LONG TERM SITE
WIND DATA ANNUAL REPORT

Paxton, MA

July 1, 2012 – June 30, 2013

Prepared for

Massachusetts Clean Energy Center
55 Summer Street, 9th Floor
Boston, MA 02110

by

Dylan D. Chase
James F. Manwell
Anthony F. Ellis

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Wind **E**nergy **C**enter
University of Massachusetts, Amherst
160 Governors Drive, Amherst, MA 01003
www.ceere.org/rerl • (413) 545-4359 • wec@ecs.umass.edu

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.

One anemometers and one wind vane are mounted each at the 77 m (252.6 ft) tower height and at the 78 m (255.9 ft) tower height and a temperature sensor is installed near the base of the tower. On November 5th, 2012 an anemometer was replaced and on April 11th, 2013 the data logger was replaced.

During the period covered by this annual report, July, 2012 – June, 2013, the mean recorded wind speed at 78 m was 7.61 m/s (17.03 mph*). 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 78 m was 0.1056. The gross data recovery percentage (the actual percentage of expected data received) was 65.51% and the net data recovery percentage (the percentage of expected data which passed all of the quality assurance tests) was 64.80%.

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

The Yankee Network Tower is located on Mount Asnebumskit. The tower is at a 417 m elevation, and located southeast of the town of Paxton,. The wind monitoring equipment is located at 42-18-11.58 North, 71-53-50.52 West, per the WGS84 standard (the World Geodetic System 1984, an international standard for absolute localization with earthly coordinates). The white circle in Figure 1 marks the site location.

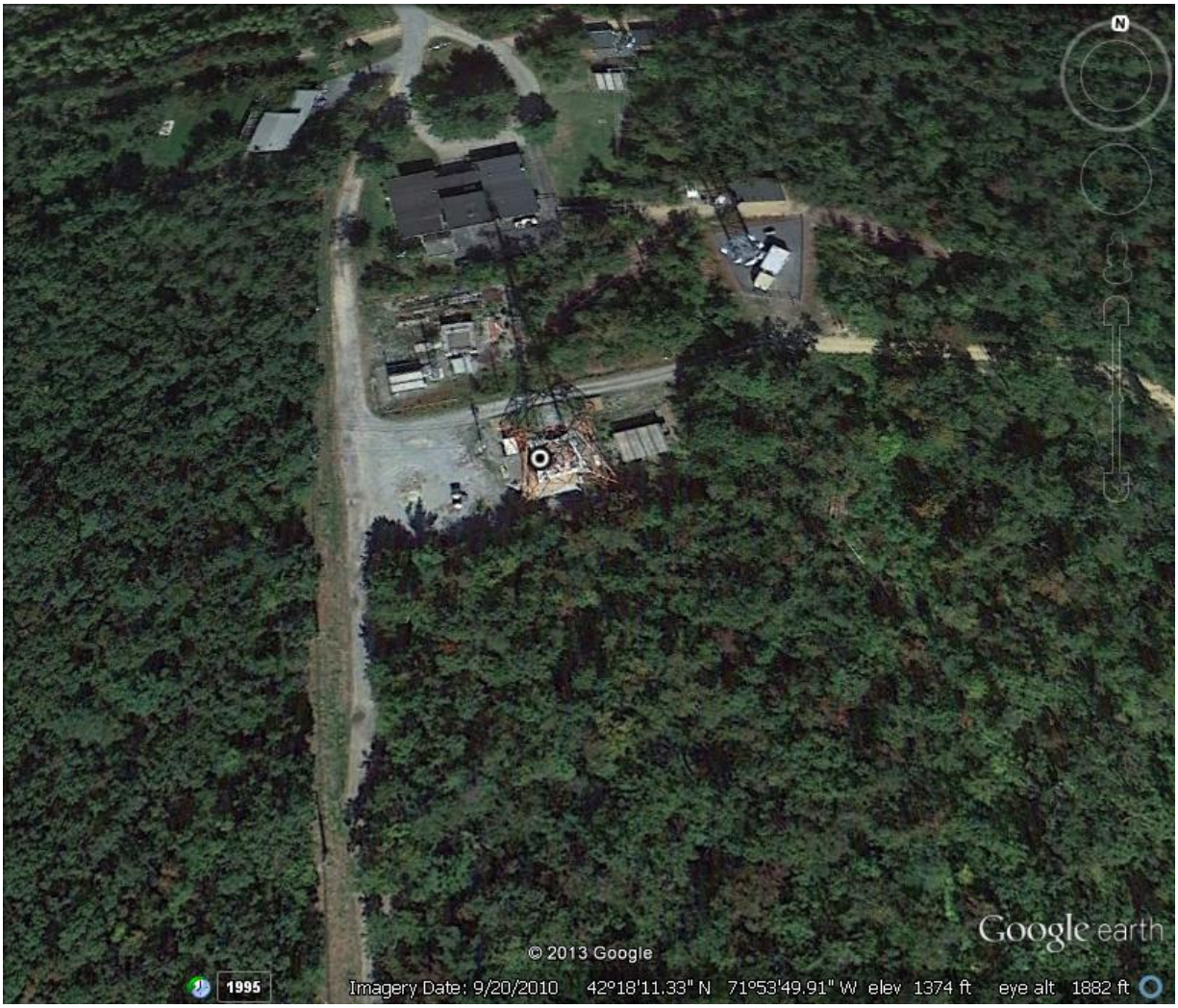

Figure 1 - Site Location

Terrain

The site is located in a fairly wooded area as can be seen in Figure 1. However there is some clearing due to a parking lot and road to the west of the tower. There is also a road and some buildings located to the north of the tower.

SECTION 2 - Instrumentation and Equipment

The wind monitoring equipment is mounted on an 8.2 foot aluminum tube that is attached vertically to the main network tower. The primary and secondary anemometers and two vanes are attached on short booms off the tube. A picture of the setup is below – note the horizontal booms where the anemometers and vanes are attached:

Figure 2- Instrumentation at top of Yankee Network Tower – note the anemometers on the left (horizontal boom and at the top of the left-hand vertical tube.

Figure 3- Bottom view of sensor array, anemometer is at photo top and wind vanes are mounted on the shorter side booms.

The installed equipment of note comprises:

- NRG Symphonie data logger with ipack modem
- One NRG #Max 40c cup anemometer, custom calibration (slope 0.764 m/s, offset 0.410 m/s)
- One Riso p2546a class 1 anemometer, custom calibration (serial # 6800 til 11/5/12 (slope 0.622 m/s, offset 0.206 m/s), serial # 6799 (slope 0..619 m/s, offset 0.206 m/s) afterwards)
- Two NRG #200P wind direction vanes
- One NRG #110S temperature sensor
- Short booms for vanes, 14" from mast
- Long side boom for Riso anemometer, 43" from mast
- One stub mast for NRG anemometer
- Lightning rod and ground cable
- Shielded sensor wire

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 [%]
78 m	12-Jul	6.491	98.61	15.9	98.61	*	0
	12-Aug	6.276	99.89	17.01	99.89	*	0
	12-Sep	7.073	99.95	16.85	99.95	*	0
	12-Oct	7.41	99.62	24.18	99.62	*	0
	12-Nov	7.632	96.46	18.09	96.46	*	0
	12-Dec	8.27	81.52	18.62	81.52	*	0
	13-Jan	9.528	90.73	21.41	90.73	*	0
	13-Feb	9.152	87.87	21.53	87.87	*	0
	13-Mar	8.002	98.32	16.8	98.32	*	0
	13-Apr	7.71	69.91	19.31	69.91	*	0
	13-May	6.704	67.59	16.24	67.59	*	0
	13-Jun	7.426	93.56	15.1	93.56	*	0
	FY 2013	7.611	90.46	24.18	90.46	*	0
77 m	12-Jul	4.095	79.46	13.81	79.46	NW	98.43
	12-Aug	3.609	71.95	12.83	71.95	NW	99.91
	12-Sep	4.973	79.28	14.56	79.28	NW	99.88
	12-Oct	5.889	84.72	20.99	84.72	NNW	99.42
	12-Nov	6.453	96.57	17.38	96.57	NNE	97.57
	12-Dec	8.186	82.21	17.87	82.21	WNW	79.93
	13-Jan	8.934	96.62	20.79	96.62	WNW	91.11
	13-Feb	8.515	94.67	20.5	94.67	WNW	88.44
	13-Mar	7.927	100	16.4	100	WNW	89.29
	13-Apr	7.626	70.37	18.93	70.37	SSW	73.15
	13-May	6.625	67.7	15.91	67.7	WNW	67.61
	13-Jun	7.356	93.68	14.66	93.68	W	93.66
	FY 2013	6.778	84.79	20.99	84.79	WNW	89.97

* Invalid data, 78 meter wind vane shifted during the monitoring period

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 [%]
78 m	12-Jul	0.05625	98.61
	12-Aug	0.07207	99.89
	12-Sep	0.0854	99.95
	12-Oct	0.1158	99.62
	12-Nov	0.1068	96.46
	12-Dec	0.1066	81.52
	13-Jan	0.113	90.73
	13-Feb	0.1201	87.87
	Mar-13	0.1271	98.32
	Apr-13	0.1376	69.91
	13-May	0.1016	67.59
	13-Jun	0.09508	93.56
	FY 2013	0.1056	90.46
77 m	12-Jul	0.07427	79.46
	12-Aug	0.1206	71.95
	12-Sep	0.07841	79.28
	12-Oct	0.1109	84.72
	12-Nov	0.1244	96.57
	12-Dec	0.1149	82.21
	13-Jan	0.1184	96.62
	13-Feb	0.1291	94.67
	13-Mar	0.1282	100
	13-Apr	0.1396	70.37
	13-May	0.1047	67.7
	13-Jun	0.09583	93.68
	FY 2013	0.1165	84.79

Wind shear is not calculated for the site because the anemometers are at very similar heights.

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 Paxton 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 speeds are in the range of 4 or 10 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 between the West and the Northwest directions.

- Annual Average Wind Speed – The annual average wind speed at the site is similar to past annual average wind speeds. The annual average wind speed is not reported for 2009 and 2010 because there was not enough data during these periods to calculate the annual average wind speed.

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

Wind Speed Time Series

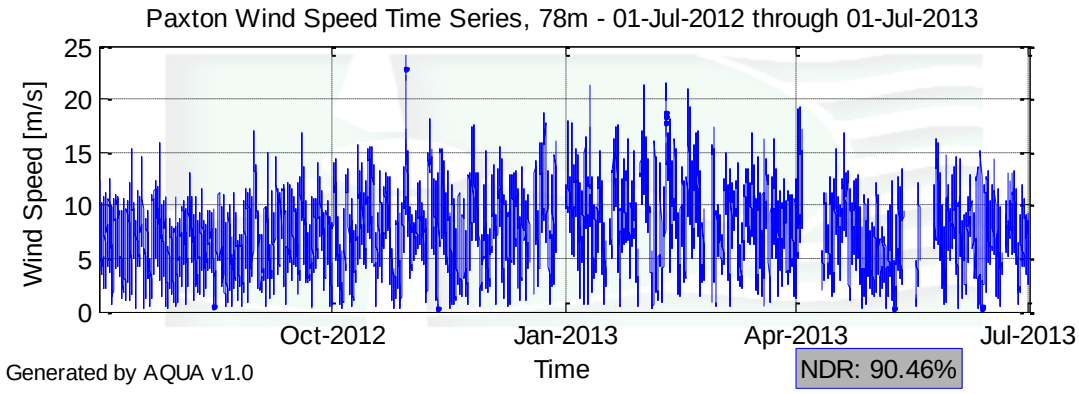

Figure 4 – Wind Speed Time Series

Wind Speed Distributions

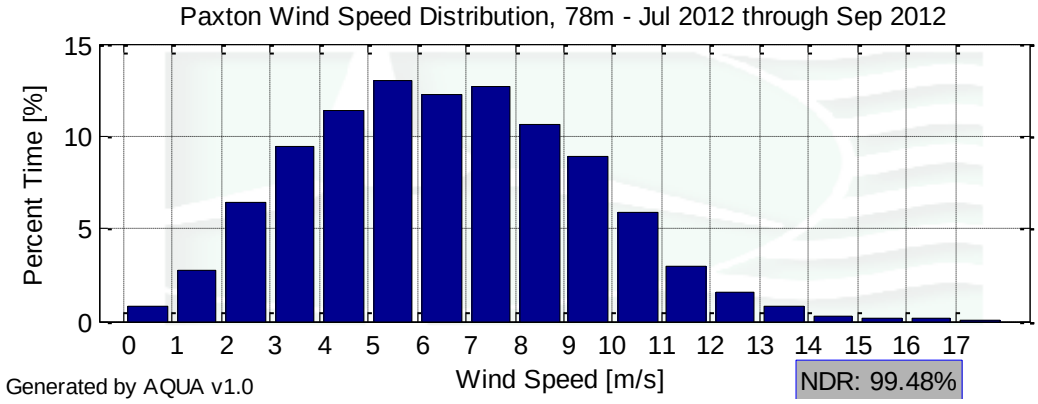

Figure 5a – Wind Speed Distribution Jul 2012 – Sep 2012

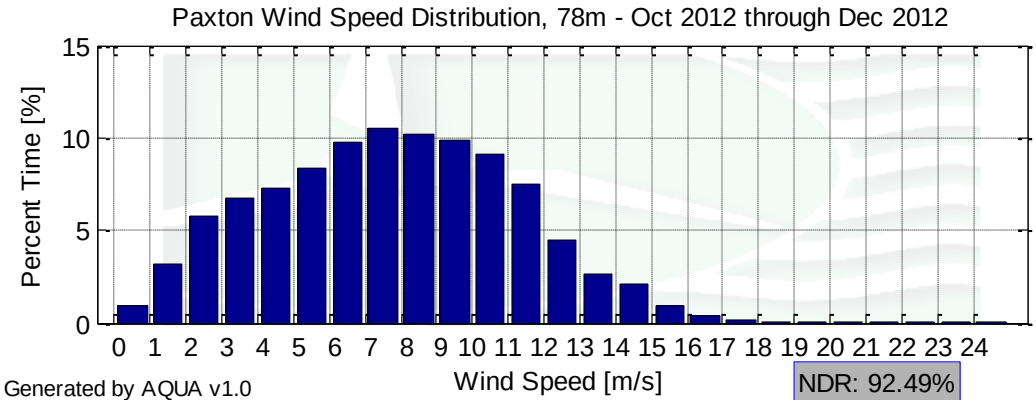

Figure 5b – Wind Speed Distribution Oct 2012 – Dec 2012

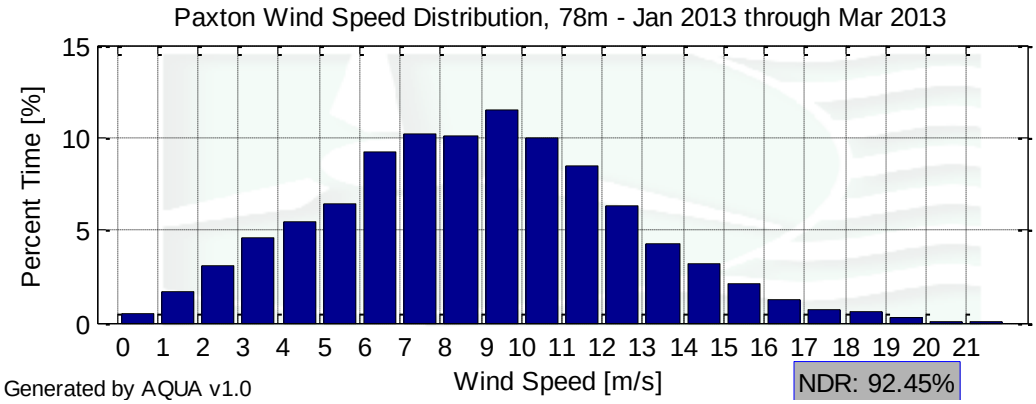

Figure 5c – Wind Speed Distribution Jan 2013 – Mar 2013

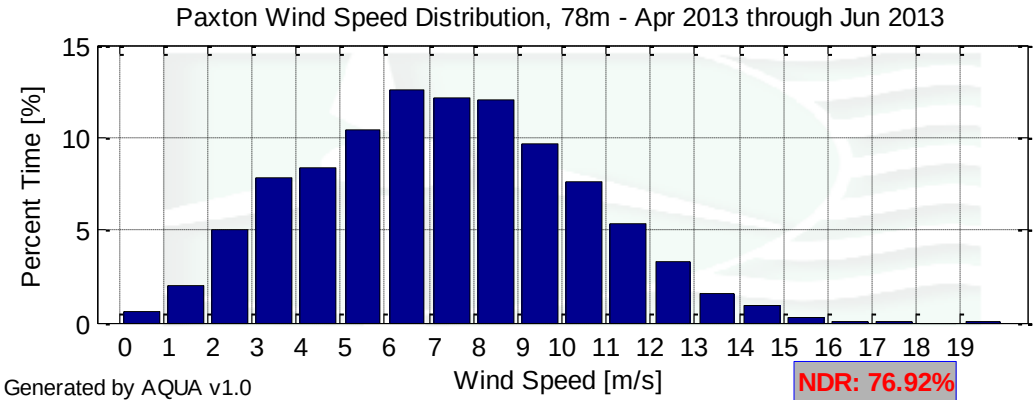

Figure 5d – Wind Speed Distribution Apr 2013 – Jun 2013

Monthly Average Wind Speeds

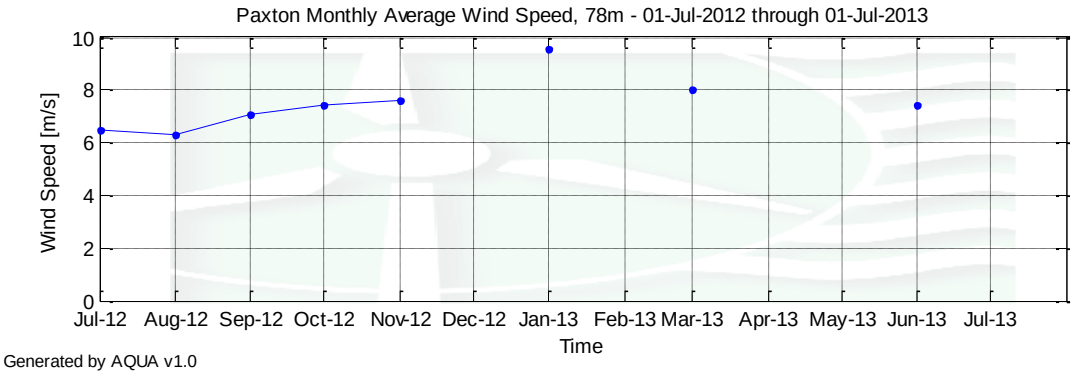

Figure 6 – Monthly Average Wind Speed

Diurnal Average Wind Speeds

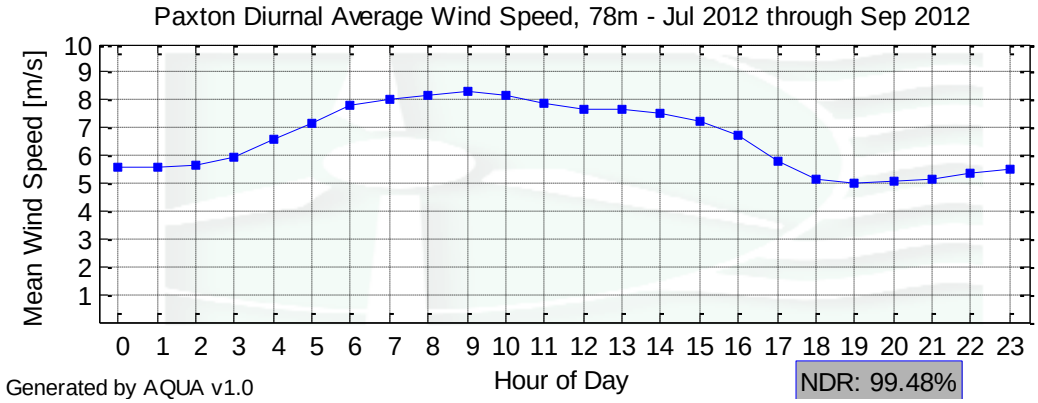

Figure 7a – Diurnal Average Wind Speeds Jul 2012 – Sep 2012

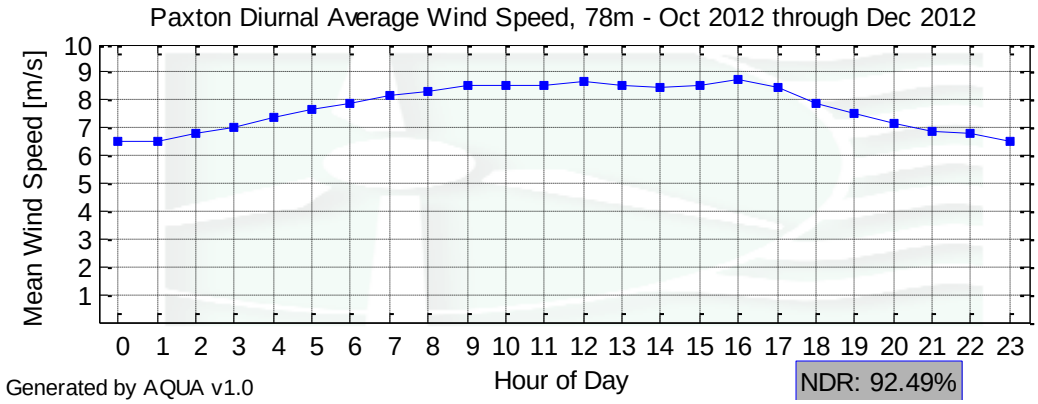

Figure 7b – Diurnal Average Wind Speeds Oct 2012 – Dec 2012

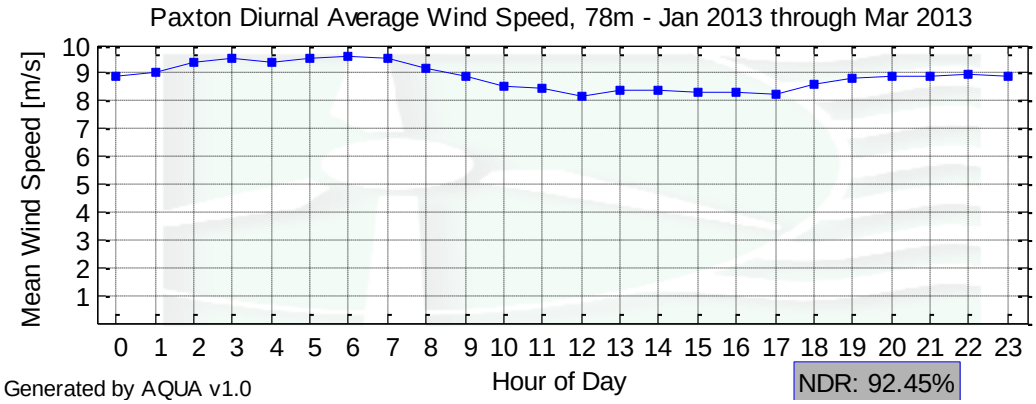

Figure 7c – Diurnal Average Wind Speeds Jan 2013 – Mar 2013

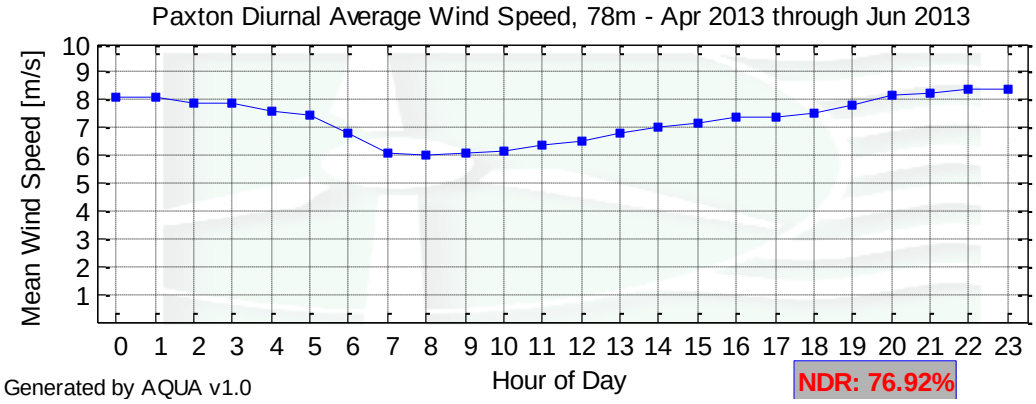

Figure 7d – Diurnal Average Wind Speeds Apr 2013 – Jun 2013

Turbulence Intensities

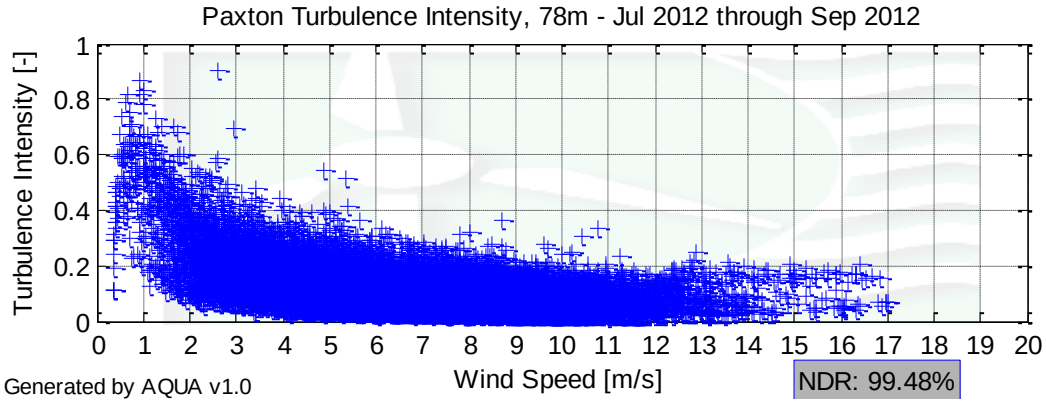

Figure 8a – Turbulence Intensity Jul 2012 – Sep 2012

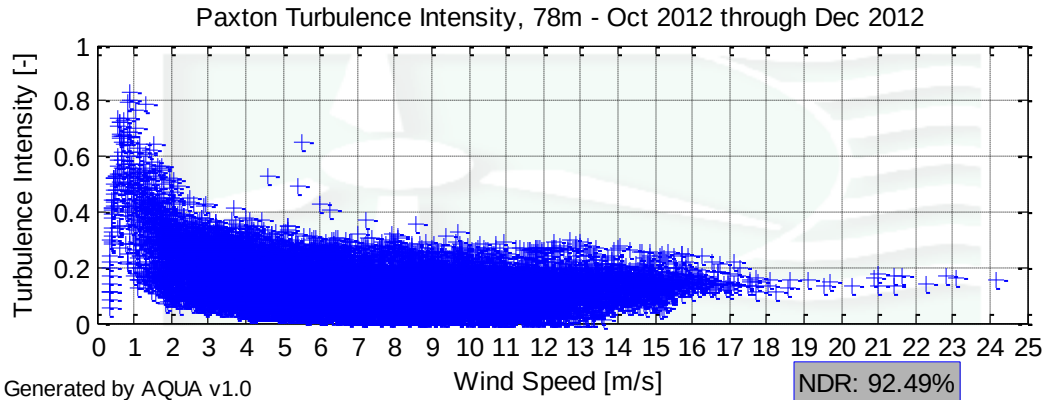

Figure 8b – Turbulence Intensity Oct 2012 – Dec 2012

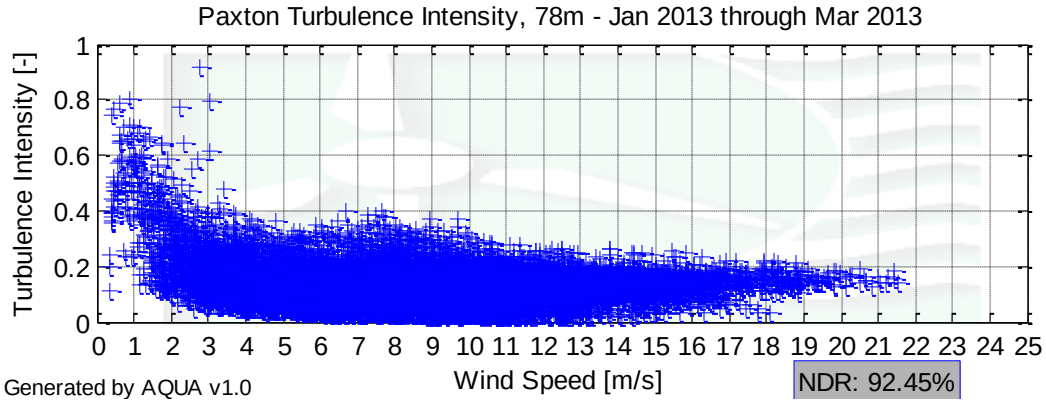

Figure 8c – Turbulence Intensity Jan 2013 – Mar 2013

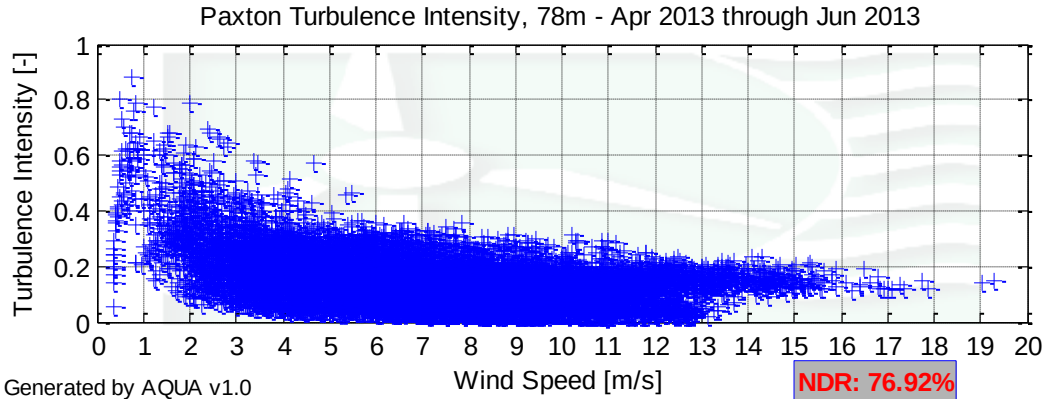

Figure 8d – Turbulence Intensity Apr 2013 – Jun 2013

Wind Roses

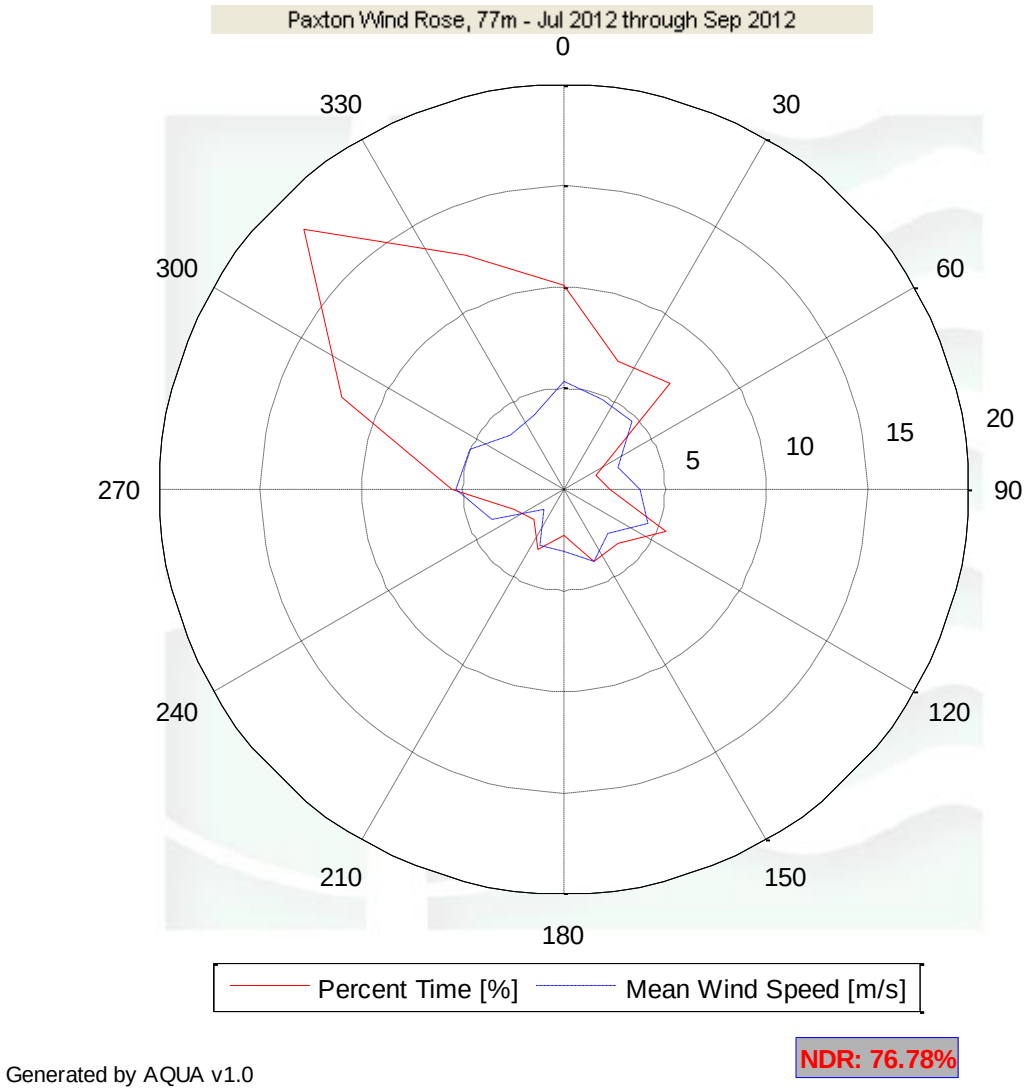

Figure 9a – Wind Rose Jul 2012 – Sep 2012

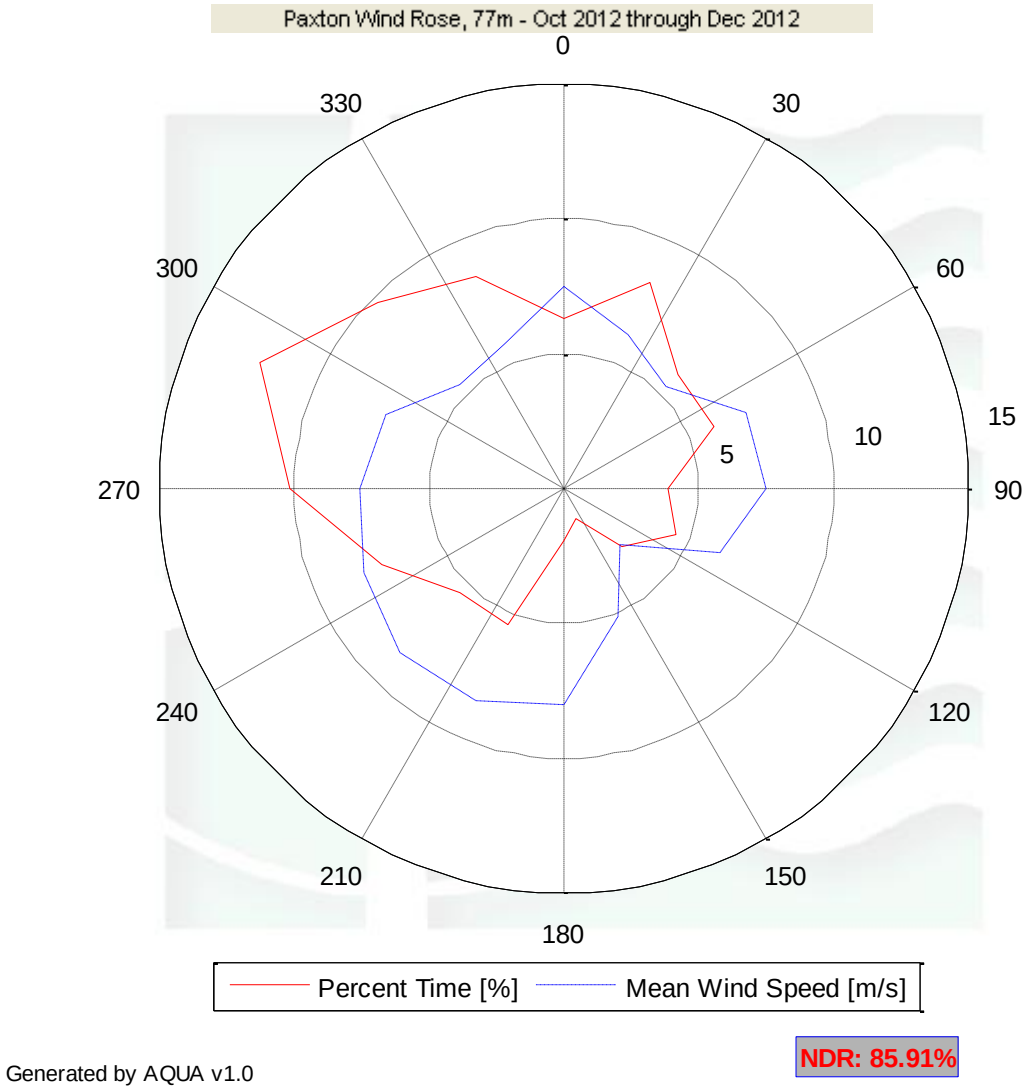

Figure 9b – Wind Rose Oct 2012 – Dec 2012

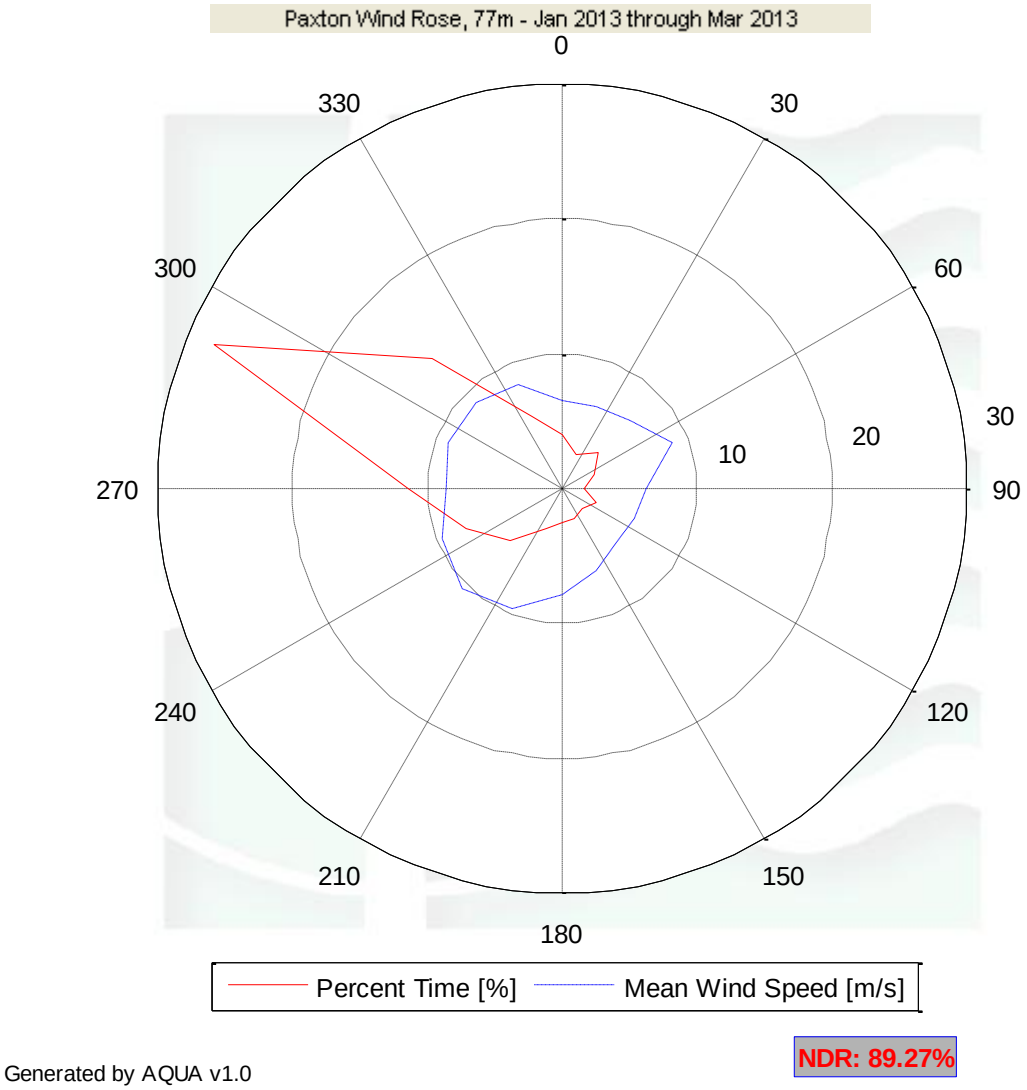

Figure 9c – Wind Rose Jan 2013 – Mar 2013

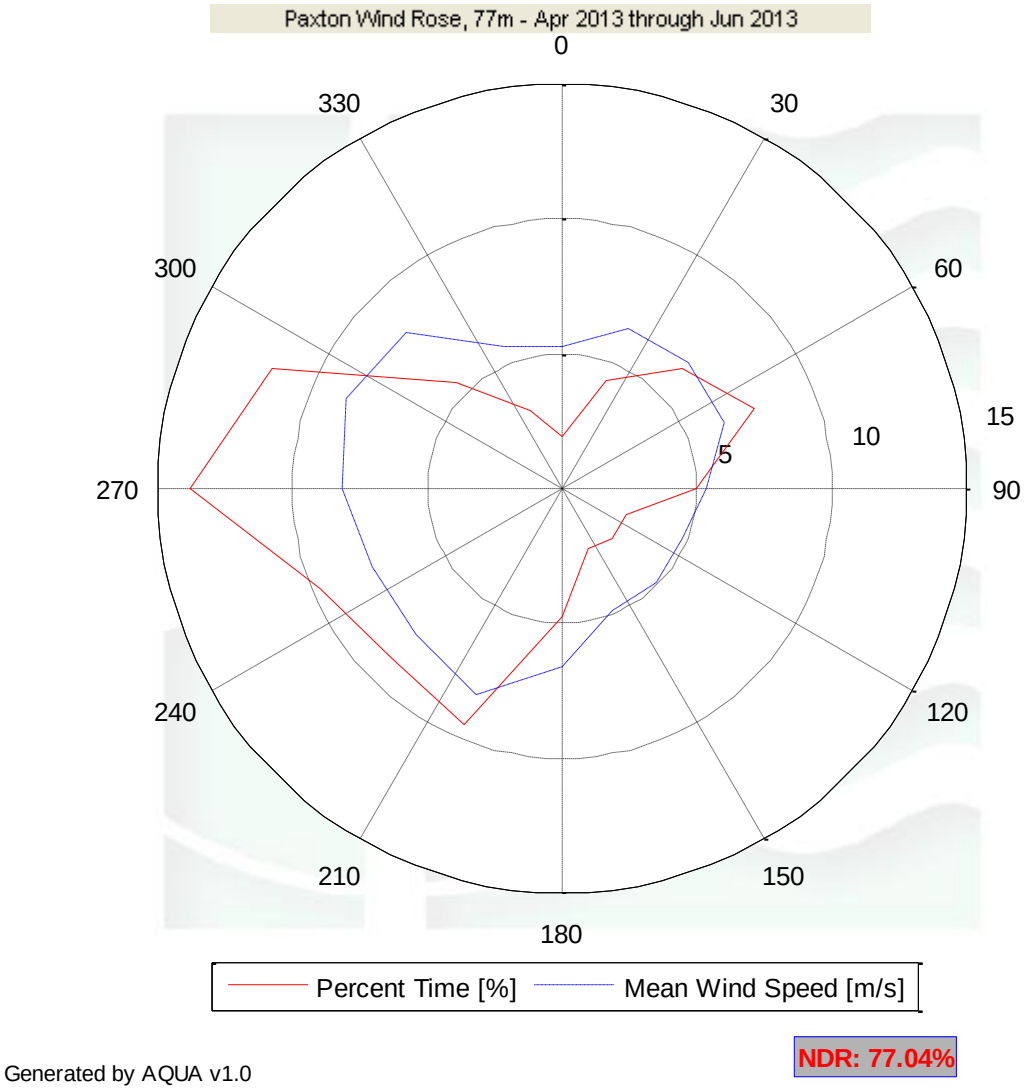

Figure 9d – Wind Rose Apr 2013 – Jun 2013

Annual Average Wind Speed

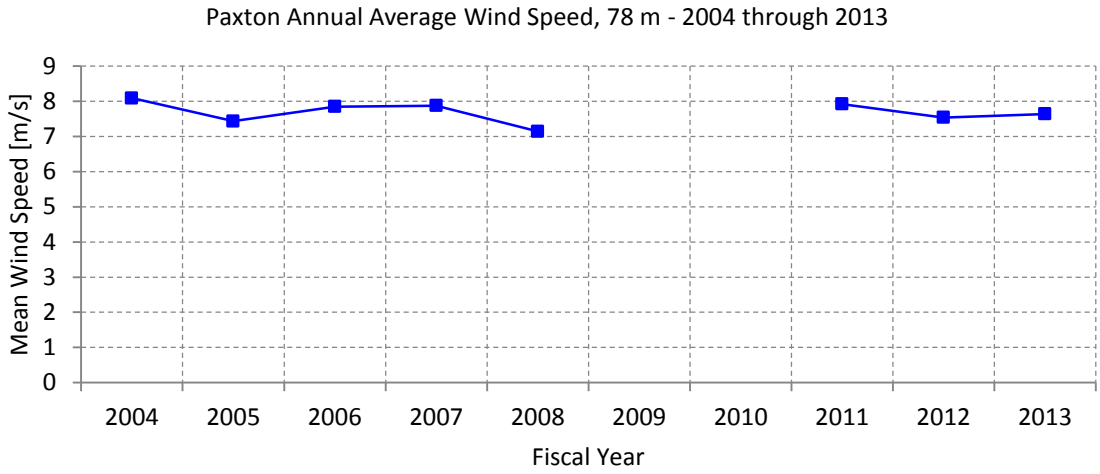

Figure 10 – Annual Average Wind Speed 2004 - 2013

Significant Meteorological Events

There was a high wind event on October 30th, 2012 which had maximum wind gusts in excess of 35 m/s.

SECTION 5 - Data Collection and Maintenance

On September 3rd, 2012 it was noted that the channel 7 wind vane boom was pivoting in the wind. This resulted in invalid wind direction data from the channel 7 wind vane. On November 5th, 2012 a broken Riso P2546a anemometer was replaced by a new Riso P2546a anemometer. The channel 7 wind vane was rotated 90 degrees to the correct position. However the repositioning of the vane did not keep the boom from moving so the wind vane data was invalid for the entire monitoring period. On April 11th, 2013 the data logger was replaced. The failing data logger resulted in some data loss prior to the logger replacement.

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 [%]	65.51
Net Data Recovered [%]	64.80

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	Batt ch9>V_val						MinMax	-30	60	0	0
2	Batt ch9>V_SD						MinMax	-30	60	0	0
3	Etmp ch10>T_val						MinMax	-30	60	0	0
4	Vane77b ch8>WD_val						MinMax	0	359.9	0	0
5	Vane77b ch8>WD_SD						MinMax	0.01	100	0	0
6	Vane77a ch7>WD_val						MinMax	0	359.9	0	0
7	Vane77a ch7>WD_SD						MinMax	0.01	100	0	0
8	Anem78a ch1>WS_val						MinMax	0	90	0	0
9	Anem78a ch1>WS_SD						MinMax	0.01	4	0	0
10	Riso77a ch4>WS_val						MinMax	0	90	0	0
11	Riso77a ch4>WS_SD						MinMax	0.01	4	0	0

Sensor Statistics

	Expected Data Points	Actual Data Points	% Data Recovered	Hours Out of Range	Hours of Icing	Hours of Fault	%Data Good
Battery ch9	13104.000	10302.000	78.617	0.000	0.000	0.000	78.617
Temp ch10	13104.000	10302.000	78.617	10.833	0.000	0.000	78.121
Vane77b ch8	13104.000	10302.000	78.617	13.000	0.000	0.000	78.022
Vane77a ch7	13104.000	0.000	0.000	0.000	0.000	0.000	0.000
Anem78a ch1	13104.000	10302.000	78.617	37.167	0.000	0.000	76.915
Anem77a ch4	13104.000	10302.000	78.617	32.167	0.000	0.000	77.144
Total	78624.000	51510.000	65.514	93.167	0.000	0.000	64.803

APPENDIX B- Plot Data

Wind Speed Distribution Data

	Percent Time [%]			
Bin Center [m/s]	Q1	Q2	Q3	Q4
0.5	0.77	0.87	0.53	0.63
1.5	2.71	3.22	1.68	2.03
2.5	6.42	5.77	3.12	5.03
3.5	9.42	6.74	4.63	7.8
4.5	11.37	7.28	5.42	8.38
5.5	13.04	8.34	6.38	10.44
6.5	12.26	9.77	9.21	12.61
7.5	12.64	10.55	10.23	12.13
8.5	10.63	10.24	10.06	12.03
9.5	8.95	9.84	11.48	9.68
10.5	5.86	9.1	10.03	7.61
11.5	2.96	7.46	8.43	5.31
12.5	1.52	4.5	6.36	3.29
13.5	0.78	2.64	4.31	1.58
14.5	0.3	2.09	3.19	0.94
15.5	0.19	0.97	2.15	0.31
16.5	0.17	0.34	1.22	0.1
17.5	0.01	0.12	0.65	0.06
18.5		0.04	0.56	0
19.5		0.02	0.23	0.02
20.5		0.02	0.1	
21.5		0.04	0.05	
22.5		0.02		
23.5		0.01		
24.5		0.01		

Monthly Average Wind Speed Data

Month	Wind Speed at 118 m 10 min Average [m/s]
12-Jul	6.491
12-Aug	6.276
12-Sep	7.073
12-Oct	7.41
12-Nov	7.632
12-Dec	8.27
13-Jan	9.528
13-Feb	9.152
13-Mar	8.002
13-Apr	7.71
13-May	6.704
13-Jun	7.426

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	6.2	7.4	8.32	8.22
1	6.35	7.49	8.35	8.18
2	6.62	7.73	8.43	7.95
3	7.01	7.9	8.47	7.84
4	7.28	7.83	8.29	7.58
5	7.42	7.92	8.29	7.42
6	7.28	7.72	8	6.84
7	7.1	7.51	7.59	6.04
8	7.08	7.48	7.39	5.94
9	7.06	7.42	7.24	5.99
10	7.06	7.37	7.16	6.09
11	7.04	7.34	7.18	6.3
12	6.98	7.3	7.14	6.4
13	7.07	7.43	7.41	6.7
14	7.17	7.5	7.53	6.89
15	7.17	7.59	7.59	7.03
16	7.05	7.69	7.69	7.29
17	6.52	7.51	7.66	7.29
18	6.34	7.5	7.91	7.5
19	6.25	7.48	8.12	7.75
20	6.25	7.51	8.3	8.09
21	6.23	7.49	8.37	8.23
22	6.26	7.55	8.5	8.45
23	6.26	7.47	8.41	8.38

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	5.54	6.23	4.03	6.88	2.9	6.19	1.72	5.32
22.5	5.53	5.89	4.98	6.32	3.31	6.47	3.97	6.45
45	5.83	5.82	5.19	6.28	4.77	6.84	5.73	6.58
67.5	4.49	6.81	5.19	7.2	4.77	7.12	7.03	6.48
90	3.15	5.91	3.34	6.33	3.07	5.62	4.53	5.37
112.5	3.8	5.34	3.21	5.78	2.56	5.34	2.36	4.82
135	2.92	3.97	2.57	4.36	2.3	5.29	2.44	4.88
157.5	2.42	5	1.95	5.68	2.32	5.81	2.24	4.93
180	2.86	6.44	3	7.22	3.56	7.01	4.58	6.53
202.5	5.29	7.77	6.05	8.49	6.35	8.48	9.68	8.09
225	5.57	8.08	7.07	8.67	7.85	8.69	10.31	7.63
247.5	6.88	7.99	9.14	8.38	10.03	8.5	12.46	7.8
270	10.24	7.81	11.8	8.11	12.6	8.32	13.67	8.03
292.5	16.22	7.93	17.31	8.53	19.81	8.93	11.39	8.62
315	11.76	6.24	9.39	7.78	9.4	8.86	5.07	8.18
337.5	7.5	5.6	5.77	6.68	4.39	7.54	2.81	5.69