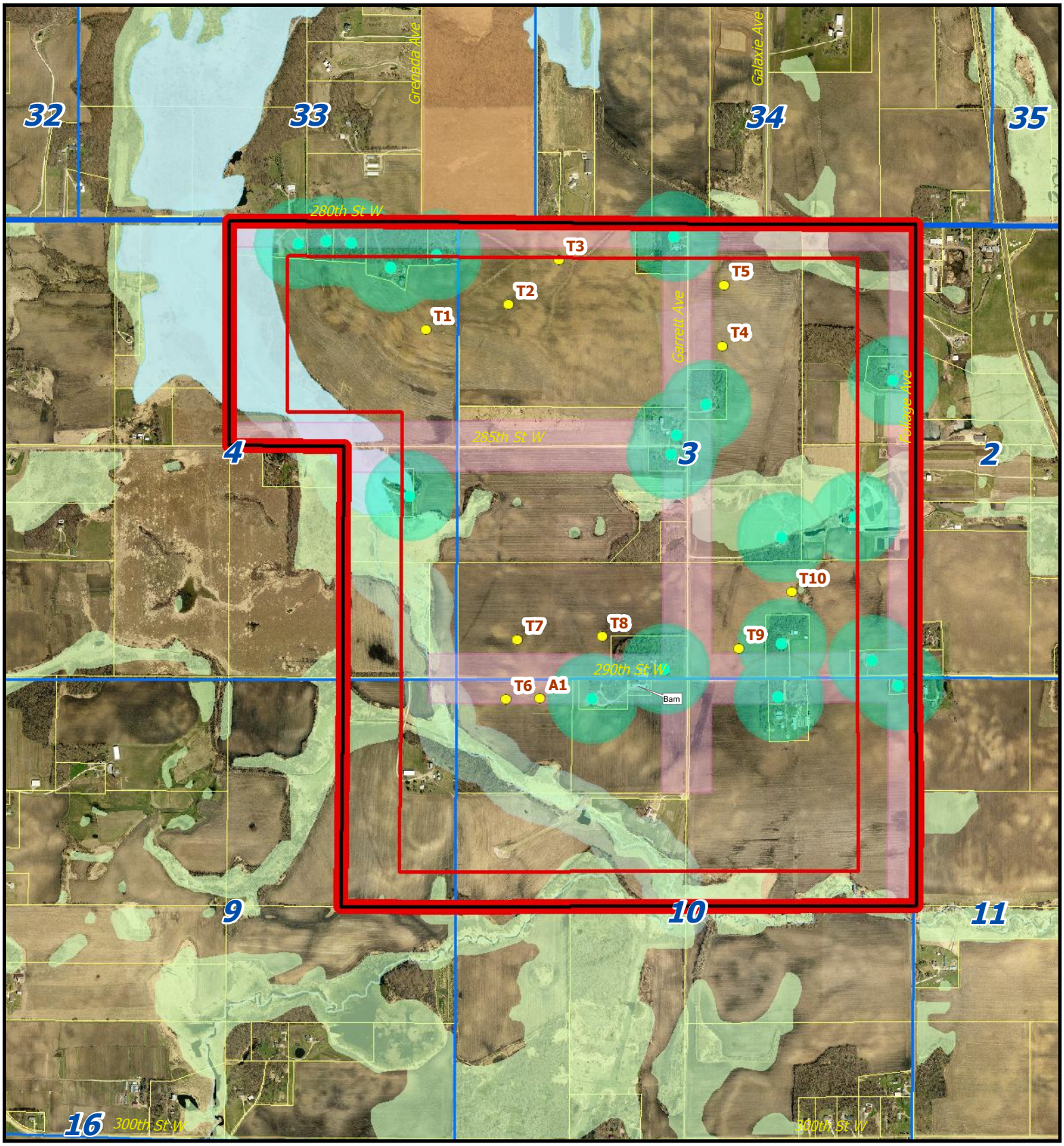


2008 Dakota County Aerial

MAP 2

Bonestroo

N
W E
S

7/6/2009

Study Area = 1,265 Acres

MEDIN RENEWABLE ENERGY LLC
SPARKS ENERGY, LLC

PROJECT SITE MAP

Greenvale Wind Farm

0 750 1,500 3,000
Feet

Data Provide By: Bonestroo, MNDNR, USGS, Dakota County
I:\4820\4820090010\GIS\Projects\Map2.mxd

Legend

- Turbine Locations
- Home Location
- Study Area
- Study Area Setback
- 500' Home Buffer
- 250' ROW Buffer
- County Boundary
- Townships
- 21 Sections
- WMA Boundary
- PWI Waterbody
- NWI Wetland
- PWI Watercourse
- 300' Chubb Creek Buffer

ATTACHMENT B

EXECUTIVE SUMMARY

To simulate wind flow patterns for the Northfield One site, WindLogics performed a detailed modeling process, consisting of a mesoscale model to simulate the large scale weather patterns and a wind flow model to resolve small scale terrain and land features, with a final resolution of 50 m. The model output was normalized to long-term climatic means using E-MCP. The results show a longterm wind resource of 7.50 m/s at 70 m above ground level at the Tower 1 location.

The long-term wind speed results were applied to the Nordic Windpower N1000 - 59m Rotor power curve, showing an estimated gross energy production of 2833 MWh/yr, which corresponds to a 32% gross capacity factor at the Tower 1 location.

1. INTRODUCTION

Medin Renewable Energy, LLC/Sparks Energy, LLC engaged WindLogics to assess the wind resource at the Northfield One site for the purposes of wind energy generation. This report contains a long-term estimation of the wind

resource at a hub height of 70 meters above ground level (m AGL), for the entire Northfield One site, including wind characteristics for one ”virtual tower” location. See Table 1 and appendix A. The site is located roughly 9 kilometers (km) northwest of the city of Northfield, Minnesota in Dakota County.

Tower	Latitude (WGS 84)	Longitude (WGS 84)	Elevation (meters AMSL)
Tower 1	N 44.52904	W 93.21595	306

Table 1: Virtual Tower Location

In addition to a thorough meteorological analysis of the site, WindLogics used archived weather data resources and physics-based numerical simulations (weather models) to calculate wind flow patterns at the site for twelve representative months from 2007 – 2009. These short-term model results were applied to the customer-specified manufacturer’s turbine power curve, and then statistically processed (“normalized”) to reflect long-term wind distributions using an additional forty years (1969 – 2008) of archived weather data. This combination of meteorological modeling and normalization provides the best available assessment of the long-term wind resource at the site.

2. SITE DESCRIPTION

2.1 Topography

The Northfield One site is characterized as generally flat, with areas of slightly rolling terrain.

Site elevations range from roughly 283 to 344 m Above Mean Sea Level (AMSL), with the land generally rising when moving from southeast to northwest. The topography can be characterized as generally flat, with areas of gently rolling terrain. Small rivers and creeks are observed in many locations, but the depressions they cut in the terrain appear shallow (5-20m) and likely do not significantly influence the flow of winds near the surface.

Taking a broader view of the topography (out to a radius of roughly 80 km), the terrain maintains the same general characteristics as the site in the all directions. Towards the east and west, as the Mississippi and Minnesota Rivers are approached, the terrain becomes higher and slightly more variable.

2.2 Land Characteristics and Vegetation

Land characteristics in the vicinity of the site include farmland and narrow areas of increased vegetation along rivers and creeks. This area appears void of significant tree growth. As a result, seasonal changes in deciduous vegetation have little impact on near-surface wind flow.

This is an area that does experience periods of snow cover during the winter. A barren winter terrain has a lower roughness length than the same land in summer. Roughness length is a derived quantity that is used to describe the effect the surface of the earth has on slowing near-surface winds. Despite the seasonality of the area, the current land use suggests roughness length changes during the year will be of little consequence in evaluating the wind resource. This is a site where the large-scale, synoptic weather patterns, as opposed to localized terrain influences, will determine the nature of the wind resource.

2.3 Meteorological Overview

Jet stream location and related tracks of large-scale weather systems are the main drivers of the low level winds at the Northfield One site.

The meteorology of the Upper Midwest is dominated by the location and strength of the jet stream and the tracks of synoptic-scale weather systems related to it (i.e., low and high pressure systems). These systems establish the pressure gradients that produce low-level winds. During the winter and transitional seasons, the Northfield One site is influenced by transient and developing synoptic-scale weather systems. In the summer, the jet stream weakens and moves north resulting in generally weaker synoptic systems and weaker winds.

3. SITE-SPECIFIC MODELING METHODS

This section describes the input data sources and modeling methods used to numerically simulate the wind flow patterns at the site. Data resources maintained by WindLogics were used for this wind resource assessment. The general types are topography, land cover and weather data.

3.1 Topography Data Source(s)

Topography data at a 50-meter horizontal grid resolution were acquired from the USGS (United States Geological Survey) and used as input data to the WindLogics modeling system. These high-resolution topography data were subsampled to the grid resolutions specified for each of the modeling domains.

3.2 Vegetative and Land Cover Data Source(s)

Land use and land cover data at a 50-meter horizontal grid resolution were acquired from the USGS and used as input data to the WindLogics modeling system. These high-resolution land use/land cover data were sub-sampled to the grid resolutions specified for each of the modeling domains. WindLogics also took into account several other data sources (GOES satellite imagery, Google Earth, etc.) to aid in the assessment of the overall land cover of the region.

The land cover over the area is mostly farmland with residences and areas of tree coverage. Given this land cover, displacement heights of 5 and 10 m were used for residences and tree cover, respectively. The displacement height was zero for all other categories.

3.3 Weather Data Archive for Detailed Analysis

The continuous modeling process used data from the WindLogics North American Archive, consisting of hour-by-hour assimilated weather data at a 20 kilometer horizontal spacing between grid points. These data were extracted from the archives and used as initial and boundary conditions for the mesoscale modeling system (See Appendix B for more detailed information).

3.4 Mesoscale and Local Wind Field Modeling Methods

WindLogics executed a detailed, twelve-month modeling process consisting of a mesoscale model to capture the large-scale weather features coupled with a local wind field model to capture local terrain and surface-friction effects. For more technical detail regarding WindLogics modeling methods see Appendix C.

To simulate the wind flow patterns of the site a detailed modeling process with a final resolution of 50 m was executed

The data archives (as described in Appendix B) were used as initial and boundary conditions to the mesoscale modeling system, with an inner grid resolution of 2 km (see Appendix A, Page 1). The output from the mesoscale model was then used as input to the detailed wind field modeling system consisting of an outer grid with a resolution of 1 km and an inner grid with a resolution of 50 m (for terrain maps of the area of interest see Appendix A, Pages 2 and 3).

4. NORMALIZATION METHODOLOGY

This section describes the methods used to normalize the short term model in order to provide a long-term characterization of the wind resource at the site.

4.1 Weather Data Archive for Long-Term Normalization

The reference dataset used for this analysis was the WindLogics Global Reanalysis Data, which contains worldwide historical weather data, dating since 1948, collected and assimilated in as consistent a manner as possible. See Appendix D for a more detailed description.

4.2 Normalization Processing

The short-term model results and multiple long-term data points from the WindLogics Global Reanalysis Data were processed together using the E-MCP method to estimate long-term characteristics of the wind resource at the site. The E-MCP method uses a non-linear multi-parameter regression engine to numerically infer the relationship between the model data and reference datasets. See Appendix E for a more complete description.

Output of E-MCP is forty-year timeseries of estimated values representative of onsite wind flow.

The output of the E-MCP processing phase was a forty-year time-series of estimated values, at an interval of every six hours. These values were then applied to the turbine power curve and statistically summarized as the annual and monthly values presented in this report. All gross energy production and capacity factor values are based on the Nordic Windpower N1000 - 59m Rotor turbine power curve. See Appendix F for a summary of the calculation methods and manufacturer-supplied information.

4.3 Normalization Validation

A site-specific validation was performed to quantify the error in the E-MCP-based prediction. This involved using a round-robin approach, predicting the wind values for each month, without using that month's data in training, and then calculating error statistics for the month that was withheld. In other words, each of the 12 months was estimated using the other 11 months of training data and then compared against the actual data from that month. This required a separate training and estimation process for each of the months, prior to running the final process that used training data from all months to estimate the long-term time series. This rigorous validation process provides a high level of insight into the predictive ability of the E-MCP process at the Northfield One site.

5. SUMMARY OF RESULTS

This section contains a summary of the results calculated for the Northfield One site.

5.1 Normalization Validation Results

There are two main ways to verify the predictive ability (validate) of the results of the E-MCP process:

- Analyze the results of the month-by-month round-robin validation
- Compare the estimated values to the model data during the period for which both data sources exist; of particular importance are the distributions of the data, which can be examined most effectively in graphical form

As can be seen in Table 2, the average monthly wind speed (power) error was 3.98% (9.11%). The 12-month overall wind speed (power) bias was -0.38% (-1.99%) for the Nordic Windpower N1000 – 59m Rotor turbine.

		Wind Speed (m/s)			Power (MWh) Nordic Windpower N1000 - 59m Rotor		
Month	Year	Actual Spd	E-MCP Spd	Error	Actual Power	E-MCP Power	Error
January	2009	7.84	7.63	-2.67%	357.58	328.75	-8.06%
February	2008	6.86	6.92	0.82%	268.88	269.36	0.18%
March	2008	6.67	6.91	3.57%	245.85	269.57	9.65%
April	2007	7.61	8.02	5.50%	340.28	370.56	8.90%
May	2008	7.64	7.74	1.32%	326.17	339.85	4.20%
June	2007	7.56	7.01	-7.28%	317.10	277.17	-21.59%
July	2007	7.18	6.44	-10.28%	300.97	224.26	-25.49%
August	2008	6.56	6.19	-5.63%	236.76	197.74	-16.48%
September	2008	7.54	7.54	-0.09%	326.42	322.64	-1.16%
October	2008	8.00	7.96	-0.48%	374.31	363.10	-2.99%
November	2008	7.69	8.38	9.03%	347.26	409.26	17.86%
December	2007	6.83	6.91	1.07%	275.27	270.49	-1.73%
				Bias			Bias
Annual		7.33	7.30	-0.38%	309.74	303.56	-1.99%
			MAE	3.98%		MAE	9.11%

Table 2: Month-By-Month E-MCP Validation Results

The quality of this E-MCP training is illustrated by the histogram in Figure 1. Figure 1 shows how well the E-MCP training captured the distribution over the full range of wind speed values. Predictions of the wind speeds from the E-MCP method are shown, along with the actual data used from the short-term training period.

Wind Speed Histogram for (12-month) Correlation Period

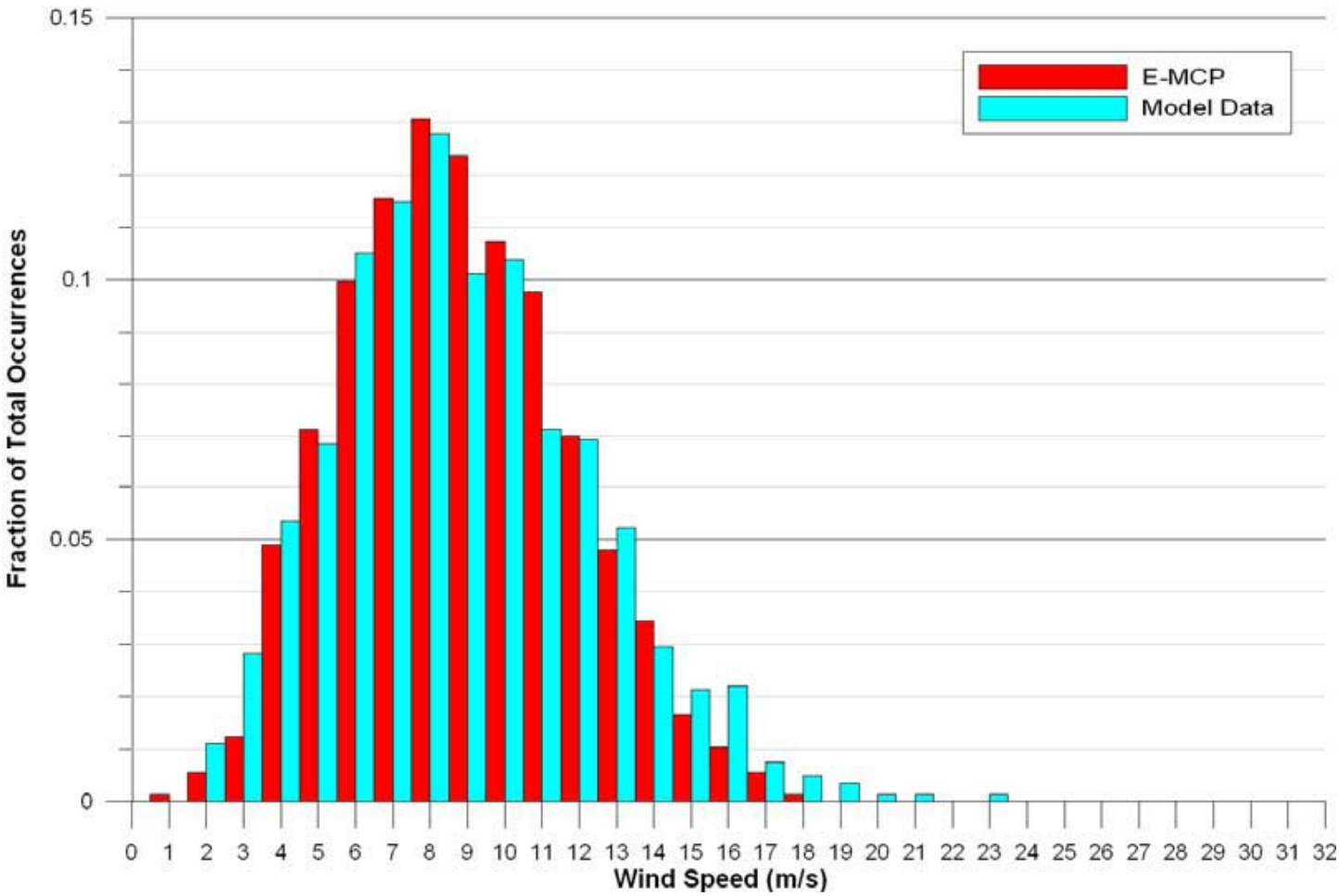


Figure 1: Histogram of Wind Speed (at 6-hour intervals) for E-MCP and the Model Data.

5.2 Normalized Monthly and Annual Wind Speed and Energy Production

At the Tower 1 location, the normalized annual average wind speed at 70 m AGL is 7.50 m/s corresponding to an annual gross capacity factor value of 32% and an annual gross energy production value of 2833 MWh for the Nordic Windpower N1000 - 59m Rotor. The normalized annual and monthly wind speed estimates at 70 m AGL are shown in Table 3.

We typically see decreased wind speeds during the summer months and increased wind speeds during the transitional and cooler months. The average wind speed for the period of September through April is 7.79 m/s, while the May through August time span has an average wind speed of 6.93 m/s. The fastest average monthly wind speed occurs in October with a value of 8.03 m/s. July has the slowest average monthly wind speed with a value of 6.65 m/s.

Note: All capacity factor and energy production values in this report are gross values. Net values will depend on losses from project-specific characteristics such as availability, array effects, icing, airfoil soiling, line losses, control losses and other factors.

	Wind Speed	Nordic Windpower N1000 - 59m Rotor	
Month	m/s	EP (MWh/mo)	GCF
January	7.95	296	38%
February	7.62	233	35%
March	7.73	253	34%
April	7.69	250	35%
May	7.28	217	29%
June	7.01	192	27%
July	6.65	180	24%
August	6.76	181	24%
September	7.61	234	33%
October	8.03	275	37%
November	7.92	265	37%
December	7.76	269	36%
		EP (MWh/yr)	GCF
Annual Ave.	7.50	2833	32%

Table 3: Normalized Monthly Average Wind Speed and Energy Production Values at 70 m AGL

5.3 Long-Term Variability Results

Data from the WindLogics archive were used to produce estimates of the longterm wind speed and gross energy variability for the study site. Information from that analysis is presented below.

The long-term (40-year) average annual wind speed was estimated as 7.50 m/s for Tower 1. The range of annual averages was estimated as 7.07 m/s to 7.88 m/s (See Figure 2).

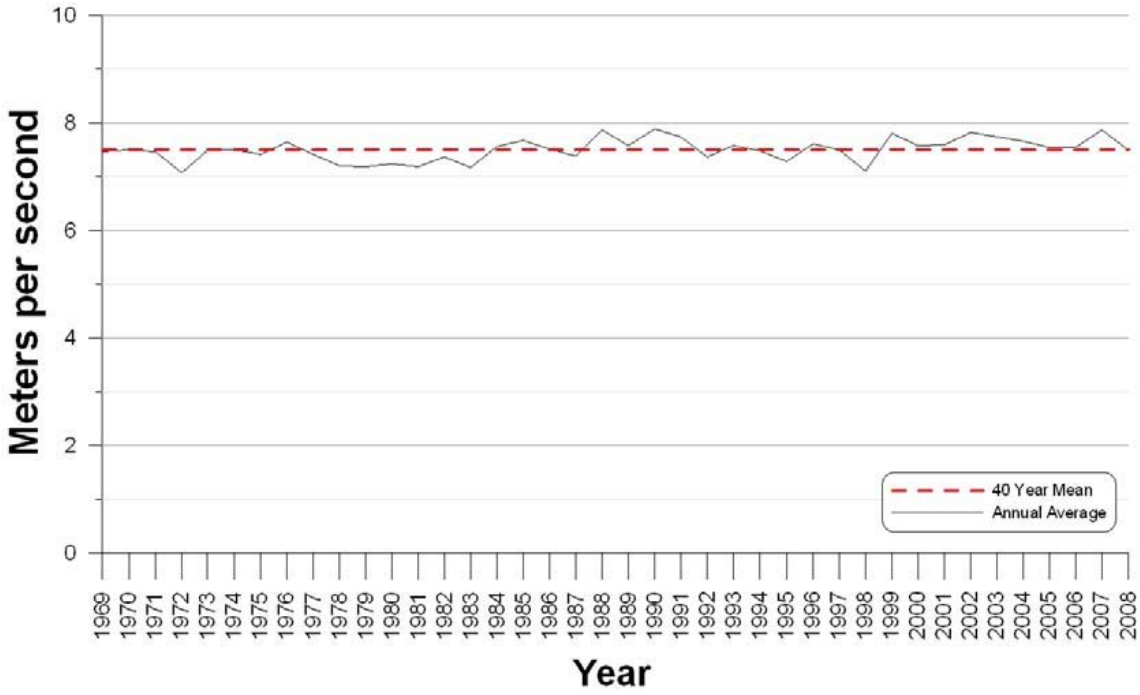


Figure 2: Long-Term Annual Wind Speed Estimates for the Period 1969-2008 at the Tower 1 Location

5.4 Wind Direction

Surface-level winds in this area prevail from the northwest or south, depending upon the time of year. Winds with a northerly component are more prevalent during the months of October through May. During the months of June through September, winds with a southerly component become more frequent. Figure 3, below, shows an annual wind rose. Full monthly and annual wind roses for the Tower 1 location are found in Section 4 of this report.

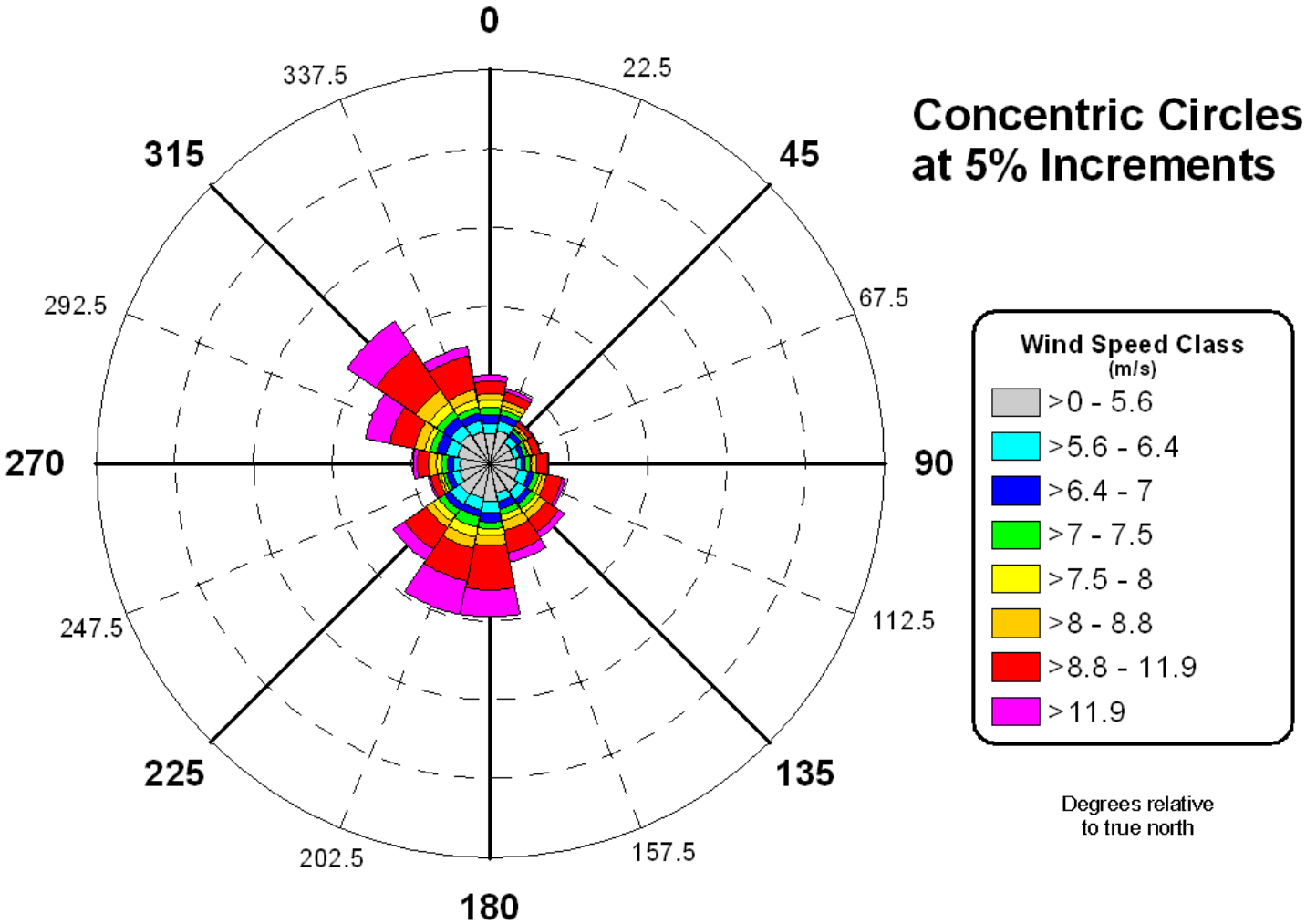


Figure 3: Annual Wind Rose at the Tower 1 Location

5.5 Spatial Variability Characteristics

The annual average wind speed at 70 m AGL was between 6.88 and 7.91 m/s across the area of study (See Figure 4), corresponding to annual gross capacity factor values between 26.84 and 35.95% and annual gross energy production values between 2351 and 3150 MWh for the Nordic Windpower N1000 - 59m Rotor turbine at that hub height.

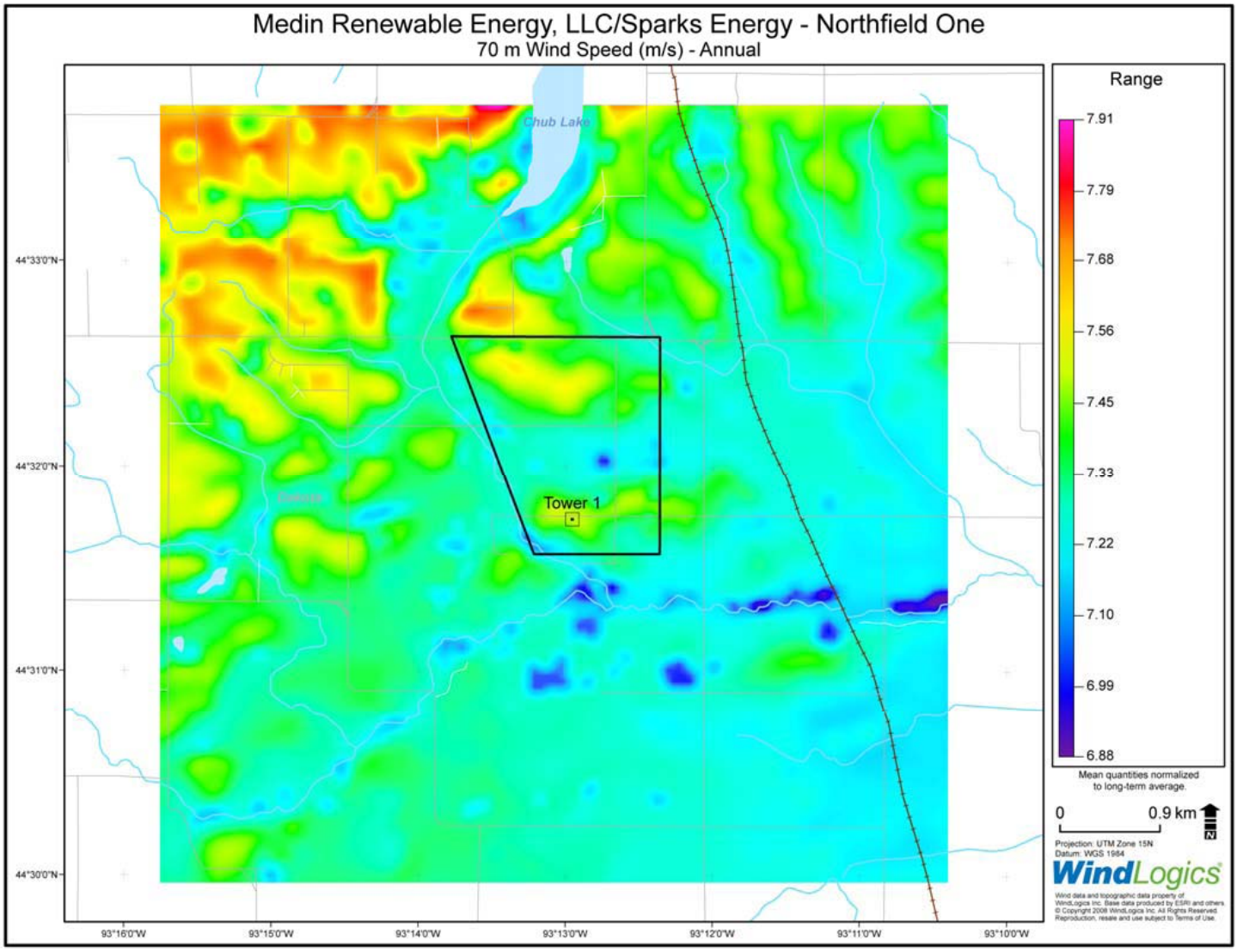


Figure 4: Normalized Annual Wind Speed Map for the Northfield One Site

6. CONCLUSIONS

To characterize the wind resource at the Northfield One site a detailed modeling process was performed, consisting of a mesoscale model to simulate the largescale weather patterns and a wind flow model to resolve small-scale terrain and land features, with a final horizontal grid resolution of 50 meters. The model output was then normalized to long-term climatic means using E-MCP. The results show a long-term wind resource of 7.50 m/s at 70 m AGL at the Tower 1 location corresponding to an estimated gross energy production of 2833 MWh/yr and a gross capacity factor of 32%.

ATTACHMENT B1

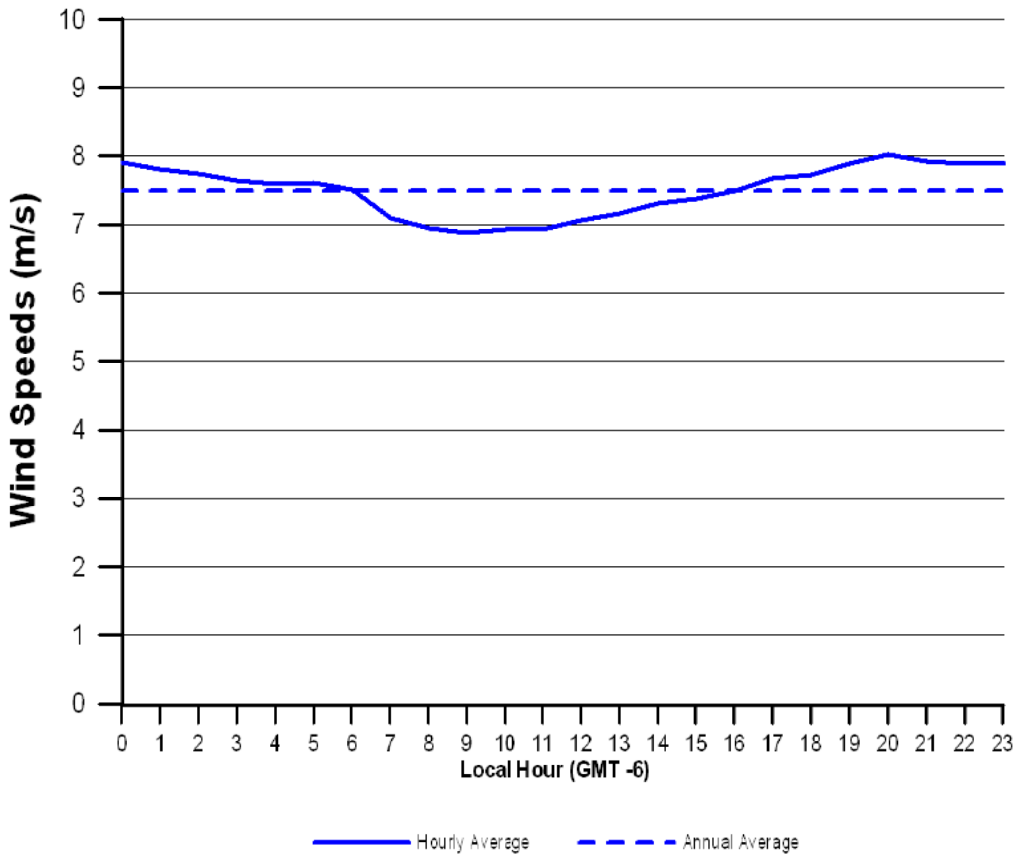
Table of Prediction Intervals on Annual Wind Speed Averages
(Based on Annual Averages)
Northfield One - Tower 1 - 70 m

	P50	P75	P90	P95	P99
m/s	7.50	7.35	7.22	7.13	6.97

Number of Years	40
Mean	7.50
Standard Deviation	0.21

ATTACHMENT B2

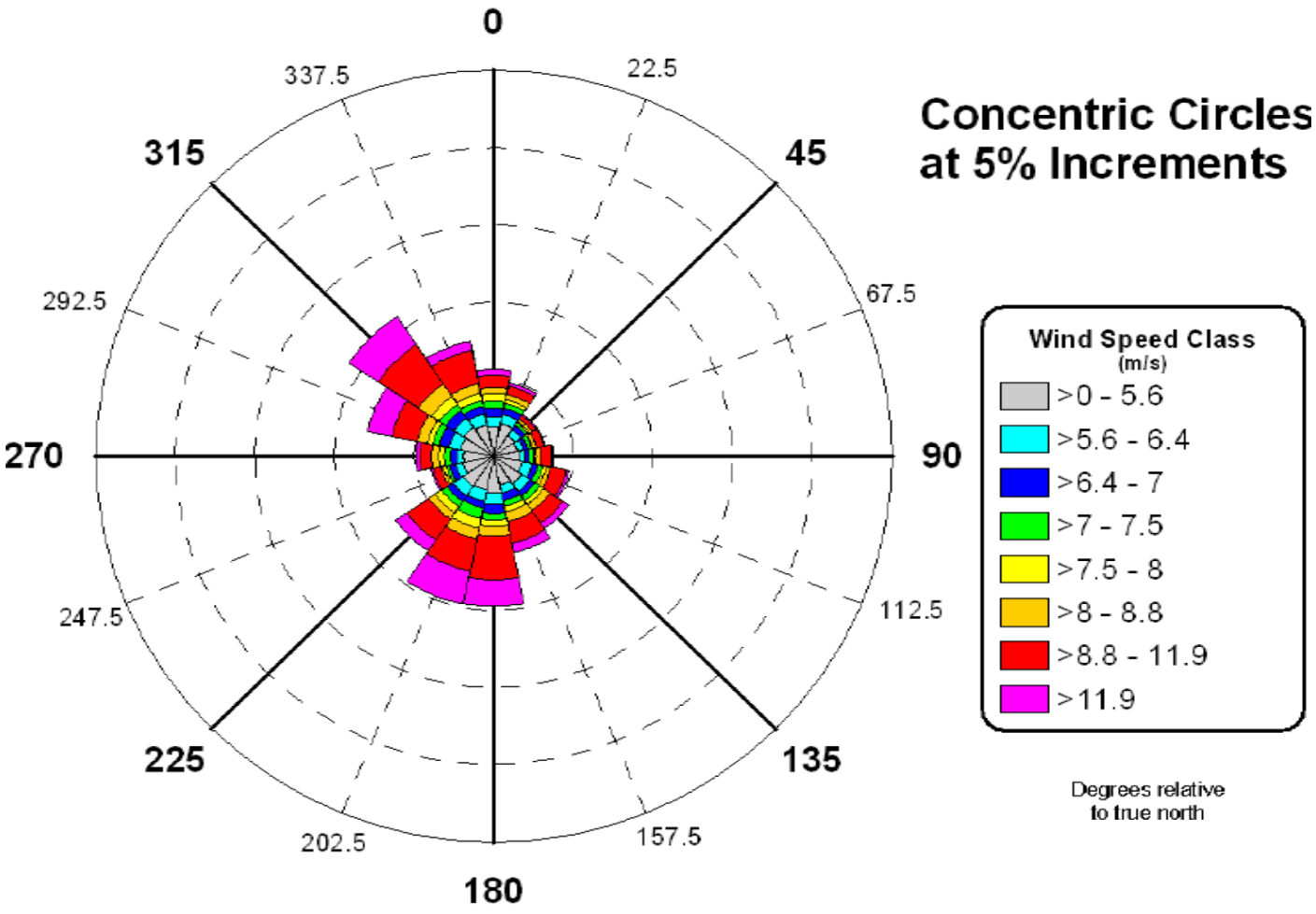
Normalized Wind Speed Diurnal Distribution Shown in Local Time
Northfield One - Tower 1 - 70 m
Annual



Mean quantities normalized to long-term average.
Data distributions representative of modeled year.

ATTACHMENT B3

Normalized Wind Speed/Direction Occurrences - Wind Rose (in %)
Northfield One - Tower 1 - 70 m
Annual



Mean quantities normalized to long-term average.
Data distributions representative of modeled year.

WindLogics Inc.
1021 Bandana Blvd. E., Suite 111, St. Paul, MN 55108 Tel: 651.556-4200 Fax: 651.556-4210
www.windlogics.com

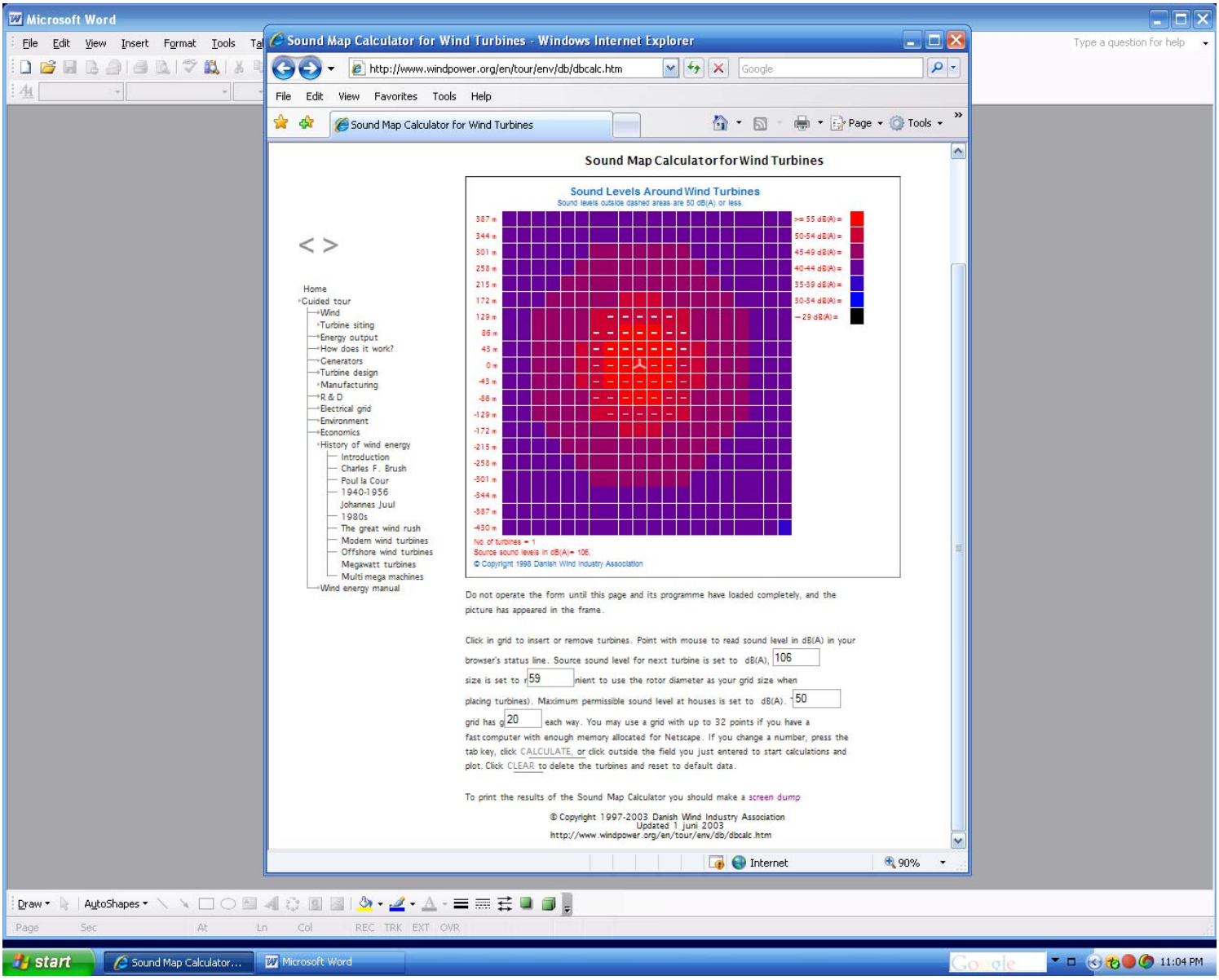
ATTACHMENT C

Nordic N1000 (60Hz)- Data Sheet

N1000 Technical Data	59 m rotor
GENERAL	
Nominal power	1000 kW
Rated wind speed	16 m/s
Operational range	4-22 m/s
Certification	DNV Design to IEC Class IIIb
Extreme wind speed	52.5 m/s
Operational Temperature Range	-10° - +40° Celsius
Survival Temperature Range	-20° - +50° Celsius
Control principle	Stall
WIND TURBINE	
Rotor diameter	59 m
Number of blades	2
Rotor orientation	Upwind
Rotational speed	23 rpm
Blade tip speed	72 m/s
Blade material	GRP/Carbon
Type of hub	Teeter
Teeter bearing	Elastomeric
BRAKING SYSTEMS	
Aerodynamic blade tip brakes	
Hydraulic disc brake on rotor shaft	
GEARBOX	
Type	2 planetary & 1 stage helical, integrated turbine bearings
Gear ratio	1:81
Cooling	heat exchanger
GENERATOR	
Rating	1,000 kW
Type of generator	4-pole induction
Voltage	690 V
Environmental Protection	NEMA3/IP34
Cooling	Air
Power factor	0.98 at 100% power
YAW SYSTEM	
Hydraulic drive motors	
TOWER	
Hub height	70 m
Diameter top/bottom	1.9/3.2 m
Type	Welded steel tube, painted
Number of tower sections	2
Tower weight	60 tonnes
CONTROL SYSTEM	
Distributed control system	
IEC 61131-3 compliant turbine controller	
SCADA system	
WEIGHTS	
Nacelle, with hub	44 tonnes
Blades (each)	4.2 tonnes
NOISE LEVEL	
Less than 104 dB(A) at 8 m/sec	
IEC 61400-11 compliant	

Nordic Windpower USA
125 University Avenue
Second Floor
Berkeley, CA 94710, USA
tel: +1 510 665 9463
www.nordicwindpower.com

ATTACHMENT D



ATTACHMENT E

---------- Original Message ----------
Subject: RE: [Fwd: TURBINE LOCATION]
From: "Cinadr, Thomas" <Thomas.Cinadr@MNHS.ORG>
Date: Wed, May 20, 2009 5:53 am
To: "'leone@medindevelopment.com'" <leone@medindevelopment.com>

THIS EMAIL IS NOT A PROJECT CLEARANCE.

This message simply reports the results of the cultural resources database search you requested. The database search produced results for only previously known archaeological sites and historic properties. Please read the note below carefully.

No archaeological sites or historic structures were identified in a search of the Minnesota Archaeological Inventory and Historic Structures Inventory for the search area requested.

The result of this database search provides a listing of recorded archaeological sites and historic architectural properties that are included in the current SHPO databases. Because the majority of archaeological sites in the state and many historic architectural properties have not been recorded, important sites or structures may exist within the search area and may be affected by development projects within that area. Additional research, including field survey, may be necessary to adequately assess the area's potential to contain historic properties.

If you require a comprehensive assessment of a project's potential to impact archaeological sites or historic architectural properties, you may need to hire a qualified archaeologist and/or historian. If you need assistance with a project review, please contact Kelly Gragg-Johnson in Review and Compliance @ 651-259-3455 or by email at kelly.graggjohnson@mnhs.org.

The Minnesota SHPO Survey Manuals and Database Metadata and Contractor Lists can be found at http://www.mnhs.org/shpo/survey/inventories.htm

Tom Cinadr
Survey and Information Management Coordinator

Minnesota State Historic Preservation Office
Minnesota Historical Society
345 Kellogg Boulevard West
St. Paul, MN 55102

651-259-3453

ATTACHMENT F

ENGINEERING REPORT
CONCERNING THE EFFECTS UPON
FCC LICENSED RF FACILITIES
DUE TO CONSTRUCTION OF THE
MEDIN-SPARKS WIND PROJECT
IN
GREENVALE TOWNSHIP, DAKOTA COUNTY, MN
& NEW MARKET TOWNSHIP, SCOTT COUNTY, MN

Medin Renewable Energy LLC
&
Sparks Energy LLC

June 4, 2009

By: B. Benjamin Evans, P.E.
Evans Associates
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Thiensville, WI 53092
262-242-6000 PHONE
262-242-6045 FAX
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**ENGINEERING REPORT
CONCERNING THE EFFECTS UPON
FCC LICENSED RF FACILITIES
DUE TO CONSTRUCTION OF THE
MEDIN-SPARKS WIND PROJECT
DAKOTA & SCOTT COUNTIES, MINNESOTA**

Medin Renewable Energy LLC & Sparks Energy LLC

I. INTRODUCTION

This engineering report describes the results of a study and analysis to determine the locations of federally licensed (FCC) point-to-point microwave and fixed station radio frequency facilities that may be adversely impacted as a result of the construction of the Medin-Sparks Wind Turbine Project. The project involves a four-square-mile area in Greenvale Township in Dakota County, about 6 miles northwest of Northfield, and a single-turbine site in New Market Township in Scott County, about 1.7 miles east of Elko . This document describes impact zones and any necessary mitigation procedures, along with recommendations concerning individual wind turbine siting. All illustrations, calculations and conclusions contained in this document are subject to on-site verification[1].

Wind turbines located on land parcels near federally licensed radio frequency facilities can cause one or more modes of RF impact, due to aperture blockage and/or re-radiation. An iterative procedure is frequently necessary to minimize adverse effects. Information provided in this document will minimize the chances that disruption of the studied facilities either does not occur or, in the alternative, that mitigation procedures will be effective. The purpose of this study is to facilitate the siting of turbines to avoid unacceptable impact.

The Medin-Sparks project involves the construction of eleven (11) new two-blade turbines. The wind turbines will have a hub height of 70 meters above ground and a blade radius of 29.5 meters. Thus, the total height will be about 99.5 meters above ground level to the tip of one blade at the 12:00 position.

Using industry standard procedures and FCC databases, a search was conducted to determine the presence of any existing microwave paths crossing the subject property, or land mobile or broadcast RF facilities within or adjacent to the identified area. A specific turbine layout has not

[1] The databases used in creating the attached tables and maps are generally accurate, but anomalies have been known to occur. An on-site verification survey is suggested as part of the due diligence process.

yet been submitted for analysis. Accordingly, this report will address specific issues and guidelines regarding the siting of turbines to minimize impact to RF communications facilities by establishing "blackout areas". The following Figure 1 shows the turbine siting area.

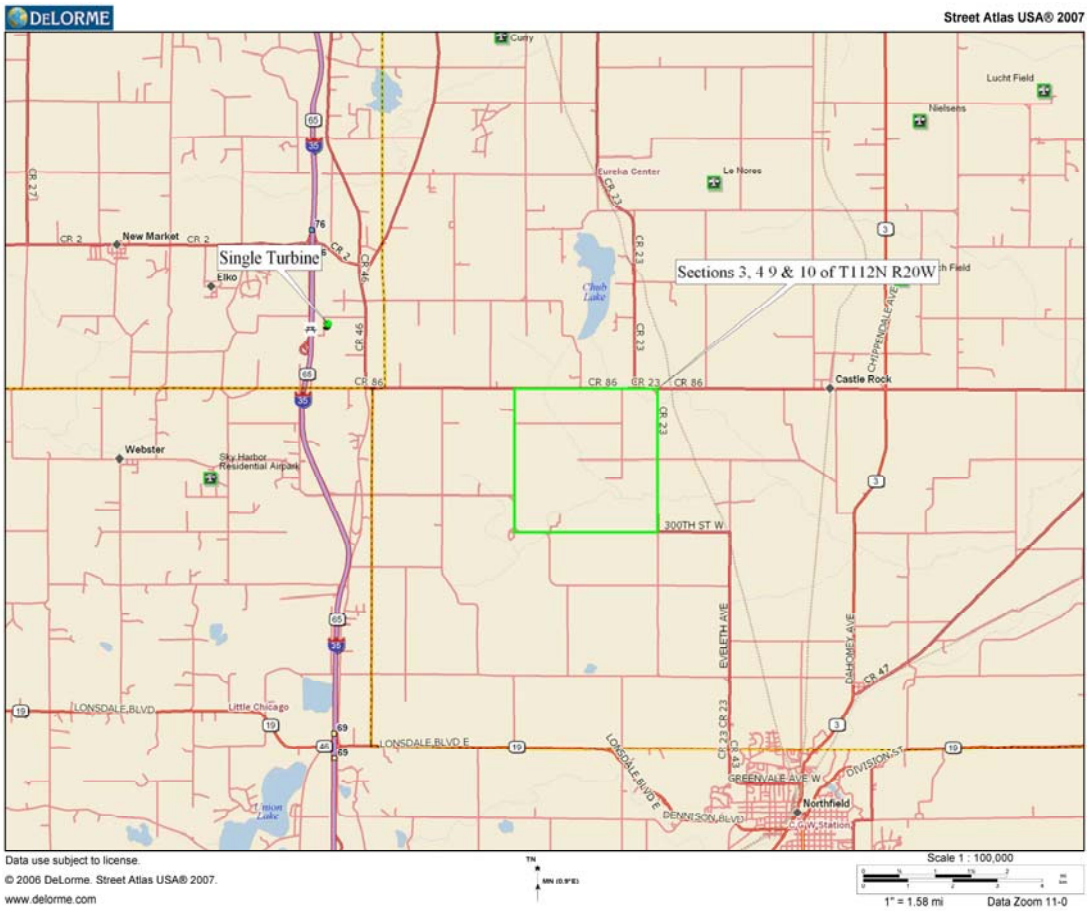


Figure 1 – Medin-Sparks Wind Project Area

With respect to broadcast facilities, pertinent TV, FM and AM stations were also reviewed in this analysis, and the potential impact to local reception of those broadcast facilities is discussed herein.

The following tabulation and analysis consists of three sections:

1. Microwave point-to-point path analysis[2]
2. Land mobile, public safety radio, FAA, DoD, Radar, Cellular and NTIA notification
3. Broadcast television and radio analysis

The attached maps were generated based upon the operating parameters of the FCC-licensed stations as contained in FCC databases.

The analysis included herein examines the pertinent FCC licensed services in the area for potential impact according to generally accepted engineering standards. This analysis assumes that all licensed services have been designed and constructed according to FCC requirements and good engineering practice. If this is not the case, the impacted facility must share responsibility with the wind turbine company for the costs of any mitigation measures[3].

Each of the RF analyses is described separately in the sections that follow.

II. ANALYSIS OF MICROWAVE LINKS

An extensive analysis was undertaken to determine the likely effect of the new wind turbine farm upon the existing microwave paths, consisting of a Fresnel x/y axis study and a z-axis (height) evaluation. The microwave paths have been overlaid on Google Earth™ maps, and the images of the microwave paths and the proposed turbines also available as KMZ and GIS shape files.

Important Note: Microwave path studies are based upon third party and FCC databases that normally exhibit a high degree of accuracy and reliability. Although Evans performs due diligence to ensure that all existing microwave facilities are represented, we cannot be responsible for errors that may lead to incomplete results. However, should such situations occur, Evans would perform an engineering analysis to determine how the additional facilities can be accommodated or, if wind turbine structures are already built, determine a method to re-direct the offending beam path. It is recommended that a consultant visit the site to visually check for anomalies.

For this microwave study, *Worse Case Fresnel Zones* (WCFZ) were calculated for each microwave path. The mid-point of a microwave path is the location where the widest (or worst case) Fresnel zone occurs. Possible geographic coordinate errors must be added to the Fresnel

[2] Only point-to-point microwave facilities were considered (for instance, a study of earth stations is not included).

[3] For instance, some microwave paths may have insufficient ground clearances as they are presently configured.

zone clearance numbers[4]. The radius *R* of the Worst Case Fresnel Zone, in meters, is calculated for each path using the following formula:

$$R \cong 8.65\sqrt{\frac{D}{F_{GHz}}}$$

where *D* is the microwave path length in kilometers and F_{GHz} is the frequency in gigahertz.

In general, the WCFZ is defined by the cylindrical area whose axis is the direct line between the microwave link endpoints and whose radius is *R* as calculated above. This is the zone where the siting of obstructions should be avoided. Evans Associates has identified and tabulated 5 microwave links transmitting over three unique paths existing in the FCC database that intersect the project area. These paths are tabulated below in Table 1 and are shown in Figure 2.

ID	Call Sign	Status	Name Xmit	Dist/Bear (km/°T))	Elevation (m AMSL)	Freq. (MHz)	Licensee	WCFZ (m)
1	WQHZ291	A	MSPCTY	7.5@148.4	435.3	10855	Telecom Transport	7.2
2	WQJS273	A	MSPDUE	7.5@328.4	393.3	11345	Telecom Transport	7.0
3	KBL97	C	New Market	50.3@125.6	406.9	5945.2	AT&T Comm. Midwest	25.2
4	WEH232	A	STATION	38.2@297.6	408.4	6825	Great River Energy	20.5
5	WEH234	A	Credit River	38.2@117.3	384.0	6665	Great River Energy	20.7

Table 1 – Microwave Links Near Wind Project Area

None of the above paths create blackout zones through the project area. None approach the four-square mile turbine area or the single turbine site to within 1 mile. Path 3 is a cancelled path, so protection is not needed at the present time[5]. Therefore, as of this date, there are no FCC-licensed microwave paths that would impede the construction of the planned Medin-Sparks wind turbines.

[4] Many microwave facilities were built before accurate methods were available to establish exact geographic coordinates (such as GPS). It is not unusual for database errors of up to 4 or 5 seconds to occur, which can effect the positioning of critical turbines located near Fresnel paths.

[5] This path is not shown in Figure 2, but is available for viewing in the associated KMZ file.

The Google Earth™ map below shows all known active FCC-licensed non-broadcast fixed station transmitting facilities near the turbine areas (shown in orange). The red outline is the area within which all facilities of this type were searched for in the FCC database.

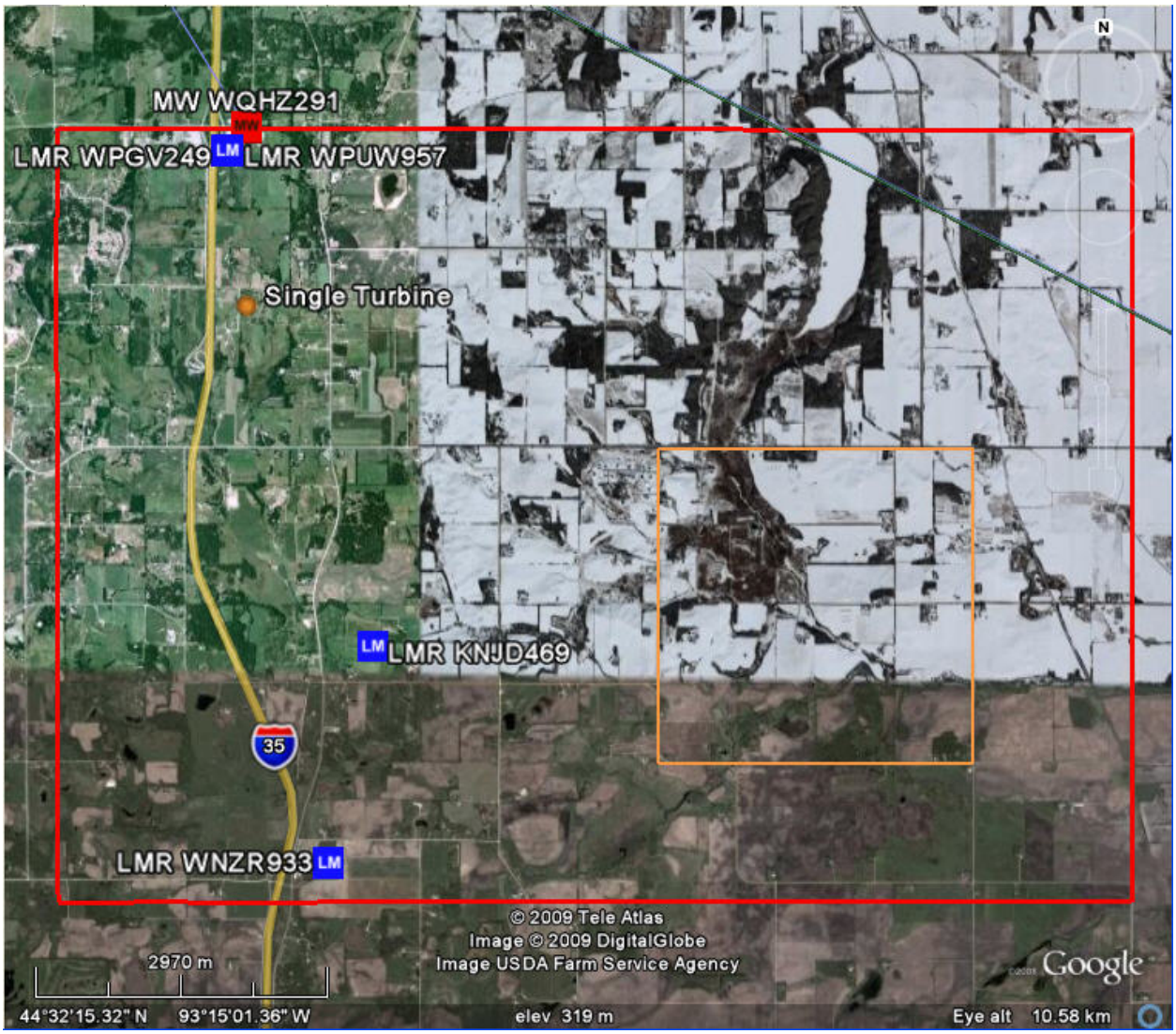


Figure 2 - Medin-Sparks Wind Turbine Project Area Showing Active Facilities

If an excessive amount of time goes by before the turbines are to be constructed, it is recommended that this study be updated in case new paths have been added to the FCC's database.

The reader is referred to the provided KMZ and GIS shape files for more magnification and closer inspection. Spreadsheets are also provided tabulating additional information concerning each facility with blackout potential.

III. ANALYSIS OF FIXED RADIO FACILITIES

3.1 Land Mobile Facilities

There are 11 *Land Mobile* stations identified from the FCC's database that fall within the search area. Note that 6 of these facilities' licenses are either expired or cancelled, and are thus not entitled to protection. The complete list of land mobile sites is tabulated in Table 2. The actively licensed land mobile station sites are shown in Figure 2.

Call Sign	Status	Latitude	Longitude	Ant. Ht. AGL (m)	Licensee
KNNU646	C	44.55830	93.31356	54	E.F. JOHNSON COMPANY
WPUW957	A	44.57083	93.29611	55	ALDRICH COMMUNICATIONS INC
KNJD469	A	44.52581	93.27800	16	DONALD SWENSON
WPGV249	A	44.57080	93.29633	60	H DAVE SCHMIDTKE
WNZR933	A	44.50608	93.28355	29	DAVES ELECTRONIC SERVICE
WPBS531	C	44.55830	93.31384	45	Blooston, Mordkofsky, Dickens, Duffy & Prendergast
WPIA603	E	44.55830	93.31384	46	ROBERT DALE
WPHK483	A	44.57080	93.29633	52	PNI SPECTRUM LLC
WPJI373	C	44.55830	93.31384	54	O CONNOR & HANNAN L L P
KNNV534	C	44.55830	93.31384	54	O CONNOR & HANNAN L L P
WPKN460	C	44.55830	93.31384	54	INNOCOMM INC

Table 2 – Land Mobile Stations in Medin-Sparks Search Area

Generally, wind turbines should not adversely affect the signals of land mobile stations if the turbines are physically spaced at least 400 meters (approximately one-quarter mile) from these stations. It is suggested that the exact positions of the antennas of these land mobile stations, indeed their very existence[6], be confirmed via a physical site survey.

The reader is referred to the provided KMZ, spreadsheets and GIS shape files for more magnification and closer inspection.

The active land mobile site nearest to any area considered for the Medin-Sparks turbines is 1.55 kilometers north of the single turbine site near Elko.

[6] Oftentimes, communication companies will "warehouse" land mobile frequencies, holding valid licenses but not utilizing them immediately, which is an illegal practice. In addition, transmitters could be dismantled without the FCC being notified.

Although significant disruption is not expected to land mobile stations more than 400 meters from any turbine, some occasional time-varying received levels for facilities between 400 and 800 meters from the nearest turbine would be possible, although not usually disruptive. In any case, no disruption is expected to known land mobile sites since the nearest land mobile station would be at least 1.55 kilometers from any turbine.

3.2 FAA and DoD Concerns

The Department of Defense and the Department of Homeland Security *Long Range Radar Joint Program Office* "JPO" has adopted a "pre-screening tool" to evaluate the impact of wind turbines on air defense long-range radar. The turbine site area was applied to this tool, and it returned a result of "impact highly likely to Air Defense or Homeland Security radar." However, a definitive determination is obtained only after formal study by the DoD, which is triggered by FAA Form 7460-1 notification.

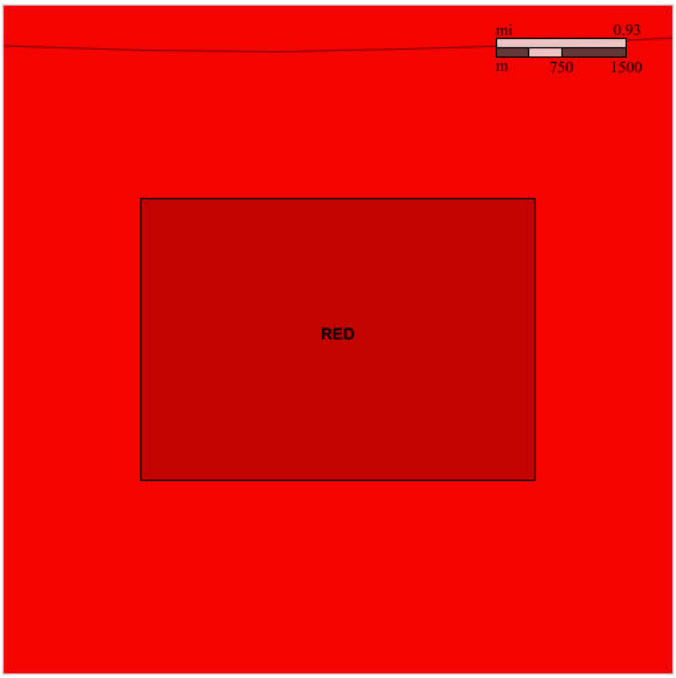


Figure 3 – Long-Range Radar Determination

It will be necessary to submit 7460-1 forms to the FAA when the turbine locations are finalized.

The public airport closest to the single turbine site in New Market Township is Airlake Airport near Lakeville, which is 5.8 miles northeast of the single turbine site. The public airport closest to the four-square-mile turbine area in Greenvale Township is Stanton Airfield in Stanton, which

is 10.6 miles east-southeast of the center of the area. The 7460-1 evaluation process will lead to the final determination of the impact, if any, to airspace navigation, as the impact of the proposed turbines on aviation safety is beyond the expertise of this firm.

3.3 NEXRAD and Other Communications Sites

A search of the FCC and FAA antenna structures databases revealed no notified communications towers within 1 kilometer of the single-turbine site or within the boundaries of the turbine area in Greenvale Township. However, the federal registries do not contain the records of all towers that are not tall enough to require notification to the FAA. A site visit is suggested to uncover undocumented transmitting antenna sites.

A pre-screening tool has been developed to evaluate the potential impact of obstructions to the NEXRAD Weather Surveillance Doppler Radar Stations. The turbine site area was applied to this tool, and it returned the result shown in Figure 5.

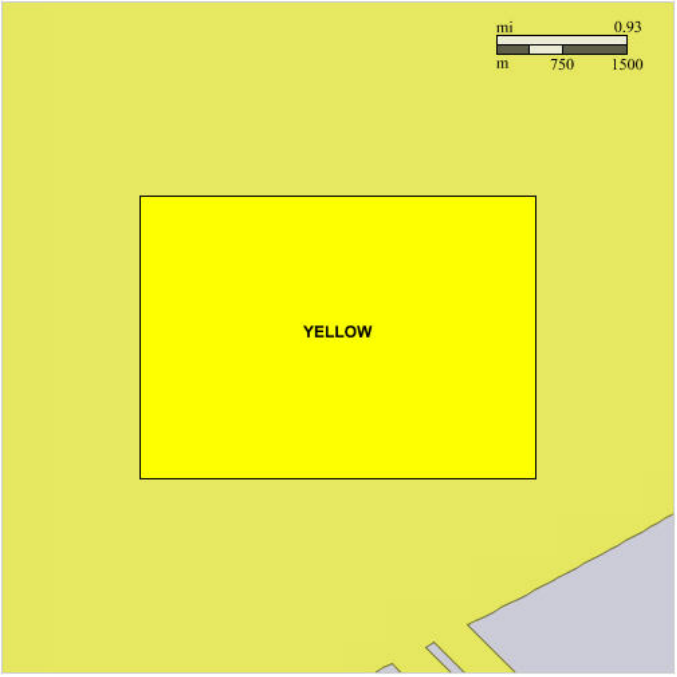


Figure 4 – NEXRAD Weather Radar Determination

Yellow: *Impact likely to WSR-88D weather radar operations. Turbines likely in radar line of sight. Aeronautical study required. NTIA notification strongly advised.*

3.4 Cell Phone Reception

There is no credible evidence known by this writer to suggest that cell phone reception has been a problem in and around wind farms. Since cell phone service is mobile by design, the transmissions should theoretically not be significantly affected. In addition, cellular antennas employ diversity and multiple receivers to compensate for any disruptions at any one location. Therefore, the proposed wind project should not disrupt cell phone service in the area.

3.5 NTIA Concerns

Operation of RF frequencies for federal government use is managed by the National Telecommunication Information Agency (NTIA), which is part of the U.S. Department of Commerce. Many of the technical specifications for most government facilities are unavailable to the public. Therefore, the NTIA has set in place a review process, wherein the Interdepartmental Radio Advisory Committee (IRAC), consisting of representatives from various government agencies, reviews new proposals for wind turbine projects for impact on government frequencies. In almost all cases, no adverse impact is found, and IRAC usually issues a determination within 45 days.

The proposed Medin-Sparks Power project area was submitted to the NTIA on May 29, 2009 by Evans Associates.

IV. ANALYSIS OF BROADCAST FACILITIES

4.1 HDTV Broadcast Facilities

The rotating blades of a wind turbine have the potential to disrupt over-the-air broadcast TV reception within a few miles of the turbine, especially when the direct path from the viewer's residence is obstructed by terrain. This is manifest in an analog TV picture by a flickering or tearing of the image in time with the blade rotation, which is caused by signals reflected by the blades arriving at the viewer's TV antenna at the same time as the direct signal. This is known as "multipath interference." However, as turbine manufacturers have replaced all-metal blades with blades constructed of mostly nonmetallic materials[7], this effect has been reduced. Also, the new generation of HDTV receivers is better equipped to deal with minor multipath interference (which is manifested by "pixilating" or "freezing" of the digital picture) than analog TV sets, as special circuitry is employed to suppress the reflected signal. Occasionally, however, multipath interference from one or more turbines can cause video failure in HDTV receivers (a blank screen or frozen picture), especially if the receiver location is in a valley or other place of low elevation.

[7] Modern turbine blades are usually constructed from glass-reinforced plastic (GRP), although they usually contain some metal for strengthening, balance and grounding.

Analog TV transmission is scheduled to end on June 12, 2009 (unless the date is extended by Congress or the FCC), after which TV stations are mandated to transmit only in HDTV ("Digital" or "High Definition"). For this reason, analog facilities have not been considered in these analyses.

Dakota and Scott Counties are in the Minneapolis-St. Paul, MN Designated Market Area (DMA) according to Nielsen Media Research. No other high-power stations other than those licensed to the Twin Cities DMA provide a primary signal over the area where the Medin-Sparks turbines are to be located. The stations that serve the area are listed in Table 3 at their final DTV channel assignments and operating parameters.

Call Sign	Network Affiliate	Channel	City of License	Power (KW ERP)	Ant. Height (m HAAT)	Distance (km)	Azimuth (°T)
KMSP-TV	Fox	9	Minneapolis, MN	21	433	58.9	7.0
KARE	NBC	11	Minneapolis, MN	27.1	455	59.2	5.9
WUCW	CW	22	Minneapolis, MN	1000	410	59.2	5.9
KTCI-TV	PBS	26	St. Paul, MN	45	413	58.9	7.0
WFTC	MyNetworkTV	29	Minneapolis, MN	1000	392	58.9	7.0
WCCO-TV	CBS	32	Minneapolis, MN	1000	432	59.2	5.9
KTCA-TV	PBS	34	St. Paul, MN	662	411	58.9	7.0
KSTP-TV	ABC	35	St. Paul, MN	755	433	59.2	5.9
KPXM	ION Television	40	St. Cloud, MN	1000	433	59.2	5.9
KSTC-TV	Independent	45	Minneapolis, MN	1000	428	59.2	5.9

Table 3 – Digital TV Stations Serving the Medin-Sparks Project Area

There is some possibility of signal disruption for residences that have to point their outdoor antennas through the turbine area, that utilize "rabbit ear" antennas, or that utilize older HDTV receivers. Most of this effect should be dissipated for locations more than 3 miles of a turbine, but some residual anomalies could be noted for HDTV receivers that are located below the grade level at the turbine base. Usually, a rule of thumb is that approximately 10% of receiver locations are affected to some extent within a few miles of a large turbine. The usual effect is intermittent "pixilation" or freezing of the digital TV picture. This estimate is based upon Evans' experience with similar turbine farms.

In the opinion of this consultant, given the small number of proposed turbines and the lack of densely-populated areas nearby, the number of instances of turbine disruption to over-the-air TV should be low and manageable. Mitigation would consist of the installation of a rooftop high-gain antenna in the nominal case, and providing a satellite receive dish or cable hookup in the worst case.

According to this engineer's calculations, there are about 368 households within an area likely to be affected[8]. It is conservatively estimated that 50% of the households in the area are served by cable or satellite TV and thus would not be affected by wind turbine disruption. Based on the 10% criteria described previously, under a worst-case scenario, up to 18 HDTV receiver locations may be affected. Mitigation costs would be approximately $300 in each instance. This estimate is based on worst-case assumptions pending information concerning the actual turbine locations.

4.2 FM FACILITIES

The following full-service FM stations each place a predicted primary signal over some or all of the turbine property:

Call Sign	Format	Freq. (MHz)	City of License	Power (KW)	Ant. Height (m HAAT)	Dist. (km)	Azimuth (°T)
KRLX	Diverse	88.1	Northfield, MN	.1	5	9.3	149.1
KCMP	Diverse	89.3	Northfield, MN	100	234	20.8	33.1
KNOW-FM	News	91.1	Minneapolis-St. Paul, MN	100	400	59.2	5.9
KQRS-FM	Classic Rock	92.5	Golden Valley, MN	100	315	58.9	7.0
KXXR	New& Classic Rock	93.7	Minneapolis, MN	100	315	58.9	7.0
KSTP-FM	Hot Adult Contemp.	94.5	St. Paul, MN	100	372	59.2	5.8
KRDS-FM	Oldies	95.5	New Prague, MN	6	100	30.4	254.9
KQCL	Classic Rock	95.9	Faribault, MN	3	100	19.6	174.4
KTCZ-FM	Adult Contemp.	97.1	Minneapolis, MN	100	315	58.9	7.0
KTIS-FM	Inspirational	98.5	Minneapolis, MN	100	315	58.9	7.0
KSJN	Classical	99.5	Minneapolis, MN	100	315	58.9	7.0
KTLK-FM	News-Talk	100.3	Minneapolis, MN	100	281	58.9	7.0
KOWZ-FM	Adult Contemp.	100.9	Blooming Prairie, MN	100	189	55.7	193.9
KDWB-FM	Contemp. Hits	101.3	Richfield, MN	100	315	58.9	7.0
KEEY-FM	Country	102.1	St. Paul, MN	100	315	58.9	7.0
WLTE	Soft Adult Contemp.	102.9	Minneapolis, MN	100	315	58.9	7.0
KZJK	Hits of the 80s	104.1	St. Louis Park, MN	100	315	58.9	7.0
WGVX	Oldies	105.1	Lakeville, MN	2.6	152	19.5	15.5
KBGY	Christian Music	107.5	Faribault, MN	48	120	37.0	195.3

Table 4 – FM Stations Serving Project Area

Because of the "capture effect" supported by the "discriminator" in FM receivers, significant disruptions to the above facilities are not expected. Although the received signal may vary with the blade rotation at some receive locations in the immediate area, good quality FM receive radios will most likely factor out such time-varying signals. In those relatively few cases where significant impact is caused, home FM radios could be connected to the rooftop TV receive antennas to pull in a stronger direct signal.

[8] Based upon the 2000 US Census centroid data.

The stations listed in Table 4, if any are disrupted, should be readily receivable using a household outdoor antenna from within the project area. The incremental cost to add FM stations to the outdoor TV receiving antenna would be approximately $40.

4.3 AM Facilities

A search of the FCC's database revealed no AM broadcast stations within the notification distance of 3 kilometers from the Medin-Sparks four-square mile area in Greenvale Township nor within 3 kilometers of the single-turbine site in New Market Township. Therefore, there should be no significant impact to this broadcast service.

Occasionally, depending upon ground conditions, local AM receivers may experience slight signal changes on distant AM stations due to local effects. However, such an anomaly is not recognized by the FCC or the standards of good engineering practice as a harmful effect.

V. CONCLUSIONS

1. The proposed turbines, including the blades, should be located so as to not penetrate the WCFZs (Worst-Case Fresnel Zones) of any known microwave path. Four microwave links transmitted over two unique paths were found in the FCC databases that are in the search area, but none have been determined to create blackout zones in the Medin-Sparks project area.

2. There are 5 active licensed land mobile transmitting sites within the project search area. If possible, turbines should not be sited within 400 meters of any active FCC licensed land mobile station. In the case of Medin-Sparks, no land mobile site is sufficiently close to any planned turbine area to warrant concern of interference to such facilities.

3. Based upon FCC database information, no significant impact is expected to the reception of FM broadcast facilities. A few receive locations may experience signal fluctuations in time with the blade rotors, but the receiver automatic gain control should be able to manage these variations. In a few cases, it might be necessary to reconfigure outdoor antennas at households within the project boundaries and within approximately two miles of the boundaries.

4. With respect to the listed TV station's signals, some pixelating, ranging from minor to moderate, could potentially occur on the HDTV channels. Up to 18 households may be affected, based on worst-case assumptions. Mitigation would consist of the installation of an updated outside antenna at a cost of approximately $300 each, or installation of satellite or cable TV equipment in intractable cases. Mitigation measures are expected to be available for all broadcast receptions anomalies.

5. An on-site inspection of the Medin-Sparks area should be done to determine the existence of any undocumented communications towers and to verify the locations and operational status of the land mobile sites that are near planned turbines.

Respectfully Submitted,

B. Benjamin Evans, P.E.
RF Impact Consultant

June 4, 2009

E:\EA\Client Services\Windmills\Medin-Sparks\RFImpactStudyReport Medin-Sparks Dakota County, MN.doc

ATTACHMENT G

---------- Original Message ----------
Subject: Re:
From: Richard_Davis@fws.gov
Date: Mon, May 18, 2009 1:39 pm
To: anna@sparksenergy.net

Hello Anna,

I have taken some time to take a look at your project. At this time I don't believe that the turbine locations will affect any federally list threatened or endangered species, because they all appear to be in fields currently utilized for annual crop production. To be absolutely positive of no construction impacts to listed species I would have to know where all the access roads(temporary and permanent) would be constructed for the project. Dakota County has two federally listed species within it, Higgins' eye pearlymussel (Endangered) and prairie bush clover (Threatened). Within Dakota County at this time the Higgins' eye pearlymussel is restricted to the Mississippi River, so I don't have any concerns with that. However, I did note that there may be some state listed mussel species within some of the streams in the project area, so if there will be any impacts to the waterways out there the DNR should be contacted regarding those species. The prairie bush clover has a preference for dry or mesic prairie habitat, and although the turbines themselves are on agricultural ground the access roads could also impact this species.

At this time I would request that you provide me with any information you have regarding access road placement. I also wanted to let you know that there is another biologist assisting with this review, and if she should need any additional information I will forward her request on to you. Could you also provide me with a rough timeline of events you are shooting for with this project?

Thanks,
Rich Davis

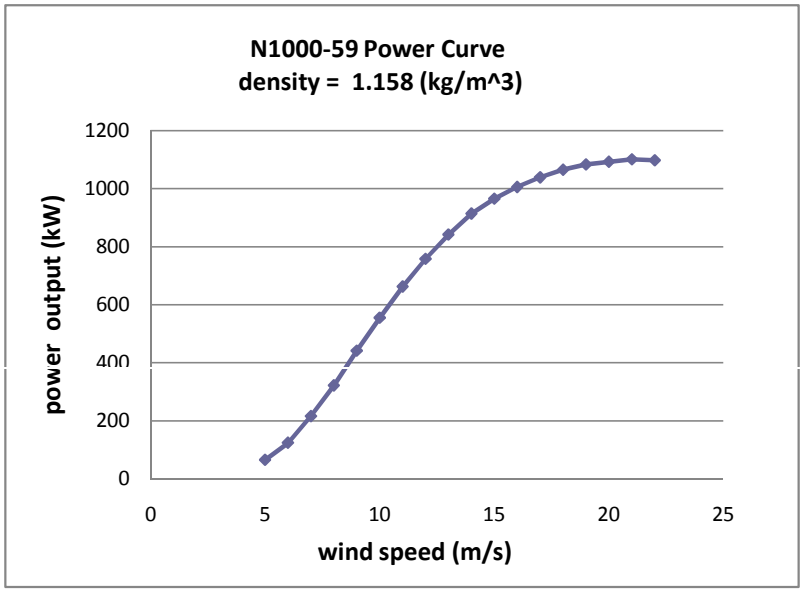
Richard Davis
Fish and Wildlife Biologist
U.S. Fish and Wildlife Service
Twin Cities Field Office
4101 American Blvd. E.
Bloomington, MN 55425
(612)725-3548 ext. 2214

ATTACHMENT H

Nordic Windpower - N1000

Power Curve and Energy Production Calculator

Wind Speed (m/s)	Power (kW)	Annual Hours	Energy (MWh)
5	65	840	55
6	124	870	108
7	216	852	184
8	322	797	256
9	441	713	315
10	555	614	341
11	662	510	338
12	758	408	309
13	841	316	266
14	914	237	216
15	965	172	166
16	1006	121	122
17	1039	83	86
18	1065	55	58
19	1083	35	38
20	1092	22	24
21	1101	13	15
22	1098	4	5



Annual Energy (MWh)	**2,900**
Capacity Factor	**33%**

User inputs: either edit these cells or enter data on the 'Wind hours' sheet.

Air density (kg/m^3)	1.158
Annual mean wind speed (m/s)	7.6

Warning: none

Nordic Windpower Ltd
125 University Avenue
Second Floor
Berkeley, CA 94710, USA
tel: +1 510 665 9463
www.nordicwindpower.com

16-Jun-2008

© Nordic Windpower 2008

Density

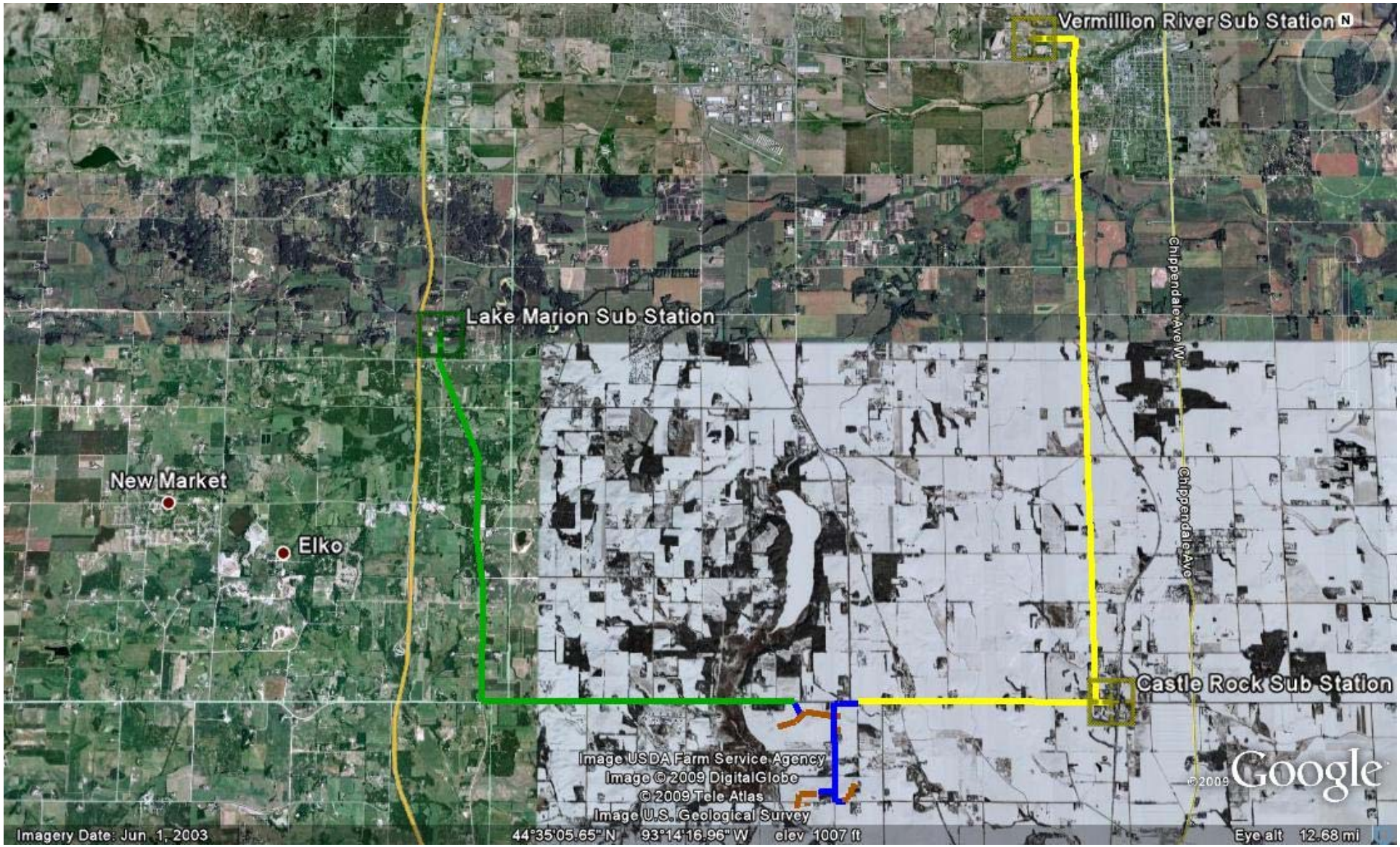
1120	ft				
339.39	m	MWh			
1.158	kg/m^3 @	20 deg C	2.806	2.643	0.941910192
1.195	kg/m^3 @	10 deg C	2.855		

ATTACHMENT I

Turbine	Latitude	Longitude	Elevation	KWH
A1	44 31 43.88 N	93 13 03.03 W	999	2,818,828
T1	44 32 25.67 N	93 13 21.36 W	1,039	2,883,000
T2	44 32 28.54 N	93 13 08.28 W	1,032	2,858,000
T3	44 32 33.58 N	93 13 00.29 W	1,015	2,728,000
T4	44 32 23.85 N	93 12 34.17 W	1,003	2,746,000
T5	44 32 30.77 N	93 12 33.97 W	985	2,689,000
T6	44 31 43.73 N	93 13 08.46 W	1,003	2,807,301
T7	44 31 50.51 N	93 13 06.69 W	1,006	2,783,000
T8	44 31 50.89 N	93 12 53.12 W	997	2,732,000
T9	44 31 49.62 N	93 12 31.44 W	1,015	2,819,174
T10	44 31 56.04 N	93 12 23.14 W	999	2,722,000

A1-T10 Total KWH	**30,586,303**
Avg A1-T10 KWH	**2,780,573**

ATTACHMENT J



Lake Marion Feeder Line

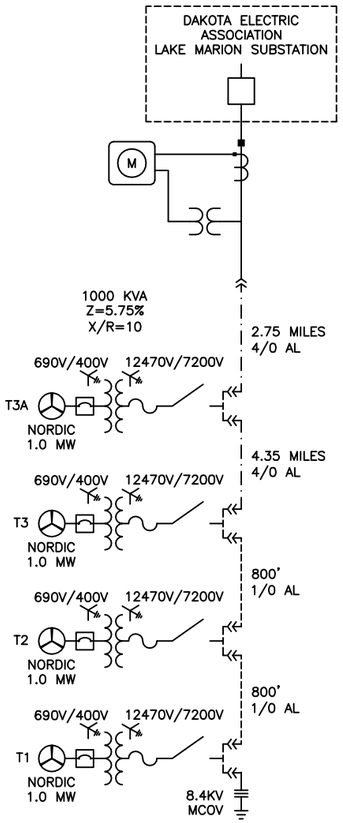
Castle Rock & Vermillion River Feeder Line

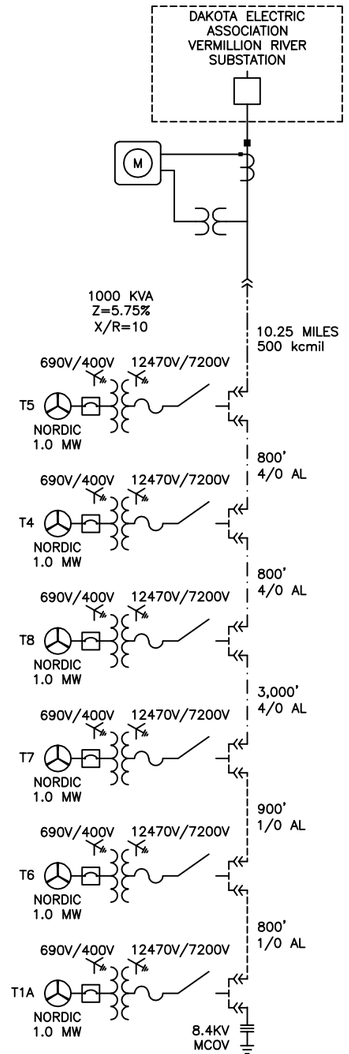
Access Road & Underground Cabling

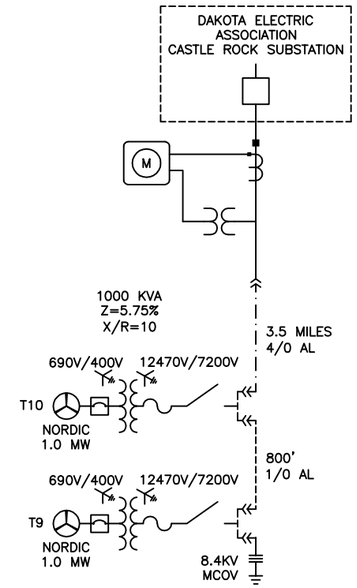
Collector Lines

ATTACHMENT K

Lake Marion Feeder Line
Castle Rock & Vermillion River Feeder Line
Access Road & Underground Cabling
Collector Lines







LEGEND

1.0 MW NORDIC WIND TURBINE

2000A MANUALLY–OPERABLE CIRCUIT BREAKER

PADMOUNT TRANSFORMER – 1000kVA
690V/12470V Z=5.75%.

15kV 500 kcmil AL WITH 1/3 NEUTRAL TRXLPE CABLE, 90°C

15kV 4/0 AWG AL WITH 1/3 NEUTRAL TRXLPE CABLE, 90°C

15kV 1/0 AWG AL WITH 1/3 NEUTRAL TRXLPE CABLE, 90°C

CABLE LOADING BASED ON ASSUMED RHO VALUE OF 150°C–cm/W. IN CONDUIT

SOIL TEMP 20°C

48" NOMINAL DEPTH

MULTI POINT GROUNDED

100% LOAD FACTOR

RANDOM LAY

REV.	DATE	DRAWN	DESCRIPTION	WORK ORDER	CHKD	APPD	DATE
A	07/01/09	MAK	ISSUE FOR REVIEW				

CEG CONSULTING ENGINEERS GROUP
FARMINGTON MINNESOTA

I HEREBY CERTIFY THAT THIS PLAN, SPECIFICATION, OR REPORT WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY REGISTERED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MINNESOTA

NAME VINCENT L. GRANQUIST

DATE _____ REGISTER NO. 43872

MEDIN RENEWABLE, LLC
ONE LINE DIAGRAM

CHECKED _____
DATE _____

SCALE NONE
W.O. NO.
MAP NO.

DRAWN MAK
DATE 07/01/09

DWG. NO. MR–OL–01RA