

WIND DATA REPORT

Deer Island Outfall

August 18, 2003 – December 4, 2003

Prepared for

Massachusetts Technology Collaborative
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by

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EXECUTIVE SUMMARY

The wind measurements were taken using a Model VT-1 Phased-Array Doppler Sodar System installed near the outfall pipe of the MWRA sewage treatment plant on Deer Island, MA. Installed August 18 of 2003, data was collected continuously until December 4 of 2003. Data was collected every 10 meters starting at 40 m and ending at 200 m. As is the nature with Sodar data, the higher elevations have a lower percentage of usable values. Only data averages that are based on at least 50% good samples out of all the possible good samples are reported in this report. One of the highest percentage of good data occurred at 50 meters, so this height is used for characterizing the general site conditions.

During the period covered by this report the mean recorded wind speed at 50 meters was 4.72 m/s (10.6 mph); The prevailing wind direction was from the W. The gross data recovery percentage (the actual percentage of expected data received) at 50 meters was 88.538% and the net data recovery percentage (the percentage of expected data which passed all of the quality assurance tests) at 50 meters was 88.538%.

SECTION 1 - Station Location

The Deer Island Outfall site is located near the outfall pipe of the MWRA sewage treatment plant on Deer Island, MA. A water tower is located WNW of the site, which may obstruct airflow from that direction. There is also a nearby settling pond with flowing water, which produces some noise that may interfere with the operation of the SODAR. The location of the SODAR is at 42.35431° North, 70.95792° West.

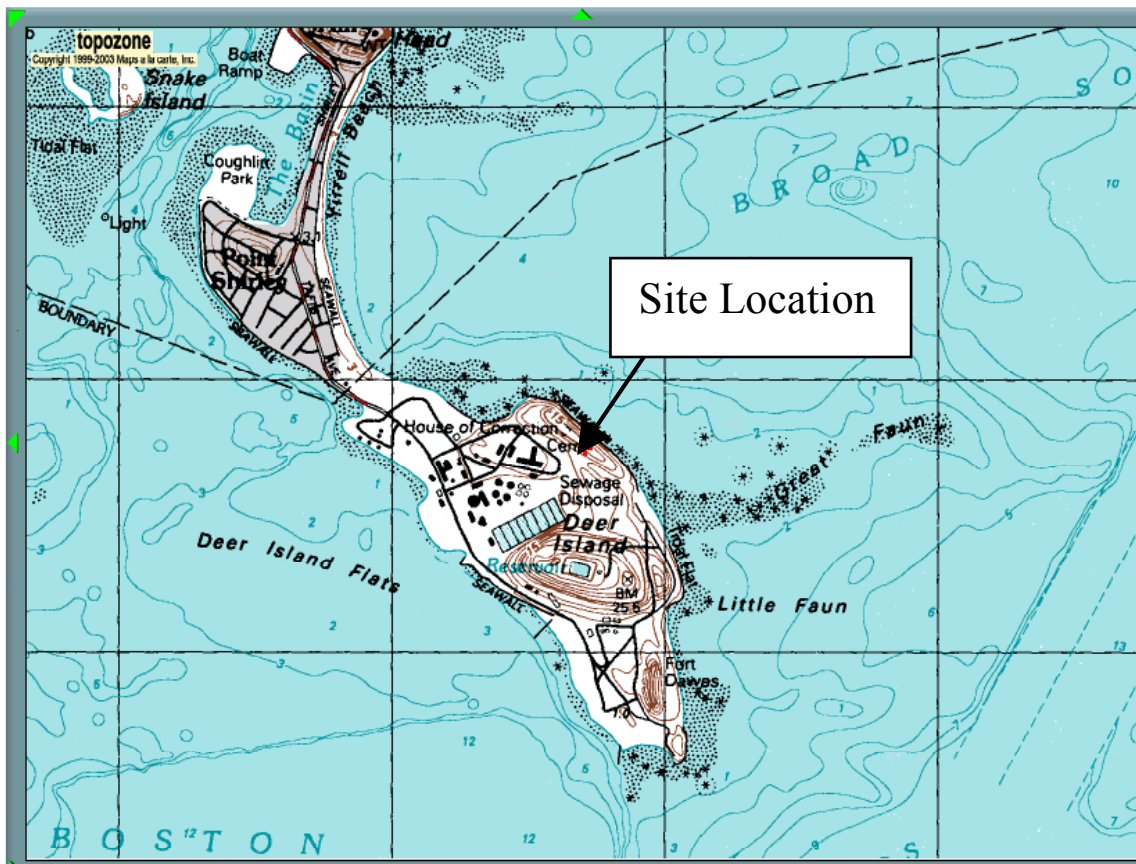


Figure 1 - Site location at Deer Island Outfall site.

Source: www.topozone.com.

SECTION 2 - Instrumentation and Equipment

Data at the Deer Island Outfall site was collected using a Model VT-1 Phased-Array Doppler Sodar System, manufactured by Atmospheric Research & Technology, LLC. The system is using PCSodar78 software.

SECTION 3 - Data Collection and Maintenance

Data from 50 meters was used to report the mean wind speeds from the three complete months of data collection.

Data Statistics Summary

Date	Mean Wind Speed [m/s]	Max Wind Speed [m/s]	Prevailing Wind Direction []
September 2003	3.36	25.1	ENE
October 2003	5.59	19.5	WSW
November 2003	4.85	16.9	W
Aug 18, 2003 – Dec 4, 2003	4.72	25.1	W

SECTION 4 - Significant Meteorological Events

The northeast region as a whole experienced slightly wet fall. According to the National Weather Service, Worcester, MA experienced above average precipitation (12.65 in, 0.25 in above average) and about average temperatures (54.02°F) during the fall of 2003. Boston, MA experienced above average precipitation (11.48 in, 0.23 in above average) and about average temperatures (54.25°F) during the fall of 2003. There were no other significant weather events. (www.erh.noaa.gov/box/MonthlyClimate2.shtml).

SECTION 5 - 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 [%]	40.874
Net Data Recovered [%]	40.874

The low Gross Data Recovery Percentage is a result of low data collection rates at the higher elevations, as is shown in Appendix A. The Net Data Recovery Percentage being equal to the Gross Data Recovery Percentage indicates that there were no other problems with the data.

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.

$$F1 > TF1 > F2$$

Sensor Statistics

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 that fall outside of an expected range.

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

SECTION 6 - Data Summary

This report contains several types of wind data graphs. Unless otherwise noted, each graph represents data from 1 quarter (3 months). The following graphs are included:

- Time Series – 10-minute average 50 m wind speeds are plotted against time.

- Wind Speed Distribution – A histogram plot giving the percentage of time that the wind at 50 m, 70 m, and 90 m is at a given wind speed. The maximum percentage is between 3 and 4 m/s for the 50 m data, 5 and 6 m/s for the 70 m data, and between 6 and 7 m/s for the 90 m data.
- Average Wind Speed Data– A plot of the average wind speed at heights from 30 m to 200 m. This graph shows the trends in the wind speed from May 1, 2003 – July 15, 2003. Of particular note is the peak wind speed at 70 m.
- Diurnal – A plot of the average wind speed for each hour of the day. This graph shows a pattern of greater wind speeds in the evening, peaking at between 4 and 5 PM.
- Data Recovery Rate – A plot of the percentage of good data at each height. The maximum Data Recovery Rate is between 40 and 50 meters.
- 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. This wind rose shows a prevailing WSW wind direction. The directional distribution of average wind speeds appears fairly even, with the highest speeds recorded from the S and W.

SECTION 7 - Graphs

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

Wind Speed Time Series

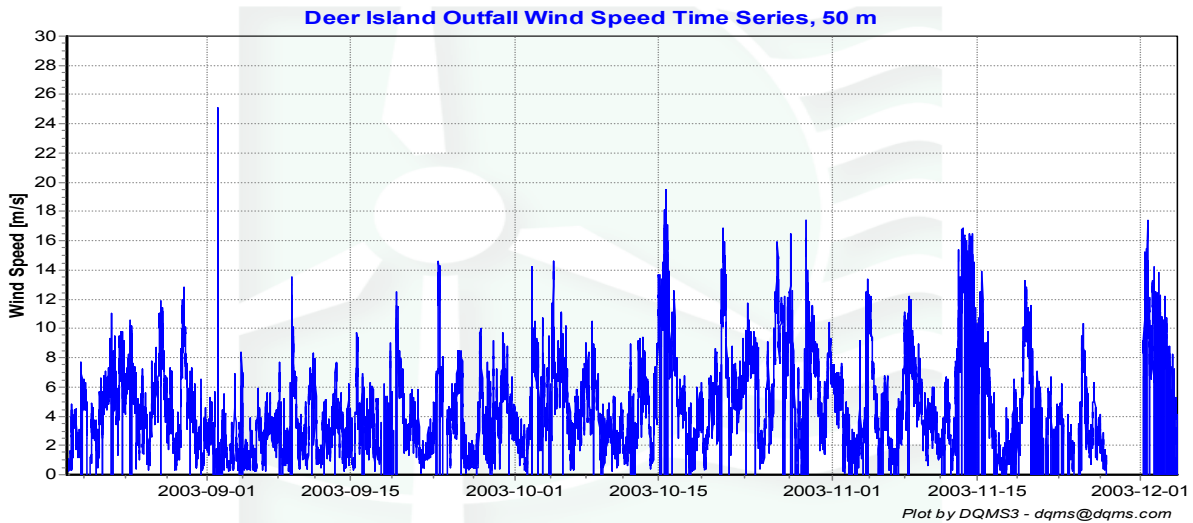


Figure 2 - Wind Speed Time Series

Wind Speed Distributions

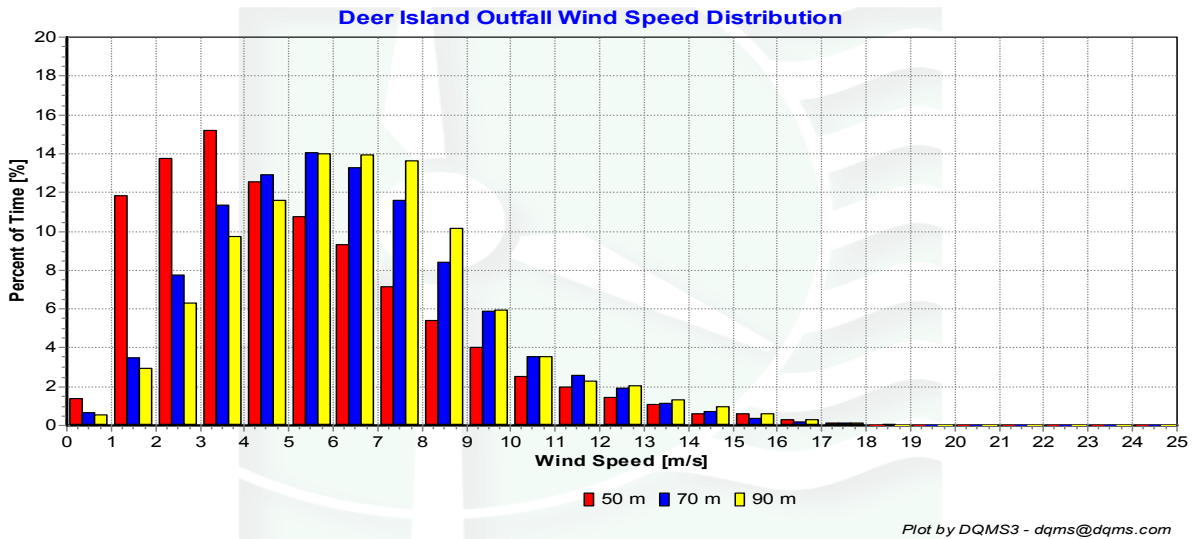


Figure 3 - Wind Speed Distribution at Various Heights

Average Wind Speeds

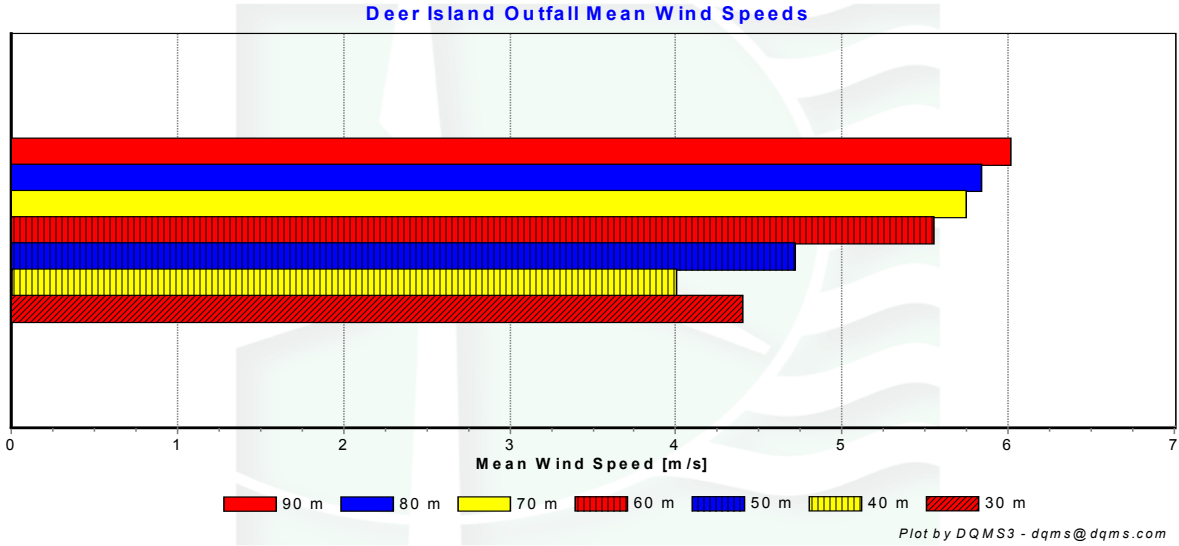


Figure 4 - Average Wind Speed at Various Heights

Diurnal Average Wind Speeds

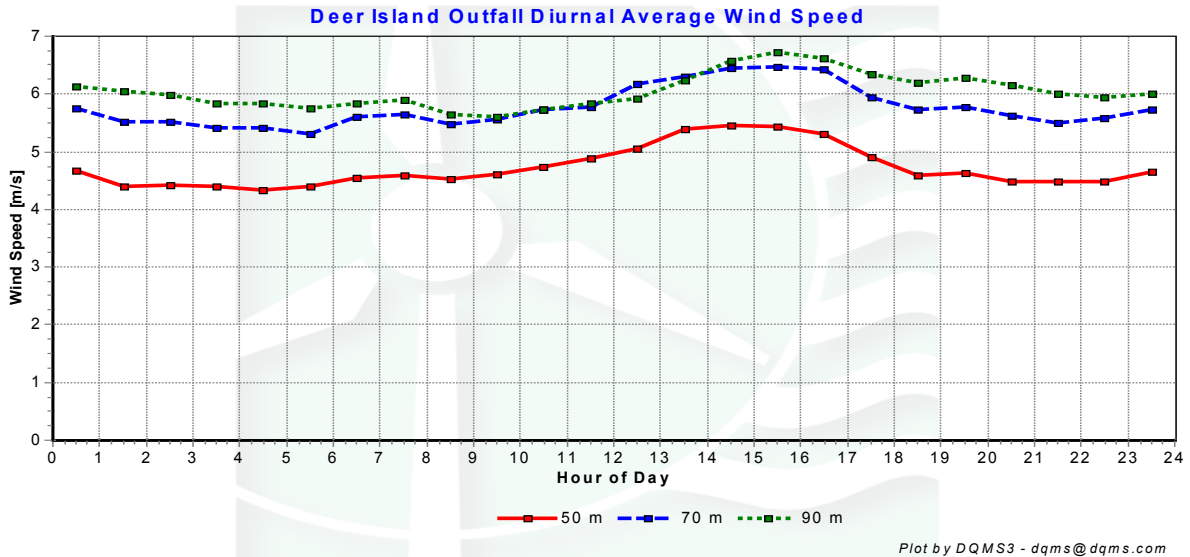


Figure 5 - Diurnal Wind Speed, August 18, 2003 – December 4, 2003

Data Recovery Rate

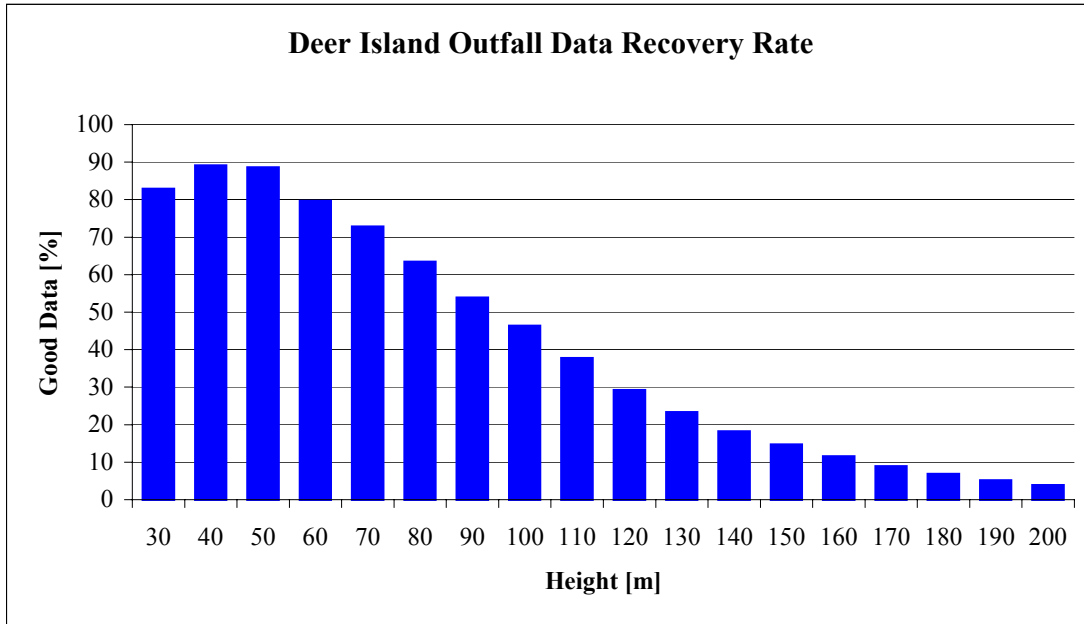


Figure 6 - Data Recovery Percentage at Various Heights

Wind Roses

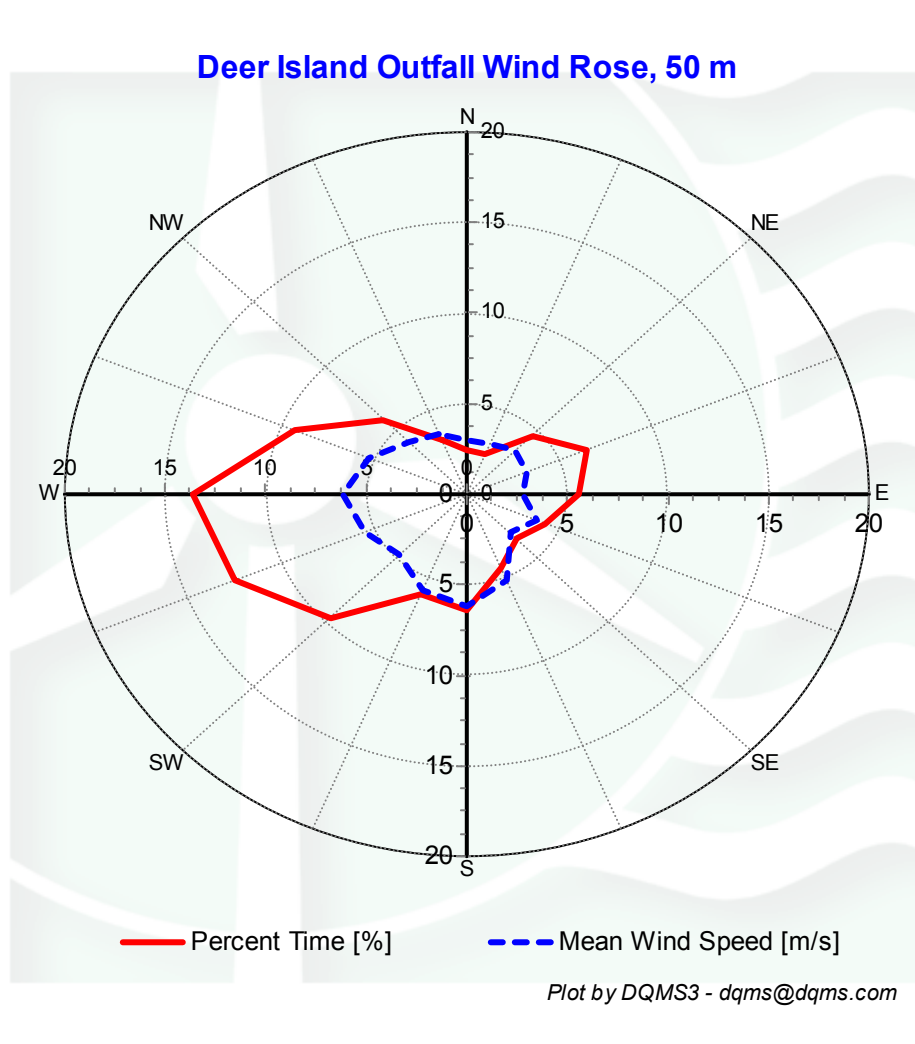


Figure 7 - Wind Rose, August 18, 2003 – December 4, 2003

APPENDIX A - Sensor Performance Report

Test Definitions

Test Order	TestField1	TestField2	TestField3	CalcField1	CalcField2	Test Type	Factor1	Factor2	Factor3	Factor4
0							TimeTest Insert	0	0	0
10	Anem30aMS						MinMax	0	90	0
11	Anem40aMS						MinMax	0	90	0
12	Anem50aMS						MinMax	0	90	0
13	Anem60aMS						MinMax	0	90	0
14	Anem70aMS						MinMax	0	90	0
15	Anem80aMS						MinMax	0	90	0
16	Anem90aMS						MinMax	0	90	0
17	Anem100aMS						MinMax	0	90	0
18	Anem110aMS						MinMax	0	90	0
19	Anem120aMS						MinMax	0	90	0
20	Anem130aMS						MinMax	0	90	0
21	Anem140aMS						MinMax	0	90	0
22	Anem150aMS						MinMax	0	90	0
23	Anem160aMS						MinMax	0	90	0
24	Anem170aMS						MinMax	0	90	0
25	Anem180aMS						MinMax	0	90	0
26	Anem190aMS						MinMax	0	90	0
27	Anem200aMS						MinMax	0	90	0
50	Vane30aDEG						MinMax	0	359.9	0
51	Vane40aDEG						MinMax	0	359.9	0
52	Vane50aDEG						MinMax	0	359.9	0
53	Vane60aDEG						MinMax	0	359.9	0
54	Vane70aDEG						MinMax	0	359.9	0
55	Vane80aDEG						MinMax	0	359.9	0
56	Vane90aDEG						MinMax	0	359.9	0
57	Vane100aDEG						MinMax	0	359.9	0
58	Vane110aDEG						MinMax	0	359.9	0
59	Vane120aDEG						MinMax	0	359.9	0
60	Vane130aDEG						MinMax	0	359.9	0
61	Vane140aDEG						MinMax	0	359.9	0
62	Vane150aDEG						MinMax	0	359.9	0
63	Vane160aDEG						MinMax	0	359.9	0
64	Vane170aDEG						MinMax	0	359.9	0
65	Vane180aDEG						MinMax	0	359.9	0
66	Vane190aDEG						MinMax	0	359.9	0
67	Vane200aDEG						MinMax	0	359.9	0

Sensor Statistics

Sensor	Expected Data Points	Actual Data Points	% Data Recovered	Hours Out of Range	% Data Good
Anem30aMS	15590	12914	82.835	0	82.835
Vane30aDEG	15590	12914	82.835	0	82.835
Anem40aMS	15590	13890	89.096	0	89.096
Vane40aDEG	15590	13890	89.096	0	89.096
Anem50aMS	15590	13803	88.538	0	88.538
Vane50aDEG	15590	13803	88.538	0	88.538
Anem60aMS	15590	12414	79.628	0	79.628
Vane60aDEG	15590	12414	79.628	0	79.628
Anem70aMS	15590	11346	72.777	0	72.777
Vane70aDEG	15590	11346	72.777	0	72.777
Anem80aMS	15590	9878	63.361	0	63.361
Vane80aDEG	15590	9878	63.361	0	63.361
Anem90aMS	15590	8397	53.861	0	53.861
Vane90aDEG	15590	8397	53.861	0	53.861
Anem100aMS	15590	7227	46.357	0	46.357
Vane100aDEG	15590	7227	46.357	0	46.357
Anem110aMS	15590	5886	37.755	0	37.755
Vane110aDEG	15590	5886	37.755	0	37.755
Anem120aMS	15590	4551	29.192	0	29.192
Vane120aDEG	15590	4551	29.192	0	29.192
Anem130aMS	15590	3625	23.252	0	23.252
Vane130aDEG	15590	3625	23.252	0	23.252
Anem140aMS	15590	2838	18.204	0	18.204
Vane140aDEG	15590	2838	18.204	0	18.204
Anem150aMS	15590	2288	14.676	0	14.676
Vane150aDEG	15590	2288	14.676	0	14.676
Anem160aMS	15590	1799	11.539	0	11.539
Vane160aDEG	15590	1799	11.539	0	11.539
Anem170aMS	15590	1378	8.839	0	8.839
Vane170aDEG	15590	1378	8.839	0	8.839
Anem180aMS	15590	1062	6.812	0	6.812
Vane180aDEG	15590	1062	6.812	0	6.812
Anem190aMS	15590	802	5.144	0	5.144
Vane190aDEG	15590	802	5.144	0	5.144
Anem200aMS	15590	604	3.874	0	3.874
Vane200aDEG	15590	604	3.874	0	3.874
Total	561240	229404	40.874	0	40.874

APPENDIX B - Plot Data

Wind Speed Distribution Data

Bin Center Wind Speed [m/s]	Percent of Time [%], 50 m	Percent of Time [%], 70 m	Percent of Time [%], 90 m
0.5	1.41	0.64	0.56
1.5	11.82	3.51	2.95
2.5	13.75	7.76	6.34
3.5	15.19	11.33	9.73
4.5	12.55	12.94	11.58
5.5	10.74	14.06	13.97
6.5	9.32	13.26	13.92
7.5	7.12	11.57	13.66
8.5	5.4	8.43	10.15
9.5	4	5.91	5.94
10.5	2.53	3.52	3.53
11.5	1.99	2.56	2.27
12.5	1.46	1.91	2.05
13.5	1.06	1.16	1.35
14.5	0.62	0.71	0.95
15.5	0.59	0.37	0.57
16.5	0.3	0.18	0.32
17.5	0.11	0.11	0.13
18.5	0.01	0.05	0.01
19.5	0.01	0.02	0
20.5	0.01	0.01	0.02
21.5	0	0	0
22.5	0	0	0
23.5	0	0	0
24.5	0	0	0

Table 1 - Wind Speed Distribution

Monthly Average Wind Speed Data

Height [m]	Mean Wind Speed [m/s]
30	4.4
40	4.01
50	4.72
60	5.55
70	5.75
80	5.84
90	6.02

Table 2 - Wind Speed Averages

Diurnal Average Wind Speed Data

Hour of Day	Average Wind Speed [m/s], 50 m	Average Wind Speed [m/s], 70 m	Average Wind Speed [m/s], 90 m
0	4.68	5.76	6.13
1	4.4	5.53	6.04
2	4.43	5.52	5.98
3	4.4	5.42	5.84
4	4.35	5.41	5.83
5	4.39	5.32	5.75
6	4.55	5.6	5.83
7	4.59	5.64	5.9
8	4.52	5.48	5.65
9	4.61	5.55	5.6
10	4.73	5.73	5.74
11	4.88	5.78	5.84
12	5.05	6.17	5.91
13	5.39	6.31	6.23
14	5.45	6.46	6.57
15	5.44	6.47	6.72
16	5.3	6.44	6.62
17	4.91	5.94	6.34
18	4.59	5.73	6.2
19	4.64	5.77	6.27
20	4.48	5.62	6.16
21	4.48	5.49	6
22	4.48	5.59	5.94
23	4.65	5.74	6.01

Table 3 - Diurnal Average Wind Speeds

Wind Rose Data

Direction	Percent Time [%]	Mean Wind Speed [m/s]
N	2.47	2.95
NNE	2.42	3.03
NE	4.59	3.41
ENE	6.42	3.22
E	5.59	2.76
ESE	4.19	3.81
SE	3.5	3.04
SSE	4.39	5.15
S	6.37	6.17
SSW	5.94	5.78
SW	9.64	4.73
WSW	12.47	5.51
W	13.68	6.15
WNW	9.27	5.3
NW	5.85	4.07
NNW	3.22	3.62

Table 4 - Wind Rose, Time Percentage and Mean Wind Speed by Direction, 50 m