INL/MIS-11-22590
Letter Report
Revision 0

Pantex Wind Analysis Summary

Kurt S. Myers
Jake P. Gentle

June 2011

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Executive Summary

This LETTER REPORT has been prepared by Idaho National Laboratory (INL) as a basic summary of wind data and energy production analyses for the DOE Pantex site in Amarillo, TX. The data and information will likely be used to support the development of a wind farm/energy project on Pantex property. The wind analysis results have been used to develop preliminary wind farm layouts and performance design documents to support the project. These summaries may also be used as supplemental material to support and accelerate further wind data analysis by other parties involved in the final development and financing for this project.

The findings to-date are as follows:

1. Wind data collected at or near site since 2005, and for longer than 10 years at local Amarillo airport about 10 miles away.
    - 60m Pantex weather met tower, N 35° 21’ 10.0”, W 101° 32’ 50.5” (WGS84), surface elevation approximately 3524’ above mean sea level (AMSL), data collected from 2005 through 2008, data to present should be available.
    - 60m SecondWind Pantex met tower #1, N 35.30852°, W 101.53293° (WGS84), data collected from 7/8/09 to present, although data since 7/10/10 needs to be downloaded from data card in logger.
    - 60m SecondWind Pantex met tower #2, N 35.32900°, W 101.54332°, data collected from 7/13/09 to present, although data since 7/14/10 needs to be downloaded from data card in logger.
    - SecondWind Triton Pantex Sodar #135, N 35.29332°, W 101.53229°, reads wind speeds up to 200m, data collected from 6/22/09 to present, data anomalies from 12/22/09 through 2/18/10, data gap from 2/9/11 to 3/4/11.
2. Turbines used for initial production estimates: Suzlon 2.1MW, 88 meter rotor, 80 meter hub height, and Clipper 2.5MW, 96 meter rotor, 80 meter hub height, power curve air density of 1.06kg/m3 used. Other turbine brands and models are likely to produce higher (or lower) capacity factors, depending on their relative rotor area versus kW rating ratios and other factors. However, site suitability studies still need to be performed by potential turbine suppliers to verify the class of turbines that will be approved for the site based on the climatic/wind conditions, as this site is estimated at Class 5-6 wind resource (excellent to outstanding). Estimates with other turbines can be performed and provided on request, as the Wasp models using the existing wind data have already been developed.
3. All data has been compared head-to-head where possible, and longer term data from the Amarillo airport and Pantex weather met tower has been utilized for long-term comparisons/correlation and estimates.
4. Long-term estimated annual average wind speed/parameters for the various locations are as follows (actual shorter-term annual averages adjusted for long-term):
    - Long-term annual average wind speed at the Pantex 60m met tower #1 location (Sodar and tower #2 locations are similar) is calculated at 18.6 mph (8.32 m/s) at 60m AGL, and 19.6 mph (8.76 m/s) at 80m AGL. Observed data from the met towers and Sodar listed above has ranged between 18.1-19.7mph annual average at 60 meters depending on the year analyzed between 2005-2011.

- Calculated wind shear (using power law method) from the Sodar data: 0.26 from 40-50m, 0.23 from 50-60m, 0.2 from 60-80m, 0.15 from 80-100m.

- Weibull shape parameter is 2.78.

- Average turbulence intensity from Sodar is 0.12 at 40m AGL, further analysis to be performed on the met tower data to refine TI estimates.

5. Data recovery rates TBD, as recent data cards from Nomad loggers need to be collected. Recovery rates from Triton Sodar have been relatively good, although some anomalies and gaps as noted above are present for the dates listed for the Sodar data.
6. Using the parameters outlined above, and through multiple energy analysis comparisons using 10-minute data, Weibull production estimates and comparisons between tower locations, the long-term projected gross capacity factor for a Suzlon S88 wind turbine at the Pantex site is 47.5% (see summaries in the attachments below). For the Clipper C96 turbine at the Pantex site, the long-term gross capacity factor is estimated at 47.2%.
7. Weibull calculations were also performed to compare the various sites, energy production estimates based on the 10-minute data, and other aspects to determine if additional adjustments were warranted. For two of the main years analyzed, Weibull parameters could not quite match the 10-minute energy production estimates no matter how they were varied, unless the annual average wind speeds in the Weibull model were increased. To stay somewhat conservative, the INL Wasp models and long-term energy estimates have used long-term annual wind speed and Weibull shape estimates for the distribution. If long-term data was to continue the trend of matching a Weibull distribution with a slightly higher wind speed average, an additional 1-2% improvement in the energy production estimates could possibly be applied if the estimated long-term wind speed average stays close to the projection shown in #4 above. However, since this has not been verified over longer-term data, this increase has not been applied to the estimates shown here or in the Wasp model results reported by INL.
8. Using an on-site data set close to the long-term annual averages shown above, Wasp was used to model the area and estimate the average capacity factors and wake losses for a whole wind farm, with 20 Clipper C96 or 25 Suzlon S88 wind turbines located as shown in the maps below. A surface roughness of 0.021 was used to approximate the surrounding terrain and mimic the wind shears shown above in the wind farm area (also to closely follow Weibull production estimates at the Pantex location based on the previous analyses). Appropriate air density power curve and adjustments were used as described above.

   <u>The result was an average gross capacity factor of 47.41% for the C96 (207.659 GWh per year for twenty Clipper 2.5MW 96m rotor, 80m hub height turbines)</u>

   or, **<u>an average gross capacity factor of 47.80% for the S88 (219.822 GWh per year for twenty five Suzlon 2.1MW 88m rotor, 80m hub height turbines)</u>**

9. For the 20 C96 turbines, the average wake losses calculated in Wasp are at 4.32% (does not include any wake losses caused by the existing turbines to the North, although those losses should be minimal).
   - Electrical losses are estimated to be 2%

- control (and BOP/grid outages/other) losses at 1%
- wind sector management at 0%
- turbine availability at 4%
- turbulence and high wind hysteresis at 1%
- power curve accuracy deviations at 0%
- blade contamination/degradation and icing losses at 1%
- other meteorology (lightning, cold or hot weather, etc.) at 0.2%
- and wind shear reduction effects above hub height at 0.5%.

Therefore the overall gross to net losses are estimated at 14.0%. Applying this to the Wasp result above, **the net capacity for the wind farm using C96 turbines is estimated at 40.77%**. This is equivalent to 178,572,600 kWh per year for twenty Clipper C96 turbines. This is a P50 production estimate; uncertainties will need to be applied to get to P75, P90 and P95 numbers.

10. For the 25 S88 turbines, the average wake losses calculated in Wasp are at 5.15% (does not include any wake losses caused by the existing turbines to the North, although those losses should be minimal). Other losses are calculated the same as in #9 above. Therefore the overall gross to net losses for the S88 layout are estimated at 14.9%. Applying this to the Wasp result above, **the net capacity for the wind farm using S88 turbines is estimated at 40.68%**. This is equivalent to 187,087,320 kWh per year for twenty five Suzlon S88 turbines. This is a P50 production estimate; uncertainties will need to be applied to get to P75, P90 and P95 numbers.

11. The turbines would not be generating until the wind speed at hub height exceeds 3 to 4 m/s (depending on the turbine model used). Based on the available wind data and the loss categories above, the wind turbines at this site would be generating approximately 85% of the time, and 15% of the time they would be shut down due to low wind or maintenance activity. The average wind speeds and percent of operating times shown above are considered excellent for wind generation purposes compared to other commercial wind generation projects.

Attachments

ACRONYMS

AGL:	Above ground level
Availability:	The percentage of time that a wind turbine is available to operate.
DOE:	Department of Energy
ECIP:	Energy Conservation Investment Program
EULA:	End User Lease Agreement
ESPC:	Energy Savings Performance Contract
INL:	Idaho National Laboratory
FAA:	Federal Aviation Administration
Hub height:	The height above ground level to the center of the wind turbine rotor.
kW:	Kilowatt
kWh:	Kilowatt-hour
LCC:	Life cycle cost
m:	Meters
m/s:	Meters per second
Met (tower):	Meteorological tower, with wind data measurement equipment (anemometers).
MW:	Megawatt
NEPA:	National Environmental Policy Act
Net metering:	A method of crediting customers for electricity that they generate on-site to offset their own electricity consumption.
O&M:	Operations and maintenance
PPA:	Power purchase agreement
PURPA:	Public Utility Regulatory Policies Act
UESC:	Utility Energy Service Contract
VAR:	Volt-amperes reactive power
Weibull:	A mathematical function used to describe frequency distributions of wind speeds.
Wind shear:	The increase or decrease in wind speed at higher elevations above the ground.

'Wind farm 1' wind farm

Produced on 6/23/2011 at 7:02:13 PM by licenced user: INL, USA using WAsP version: 8.03.0037.

Summary results

Parameter	Total	Average	Minimum	Maximum
Net AEP [GWh]	198.691	9.935	9.683	10.286
Gross AEP [GWh]	207.659	10.383	10.352	10.407
Wake loss [%]	4.32	-	-	-

Site results

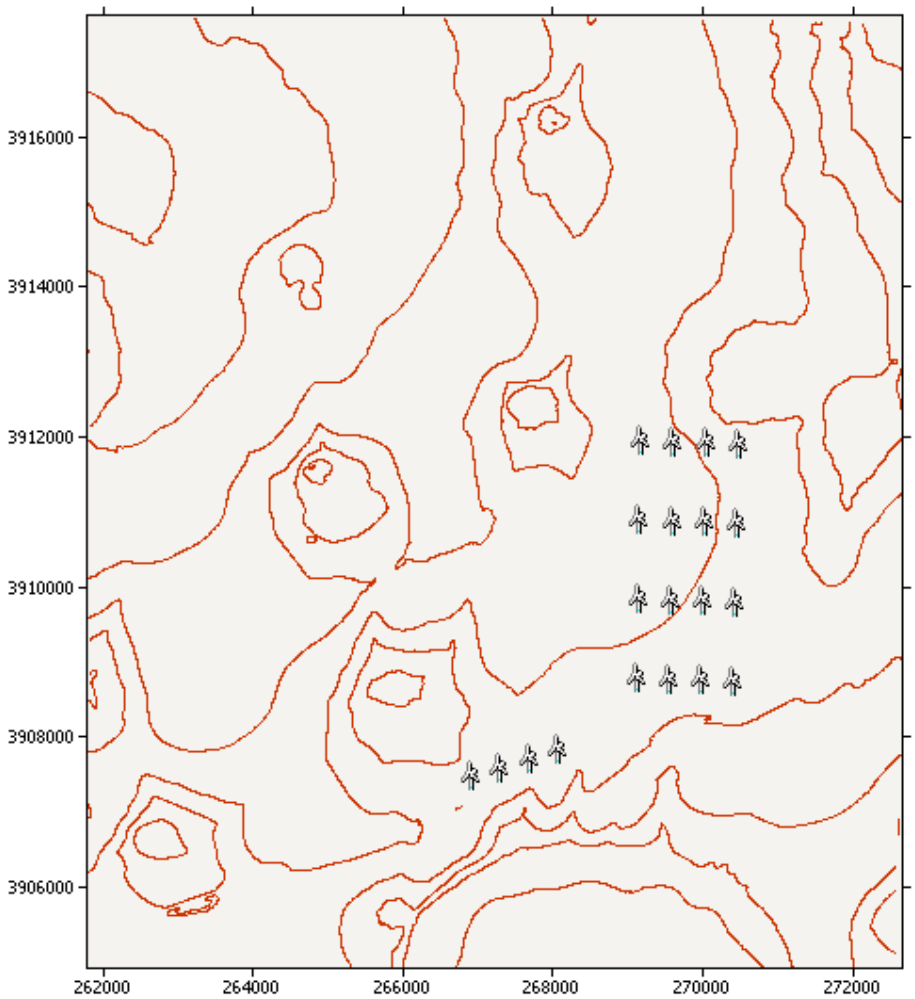
Site	Location [m]	Turbine	Elevation [m a.s.l.]	Height [m a.g.l.]	Net AEP [GWh]	Wake loss [%]
Turbine site 1	(269089.0,3908624.0)	Clip 2.5 MW, 1.06kg/m3	1072	80	10.099	2.63
Turbine site 2	(269520.0,3908613.0)	Clip 2.5 MW, 1.06kg/m3	1072	80	10.031	3.36
Turbine site 3	(269951.0,3908602.0)	Clip 2.5 MW, 1.06kg/m3	1071	80	10.035	3.37
Turbine site 4	(270382.0,3908592.0)	Clip 2.5 MW, 1.06kg/m3	1071	80	10.109	2.66
Turbine site 5	(269152.0,3911791.0)	Clip 2.5 MW, 1.06kg/m3	1075	80	9.973	3.67
Turbine site 6	(269583.0,3911781.0)	Clip 2.5 MW, 1.06kg/m3	1075	80	9.819	5.33
Turbine site 7	(270014.0,3911771.0)	Clip 2.5 MW, 1.06kg/m3	1075	80	9.794	5.80
Turbine site 8	(270445.0,3911761.0)	Clip 2.5 MW, 1.06kg/m3	1072	80	9.836	5.12
Turbine site 9	(269131.0,3910735.0)	Clip 2.5 MW, 1.06kg/m3	1075	80	9.882	4.73
Turbine site 10	(269562.0,3910724.0)	Clip 2.5 MW, 1.06kg/m3	1075	80	9.703	6.51
Turbine site 11	(269993.0,3910715.0)	Clip 2.5 MW, 1.06kg/m3	1075	80	9.683	6.82
Turbine site 12	(270424.0,3910705.0)	Clip 2.5 MW, 1.06kg/m3	1074	80	9.805	5.74
Turbine site 13	(269110.0,3909680.0)	Clip 2.5 MW, 1.06kg/m3	1075	80	9.906	4.65
Turbine site 14	(269541.0,3909668.0)	Clip 2.5 MW, 1.06kg/m3	1075	80	9.756	6.25
Turbine site 15	(269972.0,3909659.0)	Clip 2.5 MW, 1.06kg/m3	1074	80	9.749	6.32
Turbine site 16	(270403.0,3909649.0)	Clip 2.5 MW, 1.06kg/m3	1073	80	9.854	5.20
Turbine site 17	(266887.0,3907320.0)	Clip 2.5 MW, 1.06kg/m3	1071	80	10.286	0.79
Turbine site 18	(267271.0,3907440.0)	Clip 2.5 MW, 1.06kg/m3	1071	80	10.157	2.10
Turbine site 19	(267657.0,3907559.0)	Clip 2.5 MW, 1.06kg/m3	1071	80	10.116	2.60

Turbine site 20	(268041.0,3907680.0)	Clip 2.5 MW, 1.06kg/m3	1071	80	10.098	2.70

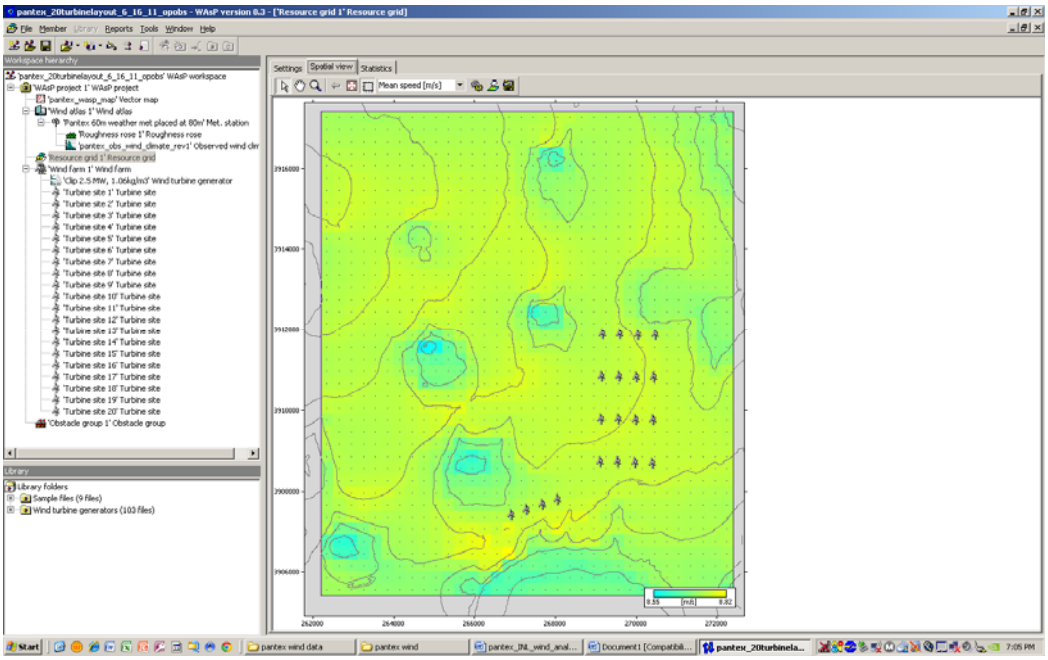
Site wind climates

Site	Location [m]	Height [m a.g.l.]	A [m/s]	k	U [m/s]	E [W/m²]	RIX [%]
Turbine site 1	(269089.0,3908624.0)	80	9.8	2.68	8.75	617	0.0
Turbine site 2	(269520.0,3908613.0)	80	9.9	2.68	8.76	618	0.0
Turbine site 3	(269951.0,3908602.0)	80	9.9	2.68	8.76	619	0.0
Turbine site 4	(270382.0,3908592.0)	80	9.9	2.68	8.76	619	0.0
Turbine site 5	(269152.0,3911791.0)	80	9.8	2.68	8.74	615	0.0
Turbine site 6	(269583.0,3911781.0)	80	9.8	2.68	8.75	618	0.0
Turbine site 7	(270014.0,3911771.0)	80	9.9	2.68	8.77	620	0.0
Turbine site 8	(270445.0,3911761.0)	80	9.8	2.68	8.75	617	0.0
Turbine site 9	(269131.0,3910735.0)	80	9.8	2.68	8.75	618	0.0
Turbine site 10	(269562.0,3910724.0)	80	9.8	2.68	8.76	618	0.0
Turbine site 11	(269993.0,3910715.0)	80	9.9	2.68	8.76	620	0.0
Turbine site 12	(270424.0,3910705.0)	80	9.9	2.68	8.77	621	0.0
Turbine site 13	(269110.0,3909680.0)	80	9.9	2.68	8.76	619	0.0
Turbine site 14	(269541.0,3909668.0)	80	9.9	2.68	8.77	621	0.0
Turbine site 15	(269972.0,3909659.0)	80	9.9	2.68	8.77	621	0.0
Turbine site 16	(270403.0,3909649.0)	80	9.9	2.68	8.77	620	0.0
Turbine site 17	(266887.0,3907320.0)	80	9.8	2.69	8.75	615	0.0
Turbine site 18	(267271.0,3907440.0)	80	9.8	2.69	8.75	616	0.0
Turbine site 19	(267657.0,3907559.0)	80	9.9	2.69	8.76	618	0.0
Turbine site 20	(268041.0,3907680.0)	80	9.8	2.69	8.76	617	0.0

The wind farm lies in a map called 'pantex_wasp_map'.



The wind farm is in a project called 'WAsP project 1'
A wind atlas called 'Wind atlas 1' was used to calculate the predicted wind climates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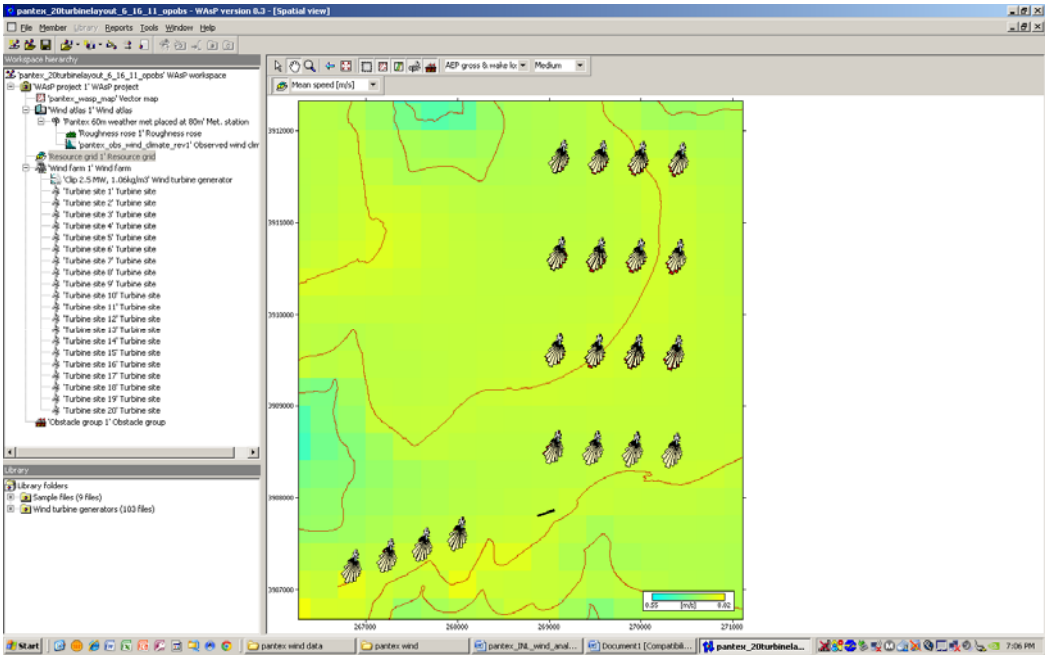
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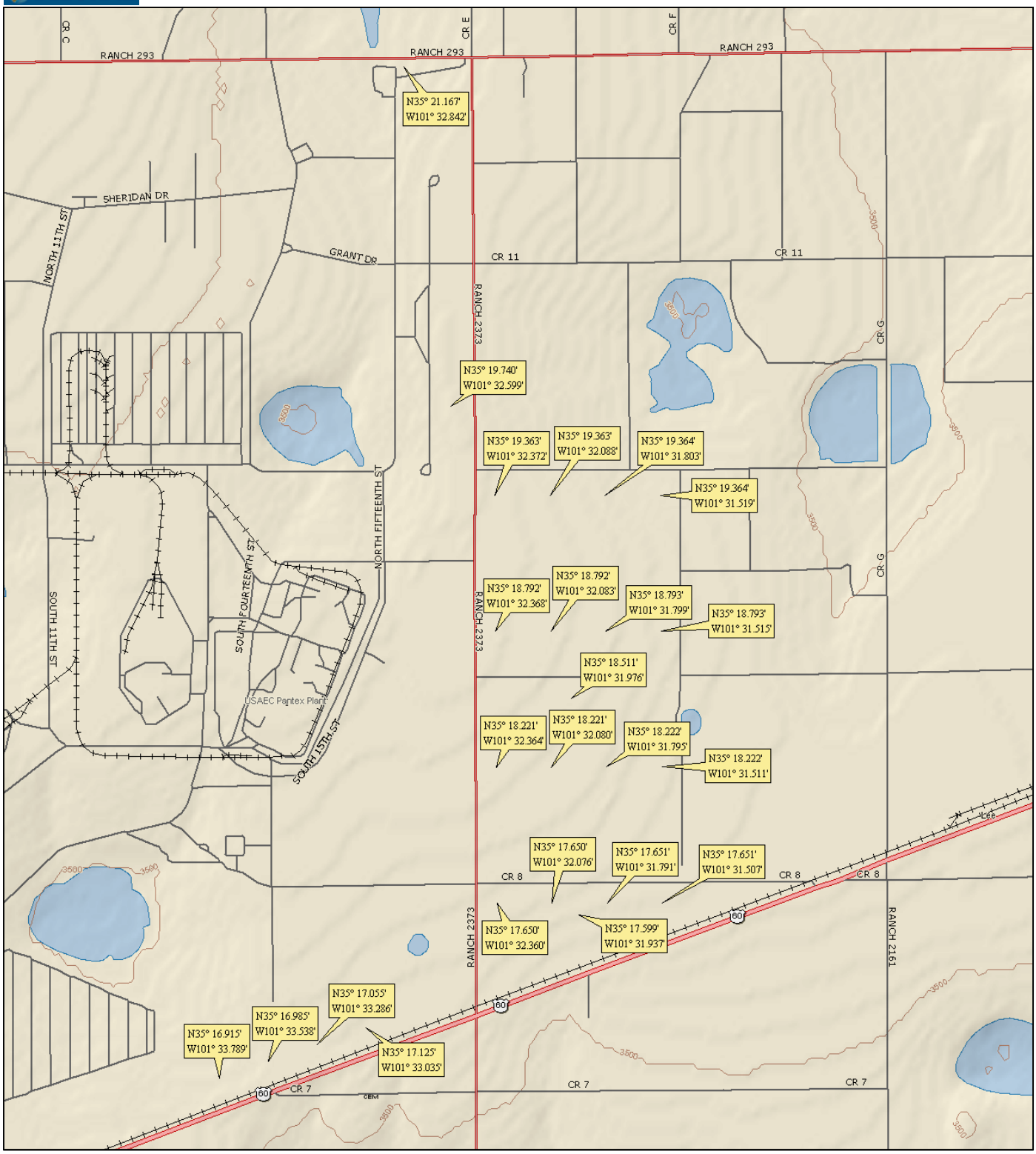

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MN (6.7°E)

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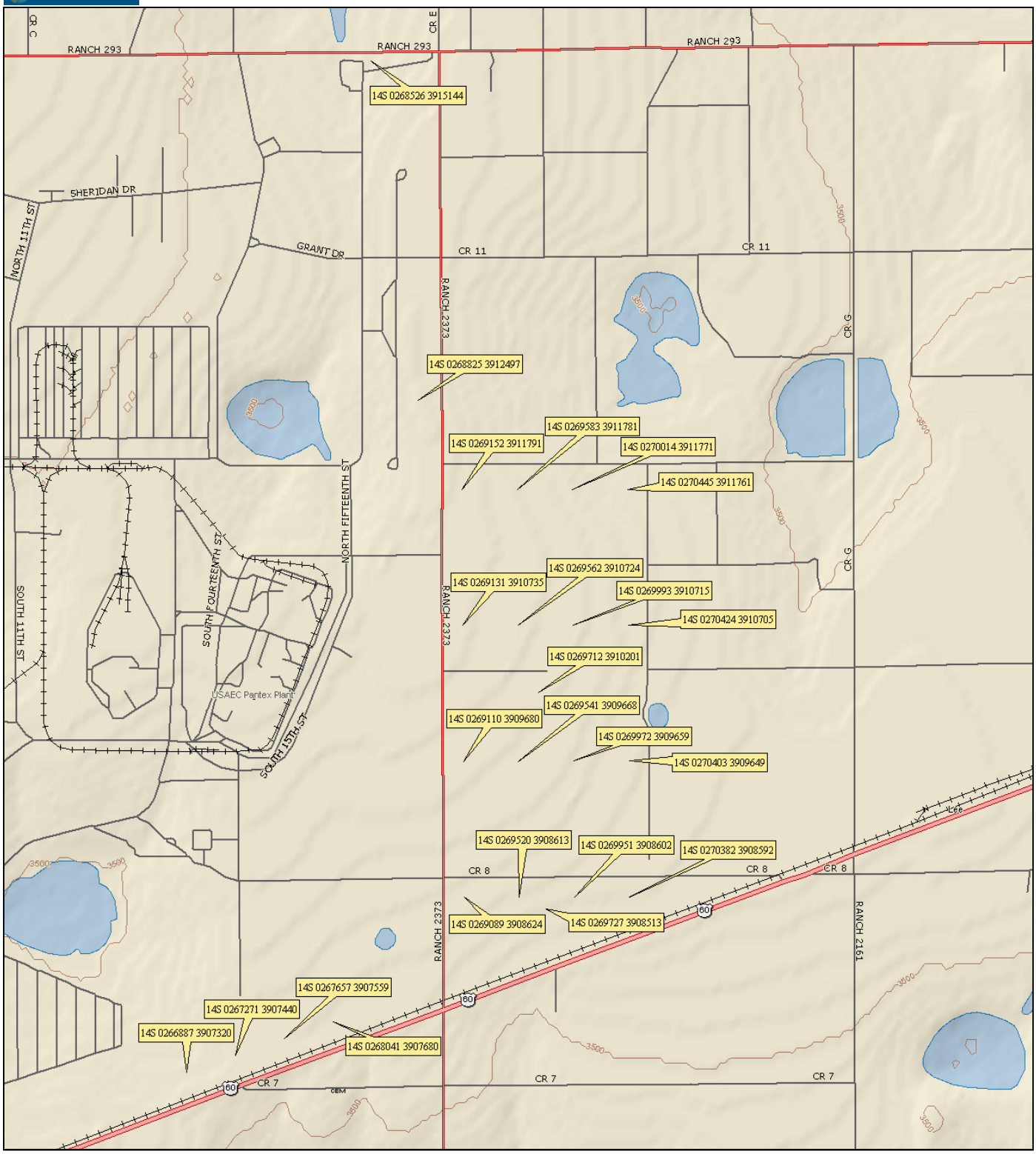

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TN

MN (6.7°E)

Data Zoom 12-5

'Wind farm 1' wind farm

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Summary results

Parameter	Total	Average	Minimum	Maximum
Net AEP [GWh]	208.496	8.340	8.093	8.700
Gross AEP [GWh]	219.822	8.793	8.766	8.818
Wake loss [%]	5.15	-	-	-

Site results

Site	Location [m]	Turbine	Elevation [m a.s.l.]	Height [m a.g.l.]	Net AEP [GWh]	Wake loss [%]
Turbine site 1	(269089.0,3908624.0)	Suzlon 2.1 MW, 1.06kg/m3	1072	80	8.533	2.84
Turbine site 2	(269411.0,3908616.0)	Suzlon 2.1 MW, 1.06kg/m3	1072	80	8.438	3.97
Turbine site 3	(269735.0,3908608.0)	Suzlon 2.1 MW, 1.06kg/m3	1071	80	8.417	4.26
Turbine site 4	(270058.0,3908600.0)	Suzlon 2.1 MW, 1.06kg/m3	1071	80	8.437	4.09
Turbine site 5	(270382.0,3908592.0)	Suzlon 2.1 MW, 1.06kg/m3	1071	80	8.505	3.29
Turbine site 6	(269152.0,3911791.0)	Suzlon 2.1 MW, 1.06kg/m3	1075	80	8.424	3.90
Turbine site 7	(269475.0,3911784.0)	Suzlon 2.1 MW, 1.06kg/m3	1075	80	8.267	5.82
Turbine site 8	(269798.0,3911776.0)	Suzlon 2.1 MW, 1.06kg/m3	1075	80	8.212	6.64
Turbine site 9	(270121.0,3911768.0)	Suzlon 2.1 MW, 1.06kg/m3	1074	80	8.206	6.70
Turbine site 10	(270445.0,3911761.0)	Suzlon 2.1 MW, 1.06kg/m3	1072	80	8.266	5.84
Turbine site 11	(269131.0,3910735.0)	Suzlon 2.1 MW, 1.06kg/m3	1075	80	8.339	5.07
Turbine site 12	(269454.0,3910728.0)	Suzlon 2.1 MW, 1.06kg/m3	1075	80	8.158	7.16
Turbine site 13	(269776.0,3910720.0)	Suzlon 2.1 MW,	1075	80	8.093	7.96

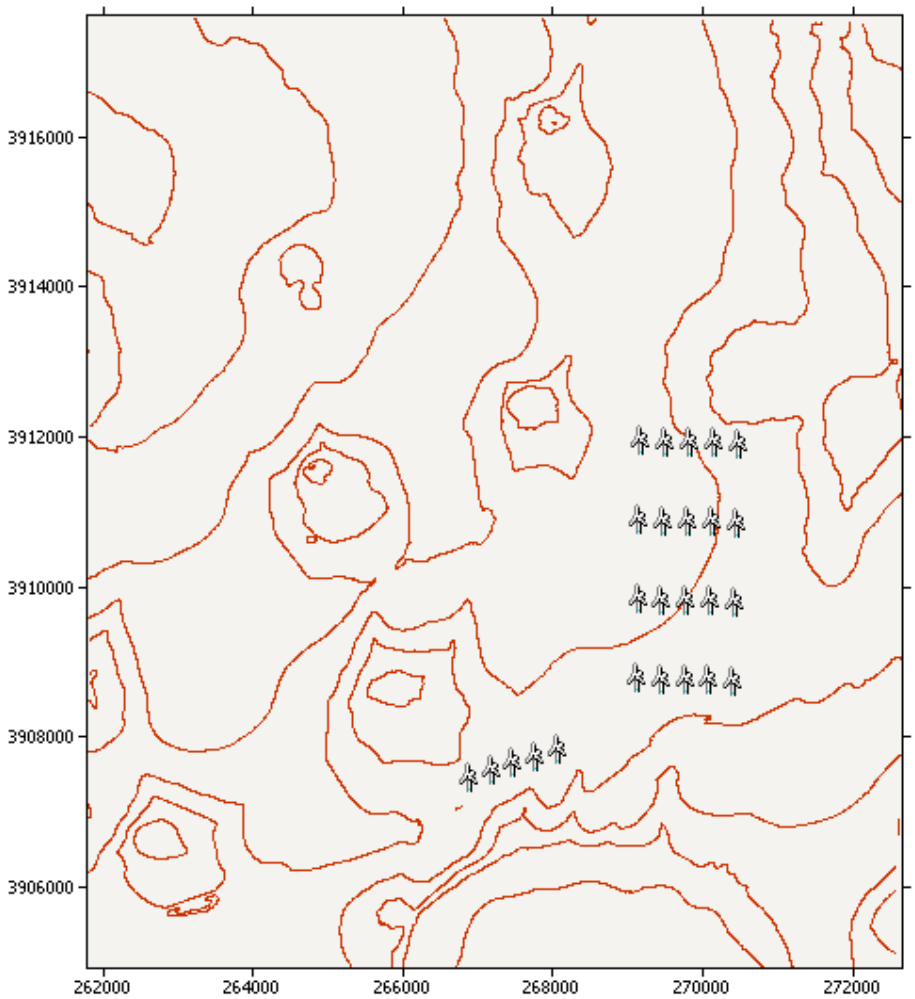
		1.06kg/m3				
Turbine site 14	(270100.0,3910712.0)	Suzlon 2.1 MW, 1.06kg/m3	1075	80	8.125	7.74
Turbine site 15	(270424.0,3910705.0)	Suzlon 2.1 MW, 1.06kg/m3	1074	80	8.232	6.54
Turbine site 16	(269110.0,3909680.0)	Suzlon 2.1 MW, 1.06kg/m3	1075	80	8.355	5.03
Turbine site 17	(269432.0,3909672.0)	Suzlon 2.1 MW, 1.06kg/m3	1075	80	8.189	7.03
Turbine site 18	(269756.0,3909664.0)	Suzlon 2.1 MW, 1.06kg/m3	1075	80	8.143	7.65
Turbine site 19	(270079.0,3909657.0)	Suzlon 2.1 MW, 1.06kg/m3	1074	80	8.160	7.37
Turbine site 20	(270403.0,3909649.0)	Suzlon 2.1 MW, 1.06kg/m3	1073	80	8.266	6.09
Turbine site 21	(266850.0,3907308.0)	Suzlon 2.1 MW, 1.06kg/m3	1072	80	8.700	0.94
Turbine site 22	(267148.0,3907401.0)	Suzlon 2.1 MW, 1.06kg/m3	1071	80	8.557	2.58
Turbine site 23	(267446.0,3907494.0)	Suzlon 2.1 MW, 1.06kg/m3	1071	80	8.507	3.23
Turbine site 24	(267743.0,3907587.0)	Suzlon 2.1 MW, 1.06kg/m3	1071	80	8.481	3.56
Turbine site 25	(268041.0,3907680.0)	Suzlon 2.1 MW, 1.06kg/m3	1071	80	8.485	3.46

Site wind climates

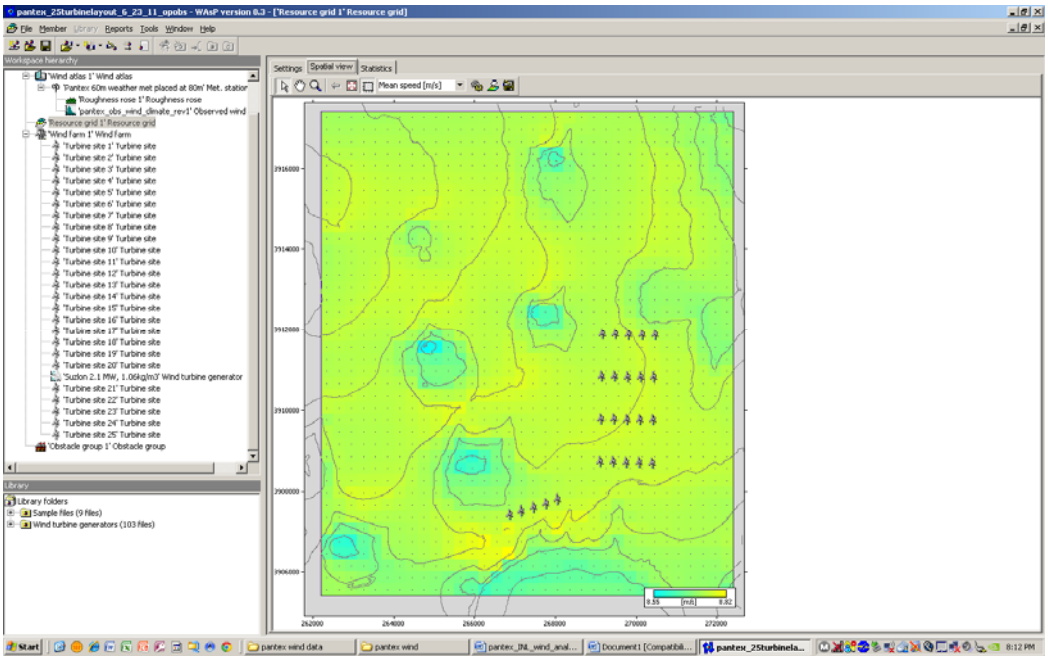
Site	Location [m]	Height [m a.g.l.]	A [m/s]	k	U [m/s]	E [W/m²]	RIX [%]
Turbine site 1	(269089.0,3908624.0)	80	9.8	2.68	8.75	617	0.0
Turbine site 2	(269411.0,3908616.0)	80	9.8	2.68	8.76	618	0.0
Turbine site 3	(269735.0,3908608.0)	80	9.9	2.68	8.76	619	0.0
Turbine site 4	(270058.0,3908600.0)	80	9.9	2.68	8.76	619	0.0
Turbine site 5	(270382.0,3908592.0)	80	9.9	2.68	8.76	619	0.0
Turbine site 6	(269152.0,3911791.0)	80	9.8	2.68	8.74	615	0.0
Turbine site 7	(269475.0,3911784.0)	80	9.8	2.68	8.75	617	0.0

Turbine site 8	(269798.0,3911776.0)	80	9.9	2.68	8.76	619	0.0
Turbine site 9	(270121.0,3911768.0)	80	9.9	2.68	8.76	619	0.0
Turbine site 10	(270445.0,3911761.0)	80	9.8	2.68	8.75	617	0.0
Turbine site 11	(269131.0,3910735.0)	80	9.8	2.68	8.75	618	0.0
Turbine site 12	(269454.0,3910728.0)	80	9.8	2.68	8.76	618	0.0
Turbine site 13	(269776.0,3910720.0)	80	9.9	2.68	8.76	619	0.0
Turbine site 14	(270100.0,3910712.0)	80	9.9	2.68	8.77	620	0.0
Turbine site 15	(270424.0,3910705.0)	80	9.9	2.68	8.77	621	0.0
Turbine site 16	(269110.0,3909680.0)	80	9.9	2.68	8.76	619	0.0
Turbine site 17	(269432.0,3909672.0)	80	9.9	2.68	8.77	621	0.0
Turbine site 18	(269756.0,3909664.0)	80	9.9	2.68	8.77	622	0.0
Turbine site 19	(270079.0,3909657.0)	80	9.9	2.68	8.77	621	0.0
Turbine site 20	(270403.0,3909649.0)	80	9.9	2.68	8.77	620	0.0
Turbine site 21	(266850.0,3907308.0)	80	9.8	2.69	8.75	615	0.0
Turbine site 22	(267148.0,3907401.0)	80	9.8	2.69	8.75	616	0.0
Turbine site 23	(267446.0,3907494.0)	80	9.8	2.69	8.76	617	0.0
Turbine site 24	(267743.0,3907587.0)	80	9.9	2.69	8.76	618	0.0
Turbine site 25	(268041.0,3907680.0)	80	9.8	2.69	8.76	617	0.0

The wind farm lies in a map called 'pantex_wasp_map'.



The wind farm is in a project called 'WAsP project 1'
A wind atlas called 'Wind atlas 1' was used to calculate the predicted wind climates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File Member Library Reports Tools Window Help
Workspace hierarchy
'Wind atlas 1' Wind atlas
'Pantex 60m weather met placed at 80m' Met. station
'Roughness rose 1' Roughness rose
'pantex_obs_wind_climate_rev1' Observed wind
'Resource grid 1' Resource grid
'Wind farm 1' Wind farm
'Turbine site 1' Turbine site
'Turbine site 2' Turbine site
'Turbine site 3' Turbine site
'Turbine site 4' Turbine site
'Turbine site 5' Turbine site
'Turbine site 6' Turbine site
'Turbine site 7' Turbine site
'Turbine site 8' Turbine site
'Turbine site 9' Turbine site
'Turbine site 10' Turbine site
'Turbine site 11' Turbine site
'Turbine site 12' Turbine site
'Turbine site 13' Turbine site
'Turbine site 14' Turbine site
'Turbine site 15' Turbine site
'Turbine site 16' Turbine site
'Turbine site 17' Turbine site
'Turbine site 18' Turbine site
'Turbine site 19' Turbine site
'Turbine site 20' Turbine site
'Suzlon 2.1 MW, 1.06kg/m3' Wind turbine generator
'Turbine site 21' Turbine site
'Turbine site 22' Turbine site
'Turbine site 23' Turbine site
'Turbine site 24' Turbine site
'Turbine site 25' Turbine site
'Obstacle group 1' Obstacle group
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Library folders
Sample files (9 files)
Wind turbine generators (103 files)
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3916000
3914000
3912000
3910000
3908000
3906000
262000
264000
266000
268000
270000
272000
[m/s]
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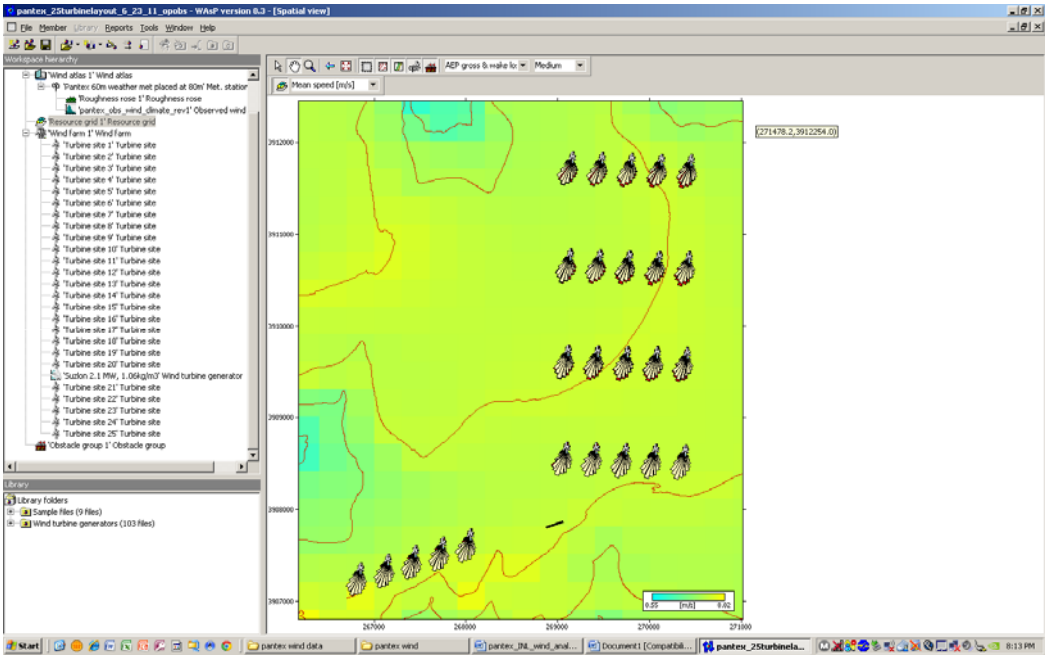
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File Member Library Reports Tools Window Help
Workspace hierarchy
'Wind atlas 1' Wind atlas
'Pantex 60m weather met placed at 80m' Met. station
'Roughness rose 1' Roughness rose
'pantex_obs_wind_climate_rev1' Observed wind
'Resource grid 1' Resource grid
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'Turbine site 1' Turbine site
'Turbine site 2' Turbine site
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'Turbine site 20' Turbine site
'Suzlon 2.1 MW, 1.06kg/m3' Wind turbine generator
'Turbine site 21' Turbine site
'Turbine site 22' Turbine site
'Turbine site 23' Turbine site
'Turbine site 24' Turbine site
'Turbine site 25' Turbine site
'Obstacle group 1' Obstacle group
Library
Library folders
Sample files (9 files)
Wind turbine generators (103 files)
AEP gross & wake lo
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Mean speed [m/s]
(271478.2,3912254.0)
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3911000
3910000
3909000
3908000
3907000
267000
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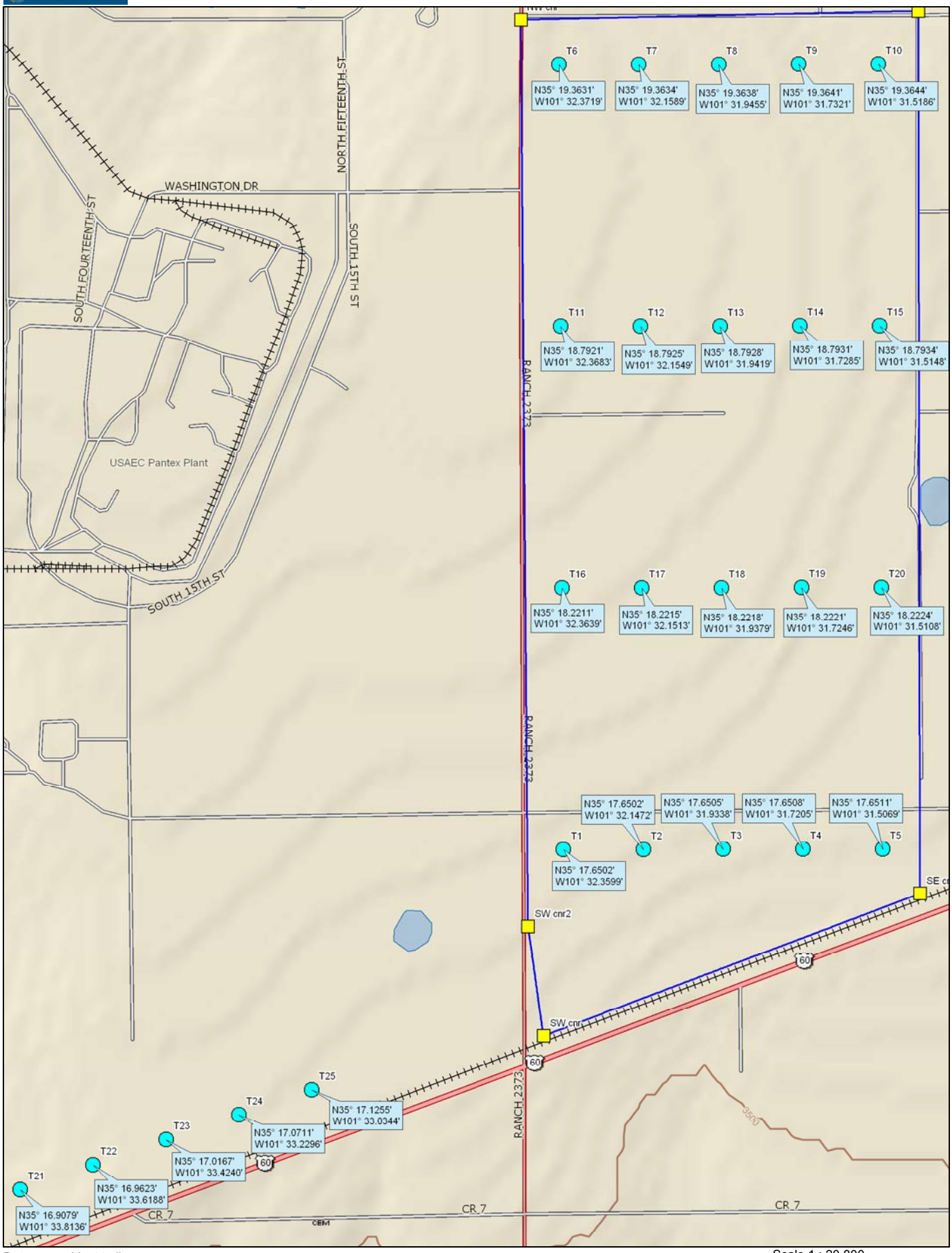

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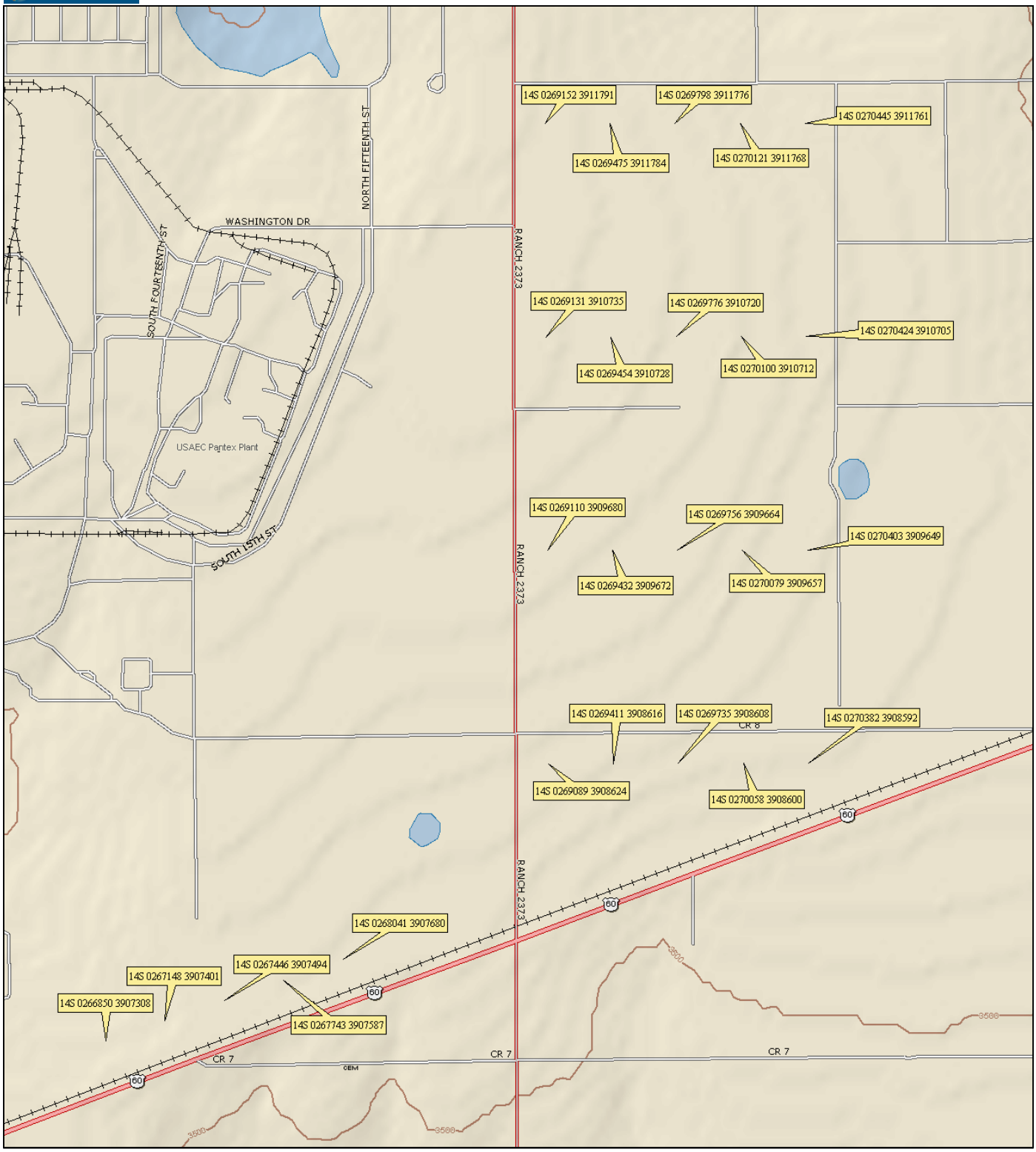
TN

MN (7.0°E)

Scale 1 : 20,800

1" = 1,733.3 ft

Data Zoom 13-3



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TN

MN (6.7°E)

0 800 1600 2400 3200 4000 ft

0 200 400 600 800 1000 m

Data Zoom 13-2

Wind Analysis Summary Report

Site Number

Triton 135

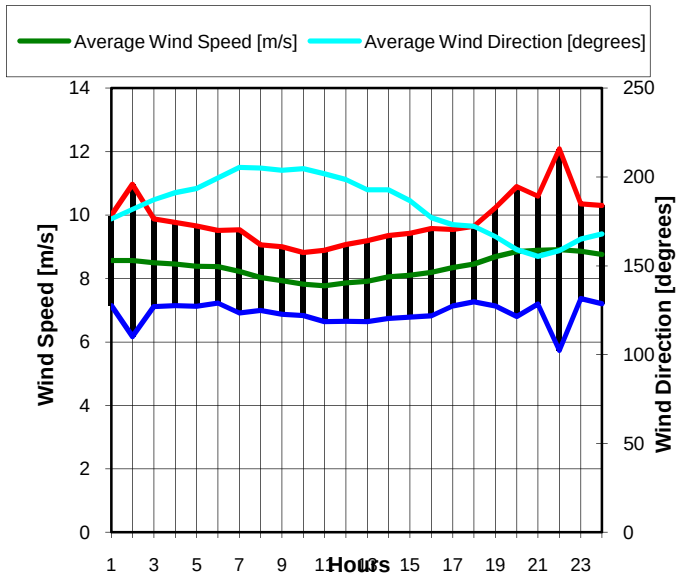
Site Information

Project:	Pantex	
Location:	Pantex Triton 135	
Site Elevation:	1071 m	3513.951 ft
Averaging Time:	10 min	
Date Range:	2/17/10 18:10-2/8/11 21:20	

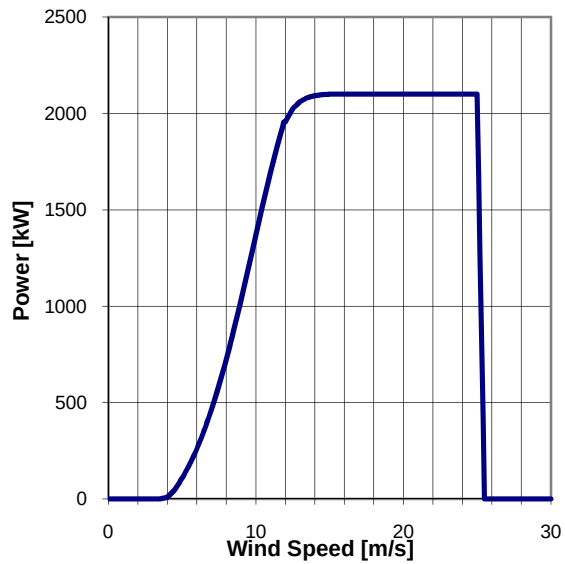
Sensor Information

Sensor/Tower Height:	60 m
Scaled Height:	80 m
Windvane Offset:	0 degrees

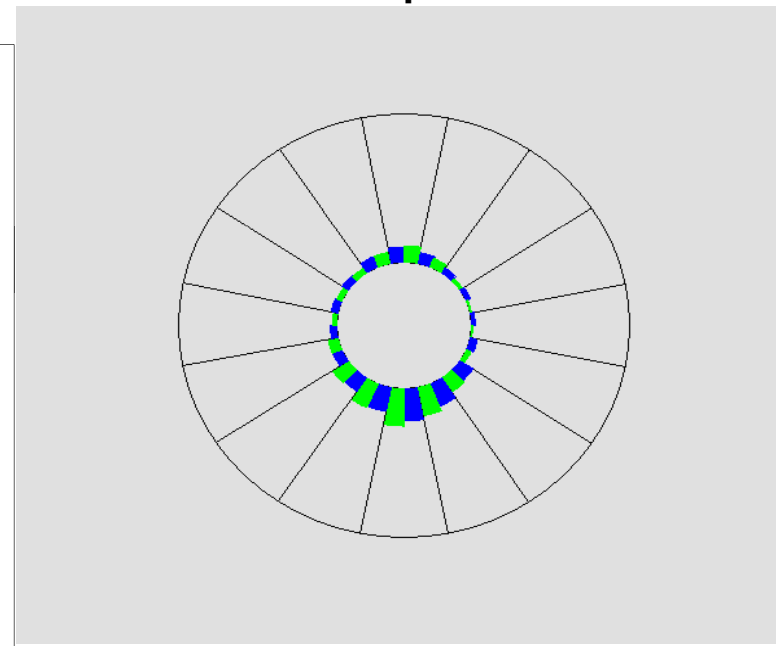
Diurnal Wind Speed Pattern



Suzlon S88, 88m rotor (1.06 kg/m3)



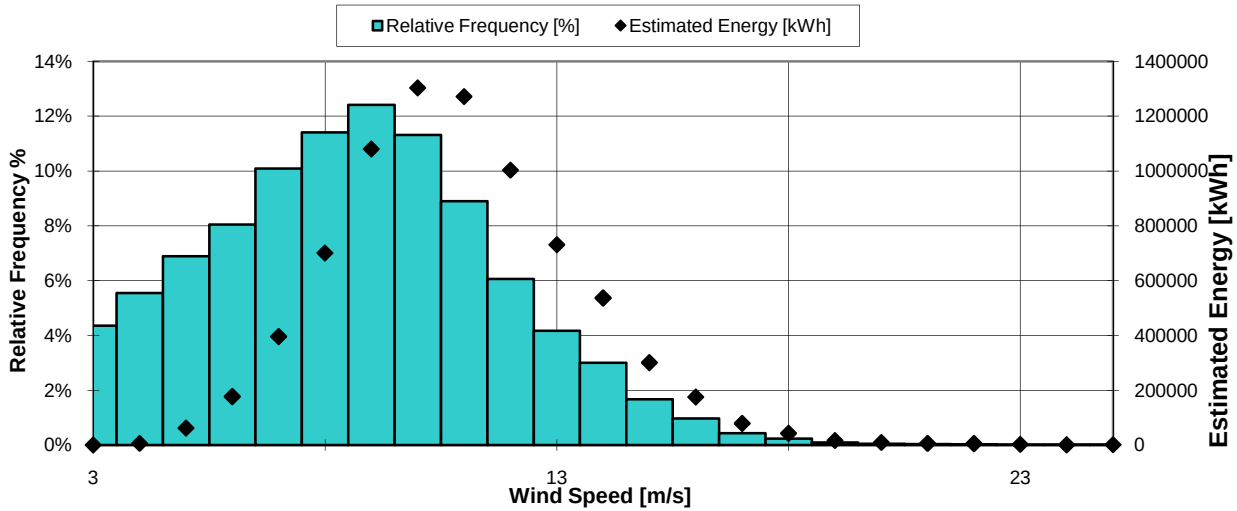
Wind Rose Graph



Percent of Total Wind Energy — Inner Circle = 0%

Percent of Total Time — Outer Circle = 70%

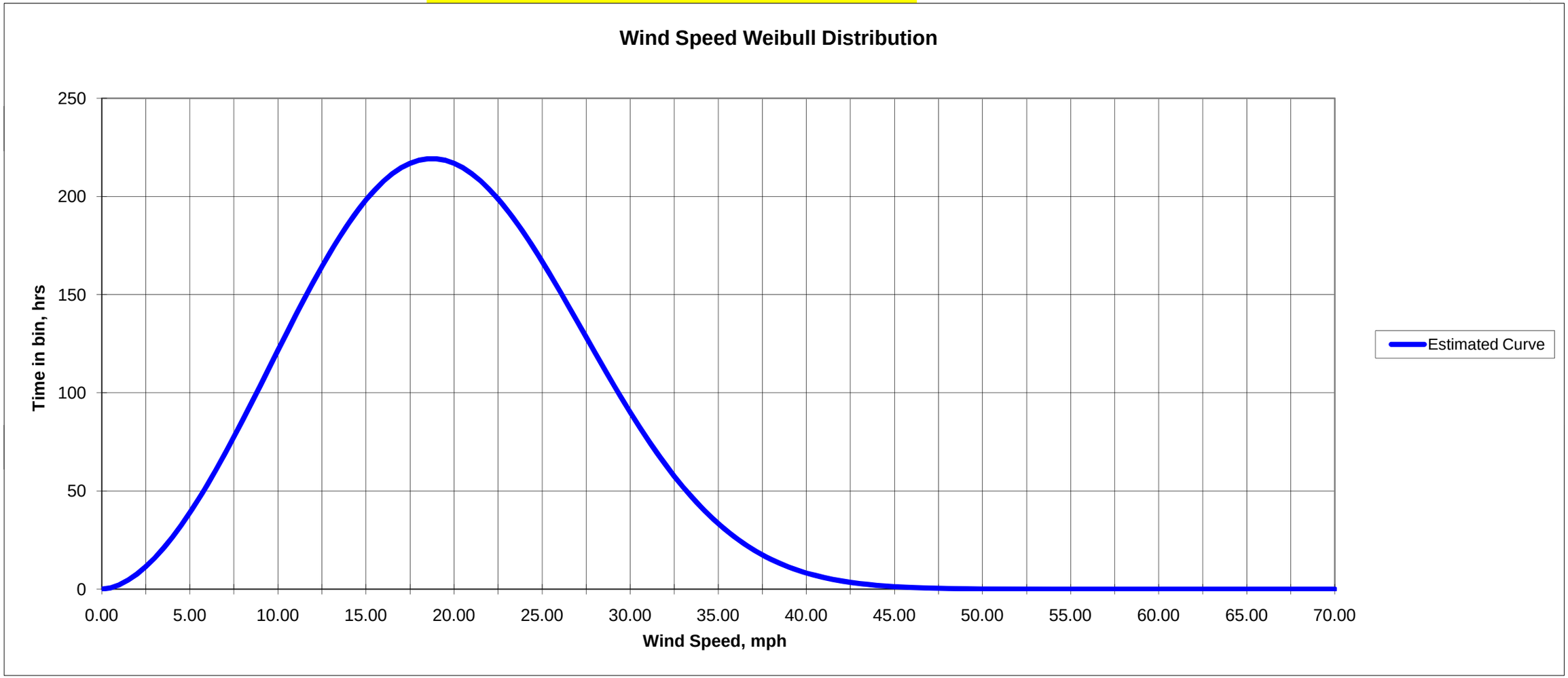
Frequency Distribution Graph



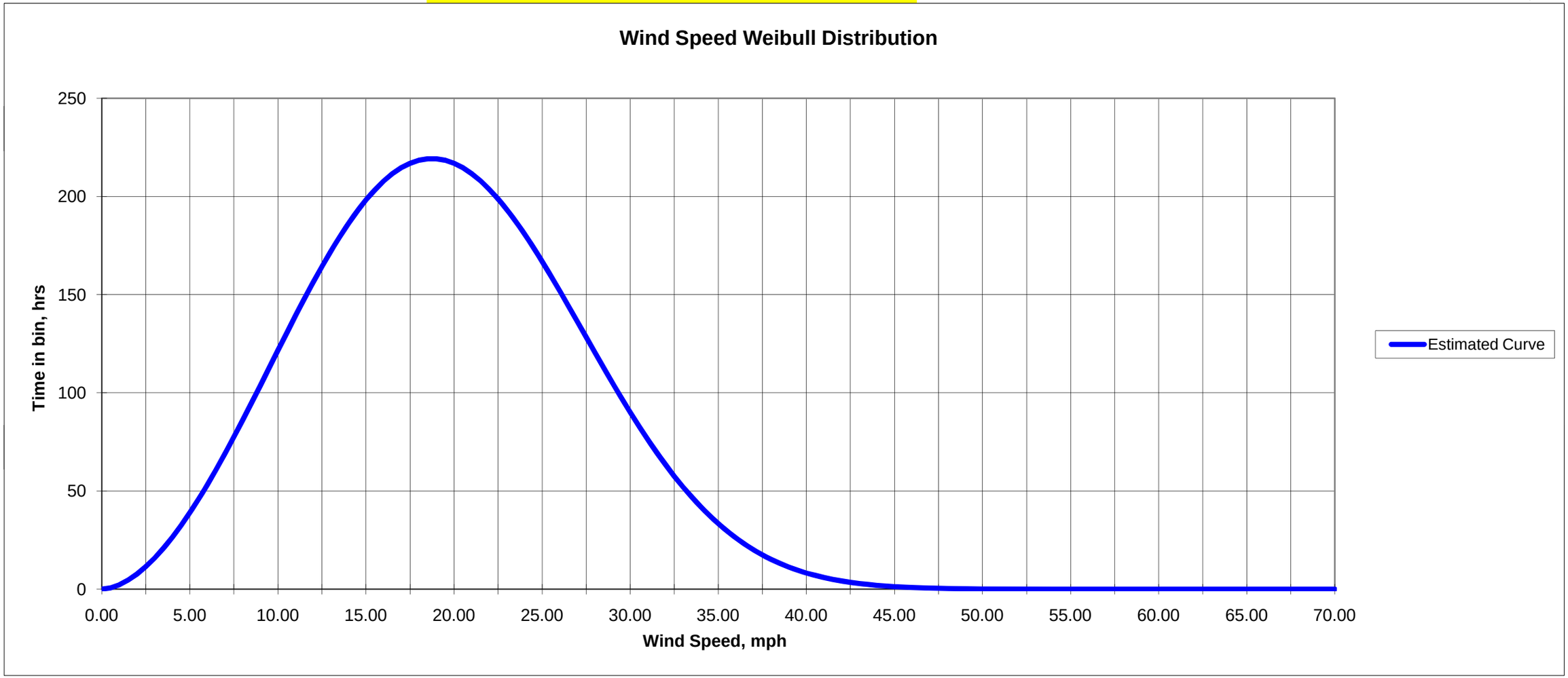
Statistics

Days Used in Calculation:	355.60
Hours Used in Calculation:	8534.50
Gust Speed:	39.77 m/s
Gust Time:	6/24/2010 21:30
Estimated Energy Output:	7905200 kWh
Calculated Air Density:	1.098 kg/m^3
Average Wind Speed:	8.37 m/s
Average Wind Direction:	184 degrees
Capacity Factor:	0.44
Turbine Manufacturer:	Suzlon
Turbine Model:	Suzlon S88, 88m rotor (1.06 kg/m3)
Turbine Rating:	2100 kW
Estimated Annual Production:	8114072 kWh/Year
Scaled Est. Annual Producion:	8915427 kWh/Year
Scaled Air Density:	1.089 kg/m^3
Scaled Capacity Factor:	0.48

shape alpha =	2.78	hours	scale beta (metric) =	Enter number to choose power curve:	1 = GE 1.5MW, 70.5m rotor, 1.225kg/m3
scale beta =	22.00437081	8760.00	9.836553783	8	2 = GE 1.5MW, 70.5m rotor, 1.12kg/m3
Enter Mean, in mph	Anemometer height, m				3 = GE 1.5MW, 70.5m rotor, 1.02kg/m3
18.60	**60**	Total Gross Energy Production	Capacity factor		4 = GE 1.5MW, 77m rotor, 1.225kg/m3
Scaled Mean, in mph	Scaled hub height, m	8746283.005	47.5445%		5 = GE 1.5MW, 77m rotor, 1.12kg/m3
19.58853319	**80**				6 = GE 1.5MW, 77m rotor, 1.02kg/m3
Scaled Mean, in m/s		Estimated Wind Shear	Site Elevation (in feet)	Calculated Air Density average [kg/m^3], based on elevation	7 = GE 1.5MW, 77m rotor, 1.06kg/m3
8.75660849		0.18	3800	1.088	8 = Suzlon 2.1MW, 88m rotor (1.06 kg/m3)



shape alpha =	2.78	hours	scale beta (metric) =	Enter number to choose power curve:	1 = GE 1.5MW, 70.5m rotor, 1.225kg/m3
scale beta =	22.00437081	8760.00	9.836553783	7	2 = GE 1.5MW, 70.5m rotor, 1.12kg/m3
Enter Mean, in mph	Anemometer height, m				3 = GE 1.5MW, 70.5m rotor, 1.02kg/m3
18.60	**60**	Total Gross Energy Production	Capacity factor		4 = GE 1.5MW, 77m rotor, 1.225kg/m3
Scaled Mean, in mph	Scaled hub height, m	10328233.56	47.1609%		5 = GE 1.5MW, 77m rotor, 1.12kg/m3
19.58853319	**80**				6 = GE 1.5MW, 77m rotor, 1.02kg/m3
Scaled Mean, in m/s		Estimated Wind Shear	Site Elevation (in feet)	Calculated Air Density average [kg/m^3], based on elevation	7 = Clipper C96, 2.5MW, 1.06kg/m3
8.75660849		0.18	3800	1.088	8 = Suzlon 2.1MW, 88m rotor (1.06 kg/m3)



SecondWind Home | Support

SECONDWIND Wind assessment without limits | skySERVE Satellite Wind Data Service

Home > Site Data

Logout

Standard Data | Extended Data | Operational Data | Analysis | Configuration

Show US Units

Site: Triton 135
Time: 6/6/2011 03:20:00 UTC

Latitude: 35.29332
Longitude: -101.53229
Elevation: 1071m

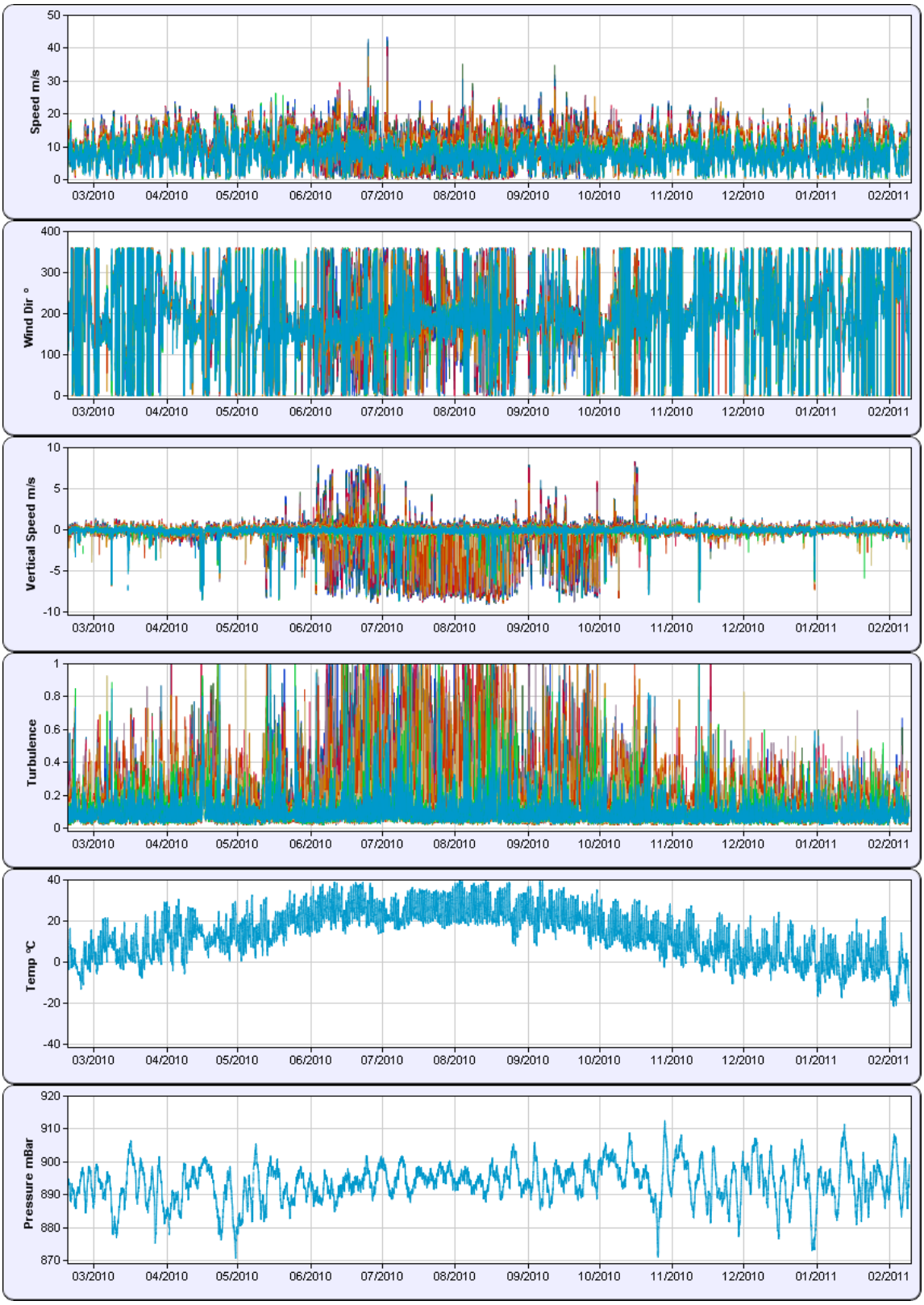
Humidity: 20%
Temperature: 22.8°C
Pressure: 896.4

Q > 75%			
Height	Wind Speed	Wind Direction	Avg. Wind Speed
200m	0.9 m/s	122°[ESE]	8.9 m/s
180m	1.4 m/s	142°[SE]	9.2 m/s
160m	2.4 m/s	129°[ESE]	9.4 m/s
140m	0.9 m/s	174°[SSE]	9.5 m/s
120m	1.2 m/s	165°[SSE]	9.5 m/s
100m	2.2 m/s	97°[E]	9.3 m/s
80m	3 m/s	211°[SSW]	9 m/s
60m	5.6 m/s	180°[S]	8.5 m/s
50m	8.3 m/s	167°[SSE]	8.1 m/s
40m	7.9 m/s	171°[SSE]	7.7 m/s

Start: 2/18/2010 00:00
End: 2/10/2011 00:00
Time selections are in UTC, mm/dd/yyyy
Other: Custom Update

Export

< Prev | Next >



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SECONDWIND Wind assessment without limits | skySERVE Satellite Wind Data Service

Home > Site Data

Logout

Show Metric

Standard Data | Extended Data | Operational Data | Analysis | Configuration

Site: Triton 135
Time: 6/6/2011 03:10:00 UTC

Latitude: 35.29332
Longitude: -101.53229
Elevation: 3512.88ft

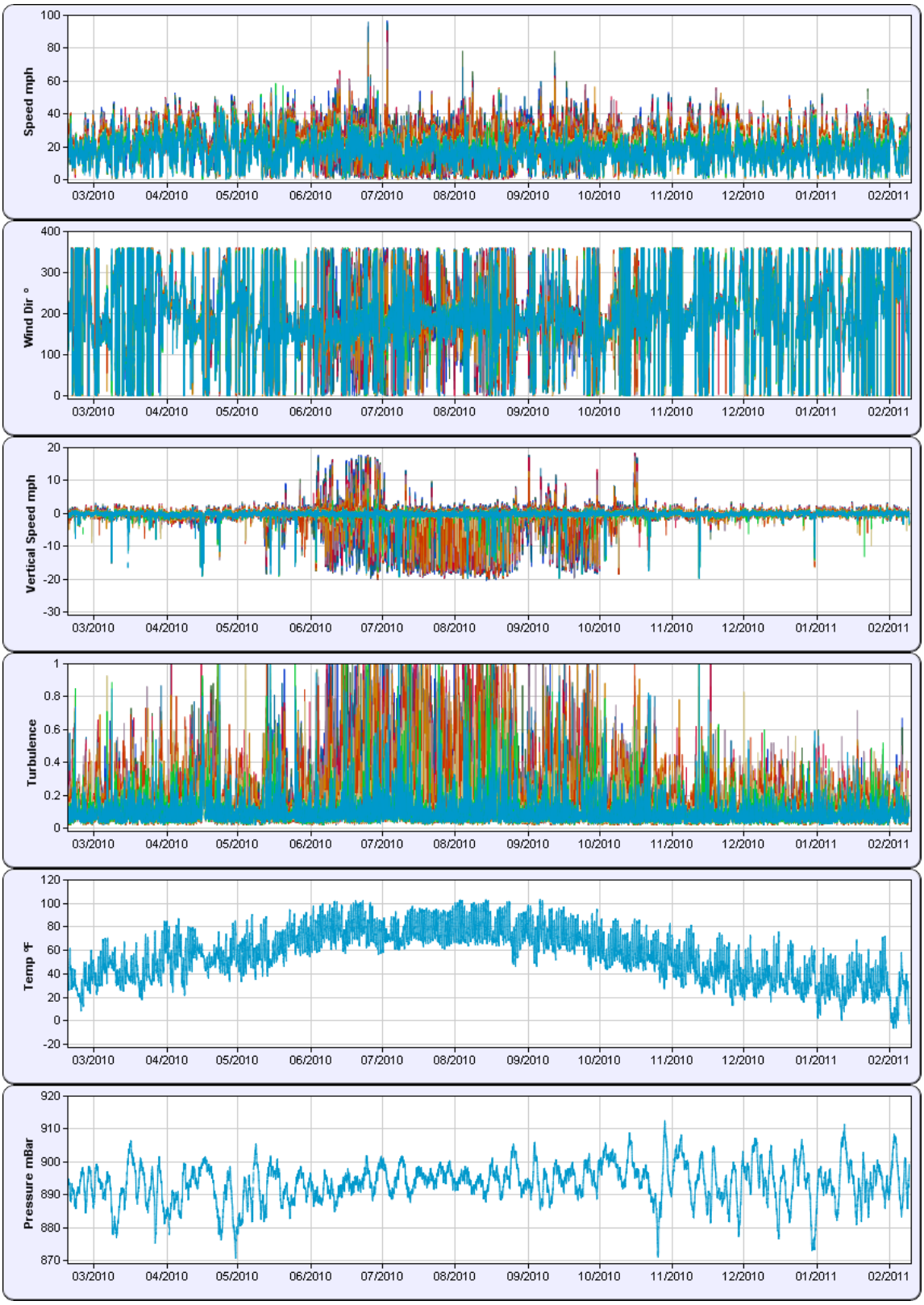
Humidity: 20%
Temperature: 73.8°F
Pressure: 896.3

Q > 75%			
Height	Wind Speed	Wind Direction	Avg. Wind Speed
656ft	5.5 mph	133°[ESE]	19.9 mph
590ft	4.9 mph	136°[SE]	20.6 mph
524ft	8.1 mph	117°[ESE]	21.1 mph
459ft	2.1 mph	132°[ESE]	21.3 mph
393ft	2.6 mph	133°[ESE]	21.2 mph
328ft	6.8 mph	178°[SSE]	20.8 mph
262ft	20.3 mph	11°[N]	20.1 mph
196ft	13.8 mph	149°[SE]	18.9 mph
164ft	17.7 mph	155°[SE]	18.1 mph
131ft	17.7 mph	170°[SSE]	17.1 mph

Start: 2/18/2010 00:00
End: 2/10/2011 00:00
Time selections are in UTC, mm/dd/yyyy
Other: Custom Update

Export

< Prev | Next >



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Home > Site Data

Logout

Standard Data | Extended Data | Operational Data | Analysis | Configuration

Show US Units

Site: Triton 135
Time: 6/8/2011 03:40:00 UTC

Latitude: 35.29332
Longitude: -101.53229
Elevation: 1071m

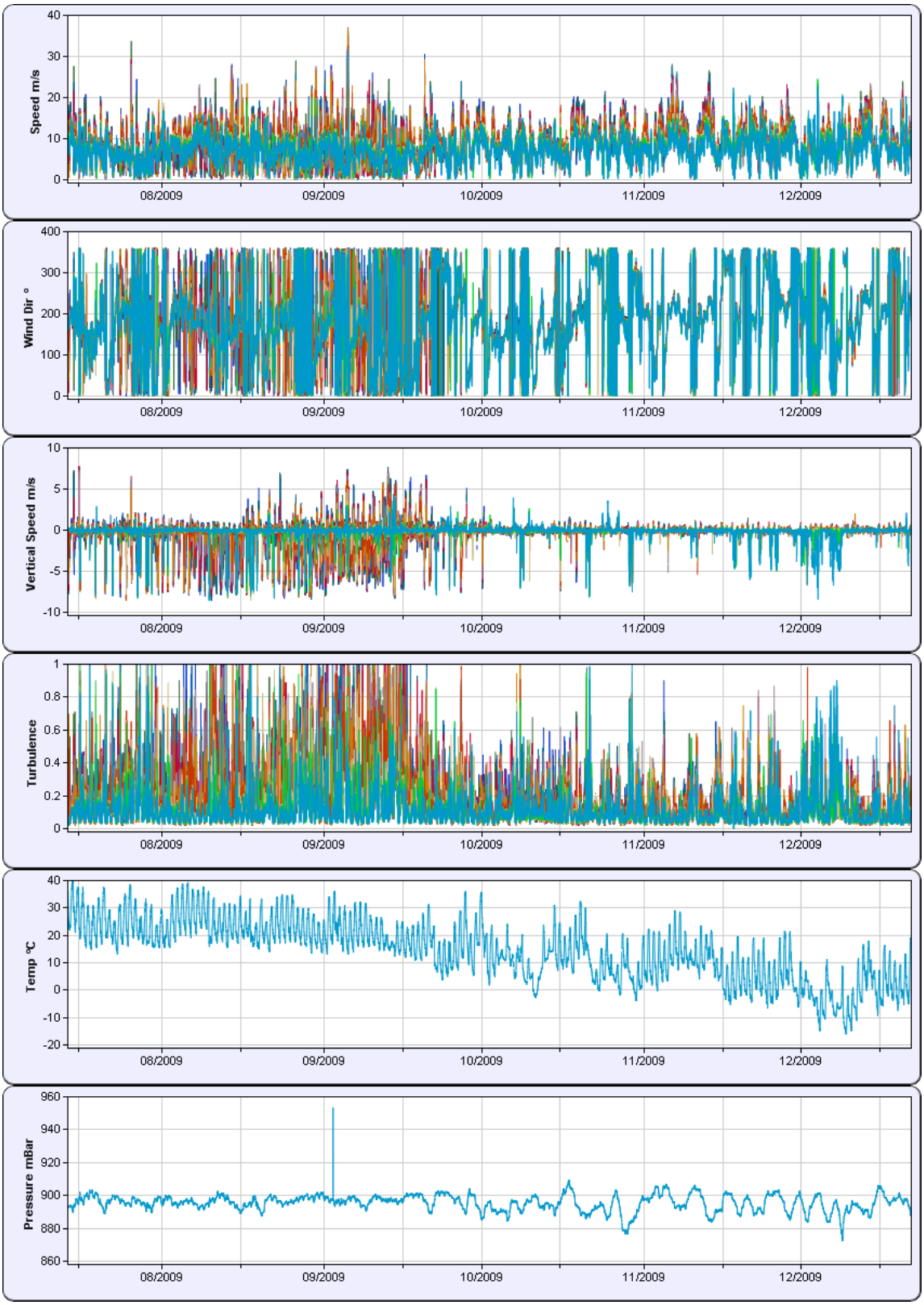
Humidity: 17%
Temperature: 28.5°C
Pressure: 887.4

Q > 75%			
Height	Wind Speed	Wind Direction	Avg. Wind Speed
200m	1.7 m/s	352°[NNW]	8.3 m/s
180m	2.6 m/s	7°[N]	8.6 m/s
160m	2.5 m/s	349°[NNW]	8.7 m/s
140m	2.4 m/s	354°[NNW]	8.7 m/s
120m	4.3 m/s	258°[WSW]	8.7 m/s
100m	15.8 m/s	163°[SSE]	8.6 m/s
80m	14.8 m/s	164°[SSE]	8.3 m/s
60m	13.2 m/s	164°[SSE]	7.8 m/s
50m	12.4 m/s	163°[SSE]	7.5 m/s
40m	11.5 m/s	163°[SSE]	7.2 m/s

Start: 7/14/2009 00:00
End: 12/22/2009 00:00
Time selections are in UTC, mm/dd/yyyy
Other: Custom Update

Export

< Prev | Next >



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SECONDWIND Wind assessment without limits | skySERVE Satellite Wind Data Service

Home > Site Data

Logout

Standard Data | Analysis | Configuration

Show US Units

Site: pantex2-
Time: 3/1/2011 13:50:00 UTC

Latitude: 35.32900
Longitude: -101.54332
Elevation: 1075m

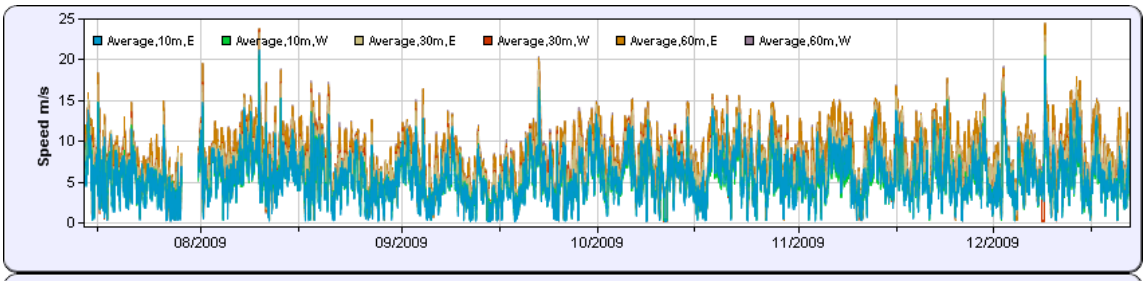
Temperature: 5.5°C
Pressure: 897mB

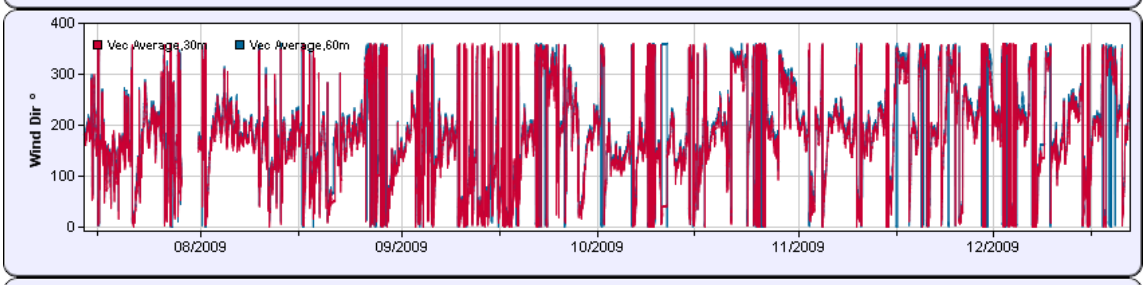
Height	Wind Speed	Wind Direction	Avg. Wind Speed
60m E	14.1 m/s	NA	7.9 m/s
60m W	14.1 m/s	NA	7.9 m/s
60m N	NA	228°[SW]	NA
30m E	11.2 m/s	NA	6.9 m/s
30m W	11.1 m/s	NA	6.8 m/s
30m N	NA	217°[SSW]	NA
10m E	9 m/s	NA	5.6 m/s
10m W	8.7 m/s	NA	5.4 m/s

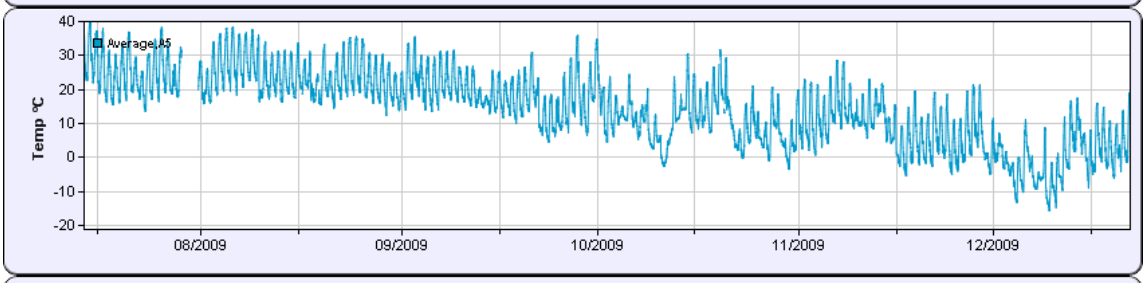
Start: 7/14/2009 00:00
End: 12/22/2009 00:00
Time selections are in UTC, mm/dd/yyyy
Other: Custom Update

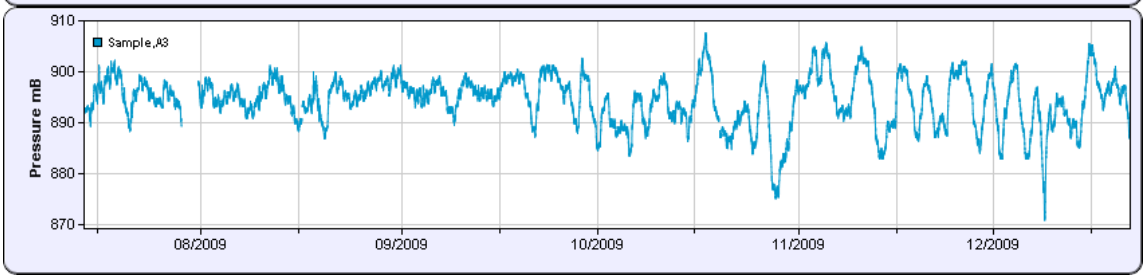
Export

< Prev | Next >









SECONDWIND 366 SUMMER STREET, SOMERVILLE, MA 02144 USA 617-776-9529