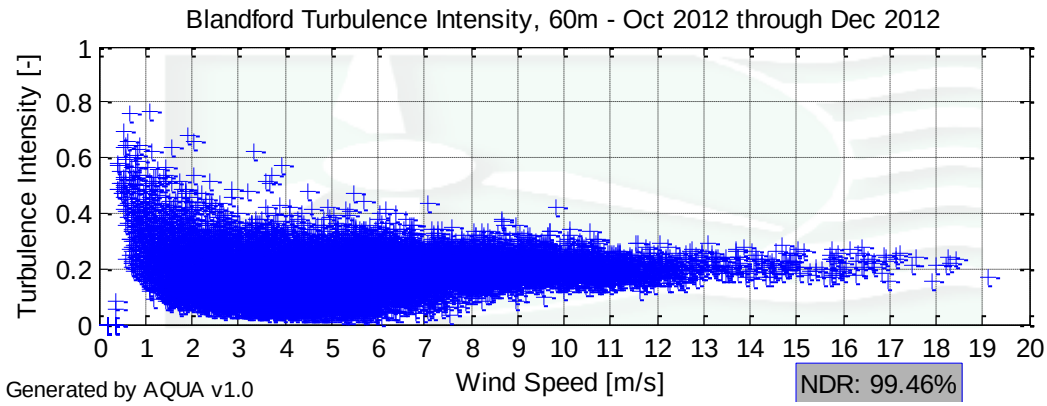

Figure 6b – Turbulence Intensity Oct 2012 – Dec 2012

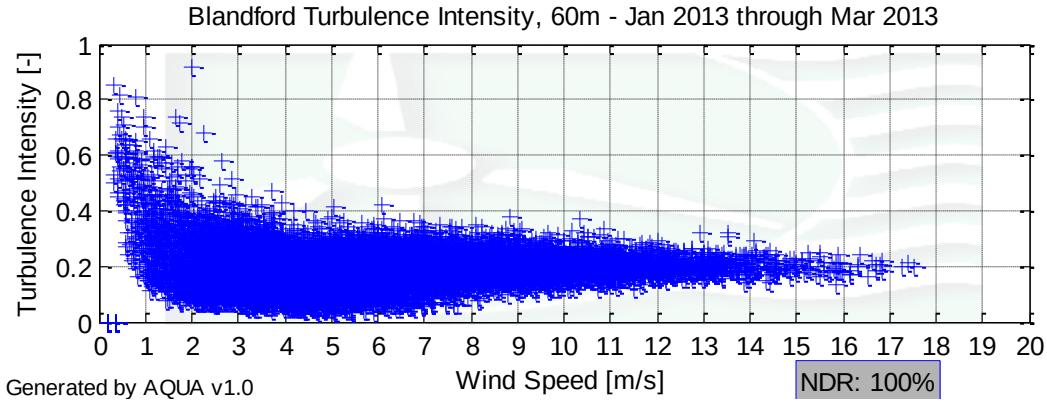

Figure 6c – Turbulence Intensity Jan 2013 – Mar 2013

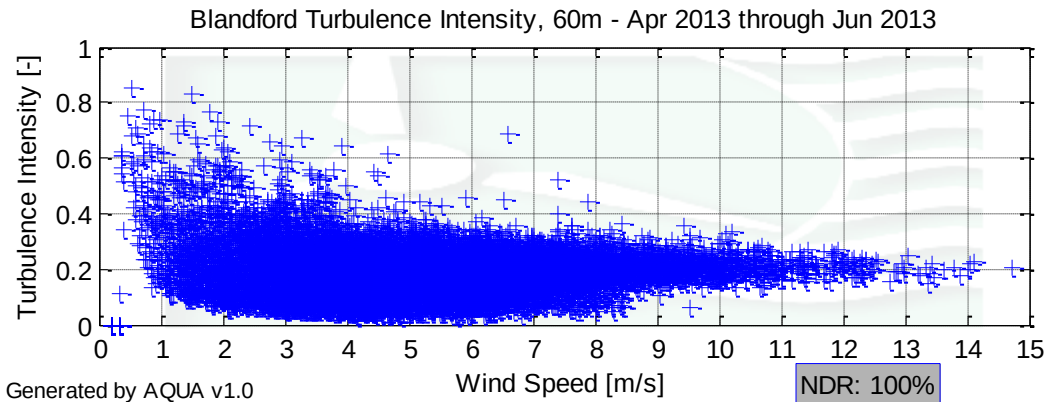

Figure 6d – Turbulence Intensity Apr 2013 – Jun 2013

Wind Roses

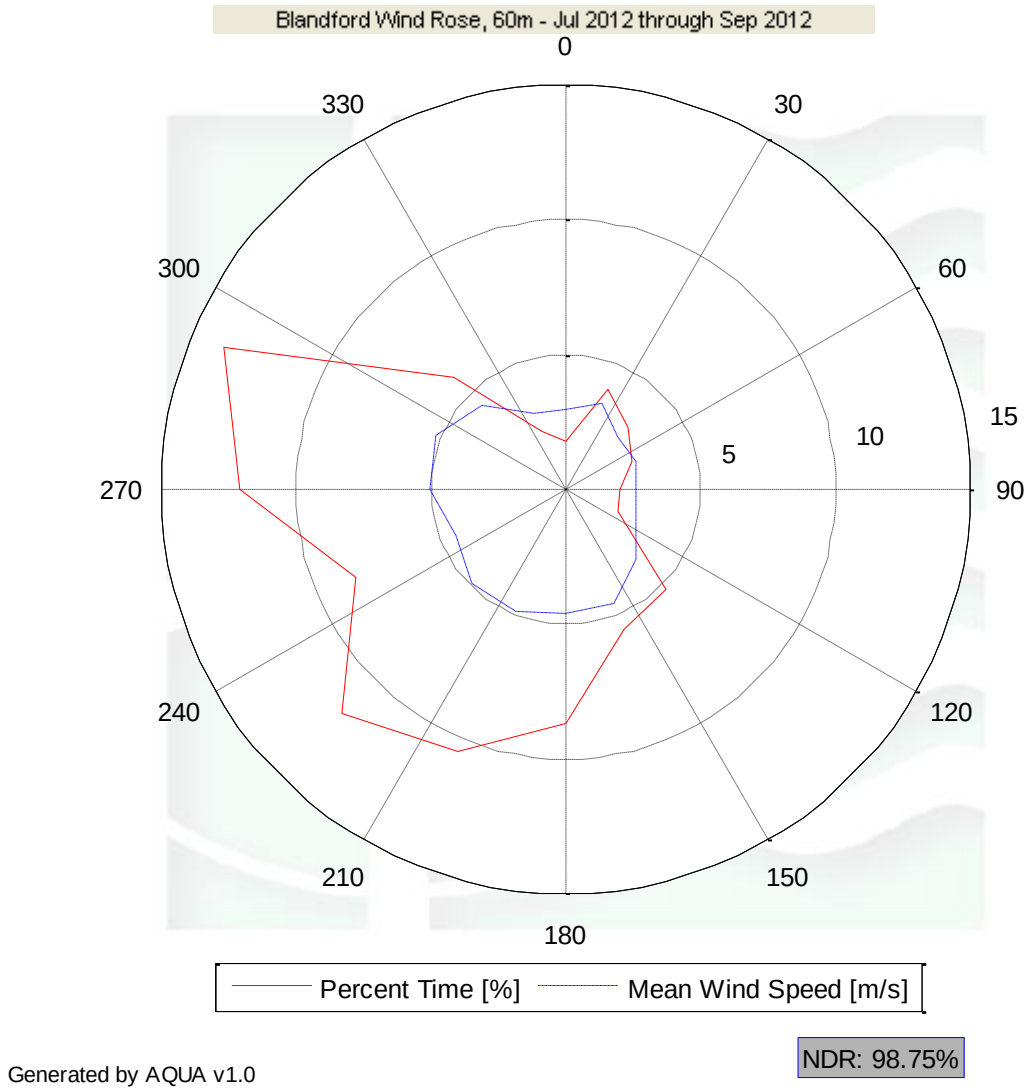

Figure 7a – Wind Rose Jul 2012 – Sep 2012

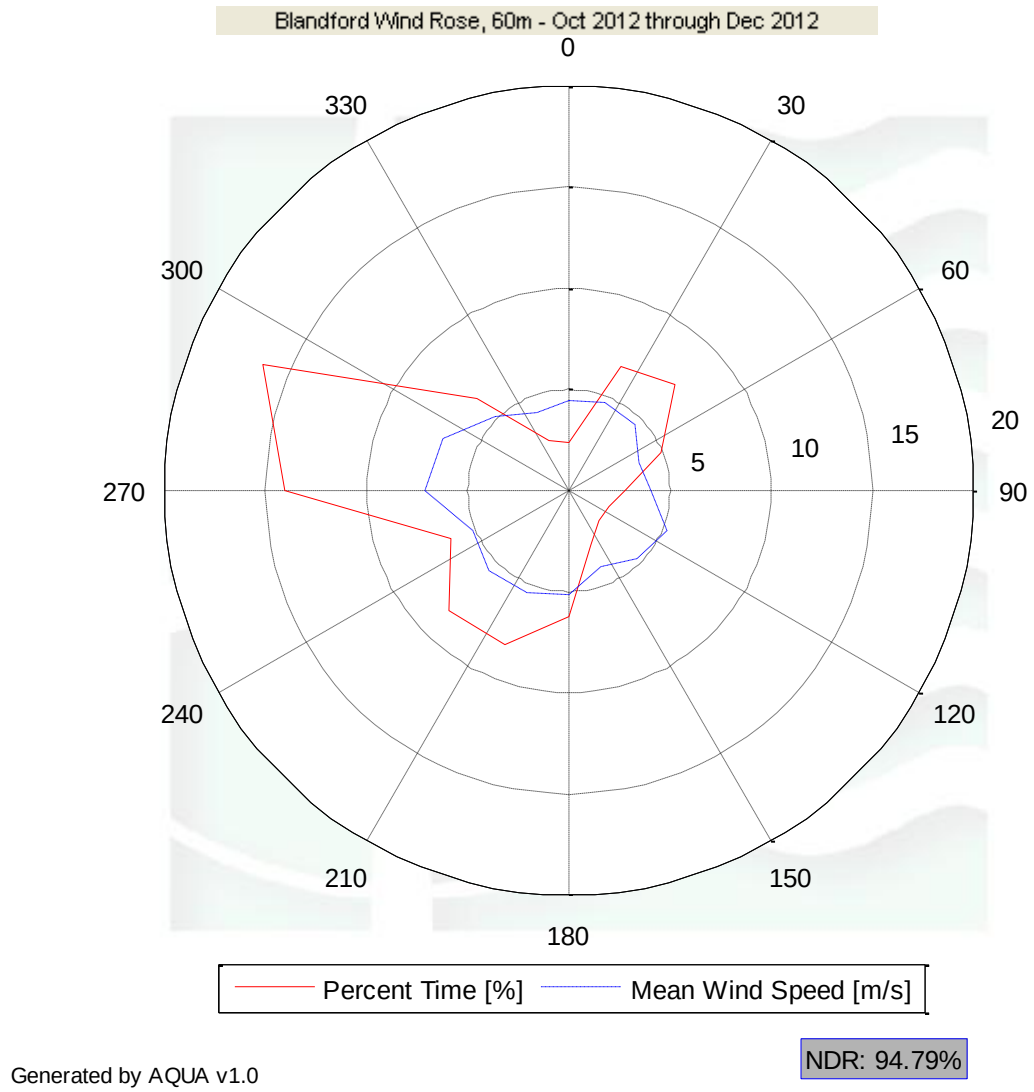

Figure 7b – Wind Rose Oct 2012 – Dec 2012

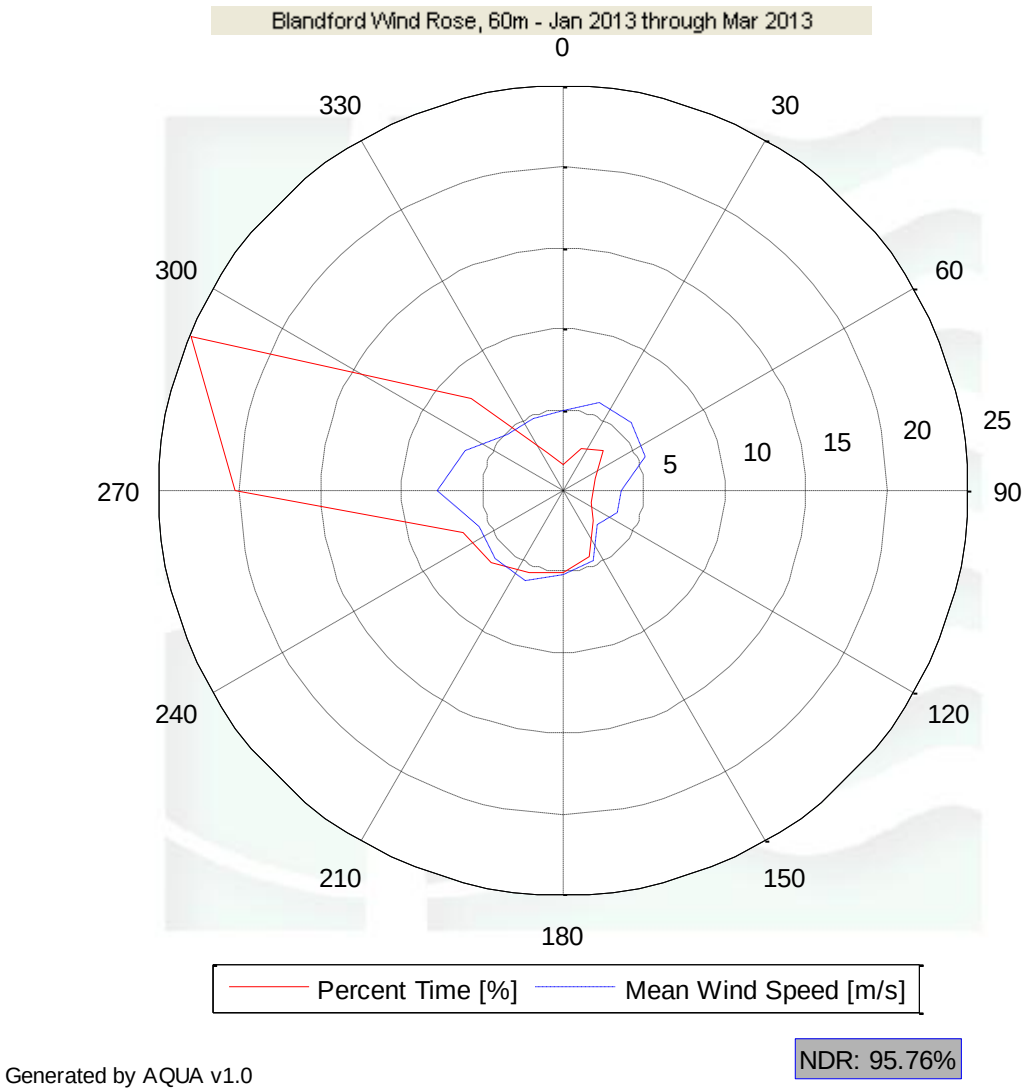

Figure 7c – Wind Rose Jan 2013 – Mar 2013

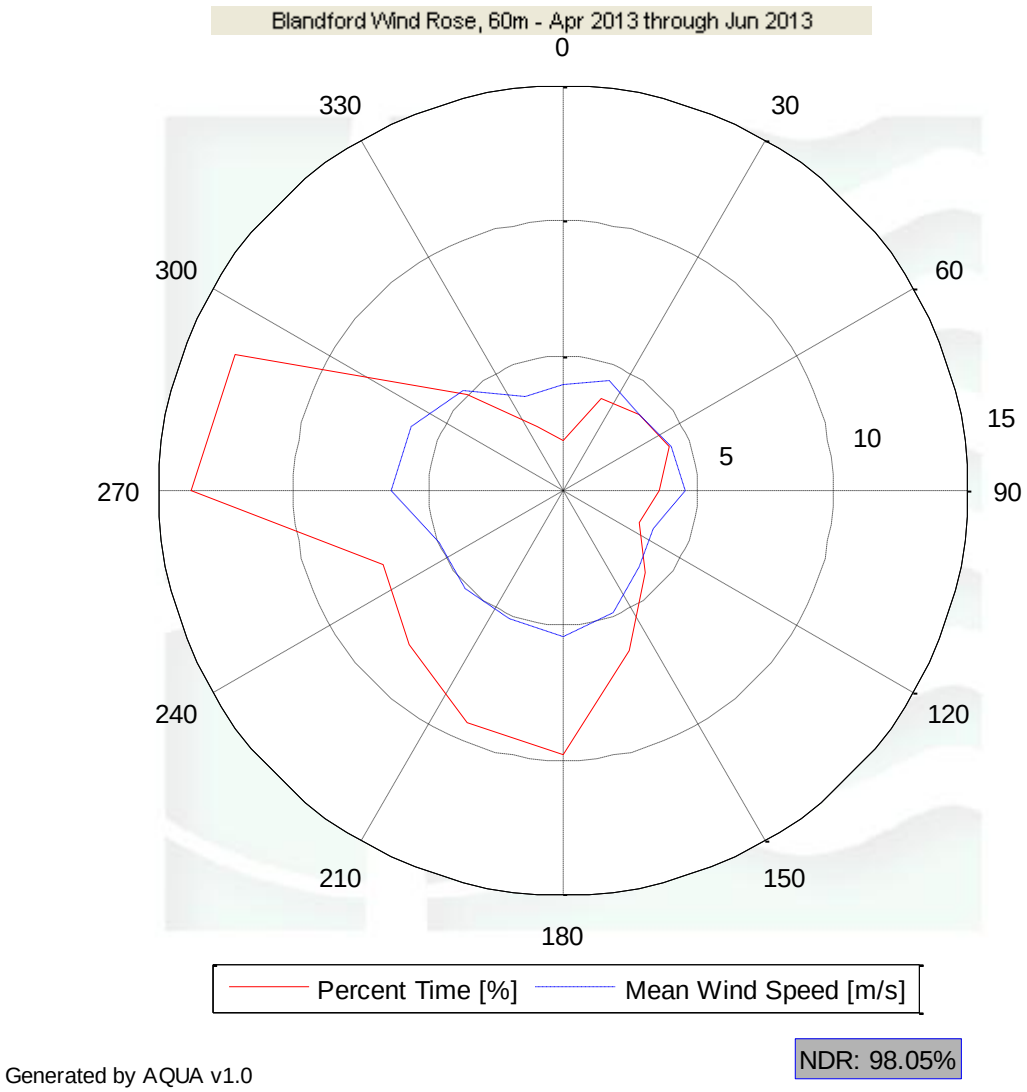

Figure 7d – Wind Rose Apr 2013 – Jun 2013

Annual Average Wind Speed

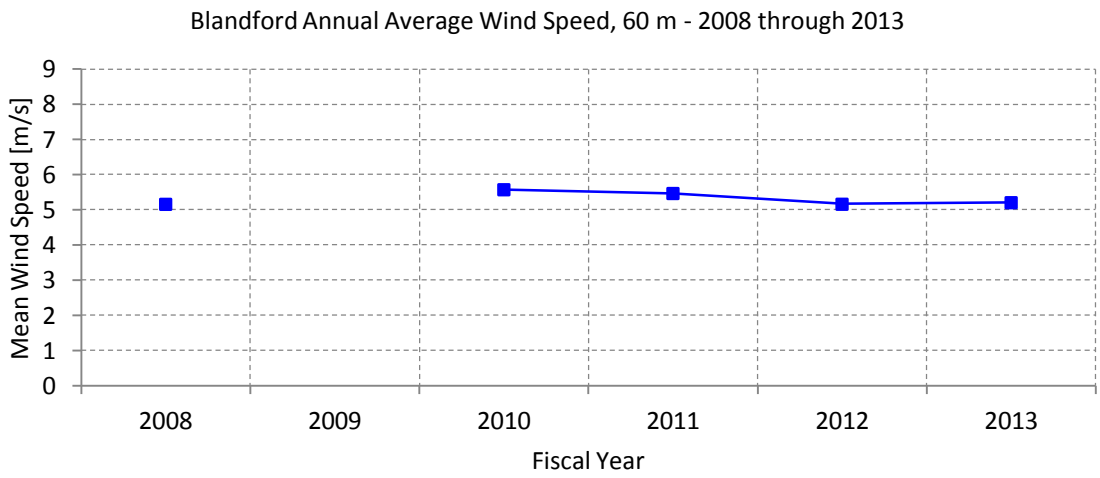

Figure 8 – Annual Average Wind Speed 2008 – 2013

Significant Meteorological Events

There were no significant meteorological events during the monitoring period.

SECTION 5 - Data Collection and Maintenance

On August 16th, 2012 the temperature sensor was replaced. On November 16th, 2012 the I-pack cellular modem of the data logger was replaced with a new WindLinx cellular modem and the data was manually downloaded from the data logger at that time. The anemometers and wind vanes were all operational for the entire monitoring period.

SECTION 6 - 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 [%]	99.86
Net Data Recovered [%]	97.55

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	Test	Factor 1	Factor 2	Factor 3	Factor 4
1	Channel 4 >WS_max						MinMax	0	50	0	0
2	Channel 6 >WS_max						MinMax	0	50	0	0
3	Channel 5 >WS_max						MinMax	0	50	0	0
4	Channel 2 >WS_max						MinMax	0	50	0	0
5	Channel 4 >WS_val	Channel 6 >WS_val					Compare Sensors	1	0.25	3	0
6	Channel 4 >WS_val	Channel 4 >WS_SD	Channel 8 >WD_val	Channel 8 >WD_SD	Channel 10 >T_val		Icing	0.5	1	2	4
7	Channel 6 >WS_val	Channel 6 >WS_SD	Channel 8 >WD_val	Channel 8 >WD_SD	Channel 10 >T_val		Icing	0.5	1	2	4
8	Channel 2 >WS_val	Channel 2 >WS_SD	Channel 7 >WD_val	Channel 7 >WD_SD	Channel 10 >T_val		Icing	0.5	1	2	4

Sensor Statistics

	Expected Data Points	Actual Data Points	% Data Recovered	Hours Out of Range	Hours of Icing	Hours of Fault	%Data Good
Ch 10	52560.000	52488.000	99.863	0.000	0.000	0.000	99.863
Ch 11	52560.000	52488.000	99.863	0.000	0.000	0.000	99.863
Ch 4	52560.000	52488.000	99.863	0.000	223.000	16.000	97.137
Ch8	52560.000	52488.000	99.863	0.000	228.167	0.000	97.258
Ch 6	52560.000	52488.000	99.863	0.000	226.000	405.833	92.753
Ch 7	52560.000	52488.000	99.863	0.000	264.833	0.000	96.840
Ch 5	52560.000	52488.000	99.863	0.000	0.000	0.000	99.863
Ch 2	52560.000	52488.000	99.863	0.000	264.833	0.000	96.840
Total	420480.000	419904.000	99.863	0.000	1206.833	421.833	97.552

APPENDIX B- Plot Data

Wind Speed Distribution Data

	Percent Time [%]			
Bin Center [m/s]	Q1	Q2	Q3	Q4
0.5	1.75	3.38	1.91	1.87
1.5	7.68	6.66	3.97	4.58
2.5	11.99	10.55	7.88	8.91
3.5	19.49	14.47	12.97	16.76
4.5	22.55	14.43	14	18.87
5.5	18.79	14.17	14.27	16.79
6.5	10.08	10.94	13.22	13.59
7.5	4.9	8.11	9.68	9.08
8.5	1.68	6.47	7.7	4.73
9.5	0.7	4.39	5.14	2.71
10.5	0.25	2.94	3.62	1.21
11.5	0.12	1.68	2.47	0.51
12.5	0.02	0.71	1.47	0.27
13.5		0.36	0.92	0.08
14.5		0.31	0.44	0.03
15.5		0.2	0.22	
16.5		0.15	0.1	
17.5		0.05	0.02	
18.5		0.03		
19.5		0.01		

Monthly Average Wind Speed Data

Month	Wind Speed at 118 m 10 min Average [m/s]
12-Jul	4.352
12-Aug	4.264
12-Sep	4.656
12-Oct	5.256
12-Nov	5.13
12-Dec	5.644
13-Jan	5.774
13-Feb	6.01
13-Mar	6.053
13-Apr	5.446
13-May	4.825
13-Jun	5.077

Diurnal Average Wind Speed Data

Hour of Day	Q1 Mean Wind Speed [m/s]	Q2 Mean Wind Speed [m/s]	Q3 Mean Wind Speed [m/s]	Q4 Mean Wind Speed [m/s]
0	4.46	5.4	5.81	5.07
1	4.37	5.39	5.73	5.07
2	4.32	5.51	5.54	4.83
3	4.36	5.49	5.62	4.68
4	4.26	5.42	5.79	4.74
5	4.17	5.49	5.78	4.63
6	4.02	5.4	5.72	4.32
7	3.77	5.33	5.71	4.41
8	3.87	5.38	5.82	4.72
9	4.12	5.31	6.02	5.02
10	4.21	5.29	6.22	5.12
11	4.35	5.33	6.39	5.37
12	4.51	5.38	6.54	5.58
13	4.58	5.35	6.53	5.59
14	4.65	5.18	6.34	5.61
15	4.61	5.05	6.23	5.54
16	4.47	5.02	6.07	5.45
17	4.37	5.14	5.81	5.18
18	4.49	5.29	5.87	5.2
19	4.74	5.36	5.82	5.27
20	4.88	5.45	5.88	5.3
21	4.92	5.41	5.86	5.41
22	4.89	5.44	5.78	5.35
23	4.73	5.49	5.76	5.24

Wind Rose Data

	Q1		Q2		Q3		Q4	
Direction Sector [deg]	Percent Time [%]	Mean Wind Speed [m/s]	Percent Time [%]	Mean Wind Speed [m/s]	Percent Time [%]	Mean Wind Speed [m/s]	Percent Time [%]	Mean Wind Speed [m/s]
0	1.77	2.94	2.41	4.42	1.6	5	1.84	3.91
22.5	3.99	3.44	6.63	4.74	2.81	5.9	3.66	4.4
45	3.27	2.71	7.37	4.57	3.51	5.91	3.99	4.03
67.5	2.68	2.8	4.89	3.72	2.08	5.53	4.27	4.36
90	2	2.63	2.75	4.08	1.85	3.63	3.6	4.51
112.5	2.12	2.82	2.18	5.29	1.89	3.65	3.01	3.64
135	5.23	3.63	2.14	4.72	2.64	2.92	4.27	4.02
157.5	5.63	4.6	2.84	4.03	4.36	4.74	6.44	4.92
180	8.64	4.63	6.24	5.18	5.12	5.25	9.81	5.42
202.5	10.49	4.87	8.3	5.49	5.52	6.08	9.33	5.14
225	11.72	4.93	8.41	5.61	6.22	5.97	8.04	5.09
247.5	8.44	4.45	6.27	5.12	6.63	5.67	7.2	4.99
270	12.1	5.06	14.02	7.12	20.24	7.74	13.79	6.37
292.5	13.7	5.26	16.37	6.74	24.92	6.56	13.18	6.12
315	5.89	4.45	6.5	5.14	8.01	4.96	5.02	5.29
337.5	2.33	3.05	2.68	4.19	2.59	4.75	2.54	3.74