

WIND DATA REPORT

Deer Island Parking Lot

May 1, 2003 – July 15, 2003

Prepared for

Massachusetts Technology Collaborative
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by

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EXECUTIVE SUMMARY

Wind measurements were taken using a Model VT-1 Phased-Array Doppler Sodar System installed in the parking lot of the MWRA sewage treatment plant on Deer Island, MA. The site was installed on May 1 of 2003 and operated until July 15 of 2003. Data was collected every 10 meters starting at 30 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 presented 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 Parking Lot site is located in the parking lot of the MWRA sewage treatment plant on Deer Island, MA. There are digesters to the north of the site that may obstruct airflow. Airplanes, boats, digesters and a nearby road may produce noise that could interfere with the operation of the SODAR. The location of the SODAR is at 42.35431° North, 70.95792° West.

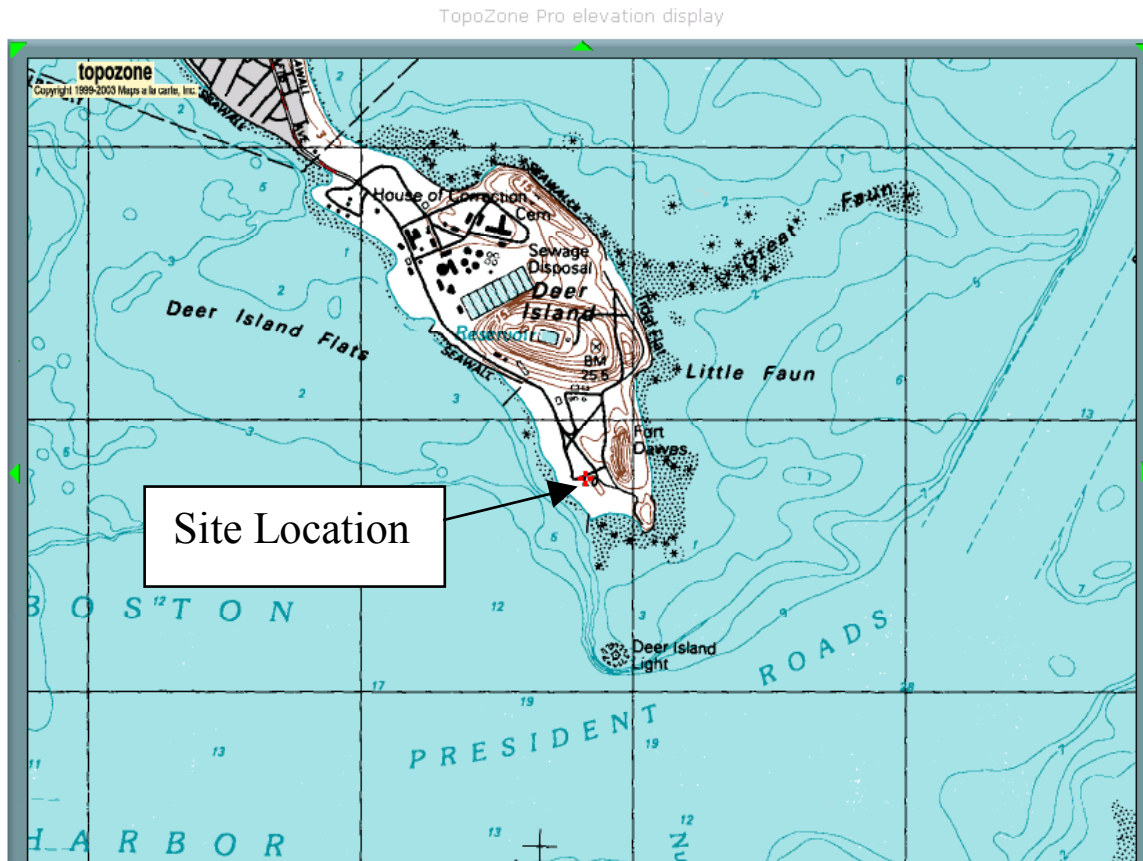


Figure 1 - Site location at Deer Island Parking Lot site.

Source: www.topozone.com.

SECTION 2 - Instrumentation and Equipment

Data at the Deer Island Parking Lot 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

This site was powered by batteries that needed to be replaced often. There were many periods when the site was down either for swapping out the batteries or when the batteries were not swapped in time (particularly over weekends).

Data from 50 meters was used to report the mean wind speeds from the one full calendar month with more than 50% good data.

Data Statistics Summary

Date	Mean Wind Speed [m/s]	Max Wind Speed [m/s]	Prevailing Wind Direction []
June 2003	3.26	14.3	S
May 1, 2003 – July 15, 2003	3.51	14.3	S

SECTION 4 - Significant Meteorological Events

The northeast region as a whole experienced a cool and wet early summer followed by a warm and wet late summer. According to the National Weather Service, Boston, MA experienced greater than average precipitation (9.67 in, 0.11 in above average) and about average temperatures (71.3°F) during the summer of 2003. Providence, RI recorded 4.29 inches of precipitation above normal. The season began with a nor'easter-like storm in early June bringing strong winds and heavy rain. By August, the weather had turned warm and humid; in Boston, August 2003 was the 8th warmest August on record and in Providence, it was the 4th warmest (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 [%]	50.542
Net Data Recovered [%]	50.542

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 the full period of data collection for this site. 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 2 and 3 m/s for the 50 m data, 6 and 7 m/s for the 70 m data, and between 1 and 3 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 3 and 6 PM.
- Data Recovery Rate – A plot of the percentage of data recovered at various heights. The Data Recovery Rate is fairly constant through 100 m where it starts to drop off. The low overall rate is due to periods of lost data due to breaks in the power supply.
- 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 S to SW wind direction. The directional distribution of average wind speeds appears fairly even, with the highest speeds recorded from the S.

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

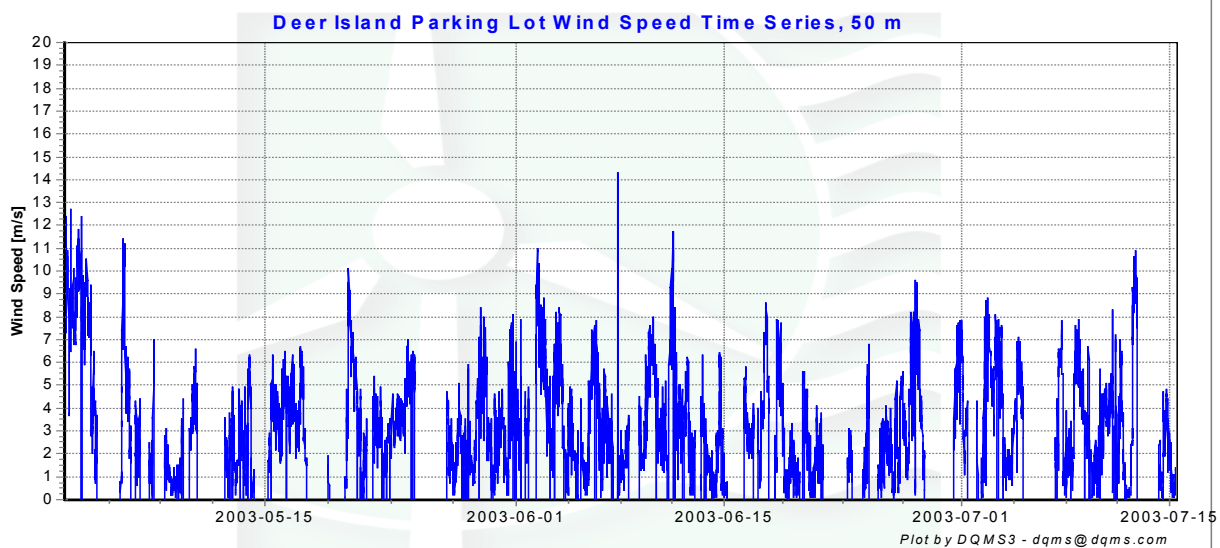


Figure 2 - Wind Speed Time Series, May 1,2003 – July 15, 2003

Wind Speed Distributions

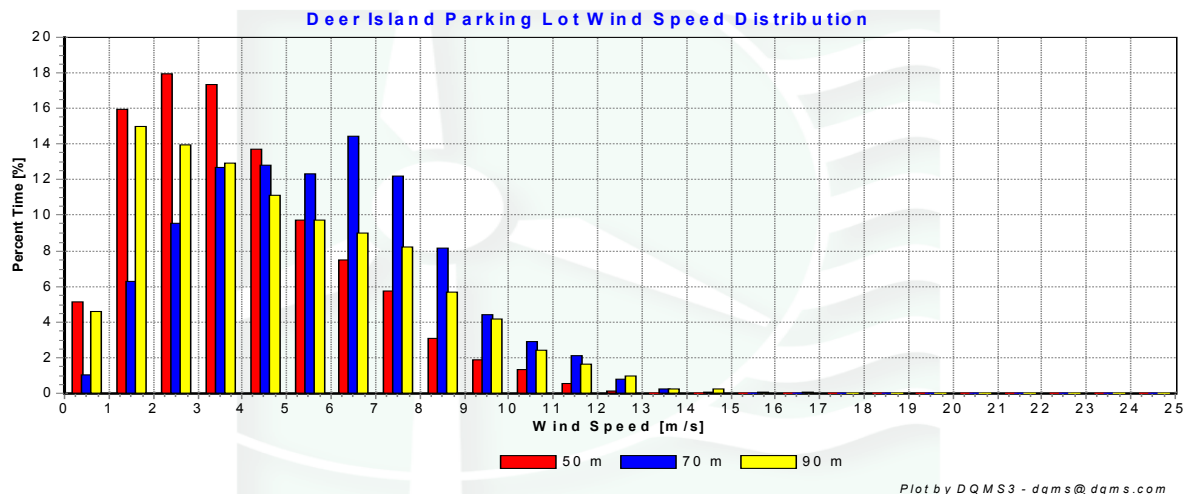


Figure 3 - Wind Speed Distribution, May 1,2003 – July 15, 2003

Average Wind Speeds

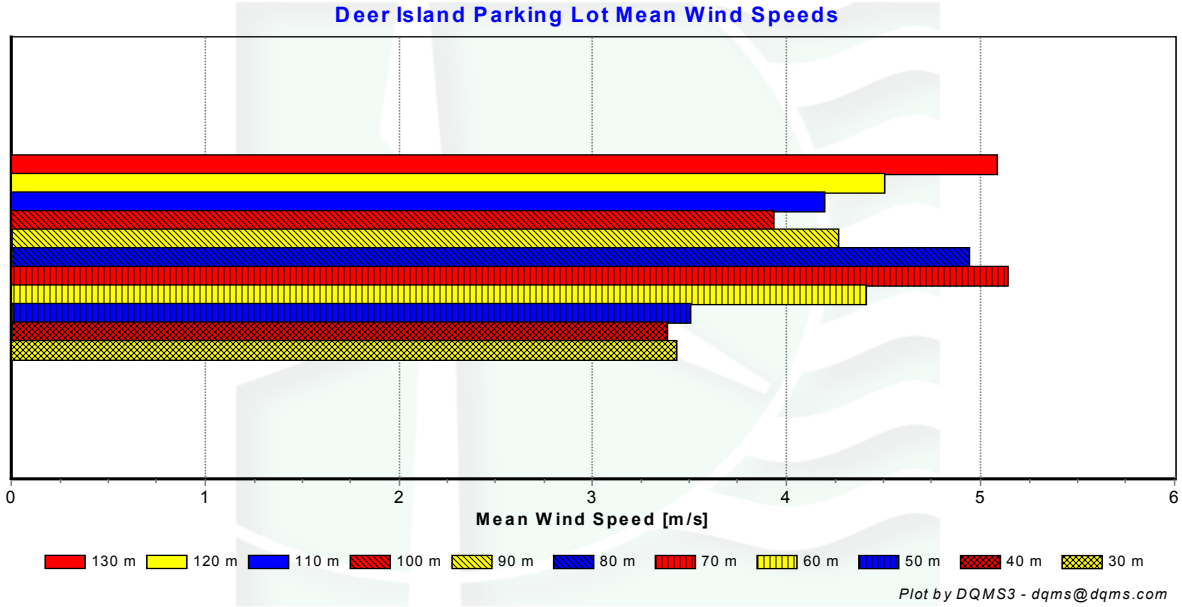


Figure 4 - Average wind speeds at Various Heights, May 1,2003 – July 15, 2003

Diurnal Average Wind Speeds

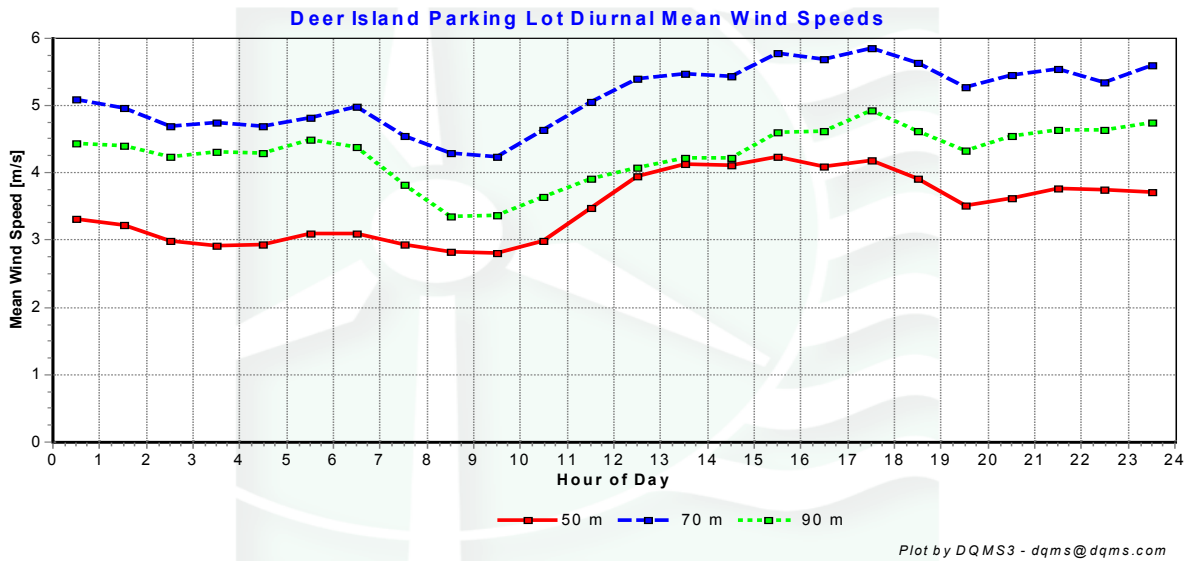


Figure 5 - Diurnal Wind Speed at Various Heights, May 1,2003 – July 15, 2003

Data Recovery Rate

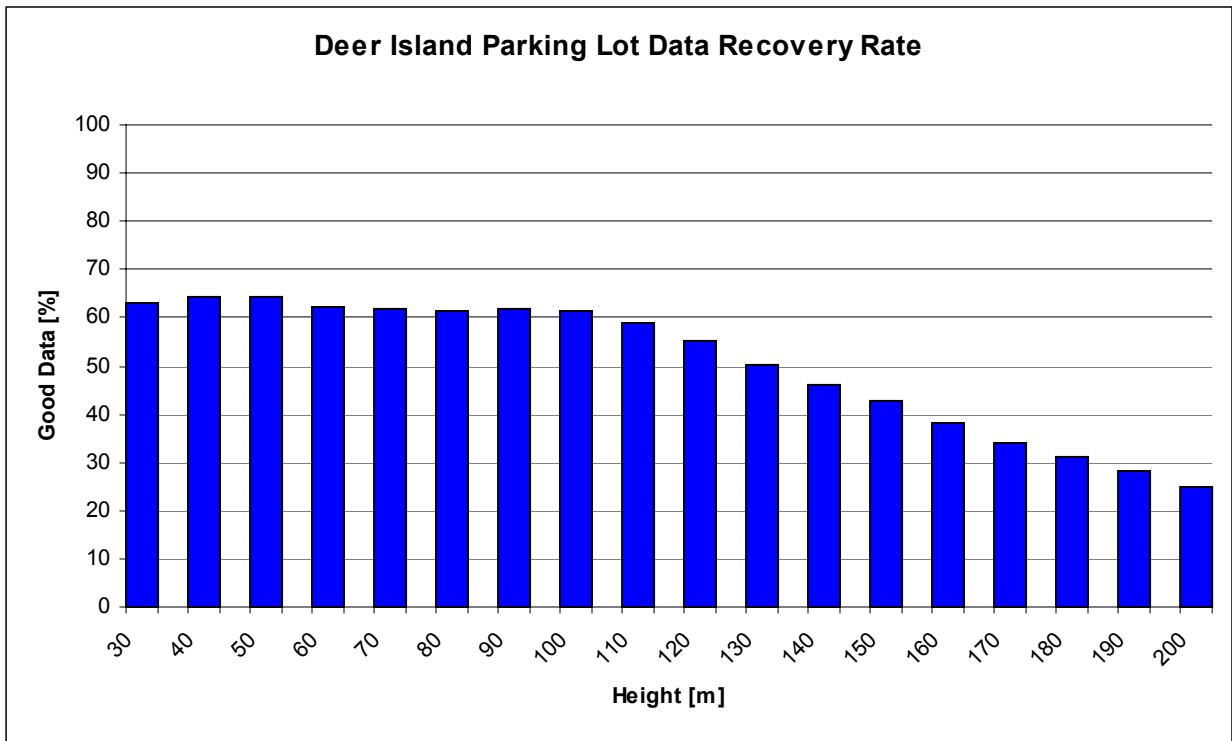


Figure 6 - Data Recover Percentage at Various Heights

Wind Roses

Deer Island Parking Lot Wind Rose, 50 m

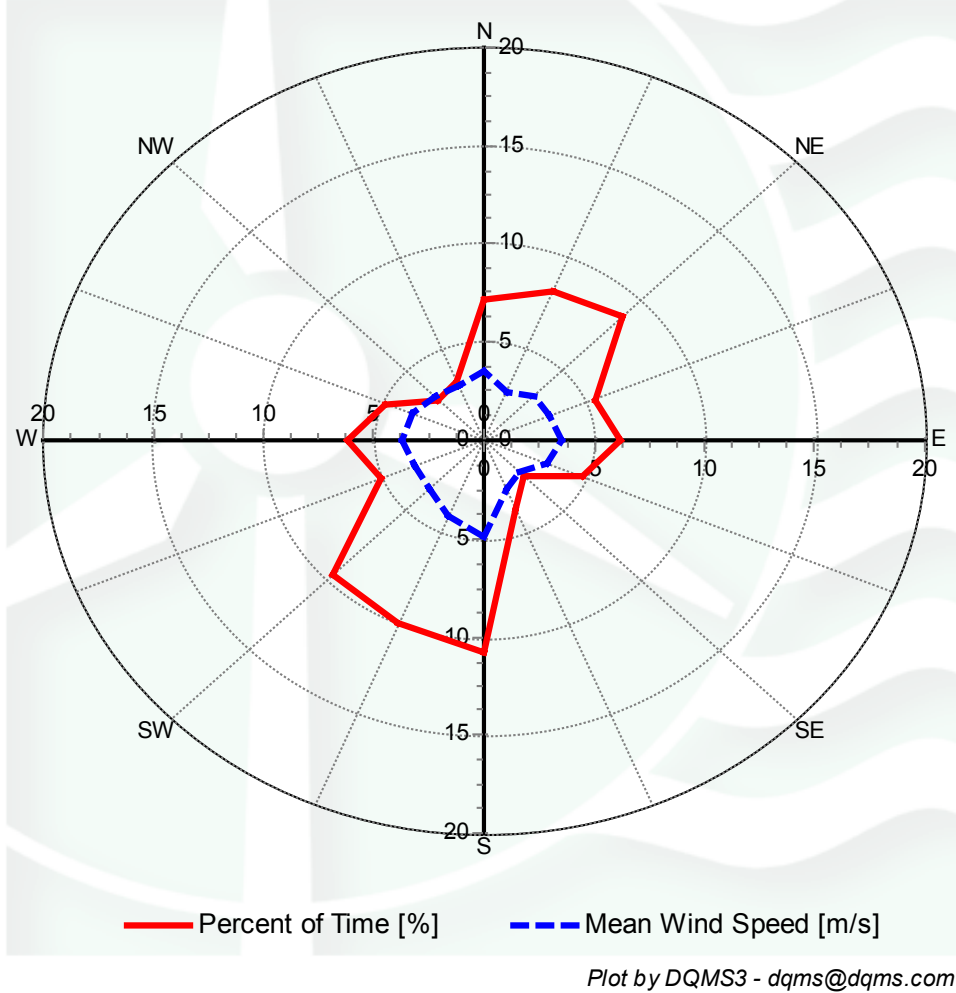


Figure 7 - Wind Rose, May 1, 2003 – July 15, 2003

APPENDIX A - Sensor Performance Report

Test Definitions

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

Sensor Statistics

Sensor	Expected Data Points	Actual Data Points	% Data Recovered	Hours Out of Range	% Data Good
Anem30aMS	10774	6793	63.05	0	63.05
Vane30aDEG	10774	6793	63.05	0	63.05
Anem40aMS	10774	6917	64.201	0	64.201
Vane40aDEG	10774	6917	64.201	0	64.201
Anem50aMS	10774	6911	64.145	0	64.145
Vane50aDEG	10774	6911	64.145	0	64.145
Anem60aMS	10774	6724	62.41	0	62.41
Vane60aDEG	10774	6724	62.41	0	62.41
Anem70aMS	10774	6652	61.741	0	61.741
Vane70aDEG	10774	6652	61.741	0	61.741
Anem80aMS	10774	6600	61.259	0	61.259
Vane80aDEG	10774	6600	61.259	0	61.259
Anem90aMS	10774	6666	61.871	0	61.871
Vane90aDEG	10774	6666	61.871	0	61.871
Anem100aMS	10774	6620	61.444	0	61.444
Vane100aDEG	10774	6620	61.444	0	61.444
Anem110aMS	10774	6368	59.105	0	59.105
Vane110aDEG	10774	6368	59.105	0	59.105
Anem120aMS	10774	5947	55.198	0	55.198
Vane120aDEG	10774	5947	55.198	0	55.198
Anem130aMS	10774	5401	50.13	0	50.13
Vane130aDEG	10774	5401	50.13	0	50.13
Anem140aMS	10774	4958	46.018	0	46.018
Vane140aDEG	10774	4958	46.018	0	46.018
Anem150aMS	10774	4605	42.742	0	42.742
Vane150aDEG	10774	4605	42.742	0	42.742
Anem160aMS	10774	4105	38.101	0	38.101
Vane160aDEG	10774	4105	38.101	0	38.101
Anem170aMS	10774	3669	34.054	0	34.054
Vane170aDEG	10774	3669	34.054	0	34.054
Anem180aMS	10774	3357	31.158	0	31.158
Vane180aDEG	10774	3357	31.158	0	31.158
Anem190aMS	10774	3024	28.068	0	28.068
Vane190aDEG	10774	3024	28.068	0	28.068
Anem200aMS	10774	2701	25.07	0	25.07
Vane200aDEG	10774	2701	25.07	0	25.07
Total	387864	196036	50.542	0	50.542

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	5.14	1.04	4.59
1.5	15.95	6.28	14.99
2.5	17.93	9.55	13.97
3.5	17.35	12.69	12.92
4.5	13.7	12.81	11.1
5.5	9.72	12.31	9.72
6.5	7.5	14.42	9.03
7.5	5.76	12.18	8.19
8.5	3.07	8.18	5.69
9.5	1.85	4.42	4.17
10.5	1.33	2.9	2.4
11.5	0.55	2.13	1.61
12.5	0.13	0.78	0.99
13.5	0.01	0.23	0.24
14.5	0.01	0.08	0.27
15.5	0	0.02	0.08
16.5	0	0	0.05
17.5	0	0	0.02
18.5	0	0	0
19.5	0	0	0
20.5	0	0	0
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

Average Wind Speed Data

Height [m]	Mean Wind Speed [m/s]
30	3.43
40	3.39
50	3.51
60	4.41
70	5.14
80	4.94
90	4.27
100	3.93
110	4.2
120	4.51
130	5.09

Table 2 - Wind Speed Averages at Various Heights

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	3.31	5.09	4.44
1	3.23	4.97	4.4
2	2.99	4.69	4.24
3	2.92	4.75	4.32
4	2.94	4.7	4.29
5	3.1	4.81	4.49
6	3.1	4.99	4.4
7	2.94	4.56	3.82
8	2.83	4.29	3.35
9	2.8	4.23	3.37
10	3	4.65	3.65
11	3.48	5.06	3.91
12	3.96	5.41	4.09
13	4.13	5.47	4.23
14	4.11	5.43	4.22
15	4.24	5.78	4.61
16	4.09	5.69	4.62
17	4.18	5.85	4.92
18	3.91	5.63	4.62
19	3.52	5.28	4.32
20	3.63	5.46	4.56
21	3.78	5.55	4.64
22	3.75	5.34	4.63
23	3.72	5.59	4.75

Table 3 - Diurnal Average Wind Speeds

Wind Rose Data

Direction	Percent Time [%]	Mean Wind Speed [m/s]
N	7.15	3.51
NNE	8.28	2.62
NE	8.88	3.22
ENE	5.43	3.23
E	6.24	3.49
ESE	4.88	3.07
SE	2.56	2.24
SSE	3.81	2.7
S	10.79	4.93
SSW	10.11	4.13
SW	9.65	3.51
WSW	5.01	3.41
W	6.22	3.71
WNW	4.85	3.56
NW	2.94	3.11
NNW	3.21	2.99

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