Public Utilities Commission Site Permit Application for a Large Wind Energy Conversion System

Moraine II Wind Project
Pipestone and Murray Counties, MN

Prepared for:

Moraine Wind II, LLC

Docket No: IP6632/WS-07-389

April 11, 2007

PPM Energy
A ScottishPower Company

April 11, 2007

Dr. Burl W. Haar
Executive Secretary
Minnesota Public Utilities Commission
121 Seventh Place East, Suite 350
St. Paul, Minnesota 55101

Re: In the Matter of a Site Permit Application for a Large Wind Energy Conversion System for the Moraine II Wind Project in Pipestone & Murray Counties, Minnesota
Docket No. IP6632/WS-07-389

Dear Dr. Haar:

Enclosed you will find 15 hard copies and 2 electronic copies of the Site Permit Application (Application) for a Large Wind Energy Conversion System for the Moraine II Wind Project in Pipestone & Murray Counties, Minnesota. This Application is being submitted by Moraine Wind II, LLC which is an unregulated wholly owned affiliate of PPM Energy, Inc. of Portland, Oregon.

The Applicant seeks a Site Permit authorizing construction of up to 49.9 Megawatts (MW) of wind energy for the Moraine II Wind Project in Pipestone & Murray Counties, Minnesota. PPM seeks flexibility in turbine selection to provide 49.9 MW of wind energy and proposes a range in turbine size from 1.5 to 3.0 MW. If PPM selects a 1.5 MW turbine, then up to 33 turbines would be sited at the Project. Associated facilities for the Project include gravel access roads, Operations and Maintenance building, and electrical collection system.

No confidential information is included in the Application. Therefore, only a public version is being filed. Enclosed are 15 hard copies and two electronic copies of the Application. I have submitted a check to the Department of Commerce under a separate cover for $7,500 as the initial payment for costs associated with processing this Application.

Thank you for your consideration.

Sincerely,

Tim Seck

Tim Seck – PPM Energy, Inc.

cc: Mr. Bob Cupit – Minnesota Public Utilities Commission
Mr. Adam Sokolski – Minnesota Department of Commerce
Ms. Sarah Emery – HDR Engineering, Inc.

Enclosures

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Pipestone and Murray Counties, Minnesota

PUC Docket Number: IP6632/WS-07-389

Prepared for:

Moraine Wind II, LLC

April 11, 2007

Prepared by:

HDR Engineering, Inc.
701 Xenia Ave. S, Suite 600
Minneapolis, Minnesota 55416

Applicant: PPM Energy, Inc.

Address: 2221 Riverwood Place
St. Paul, MN 55104

Authorized Representative: Mr. Tim Seck

Signature: Tim Seck

Phone: (651) 917-9285

Email: timothy.seck@ppmenergy.com

Preparer of Application: Ms. Sarah L. Emery

Signature: Sarah L. Emery

Company: HDR Engineering, Inc.

Address: 701 Xenia Ave. S, Suite 600
Minneapolis, MN 55416

Phone: (763) 591-5475

Fax: (763) 591-5413

Email: sarah.emery@hdrinc.com

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1.0 INTRODUCTION

Moraine Wind II, LLC, an unregulated wholly-owned subsidiary of PPM Energy, Inc, (Applicant) is submitting this application for a site permit to construct and operate the Moraine II Wind Project (the Project) to the Minnesota Public Utilities Commission (PUC). The Project is a Large Wind Energy Conversion System (LWECS), as defined in the Wind Siting Act, Minnesota Stat. §216F.01. The Project is located in Pipestone and Murray Counties, Minnesota (Figure 1-1) and will be up to 49.9 megawatts (MW) in size, consisting of up to 33 wind turbine generators. The Applicant has not made a final selection on turbines for the Project and proposes to permit the Project for a range in turbine size from 1.5 to 3.0 MW. The application uses the General Electric (GE) 1.5 MW machine as a representative turbine for the 1.5 MW Class, the Suzlon 2.1 MW machine as a representative turbine for the 2.1 MW Class, the GE 2.5 MW machine as a representative turbine for the 2.5 MW Class and the Vestas 3.0 MW machine as a representative turbine for the 3.0 MW Class. Together these four turbines span the spectrum of the turbine models in the 1.5 to 3.0 MW range. The Applicant may elect to select turbines by other turbine vendors in the 1.5 to 3.0 MW range. Associated facilities include gravel access roads, Project Substation, Operations and Maintenance (O&M) building, a permanent meteorological tower, and wind electrical collection system. The Project is expected to come online in the 2008-2009 timeframe.

PPM develops environmentally responsible generation in the United States. PPM owns and operates or markets the output for over 2000 MW of renewable energy generation capacity. PPM owns the 150 MW MinnDakota Wind Farm currently under construction in Lincoln County, Minnesota and Brookings County, South Dakota, the 51 MW Moraine Wind Project located in Pipestone and Murray Counties in Minnesota, and the 100 MW Trimont Wind Project in Jackson and Martin Counties in Minnesota. PPM also owns the 44 MW Flying Cloud Wind Project in Dickinson County, Iowa and additional wind facilities in New York, Kansas, Colorado, Oregon, and California. PPM owns gas storage and gas-fired generation facilities in the western United States. PPM's headquarters is located in Portland, Oregon.

Consistent with the PUC objectives, the Applicant is committed to optimizing the wind resource for the Project. All decisions with respect to equipment selection, site layout, and spacing are designed to make the most efficient use of land and wind resources. The Applicant will evaluate the site to optimize wind resources, transmission interconnection opportunities, and economic factors, while avoiding and minimizing impacts to environmental resources. The turbine selected for the Project will be dependent on the most appropriate technology available at the time of ordering equipment prior to construction.

1.1 PROJECT SUMMARY

It is anticipated that the Applicant will design, construct, finance, operate, and maintain the Project. The Applicant expects to initiate construction as early as summer 2008 and complete construction of the Project by the end of 2008 or 2009.

1.1.1 PROPOSED SITE

The Moraine II Project is primarily in western Murray County, Minnesota and extends northwest into Pipestone County, Minnesota (Figure 1-1). The proposed wind Project is located in Murray and Pipestone Counties within the following townships (Table 1-1).

Table 1-1
Project Location

County	Township Name	Township	Range	Section
Pipestone	Aetna	108N	44W	22 – 27, 35, 36
Murray	Ellsborough	108N	43W	30 - 35
Pipestone	Rock	107N	44W	1, 12, 13, 24, 25
Murray	Cameron	107N	43W	2 – 10, 15 – 22, 27 - 34
Murray	Chanarambie	106N	43W	4 - 6

The 26,992-acre Project area lies northwest of Lake Wilson and southeast of Ruthton, Minnesota (Figure 1-2). The Project's preliminary site layout for 48.3 MW is shown in Figure 1-3. See Section 3.0 for a description of the Project area.

1.1.2 PROJECTED OUTPUT

The Project will have a nameplate capacity of up to 49.9 MW. Assuming net capacity factors of between 35 to 45 percent, projected average annual output will be between approximately 153,000 and 197,000 MWh. As with all wind projects, output will be dependent on final design, site-specific features, and equipment.

1.1.3 SITING PLAN

The turbines and associated facilities will be sited primarily on agricultural land in Pipestone and Murray Counties, Minnesota. The Applicant will prepare the final siting layout to optimize wind resources while minimizing the impact on land resources and potentially sensitive resources. The topography of the site and the selected turbine technology will dictate turbine spacing. A description of turbine technology is presented in Section 4.2.

The wind turbines will have a rotor diameter (RD) of 78 meters (m) (256 feet [ft]) to 100 m (328 ft), depending on the turbine model selected. The minimum turbine spacing internally within the Project area would range from 3 RD east-west spacing to 5 RD north-south spacing. The setback from the site perimeter and unleased lands would be 5 RD on the north-south axis and 2.5 RD on the east-west axis. Project turbines would be setback at least 5 RD from existing wind turbines. Table 1-2 depicts the range of setback distances based on several possible turbine RDs.

Table 1-2
Minimum Turbine Spacing Distances

Rotor Diameter*	Internal East-West Spacing	Internal North-South Spacing	N-S Perimeter Setback	E-W Perimeter Setback
	3 RD	5 RD	5 RD	2.5 RD
78 m RD	234 m (768 ft)	390 m (1280 ft)	390 m (1280 ft)	195 m (640 ft)
88 m RD	264 m (866 ft)	440 m (1444 ft)	440 m (1444 ft)	220 m (722 ft)
90 m RD	270 m (886 ft)	450 m (1476 ft)	450 m (1476 ft)	225 m (738 ft)
95 m RD	285 m (936 ft)	475 m (1560 ft)	475 m (1560 ft)	238 m (780 ft)
100 m RD	300 m (984 ft)	500 m (1640 ft)	500 m (1640 ft)	250 m (820 ft)

* the listed RDs provide the range of rotor sizes; depending on the final turbine selection, the RD could vary slightly from the listed values, but would remain between 78 m to 100 m.

The perimeter setback ranges between a quarter mile to a third of a mile on the north-south axis and ranges between a fifth and an eighth of a mile in the east-west axis. Previous LWECS Site Permit requirements identify minimum setbacks from occupied residences of 500 feet and setbacks from public or developed roads of 250 feet.

1.1.4 OPERATION AND MAINTENANCE

The Project could to be operational as early as the fourth calendar quarter of 2008. The Applicant will be responsible for the operation and maintenance of the wind farm for the life of the Project, which is anticipated to be a minimum of 30 years. The Applicant will manage the O&M of the Facility. The nearest O&M facility that PPM owns is at the PPM Moraine Wind site located in Cameron Township, Murray County. PPM has three maintenance facilities within 200 miles of the Moraine II site. The Applicant anticipates that a new O&M facility will be built for the Project.

1.1.5 SITE CONTROL

The Applicant has site control on over 16,000 acres of land within the site boundaries, which is more than sufficient to support the Moraine II Project.

1.1.6 PERMITS AND LICENSES

The Applicant will obtain all permits and approvals that are necessary and not covered by this LWECS Site Permit. Permits and approvals for the Project are identified in Section 6.0.

1.1.7 DEVELOPMENT AND CONSTRUCTION

The Applicant and its engineering and construction contractors will perform or manage all development and installation activities. Specifically, the Applicant will:

- Perform site resource analysis and siting;
- Undertake environmental review; and
- Obtain specific permits and licenses for the Project.

Under the oversight of the Applicant's engineering and construction management staff, the engineering and construction contractors:

- Perform civil engineering for roads and turbine foundations
- Construct foundations, towers, and transformers;
- Assemble and install wind turbines; and
- Install the communication system, including supervisory control and data acquisition software and hardware, telephone and fiber-optic cable, and construct the electrical feeder and collection system

1.2 COMPLIANCE WITH THE WIND SITING ACT AND MINNESOTA RULES 4401

The Wind Siting Act requires an application for a site permit for a LWECS to meet the substantive criteria set forth in Minn. Stat. §216E.03, subd. 7. This application provides information necessary to demonstrate compliance with these criteria and the Minnesota Rules Chapter 4401. The siting of LWECS is to be made in an orderly manner compatible with environmental preservation, sustainable development, and the efficient use of resources (Minn. Stat. §216F.03).

The Wind Siting Rules (Minnesota Rules Chapter 4401) govern the contents and treatment of applications for LWECS site permits under the Wind Siting Act. To the extent available, the Applicant has presented information required by the Wind Siting Rules. In addition, sufficient project design, wind resource, and

technical information have been provided for a thorough evaluation of the reasonableness of the proposed site as a location for the Project.

1.2.1 CERTIFICATE OF NEED

Under Minnesota Statutes §216B.2421, subp. 2, a large energy facility is defined as an electric power generating plant of 50,000 kilowatts (50 MW) or more. A Certificate of Need (CON) is not required from the Minnesota PUC for the 49.9 MW Moraine II Wind Project.

1.2.2 STATE POLICY

The Applicant will further the state policy (Minnesota Statute §216F.03) by siting the Project in an orderly manner compatible with environmental preservation, sustainable development, and the efficient use of resources. The Applicant is designing the Project to include closer spacing of turbines to maximize wind development while minimizing the use of land resources.

1.3 OWNERSHIP OF THE PROPOSED FACILITY

It is anticipated that the Project will be developed, owned, and managed by Moraine Wind II, LLC, an unregulated wholly owned affiliate of PPM (Applicant). The Applicant and its engineering and construction contractors will perform all engineering, procurement, and construction of the wind farm.

It is anticipated that the Applicant will construct and own all equipment up to the low side of the busbar at the Xcel Energy Chanarambie Substation or other designated points of interconnection.

The local utility (Xcel Energy) or transmission provider typically owns and operates the interconnection facilities, including any new substation or transmission system upgrades, which may be necessary for the Project. The ownership and allocation of responsibility for costs, construction, and operations of interconnection and transmission facilities will be detailed in the Interconnection Agreement and Power Purchase Agreement (PPA). The Applicant has an Interconnection Agreement with Xcel Energy; therefore, there is interconnection capacity for the Project.

2.0 GENERAL DESCRIPTION OF THE PROPOSED FACILITY

2.1 WIND POWER TECHNOLOGY

As the wind passes over the blades of a wind turbine, it creates lift and causes the rotor to turn. The rotor is connected by a hub and main shaft to a gearbox, which is connected to a generator. Exact turbine models are subject to change to ensure selection of a turbine that is both cost effective and optimizes land and wind resources. The Applicant is proposing to use wind turbines in the 1.5 MW to 3.0 MW size range. If the Applicant selects a 1.5 MW turbine, up to 33 turbines would be used, while the selection of a 2.1 MW, 2.5 MW or 3.0 MW turbine would result in the use of up to 23, 19 or 16 turbines, respectively. The Applicant proposes to finalize its turbine choice when it submits its final site plan to the PUC prior to construction.

The application uses the GE 1.5 MW machine as a representative turbine for the 1.5 MW Class, the Suzlon 2.1 MW machine as a representative turbine for the 2.1 MW Class, the GE 2.5 MW machine as a representative for the 2.5 MW class and the Vestas 3.0 MW machine as a representative turbine for the 3.0 MW Class. Together these turbines span the spectrum of the turbine models in the 1.5 to 3.0 MW range. The Applicant may select turbines by other turbine vendors in the 1.5 to 3.0 MW range; these turbines may have slightly different hub heights and/or RDs. Regardless of the turbine selected, the hub heights would range between 80 to 105 m and the RD would range between 78 to 100 m. Table 2-1 shows the range of characteristics for the four representative turbines.

Table 2-1
Wind Turbine Characteristics

Characteristic	Turbine			
	GE 1.5 MW	Suzlon 2.1 MW	GE 2.5 MW	Vestas 3.0 MW
Nameplate capacity	1,500 kW	2,100 kW	2,500 kW	3,000 kW
Hub height	80 m (262 ft)	80 m (262 ft)	85 to 100 m (279 to 328 ft)	80 to 105 m (262 to 345 ft)
Rotor Diameter	78 m (256 ft)	88 m (289 ft)	88 to 100 m (289 to 328 ft)	90 m (295 ft)
Total height[1]	119 m (390 ft)	124 m (407 ft)	135 to 150 m (443 to 493 ft)	125 to 150 m (410 to 493 ft)
Cut-in wind speed[2]	3 m/s (6.7 mph)	4 m/s (8.9 mph)	3.5 m/s	4 m/s (8.9 mph)
Rated capacity wind speed[3]	11.8 m/s (26.4 mph)	14 m/s (31.3 mph)	12.5 m/s	15 m/s (33.6 mph)
Cut-out wind speed[4]	25 m/s (45 mph)	25 m/s (45 mph)	25 m/s	25 m/s (45 mph)
Maximum sustained wind speed[5]	Over 45 m/s (100 mph)	Over 45 m/s (100 mph)	N/A	Over 42.5 m/s (05 mph)
Rotor speed	10.1 to 20.4 rpm	15.1 to 17.7 rpm	5.5 to 16.5 rpm	9.9 to 18.4 rpm
Distance to 50 dBA noise level	623 ft	850 ft	N/A	788 ft

[1] Total height = the total turbine height from the ground to the tip of the blade in an upright position
[2] Cut-in wind speed = wind speed at which turbine begins operation
[3] Rated capacity wind speed = wind speed at which turbine reaches its rated capacity
[4] Cut-out wind speed = wind speed above which turbine shuts down operation
[5] Maximum sustained wind speed = wind speed up to which turbine is designed to withstand
N/A = information is not available.

Each tower will be secured by a concrete foundation that can vary in design depending on the soil conditions. A control panel inside the base of each turbine tower houses communication and electronic circuitry. Each turbine is equipped with a wind speed and direction sensor that communicates to the turbine's control system to signal when sufficient winds are present for operation. The turbines feature variable-speed control and independent blade pitch to assure aerodynamic efficiency.

The electricity generated by each turbine is stepped up by a pad-mounted transformer at the base of each turbine to power collection line voltage of 34.5 kV. The electricity is collected by a system of underground or overhead power collection lines within the Project area. Both power collection lines and communication cables will be buried in trenches or may be constructed as overhead lines on private property or public right-of-way (ROW). Typically, this infrastructure is run adjacent to the Project access roads, between turbine strings and along public ROWs or easements. In cases where such infrastructure must be sited on property that is not governed by the existing wind easement and land lease options, the Applicant will obtain easements for the necessary property.

Each wind turbine will be accessible via all-weather gravel roads approximately 16 feet in width providing access to the turbines via public roads. At the point where the access and public roads meet, the communication and power lines will either rise from underground to overhead lines or continue as underground lines. The collection system delivers power to the Project Substation. From the Project Substation, the power will be transmitted via 34.5 kV lines to Xcel Energy's Chanarambie Substation. At the Chanarambie Substation the power from the Project will be transformed to transmission level voltage for delivery into the transmission grid. The Project Substation and interconnection into the Chanarambie Substation will conform to Midwest Independent Transmission System Operator (MISO) standards. Figure 2-2 is a diagram of the path of energy from the wind farm to energy users. Figure 2-3 shows a typical wind farm facility layout.

2.2 WIND FARM PROJECT LAYOUT

The Applicant will develop a site layout that optimizes wind resources while minimizing the impact on land resources and any potentially sensitive areas.

The Project will consist of wind turbines in the 1.5 MW to 3.0 MW size range. If the Applicant selects a 1.5 MW turbine, 33 turbines would be used, while the selection of a 2.1, 2.5 or 3.0 MW turbine would result in the use of 23, 19 or 16 turbines, respectively. A preliminary 48.3 MW site layout based on 23 2.1 MW turbines is presented as Figure 1-3.

Wind-powered electric generation is entirely dependent on the availability of the wind resource at a specific location. The energy available from the wind is proportional to the cube of the wind velocity. In other words, a doubling of the wind velocity will increase the available energy by a factor of eight times. Analysis of wind direction data suggests that the optimal turbine string alignments are from west to east and from west-northwest to east-southeast. Turbine placement was designed to provide an internal 3 RD crosswind spacing and 5 RD downwind spacing between turbines. Design of the turbine array and collection system will minimize energy loss due to wind turbine wakes, turbulence, and electrical line losses.

In accordance with previous LWECS Site Permit requirements, the Applicant has incorporated setbacks of at least 500 feet from inhabited (not vacant or abandoned) residences and 250 feet from public roads. The Applicant will maintain an appropriate setback from inhabited residence to stay below the Minnesota Pollution Control Agency (MPCA) Nighttime Noise Limit of 50 dBA. Based on 1.5 to 3.0 MW turbines, the setback from residences would range from 623 to 850 feet (see Section 5.3 for further discussion of the noise analysis). The Applicant proposes a 5 RD setback from the perimeter along the north-south axis (downwind spacing) and a 2.5 RD setback from the perimeter on the east-west axis (crosswind spacing). The Applicant turbines would be setback at least 5 RD from existing wind turbines.

Table 2-2 identifies the most conservative setbacks applicable to the Project, based on the representative turbines discussed above. Although no noise data is currently available for the 2.5 MW turbine, setbacks from occupied residences would likely still range between 623 to 850 feet, based on meeting the 50 dBA noise level of the selected turbine.

Table 2-2
Setback Distances for Wind Turbines

Turbine Description	N-S Perimeter Setback (5 RD)	E-W Perimeter Setback (2.5 RD)	Occupied Residences	Public Roads
	(ft)	(ft)	500 ft minimum	250 ft minimum
1.5 MW Turbine with 78 m RD	1280 ft	640 ft	623 ft	250 ft
2.1 MW Turbine with 88 m RD	1444 ft	722 ft	850 ft	250 ft
2.5 MW Turbine with 100 m RD	1640 ft	820 ft	N/A	250 ft
3.0 MW Turbine with 90 m RD	1476 ft	738 ft	788 ft	250 ft

2.3 ASSOCIATED FACILITIES

In addition to the wind turbines and the step-up transformers, the Project will include gravel access roads that allow for easy access to the wind turbines year-round. These roads will be approximately 4.9 meters (16 feet) wide and low profile to allow cross-travel by farm equipment. The Applicant will work closely with the landowners in locating access roads to minimize land use disruptions to the extent possible.

Consideration will be taken in locating access roads to minimize impact on current or future row crop agriculture, grazing, and environmentally sensitive areas.
An O&M building may be constructed within the Project area. Please see Section 4.5.4 for a description of this facility.

The electricity generated by each turbine is stepped-up by a pad-mounted transformer at the base of each turbine to power collection line voltage of 34.5 kV. The electricity generated at each turbine is collected by a system of underground or overhead power collection lines within the Project area and brought to the Project Substation, which may be located adjacent to the existing substation for the Moraine wind project. The power collection lines from the turbines will be plowed or trenched underground adjacent to the access roads, or they will cut across property to another turbine string. At the point where the access and public roads meet, the power collection lines will either rise from underground to overhead lines or continue as underground lines. The Project Substation will connect to Xcel Energy's Chanarambie Substation. The electric energy collected at the Project Substation will be transmitted to Chanarambie Substation on 34.5-kV lines in accordance with Xcel and MISO guidance provided in the interconnection agreement. At the Chanarambie Substation, the power from the Project will be transformed to transmission level voltage to interconnect with the transmission grid.

The Applicant has constructed two temporary meteorological towers within the Project area boundaries, and may construct more. It is anticipated that the site will include one permanent meteorological tower to house an anemometer. The tower will be painted red on top and lighted to comply with Federal Aviation Administration (FAA) guidelines.

2.4 LAND RIGHTS

The Applicant has obtained wind rights and easements to support the Moraine II Project. Within the 26,992-acre Project boundary, the Applicant has land rights for 16,057 acres at the time of this application. Land rights will encompass the proposed wind farm and all associated facilities, including but not limited to wind and buffer easements, wind turbines, access, transmission feeder lines located on public roads when necessary, and possibly land to mitigate environmental impacts incurred due to development.

3.0 PROPOSED SITE

3.1 IDENTIFICATION OF PROJECT AREA

In addition to wind resource considerations, the Project area was selected based on its close proximity to available transmission infrastructure, substation, and landowners' interest in participating in the Project. Land-use patterns and environmentally sensitive features were factored into the site selection criteria. The site boundary in Minnesota encompasses an area of approximately 26,992 acres. However, the land occupied by the wind farm would be less than one-half of one percent of this area, assuming up to 33 turbines and access roads. It is anticipated that the area of direct land use for 33 1.5 MW turbines and gravel access roads would be approximately 22 acres. If 23 2.1 MW turbines, 19 2.5 MW turbines or 16 3.0 MW turbines are used, approximately 20 acres, 18 acres or 16 acres of direct land use, respectively, will be required for the turbines and access roads. An additional 5 acres is anticipated to be required for the Project substation and O&M facility.

The approximate location of existing wind farms immediately adjacent to the Project is shown on Figure 5-3. There is some overlap with the site boundary and existing wind farms because there are available wind resources within the existing wind farm areas and additional land is needed to meet setback requirements. The Applicant has obtained wind rights for these areas. See Section 5.0 for a detailed description of the Project impacts and mitigation. Figure 1-3 shows preliminary turbine locations for a 48.3 MW layout of 2.1 MW turbines, which are subject to change during the preconstruction surveys and micrositing.

3.2 WIND RESOURCE AREAS – GENERAL

The United States Department of Energy (DOE) and the Minnesota Department of Commerce (DOC) have conducted wind resource assessment studies in Minnesota since 1982. In October 2002, the DOC published the latest "Wind Resource Analysis Program" (WRAP) report that presents wind analysis data from monitoring stations across the state of Minnesota. In the vicinity of the Project area, the mean annual wind speed at an elevation of 50 m (164 ft) is mapped as 7.66 to 8.00 m/s (17.13 to 17.90 mph). At an elevation of 70 m (230 ft) above ground level, mean annual wind speed is mapped as 7.66 to 8.05 m/s (17.13 to 18.00 mph).

The Applicant has reviewed and analyzed meteorological information for Buffalo Ridge and the Project area. This information is described below in Section 3.3.

3.3 WIND CHARACTERISTICS IN PROJECT AREA

PPM has several meteorological towers in the Project area that have been collecting data since 2002. To supplement the data from the Project area, eight years of historical data from the Minnesota Department of Commerce meteorological site in Brewster, located approximately 30 miles east-southeast of the Project area, were correlated with the wind data from the Project area to provide a more robust data set. The Brewster meteorological tower is at an elevation of 1,400 feet and the meteorological tower at the Project area is at an elevation of 1,370 feet.

WindPRO and WAsP software were used to analyze the available wind data from the Brewster meteorological tower and make corrections for the site effects (topography, surface roughness, and obstacles) to produce a site-independent characterization of the local wind climate. The resulting local wind climate was applied in conjunction with the Project area site effects to predict the spatial wind variations at the Project area.

Various site layouts and wind turbine generator parameters can be tested to predict the energy production and array efficiency to optimize the site layout and turbine selection. Project area data has been compared to the long term Brewster data and other regional wind measurements using a parallel time period. There is a good correlation between the long-term wind measurements and the short-term Project area wind measurements. Based on the available data, the Brewster and Moraine II sites can be judged as having similar wind climates.

3.3.1 INTERANNUAL VARIATION

Based on adjusted data from the Department of Commerce's Brewster site, the estimated average annual wind speed at the Project area from 1995 to 2003 was 7.7 meters/second (m/s), with a range of 7.1 to 8.0 m/s, or a variation of approximately twelve percent.

3.3.2 SEASONAL VARIATION

The expected wind speed in the Project area at 80 meters is shown in Table 3-1. The strongest winds are during the months February, 8.4 m/s and April, 8.5 m/s. The summer months of July and August have the lowest average wind speeds of 6.3 and 6.0 m/s, respectively.

Table 3-1
Estimated Wind Speed (m/s) at 65 meters in the Project Area

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1995							6.5	6.0	7.0	8.5	8.4	7.4	7.3
1996	7.7	9.3	8.5	8.4	7.8	7.0	6.1	6.0	6.7	9.2	7.5	7.8	7.7
1997	9.0	8.1	8.9	7.8	8.9	7.0	6.9	5.3	7.1	9.1	7.4	7.0	7.7
1998	5.7	6.5	7.8	8.0	8.0	6.8	5.1	5.7	6.8	7.9	8.4	8.3	7.1
1999	7.3	8.8	8.2	8.8	8.5	7.6	6.8	6.6	7.8	8.5	8.3	8.1	7.9
2000	7.8	8.1	7.5	8.2	7.8	8.0	5.7	6.2	7.5	7.5	8.5	8.0	7.6
2001	8.2	7.5	7.2	8.8	7.8	7.8	6.0	6.0	6.3	9.0	9.2	8.9	7.7
2002	8.4	10.0	7.1	9.3	8.6	8.4	6.5	6.7	7.4	6.8	7.9	8.4	8.0
2003	7.7	8.7	8.5	8.4	7.7	6.6	6.8	5.7	7.8	7.9			7.6
Mean of the Means	7.7	8.4	8.0	8.5	8.1	7.4	6.3	6.0	7.1	8.3	8.2	8.0	7.7

3.3.3 DIURNAL CONDITIONS

Figure 3-1 shows the expected diurnal variations of wind speeds. Wind speeds are generally greatest during nighttime and early morning hours and decline at midday.

3.3.4 ATMOSPHERIC STABILITY

The atmospheric stability is defined by lateral fluctuation of the wind, or sigma theta. Stability level is characterized by sigma theta 0 to 2.5 degrees as stable, 2.5 to 7 as moderately stable, 7 to 9 as neutral, 9 to 15 as moderately unstable, and greater than 15 degrees as very unstable (these categories are from *Meteorology and Atomic Energy*, Slade D.H., 1968). The atmospheric stability based on the Department of Commerce's Brewster site at the 70 meter level is moderately stable at 6.8 degrees. The stability level frequency is shown in Table 3-2.

Table 3-2
Frequency of Stability Class

Stability Level	Frequency
Stable	10%
Moderately Stable	59%
Neutral	16%
Moderately Unstable	11%
Unstable	4%

3.3.5 HUB HEIGHT TURBULENCE

The Turbulence Intensity (TI) is defined as the measured standard deviation of wind speed over an hour, divided by the mean for the same time period. For wind speeds greater than 5 m/s the expected TI is 11.3%. For wind speeds greater than 15 m/s, the expected TI is 10.98%.

3.3.6 EXTREME WIND CONDITIONS

The maximum hourly wind speed measured at the Department of Commerce's Brewster tower over from July 1995 through October 2003 was 25 m/s. Using a conservative gust factor of 1.3, the expected highest one-second gust would have been 33 m/s.

Extreme temperature range is expected be between 40 and -35° C. Glaze icing may occur up to 2 % of the operating hours of the year for wind turbines.

3.3.7 WIND SPEED FREQUENCY DISTRIBUTION

Figure 3-2 presents a wind speed frequency distribution for the Moraine II area. Wind speeds range between 4 and 11 m/s approximately 75 percent of the time, and between 6 and 10 m/s approximately 50 percent of the time.

3.3.8 WIND VARIATION WITH HEIGHT

Wind shear is the relative change in wind speed as a function of height. Wind shear is calculated using a power function based upon the relative distance from the ground. The general equation used for calculating wind shear is $S/S_0 = (H/H_0)^{\alpha}$, where S_0 and H_0 are the speed and height of the lower level and α is the power coefficient. The power coefficient can vary greatly due to the terrain roughness and atmospheric stability. The power coefficient will also change slightly with variation in height. The vertical variation with height or shear coefficient is 0.278 based on the 50 to 70 meter level at Department of Commerce's Brewster site.

3.3.9 SPATIAL WIND VARIATION

A map of the spatial variation of the wind for the Project area was prepared using a regional wind statistic generated from the Minnesota Department of Commerce's Brewster wind data. The model used to develop the map takes into account wind data, topography and surface roughness characteristics. The map shows that well-exposed terrain in the Project area is in the 7.6 to 7.8 m/s range of wind speeds at 80 meters.

Little variation is expected across the Project area, because of the relatively flat, open terrain. Wind speeds should be quite similar at all the tower sites proposed for this project.

3.3.10 WIND ROSE

A wind rose is a graphical presentation that shows the various compass points, and specifies the frequency that the wind is observed to blow from a given compass point. Small-scale variations are expected at the proposed site depending on individual turbine height and exposure.

The prevailing energy wind direction is SSE-S, with significant energy from the WNW-N sectors. Figure 3-3 shows the expected energy rose for the Project area generated from the Department of Commerce's Brewster site. The data shown in Figure 3-3 is consistent with data collected at the existing Moraine wind project.

3.4 OTHER METEROLOGICAL CONDITIONS

3.4.1 AVERAGE AND EXTREME WEATHER CONDITIONS

The Project area has a subhumid, continental climate that is characterized by cold winters and hot summers. Summers provide long periods of sunshine and southerly winds bring warm, moist air from the Gulf of Mexico. In winter, the climate cools rapidly because solar insulation is reduced and northerly winds bring in cold, dry air from high latitudes. The climate of the Project area is quite uniform because there are no large bodies of water or sharply marked differences in topography within the area.

There are no existing long-term data available specifically for the Project area; however, the data from Lake Wilson, Minnesota, located approximately two miles to the southeast, should be representative of the Project area. Table 3-3 provides data on temperature and precipitation for the Project area, as recorded at Lake Wilson, Minnesota during the period 1971 to 2000. This period is assumed to be representative of the climate for the Project area. In the winter (December to February), the average maximum temperature is 25 °F, and the average minimum temperature is 6 °F. The lowest temperature recorded at Lake Wilson, Minnesota during the representative period is -29 °F, which occurred on

January 10, 1982. In the summer (June to August), the average maximum temperature is 81 °F. The highest temperature recorded at Lake Wilson, Minnesota during the representative period is 105 °F, which occurred on June 21, 1988. The total annual precipitation is about 27 inches. The greatest one-day rainfall recorded at Lake Wilson, Minnesota during the representative period is 3.97 inches, which occurred on October 31, 1979. The average seasonal snowfall is 42.6 inches.

The National Climatic Data Center (NCDC) has records of 122 extreme weather events for Murray County and 131 extreme weather events for Pipestone County for the period from January 1, 1950 to October 31, 2006. These events include thunderstorms, tornadoes, hail, heavy snow and ice, extreme cold, heat waves, and drought. Tornadoes and severe thunderstorms strike occasionally. The state of Minnesota sees approximately 15 to 20 tornadoes a year. The NCDC has records of 39 thunderstorms and high wind events in Murray County, and 48 thunderstorms and high wind events in Pipestone County, for the period January 1, 1950 to October 31, 2006. These storms are local in extent and of short duration. They result in damage to small geographic areas. Hail occasionally falls in scattered areas during the warmer periods. Neither hail nor lightning from severe storms presents a problem for operation of the proposed development. Wind turbines, however, are not designed to survive tornado-force winds of 89+ m/s (200+ mph). In the winter, icing events are variable in frequency. It is expected that the average annual energy loss will be 2 percent due to icing.

The turbines being considered for this project are designed to withstand extreme weather conditions. In high winds, the turbine blades “feather” into the prevailing wind direction to reduce energy capture, and the turbines shut down above the cut out wind speed (generally 45 mph). In icy weather, the turbines stop turning when they have significant ice loads due to the resultant imbalance. The setbacks associated with this Project and equipment safeguards control the potential hazard associated with ice throw.

Table 3-3
Temperature and Precipitation
(Recorded in the Period 1971-2000 at Lake Wilson, Minnesota)

Month	Temperature			Precipitation	
	Average Daily Maximum °F	Average Daily Minimum °F	Average °F	Average In	Average Snowfall In
January	21.8	1.8	11.8	0.66	9.1
February	28.3	9.0	18.7	0.66	6.1
March	40.0	20.5	30.3	1.88	8.7
April	56.0	33.6	44.8	2.68	2.7
May	70.1	46.8	58.5	3.35	0.0
June	79.3	56.4	67.9	3.81	0.0
July	83.1	60.8	72.0	3.25	0.0
August	80.7	58.5	69.6	3.66	0.0
September	72.4	48.6	60.5	2.67	0.0
October	59.7	35.6	47.7	2.11	0.8
November	39.6	21.6	30.6	1.59	7.9
December	25.8	7.6	16.7	0.68	7.3
Yearly					
Average	54.7	33.4	44.1		
Total				27.00	42.6

Source: Midwest Regional Climate Center, November 2003.

The total annual average precipitation is about 27 inches. More than 19 inches, about 72 percent, falls in April through September. Tornadoes and severe thunderstorms strike occasionally. These storms are local in extent, are of short duration, and can result in damage to isolated areas. Hail occasionally falls in scattered small areas during the summer.

3.5 ENERGY PROJECTIONS

3.5.1 PROPOSED ARRAY SPACING FOR WIND TURBINES

Wind turbines will be placed along higher elevation features at the site to provide maximum exposure to wind resources. The proposed internal array spacing for the turbines at the Project is a minimum of 3 RD in an east-west direction (crosswind spacing) and a minimum of 5 RD in a north-south direction (downwind spacing). The spacing is dependent upon the selected equipment and the topography of the site. The Applicant will develop the site to minimize array wake losses and to optimize efficient use of wind and land resources.

3.5.2 BASE ENERGY PROJECTIONS

The Project will have a nameplate capacity of up to 49.9 MW. Assuming net capacity factors of between 35 to 45 percent, projected average annual output will be between approximately 153,000 and 196,750 MWh. As with all wind projects, output will be dependent on final design, site-specific features, and equipment. Gross to net calculations take into account, among other factors, energy losses in the gathering system, mechanical availability, array losses, and system losses. An industry-wide estimate of energy losses ranges from 8 to 10 percent of maximum output.

3.6 COST ANALYSIS

The Applicant has estimated the cost for a large mid-continent wind farm to be approximately $1,500 to $1,900 per kW, pending final interconnection costs. The largest component in the total cost of the Project will be the wind turbines; however, infrastructure costs for access road construction and electrical collection systems also are factors. For purposes of comparison, a service life of 30 years has been assumed in order to estimate annualized capital costs. The actual price that the Project will obtain from the sale of its energy is proprietary and confidential.

4.0 ENGINEERING AND OPERATIONAL DESIGN ANALYSIS

This section provides a summary description of the Project, which includes a description of the Project layout, turbines, electrical system, and associated facilities. Additional information addressed in this section is Project construction, schedule, operation, and decommissioning of the site. The Applicant wishes to preserve the right to evaluate and select turbine equipment of varying sizes and outputs.

There are other turbines that are feasible choices for the Moraine II site that are available from various manufacturers, and include turbines up to 3.0 MW in size. Turbine type may affect the number and configuration of the turbine array.

4.1 MORAINE II WIND PROJECT LAYOUT AND ASSOCIATED FACILITIES

The Project will consist of an array of wind turbines, transformers, access roads, permanent meteorological tower, and an O&M building. The turbines will be interconnected by communication and electric power collection cable within the wind farm. In addition, the wind farm facilities will include electrical collection lines and junction boxes that deliver the electricity to a Project Substation that will be connected to the transmission system through Xcel Energy's Chanarambie Substation. Because there are many existing wind projects in the area (Figure 5-3), the layout will take into account the locations of existing wind turbines, for both setback and operational efficiency considerations.

Land will be graded on-site for the turbine pads. Drainage systems, access roads, storage areas, and shop facilities will be installed as necessary to fully accommodate all aspects of the construction, operation, and maintenance of the wind farm.

The electrical system design and interconnection details will be determined as a result of studies and discussions with Xcel Energy and MISO. The electrical system will deliver the power to Xcel Energy's Chanarambie Substation, as detailed in the Interconnection Agreement. At the Chanarambie Substation, the electric voltage will be stepped up to transmission level voltage.

The Project includes a computer-controlled communications system that permits automatic, independent operation, and remote supervision, thus allowing the simultaneous control of the wind turbines. The Applicant will be responsible for the operation and maintenance of the Project. The Applicant may contract with suppliers of operations and maintenance services at the time of operation. The Applicant will maintain a computer program and database for tracking each wind turbine's operational history.

4.2 DESCRIPTION OF WIND TURBINES

The Applicant anticipates using up to 33 1.5 MW turbines or up to 16 3.0 MW turbines. The Applicant seeks the flexibility to select the most appropriate technology at the time for the Project to ensure optimization of wind and land resources and cost efficiency. The preliminary site layout is 48.3 MW based on 23 2.1 MW wind turbines (Figure 1-3). The Applicant will update the site layout, consistent with the parameters laid out in the LWECS Permit, when equipment is selected and if information regarding the wind resource identifies opportunities to further optimize the site. As stated previously, other turbines up to 3.0 MW and 100 m RD in size are also under consideration. A comparison of the turbines under consideration, the 1.5 MW generator, the 2.1 MW generator, the 2.5 MW generator and the 3.0 MW generator, is presented below and in Section 2.1.

4.2.1 TURBINE

Table 2-1 provides details on the hub heights, RDs, and wind speed operation parameters for the GE 1.5 MW turbine, the Suzlon 2.1 MW turbine, the GE 2.5 MW turbine and the Vestas 3.0 MW turbine. The 1.5 MW, 2.1 MW, 2.5 MW and 3.0 MW turbines have active yaw and pitch regulation and asynchronous generators. The turbines use a bedplate drive train design where all nacelle components are joined on common structures to improve durability.

The 1.5 MW, 2.1 MW, 2.5 MW and 3.0 MW turbines have Supervisory Control and Data Acquisitions (SCADA) communication technology to control and monitor the wind farm. The SCADA communications system permits automatic, independent operation and remote supervision, thus allowing the simultaneous control of the wind turbines.

Operations, maintenance and service arrangements between the turbine manufacturer and the Applicant will be structured to provide for timely and efficient operations. The computerized data network will provide detailed operating and performance information for each wind turbine. The Applicant will maintain a computer program and database for tracking each wind turbine's operational history.

Other specifications of the turbines include:

- Rotor blade pitch regulation.
- Gearbox with three-step planetary spur gear system (1.5 MW, 2.1 and 2.5 MW) and a 2-stage planetary gear and a 1-stage helical gear (3.0 MW);
- Double fed three-phase asynchronous generator (1.5 MW), a permanent magnet generator (2.5 MW) and an asynchronous 4-pole generator with a wound rotor (2.1 MW and 3.0 MW);
- A braking system for each blade and a hydraulic parking brake (disc brake);

- Yaw systems are electromechanically driven.

Some of the turbines being considered also incorporate new technology compared to turbines currently in the landscape, including:

- Force-flow bedplates (nacelle components joined on a common structure to improve durability);
- Permanent magnet generators (providing higher efficiency at lower wind speeds); and
- New gearbox bearing designs (improving reliability by reducing bending and thrust).

4.2.2 ROTOR

The rotor consists of three blades mounted to a rotor hub. The hub is attached to the nacelle, which houses the gearbox, generator, brake, cooling system and other electrical and mechanical systems. The preliminary 1.5 MW turbine design identifies a 78 m (256 feet) RD, the 2.1 MW turbine design identifies an 88 m (289 ft) RD, the 2.5 MW turbine design identifies an 88 to 100 m (289 to 328 ft) RD and the 3.0 MW turbine will have a RD of 90 m (295 ft). For the 1.5 MW turbine, the swept area for the 78 m RD would be 4,778 m^2 (51,472 ft^2). For the 2.1 MW turbine, the swept area for the 88 m RD would be 6,082 m^2 (65,597 ft^2). For the 2.5 MW turbine, the swept area for the 88 m RD and the 100 m RD would be 6,082 m^2 (65,597 ft^2) m and 7,854 m^2 (84,496 ft^2), respectively. The swept area for the 3.0 MW turbine (90 m RD) would be 6,362 m^2 (68,480 ft^2). As Table 2-1 shows, the rotor speed would be 10.1 to 20.4 rpm for the 1.5 MW turbines, 15.1 to 17.7 rpm for the 2.1 MW turbines, 5.5 to 16.5 rpm for the 2.5 MW turbines and 9.9 to 18.4 rpm for the 3.0 MW turbines.

4.2.3 TOWER

The towers are conical tubular steel with a hub height of 80 to 105 meters (262 to 345 feet). The turbine towers, where the nacelle is mounted, consist of three to four sections manufactured from certified steel plates. Welds are made in automatically controlled power welding machines and ultrasonically inspected during manufacturing per American National Standards Institute (ANSI) specifications. All surfaces are sandblasted and multi-layer coated for protection against corrosion. Access to the turbine is through a lockable steel door at the base of the tower. Four platforms are connected with a ladder and a fall arresting safety system for access to the nacelle.

4.2.4 LIGHTNING PROTECTION

The entire turbine is equipped with a lightning protection system. The turbine is grounded and shielded to protect against lightning. The grounding system will be installed during foundation work and must be accommodated to local soil conditions. The resistance to neutral earth must be in accordance with local utility or code requirements. Lightning conductors are placed in each rotor blade and in the tower. The electrical components are also protected.

4.3 DESCRIPTION OF ELECTRICAL SYSTEM

At the base of each turbine a step-up transformer will be installed to raise the voltage to power collection line voltage of 34.5 kV. Power will be run through an underground and/or overhead collection system to the Project Substation and eventually the point of interconnection.

Generally, the electrical lines will be buried in trenches and run to the edge of the farm field. At the public road at the edge of the farm field, the power collection lines will either rise from underground to overhead lines or continue as underground lines. The collection lines will occasionally require an aboveground junction box when the collection lines from separate spools need to be spliced together. The Project Substation will connect to Xcel Energy's Chanarambie Substation. The Project Substation will deliver 34.5 kV wind-generated energy to the Chanarambie Substation. At the Chanarambie Substation, the electric voltage will be stepped up to transmission level voltage.

The electrical system design and interconnection details will be determined as a result of studies and discussions with Xcel Energy and MISO. No details on the design have been determined at this time.

All utility protection and metering equipment will meet PPM, National Electric Safety Code (NESC), and Xcel Energy standards; conformance will be ensured by inspection, as laid out in the Interconnection Agreement. The construction manager will work closely with Xcel Energy's engineers to ensure that proper interconnection protection is established. Detailed interconnection information will be supplied to the PUC as it becomes available.

4.4 MORAINE II WIND FARM CONSTRUCTION

Several activities must be completed prior to the proposed commercial production date. The majority of the activities relate to equipment ordering lead-time, as well as design and construction of the facility. Below is a preliminary schedule of activities necessary to develop the Project. Pre-construction, construction, and post-construction activities for the Project include:

- Ordering of all necessary components including towers, nacelles, blades, foundations, transformers, etc.;
- Final turbine micro-siting;
- Complete survey to establish locations of structures and roadways;
- Soil borings, testing and analysis for proper foundation design and materials;
- Complete construction of access roads, to be used for construction and maintenance;
- Construction of overhead or underground feeder lines;
- Design and construction of the Project Substation;
- Installation of tower foundations;
- Installation of underground cables;
- Tower placement and wind turbine setting;
- Acceptance testing of facility; and
- Commencement of commercial production date

Access roads will be built adjacent to the towers, allowing access both during and after construction. The roads will be approximately 4.9 meters (16 feet) wide and have gravel as cover, adequate to support the size and weight of maintenance vehicles. These roads will meet state and local requirements. The specific turbine locations will determine the amount of roadway that will be constructed for this Project. In addition, there will be a 30 ft diameter gravel work area centered on the base of each turbine.

Temporary disturbances during construction of the Project include crane pads at each turbine site, temporary travel roads for the cranes, temporary laydown areas around each turbine, trenching in the underground electrical collection system, and storage/stockpile area. Construction of the turbine will include temporary impacts of approximately an additional 12 ft of gravel roadway on either side of the permanent roadway (40 ft total width), a 40 ft by 120 ft gravel crane pad extending from the roadway to the turbine foundation which will be graded to a minimum of 1 percent, and a component lay down and rotor assembly area centered close to the turbine foundation which will be graded to a minimum of 5 percent. The component lay down area will range from approximately 260 ft by 260 ft to 335 ft by 335 ft, depending on the turbine size selected. In addition to the disturbances associated with the temporary

travel roads for the cranes, it is possible that temporary impacts could occur when cranes move cross country between strings of turbines.

During the construction phase, several types of light, medium, and heavy-duty construction vehicles will travel to and from the site, as well as private vehicles used by the construction personnel. The Applicant estimates that there will be 75 large truck trips per day and up to 200 small-vehicle (pickups and automobiles) trips per day in the area during peak construction periods. That volume will occur during the peak time when the majority of the foundation and tower assembly is taking place. At the completion of each construction phase, this equipment will be removed from the site or reduced in number. Prior to construction, PPM will coordinate with local jurisdictions (county and township) in order to obtain the necessary road access and overwidth/overweight permits. PPM will also coordinate with local entities to determine appropriate mitigation for any damage incurred to local roads during construction.

4.4.1 CONSTRUCTION MANAGEMENT

The civil contractor will be the lead entity for the construction management of the Project. The primary civil, erection and electrical contractors will use, where possible, the services of local contractors to assist in the construction of the wind farm. The contractors, in coordination with local contractors, will undertake the following activities:

- Securing building, electrical, grading, road, and utility permits
- Perform detailed civil, structural, and electrical engineering
- Schedule execution of construction activities
- Complete surveying and geotechnical investigations
- Forecast Project labor requirements and budgeting

The primary contractors also serve as key contacts and interface for subcontractor coordination. The Applicant has a site construction manager who is responsible to manage the overall coordination between contractors. The electrical contractor will oversee the installation of communication and power collection lines as well as the substation. The civil contractor will oversee the installation of roads and foundations, as well as the coordination of aggregate and concrete materials receiving, inventory, and distribution. The construction consists of the following tasks:

- Site development, including roads
- Foundation excavation
- Concrete foundations
- All electrical and communications installation
- Tower assembly and machine erection
- System testing

The construction team will be on site to handle materials purchasing, construction, and quality control. The primary contractors will select and manage their local subcontractors to complete all aspects of construction.

Throughout the construction phase, ongoing coordination occurs between the Project development and the construction teams. The Applicant's on-site manager helps to coordinate all aspects of the Project, including ongoing communication with local officials, citizens groups and landowners. Even before the Project becomes fully operational, the O&M staff is integrated into the construction phase of the Project. The construction manager and the O&M staff manager work together continuously to ensure a smooth transition from construction through wind farm commissioning and, finally, operations.

4.4.2 FOUNDATION DESIGN

The wind turbines' freestanding 80 to 105 meter (262 to 344 ft) tubular towers will be connected by anchor bolts to a concrete foundation. Geotechnical surveys, turbine tower load specifications and cost considerations will dictate final design parameters of the foundations. The base portion of the foundation for a 1.5 MW turbine is an octagon approximately 40 to 60 feet in diameter and approximately 8 feet thick. The base portion of the foundation for a 2.1 MW, 2.5 MW or 3.0 MW turbine is an octagon approximately 80 feet in diameter. The pedestal of the foundation (the top portion on which the turbine tower base rests) is approximately 14 to 16 feet in diameter and 5 feet thick.

4.4.3 CIVIL WORKS

Completion of the Project will require various types of civil works and physical improvements to the land. These civil works include the following:

- Improvement of existing access roads to the Project area
- Construction of roads adjacent to the wind turbine strings to allow construction and continued servicing of the wind turbines
- Clearing and grading for wind turbine tower foundation installations
- Trenching for underground cabling for connecting the individual wind turbines
- Installation of an on-site feeder system for connecting wind turbine strings for delivery to the electricity collection/metering location
- Clearing and grading for pad-mount transformers and other installations
- Clearing and grading for Project Substation and O&M building
- Installation of any site fencing and security

Any improvements to existing access roads will consist of re-grading and filling of the gravel surface to allow access even in inclement weather. No asphalt or other paving is anticipated.

Access roads will be constructed along turbine strings or arrays. These roads will be sited in consultation with local landowners and completed in accordance with state and local requirements. They will be located to facilitate both construction (cranes) and continued operation and maintenance. Siting roads in areas with unstable soil will be avoided wherever possible. All roads will include appropriate drainage and culverts while still allowing for the crossing of farm equipment. The roads will be approximately 4.9 meters (16 feet) wide and will be covered with road base designed to allow passage under inclement weather conditions.

The roads will consist of graded dirt, overlaid with geotechnical fabric (if needed) and covered with gravel. To facilitate crane movement and equipment delivery, an additional 12 feet of gravel roadway will be temporarily installed on either side of the permanent roadway (40 ft total width).

In addition, turbine assembly will require a 40 ft by 120 ft gravel crane pad extending from the access road to the turbine foundation which will be graded to a minimum of one percent, and an approximate 260 ft by 260 ft to 335 ft by 335 ft area for component lay down and rotor assembly centered close to the turbine foundation which will be graded to a minimum of 5 percent.

After construction, the temporary construction areas adjacent to the turbine pad and access road will be restored. The site will be graded to natural contours, soil will be loosened if needed, and the site will be seeded if needed. Once construction is completed, the access roads will be regraded, filled, and dressed as needed.

4.4.4 COMMISSIONING

The Project will be commissioned after completion of the construction phase. The Project will undergo detailed inspection and testing procedures. Inspection and testing occurs for each component of the wind turbines, as well as the communication system, meteorological system, high voltage collection and feeder system, and the SCADA system. Once the interconnection is established, the Applicant will commission each turbine to generate electricity after completion of inspection and testing.

4.5 PROJECT OPERATION AND MAINTENANCE

Each wind turbine in the Project will communicate directly with the SCADA system for the purposes of performance monitoring, energy reporting, and trouble-shooting. The SCADA system also provides the overall control of the wind farm.

The Applicant will augment its O&M staff as needed with appropriate contractors to service and maintain the Project.

4.5.1 PROJECT CONTROL, MANAGEMENT, AND SERVICE

In addition to providing wind farm control, the SCADA system offers access to wind turbine generation or production data, availability, meteorological, and communications data, as well as alarms and communication error information. Performance data and parameters for each machine (generator speed, wind speed, power output, etc.) can also be viewed, and machine status can be changed. There is also a snapshot facility that collects frames of operating data to aid in diagnostics and troubleshooting of problems.

The primary functions of the SCADA are to:

- Control and monitor the wind farm;
- Alert operations personnel to wind farm conditions requiring resolution;
- Provide a user/operator interface for controlling and monitoring wind turbines;
- Collect performance data from turbines;
- Monitor field communications;
- Provide information on wind turbine performance for operators and maintenance personnel;
- Collect data on wind turbine and wind farm maintenance;
- Serve as an information archive;
- Provide spare parts inventory control; and
- Generate operations and maintenance reports.

4.5.2 MAINTENANCE SCHEDULE

Equipment will be monitored by local O&M staff and remotely by the Applicant's operations and power scheduling desk, which is staffed 24 hours per day. When needed, during off hours, local personnel will be dispatched to the site by the remote monitoring staff. Performance testing is done during the early months of operation to see that the wind farm is operating within expected parameters.

Project inspection and maintenance is performed on the following intervals:

A) First Service Inspection. The first service inspection will take place one to three months after the turbines have been commissioned. At this inspection, particular attention is paid to tower bolt tensioning and equipment lubrication.

B) Semi-Annual Service Inspection. Regular service inspections commence six months after the first inspection. The semi-annual inspection consists of lubrication and a test of the turbine trip system.

C) Annual Service Inspection. The yearly service inspection consists of a semi-annual inspection plus a full component check. Bolts are checked with a torque wrench. The check covers 10 percent of the bolts. If any bolts are found to be loose, all bolts in that assembly are tightened and the event is logged.

D) Two Years Service Inspection. The two years service inspection consists of the annual inspection, plus checking and tightening of electrical terminal connectors.

E) Five Years Service Inspection. The five years inspection consists of the annual inspection, an extensive inspection of the wind braking system, checking and testing of oil and grease, balance check, and tightness of terminal connectors.

4.5.3 GENERAL MAINTENANCE DUTIES

The O&M field duties include performing all scheduled and unscheduled maintenance including periodic operational checks and tests, regular preventive maintenance on all turbines, related plant facilities and equipment, safety systems, controls, instruments, and machinery, including:

- Maintenance on the wind turbines and on the mechanical, electrical power, and communications system;
- Performance of all routine inspections;
- Maintenance of all oil levels and changing oil filters;
- Maintenance of the control systems, all structures associated with the wind farm, access roads, drainage systems, and other facilities necessary for the operation of the wind farm;
- Maintenance of all O&M field maintenance manuals, service bulletins, revisions, and documentation for the wind farm;
- Maintenance of all parts, price lists, and computer software;
- Maintenance and operation of interconnection facilities;
- Provide all labor, services, consumables, and parts required to perform scheduled and unscheduled maintenance on the wind farm, including repairs and replacement of parts and removal of failed parts;
- Assist as needed with avian and other wildlife studies;
- Manage lubricants, solvents and other hazardous materials as required by local and/or state regulations;
- Maintain appropriate levels of spare parts in order to service equipment;
- Obtain all necessary equipment including the rental of industrial cranes for removal and reinstallation of turbine components;
- Hire, train, and supervise a work force necessary to meet the general maintenance requirements; and
- Maintain site security.

4.5.4 OPERATIONS AND MAINTENANCE FACILITY

The location of the O&M facility at the Project has not been determined at this time. The buildings used for this purpose are 3,000 to 5,000 square feet, and house the equipment to operate and maintain the wind farm. A gravel parking pad would surround the building. The parking lot adjacent to the building is typically 3,000 square feet.

4.6 PROJECT SCHEDULE

4.6.1 LAND ACQUISITION

The Applicant will be responsible for all land acquisition and will obtain the necessary easements from landowners.

4.6.2 PERMITS

The Applicant will be responsible for undertaking all required environmental review and will obtain all permits and licenses that are required following issuance of the LWECS Site Permit.

4.6.3 EQUIPMENT PROCUREMENT, MANUFACTURE AND DELIVERY

PPM is in the process of procuring turbines for Moraine Wind II and its other projects. Turbines will be allocated to the Project after meteorological and economic studies are completed to achieve the best match of turbines and sites. Turbines could arrive on-site as early as mid-2008.

4.6.4 CONSTRUCTION

PPM Construction Management personnel will oversee the primary contractors performing Project construction, including roads, wind turbine assembly, electrical, and communications work. The construction will take approximately 12 months to complete.

4.6.5 CONSTRUCTION FINANCING

The Applicant will be responsible for financing all pre-development, development, and construction activities. The Applicant anticipates financing the cost of all pre-development activities through internal funds. Construction will be financed with internal funds or a combination of internal funds and third-party sources of debt and equity capital.

4.6.6 PERMANENT FINANCING

Permanent financing will be provided with the Applicant's internal funds or a combination of internal funds and third-party sources of debt and equity capital. PPM Energy typically retains a long term interest in its wind projects.

4.6.7 EXPECTED COMMERCIAL OPERATION DATE

The Applicant anticipates that the Project could begin commercial operation as early as the fourth calendar quarter of 2008. The commercial operation date is dependent on the completion of the interconnection, permitting, and other development activities.

4.7 DECOMMISSIONING AND RESTORATION

The Project decommissioning and restoration plan is in accordance with the requirements of Minn. Rules part 4401.0450, subp. 13. The Applicant anticipates that the life of the Project will be no less than 20 years and reserves the right to re-apply for a Site Permit and continue operation of the Project upon expiration of the original Site Permit.

4.7.1 DECOMMISSIONING AND RESTORATION

The Applicant will begin decommissioning the facility within 8 months from the time the facility ceases to operate. Decommissioning will be completed within 15 months from the time the facility ceases to operate.

The Applicant also reserves the right to explore alternatives regarding Project decommissioning at the end of the Project area Site Permit term. One such option may be to re-apply for a Site Permit and continue operation of the Project, providing energy under a new long-term contract or on a merchant basis. Retrofitting, repowering or replacing the turbines and power system with upgrades based on new technology may allow the wind farm to produce efficiently and successfully for many more years.

4.7.2 ESTIMATED DECOMMISSIONING COSTS IN CURRENT DOLLARS

The Applicant will be responsible for all costs to decommission the Project and associated facilities. Based on estimated costs of decommissioning and the salvage value of decommissioned equipment, the salvage value of the wind farm will exceed the cost of decommissioning. Decommissioning costs are estimated at $55,000 per turbine in current dollars. Based on the historical average of scrap metal prices, the salvage value per turbine is estimated at $58,000. This methodology provides a conservative estimate of the Project's residual value because: 1) Long-term average scrap metal prices were used instead of recent years' scrap metal values that are much higher, and 2) During the majority of the wind farm's life, the components would be sold as used equipment at significantly higher prices than their underlying scrap metal value. In summary, the salvage value of the turbines and other components ensures that sufficient funds will be available to cover decommissioning and restoration costs. Because the uncertainty surrounding future decommissioning cost and salvage value increases with time, the Applicant will review and update the cost estimate of decommissioning and restoration for the Project in December 2022, 15 years after Project commissioning. This revised cost estimate of decommissioning and salvage value will then be submitted to the PUC for review and comment.

4.7.3 LIST OF DECOMMISSIONING ACTIVITIES

Decommissioning will involve removal of all above-ground wind facilities including towers, turbine generators, transformers, overhead cables, buildings, and ancillary equipment. Foundations will be removed to a depth of 4 feet below grade. All access roads will be removed unless the affected landowner provides written notice that the road or portions of the road shall be retained. Additionally, any disturbed surface shall be graded, reseeded, and restored as nearly as possible to its preconstruction condition.

5.0 ENVIRONMENTAL ANALYSIS

This section provides a description of the environmental conditions that exist within the Project. Consistent with PUC procedures on siting LWECS and applicable portions of the Power Plant Siting Act, various exclusion and avoidance criteria were considered in the selection of the Project area.

5.1 DESCRIPTION OF ENVIRONMENTAL SETTING (INTRODUCTION)

The Project is located on a landform known as Buffalo Ridge in southwestern Minnesota. Buffalo Ridge is a part of the Bemis Moraine that runs diagonally northwest to southeast from roughly Watertown, South Dakota, across southwestern Minnesota, and into Iowa. It is located in the Coteau des Prairies physiographic region and ranges in elevation from 1,700 to 2,000 feet above sea level. Buffalo Ridge is the watershed divide between the Missouri and Mississippi River watersheds. The proposed Project area is approximately 26,992 acres.

5.2 DEMOGRAPHICS

5.2.1 DESCRIPTION OF RESOURCES

The Project is located within a lightly populated rural area in southwestern Minnesota. There is no indication of any new residential construction on the site. Information on demographics and housing for this section was taken from the U.S. Census.

The site is located in Murray and Pipestone counties. The estimated 2005 population of Murray County was 8,852 and the 2000 population was 9,165. The estimated 2005 population of Pipestone County was 9,421 and the 2000 population was 9,895. The Project is located in parts of Aetna, Cameron, Chanarambie, Ellsborough and Rock townships. In 2000, the average household size was 2.42 and 2.38 in Murray and Pipestone counties, respectively. The total number of housing units in 2005 was 4,525 in Murray County and 4,496 in Pipestone County.

According to the 2002 U.S. Economic Census, the largest industries employing residents of Murray County are retail, health and social services. In Pipestone County, the primary industries are manufacturing, retail, health and social services

The 2003 median household income for Murray and Pipestone Counties was $37,730 and $36,813, respectively. In general, poverty levels are higher and per capita incomes are lower in the Project area townships compared to the overall county levels. This is likely because the townships are lightly populated, rural areas with declining populations. Table 5-1 summarizes some of the population and economic characteristics within the Project area. The 1999 per capita income and poverty level data area the most recent data available at the township level.

Table 5-1
Population and Economic Characteristics

Location	Population (2000)	Per Capita Income (1999)	Percentage of Population Below Poverty Level (1999)
Murray County	**9,165**	**$17,936**	**7.5**
Pipestone County	**9,895**	**$16,450**	**8.8**
Cameron Township	151	$12,991	17.0
Chanarambie Township	223	$11,696	11.2
Ellsborough Township	198	$10,551	12.4
Aetna Township	201	$13,623	14.3
Rock Township	184	$16,874	15.5

5.2.2 IMPACTS

Short-term impacts to socioeconomic resources will be relatively minor. Roughly 21 to 27 acres of agricultural land will be permanently removed from production. Landowner compensation will be established by their lease, and the areas surrounding each turbine may still be farmed. Project construction will not cause additional impacts to leading industries within the Project area. Although the poverty levels are generally lower in the Project area than the overall county averages, no negative impacts to low-income populations are expected because landowners will be compensated for impacts, and other economic effects from construction of the Project are expected to be positive. In an environment of uncertain and often declining agricultural prices and yields, the supplemental income provided to farmers from wind energy leases will provide stability to farm incomes and thus will help assure the continued viability of farming in the Project area. There is no indication that any minority or low-income population is concentrated in any one area of the Project, or that the wind turbines will be placed in an area occupied primarily by any minority group.

Local contractors and suppliers will be used for portions of the construction. Total wages and salaries paid to contractors and workers in Murray and Pipestone counties will contribute to the total personal income of the region. Additional personal income will be generated for residents in the county and state by circulation and recirculation of dollars paid out by the Applicant for business expenditures and for state and local taxes. Expenditures made for equipment, fuel, operating supplies, and other products and services benefit businesses in the county and the state. Landowners having turbine or other Project facilities on their land will receive a royalty or lease payment annually for the life of the Project. This payment diversifies and strengthens the local economy as discussed below.

Long-term beneficial impacts to the counties' tax base as a result of the construction and operation of the wind farm will contribute to improving the local economy in this area of Minnesota. The development of wind energy in this region has been important in diversifying and strengthening the economic base of southwestern Minnesota. Northwest Economic Associates prepared a report, "Assessing the Economic Development Impacts of Wind Power," that includes a case study of the Lake Benton I wind Project in Lincoln County, Minnesota. In addition to the creation of jobs and personal income, the Project will pay a Wind Energy Production Tax to the local units of government of $0.0012 per kWh of electricity produced, resulting in an annual Wind Energy Production Tax ranging from approximately $183,600 to $236,400.

5.2.3 MITIGATIVE MEASURES

Socioeconomic impacts associated with the Project will be primarily positive with an influx of wages and expenditures made at local businesses during Project construction and an increase in the counties' tax bases from the construction and operation of the wind turbines.

The Applicant proposes minimum setbacks for turbines from occupied residences of 623 feet for 1.5 MW turbines, 850 feet for 2.1 MW turbines, and 788 feet for 3.0 MW turbines, to comply with Minnesota noise standards. The Applicant proposes a minimum setback of 250 feet from public roads.

5.3 NOISE

5.3.1 DESCRIPTION OF RESOURCES

Background noise levels in the Project area are typical of those in rural settings, where existing nighttime noise levels are commonly in the low to mid-30 dBA. The dBA scale is A-weighted decibels based on the range of human hearing. Low to mid-30 dBA are relatively low background levels and are generally representative of the site. Higher levels exist near roads and other areas of human activity. The windy conditions in this region tend to increase ambient noise levels compared to other rural areas.

For the noise evaluation, the Applicant used representative sound power levels (Lp) of the GE 1.5 MW, the Suzlon 2.1 MW and Vestas 3.0 MW wind turbines that were provided by the manufacturers.

5.3.2 IMPACTS

When in motion, the wind turbines emit a perceptible sound. The level of this noise varies with the speed of the turbine and the distance of the listener from the turbine. On relatively windy days, the turbines create more noise; however, the ambient or natural wind noise level tends to override the turbine noise as distance from the turbines increases.

The wind turbines will create sources of additional noise. Since the noise levels provided did not include any time-weighted average sound levels, the sound power levels at the turbine hub of 104.5 dBA for the 1.5 MW turbine, 107.4 dBA for the 2.1 MW turbine and 106.7 dBA for the 3.0 MW turbine were converted to sound pressure levels and compared to the MPCA Daytime and Nighttime L10 and L50 Limits for residential receptors (NAC-1) as stated in the Minnesota Rule 7030.0040.

The Nighttime L50 limit of 50 dBA is the most stringent limit. The turbines were modeled to determine at what distance turbine noise would not exceed the 50 dBA limit. Turbines were modeled using the following equation for a hemispherical point source: $Lp = Lw - 10 \log (2\pi r2)-Aatm$ where Lp is defined as the sound pressure level at the distance of interest (r), Lw is the sound power level provided by the turbine manufacturers and Aatm is defined as the attenuation provided by atmospheric absorption. Sound is generated from the wind turbine at points near the hub or nacelle, 80 to 105 meters in the air, from the blade rotation, and motors near ground level. Therefore, the noise source could be considered both spherical and hemispherical. Use of the sound propagation equation for a hemispherical point source is therefore conservative and predicts the maximum distance for noise exceedances.

The maximum distances calculated where an exceedance of the 50 dBA limit would no longer occur is 190 meters (623 feet) for the 1.5 MW turbine, 259 meters (850 feet) for the 2.1 MW turbine and 240 meters (788 feet) for the 3.0 MW turbine (Figure 5-1). Noise levels for the 2.5 MW turbine are not available. If the 2.5 MW model is selected, then noise modeling will be conducted to ensure that the 50 dBA limit would not be exceeded at occupied residences. It is anticipated that the distance setback to avoid exceeding 50 dBA at occupied residences would range from 788 to 850 feet.

5.3.3 MITIGATIVE MEASURES

Impacts to nearby residents and other potentially affected parties in terms of noise will be taken into consideration as part of the siting of the turbines. The Applicant proposes minimum setbacks for turbines from occupied residences of 190 meters (623 feet) for 1.5 MW turbines, 259 meters (850 feet) for 2.1 MW turbines and 240 meters (788 feet) for 3.0 MW turbines. During micrositing, the placement of turbines will also take compound noise sources into account to determine the appropriate setback if a residence is near more than one turbine. To the extent that the sound characteristics of the selected turbine vary, the Applicant will ensure compliance with MPCA noise standards.

5.4 VISUAL IMPACTS

5.4.1 DESCRIPTION OF RESOURCES

The topography of the Project area is relatively flat with gently rolling hills and ridges with elevations that range from 1,700 to 2,000 feet above sea level. Agricultural fields, farmsteads, fallow fields, large open vistas, and gently rolling topography visually dominate the Project area. The landscape can be

classified as rural open space. The photo in Figure 5-2 shows a typical landscape of an agricultural field within the Project area.

Within the Project area local vegetation is predominantly agricultural crops and pasture. Crops include corn, soybeans, small grains, and forage crops, which visually create a low uniform cover. A mix of deciduous and coniferous trees planted for windbreaks typically surrounds farmsteads. Generally, these forested areas are isolated groves or windrows established by the landowner/farmers to prevent wind erosion and shelter dwellings. In the swales, there are patches of native willows, cattails, sedges, and rushes.

The settlements in Murray and Pipestone Counties are residences and farm buildings (inhabited and uninhabited) scattered along the rural county roads. These structures are focal points in the dominant open space character of the vicinity. A number of the farm structures date back to the late 19th or early 20th centuries and are representative of that era of Minnesota farm architecture. Typically, the farmsteads and residences are located at lower elevations to avoid winds common to the area.

A number of existing wind farms (NSP Phases I – III and other private wind projects totaling over 350 MW) are located northeast, east, and southeast of the Project area along Buffalo Ridge (Figure 5-3). These turbines are most visually apparent from highways and roads in the Project vicinity.

5.4.2 IMPACTS

Turbines will affect the visual character of the landscape within the Project area. However, discussion of the aesthetics of the proposed wind farm is based on subjective human responses. For some viewers, the Project could be perceived as a visual intrusion, characterized as “industrial” metal structures, 80 to 105 meters (262 to 345 feet) high at hub height for the range of turbines considered, intruding on the natural aesthetic value of the landscape. Wind farms have their own aesthetic quality and appeal. For other viewers, operation of the wind farm will not generate much traffic or significantly increase day-to-day human activity in the area. Therefore, the Project area will retain the rural sense and remote character. Also, although “industrial” in form and purpose, turbines are essentially “farming” the wind for energy.

The proposed land use would not involve any ongoing industrial use of non-renewable resources or emissions into the environment. Although the turbines are high-tech in appearance, they are compatible with the rural, agricultural heritage and the other existing wind turbines in the area.

Essentially, the installation of the Project will alter the land use and visual quality of the site. The topography in the vicinity is generally flat and the vegetation cover is uniformly low, making the ridgelines of the landform in the vicinity highly vulnerable to visual disruptions. Wind turbines already existing near the Project have altered the landscape in the area from agricultural to wind farm/agricultural.

The proposed Project will cumulatively contribute to the visual character imposed by the existing wind turbines.

Because the site is in the vicinity of other wind farms, the combined projects will have a larger overall visual impact. Figure 5-3 shows the locations of existing wind farms near the Project area. The Project will increase both the "industrial" appearance of the wind farms on Buffalo Ridge and the areas from which they will be seen. Since wind generation development is likely to continue on the ridge, this visual impact is inevitable.

The FAA requires obstruction lighting or marking of structures over 200 feet above ground surface because they are considered obstructions to air navigation (U.S. DOT FAA Advisory Circular 70/7460-IJ dated 11/29/95). The FAA recently released guidance (DOT/FAA/AC 70/7460-1K Chg2 dated 02/07) on standards for obstruction lighting for wind turbine farms. The Applicant will use this guidance when applying to the FAA for approval of a lighting plan that will light the Moraine II Project as one large obstruction versus every structure over 200 feet in height. This will potentially reduce the number of lights on turbines in the Project, compared with what FAA required in the past. In addition, the FAA now requires synchronized red strobe lights (compared to their earlier typical requirements for both red strobes at night and white strobes in the day).

It has been noted that the presence of turbines within the viewshed of wildlife management areas (WMAs) or other natural areas may diminish the natural quality of those areas and the experience of the persons utilizing those areas (Figure 5-4). While it may be true to some extent that the ability to see turbines in the background intrudes upon the purity of that experience, the same could be said of any human habitation or activity in the vicinity, and the presence of turbines may be less intrusive than many such activities. Nonetheless, some people may perceive the project to have negative effects.

The visual difference between the 1.5 MW, 2.1 MW, 2.5 MW and 3.0 MW turbines will be primarily in the RD. The 1.5 MW turbine design will have a maximum of 78 m (256 feet) RD, whereas the 2.1 MW turbine will have a RD of 88 m (289 feet), the 2.5 MW turbine will have a RD of 88 to 100 m (289 to 328 feet) and the 3.0 MW turbine will have a RD of 90 m (295 feet). The difference in visual impacts between the 1.5 and 2.5 MW turbines' RD will be difficult to ascertain. The major difference will be in the number of turbines associated with the wind farm. The visual impact on the landscape will be reduced by almost 50% if the Project is built using 3.0 MW versus 1.5 MW turbines (16 versus 32 turbines).

5.4.3 MITIGATIVE MEASURES

Moraine II proposes the following mitigative measures:

- Turbines will be uniform in color;
- Turbines will not be located in biologically sensitive areas such as parks, WMAs, or wetlands;
- Turbines will be illuminated to meet the minimum requirements of FAA regulations for obstruction lighting of wind turbine farms;
- Existing roads will be used for construction and maintenance where possible to minimize the amount of new roads constructed; and
- Access roads created for the wind farm facility will be located on gentle grades to minimize erosion, visible cuts, and fills

To attain maximum efficiency, wind power technology requires as much exposure to the wind as possible. As a result, the turbines are located on the ridge tops of Buffalo Ridge, which makes them highly visible to a wide range of surrounding areas. Shorter towers or placement of the turbines at alternate locations off the ridgelines are not feasible as visual mitigation measures because these measures would result in less efficiency per unit and adversely impact the economic viability of the Project.

5.5 PUBLIC SERVICES AND INFRASTRUCTURE

5.5.1 DESCRIPTION OF RESOURCES

The Project is located in a lightly populated, rural area in southwestern Minnesota. An established transportation and utility network provide access and necessary services to the light industry, small cities, homesteads, and farms existing near the Project area. The closest towns are Ruthton and Lake Wilson, located approximately 1.5 miles northwest and two miles southeast of the Project, respectively.

The towns provide sanitation, sanitary sewer, and library services. The Murray and Pipestone County Sheriff's Departments offer 24-hour service for the citizens of the counties. The Sheriff's Departments Communications Centers receive and dispatch all 911 calls for the county, including fire, medical, and police related emergencies.

The townships have limited public infrastructure services. Homes typically utilize septic systems and rural water for their household needs. Some homes may have private wells.

In general, the existing roadway infrastructure in and around the Project area is characterized by county and township roads that generally follow section lines. Various county state aid highways (CSAHs),

county roads (CRs), and township roads provide access to the proposed site. Access to the site also includes public and private two-lane paved and gravel roads. Many landowners use private single-lane farm roads and driveways on their property.

No Interstate or U.S. Highways are in the vicinity of the Project area. Trunk Highway (TH) 23 crosses the northwest corner of the Project area in Aetna Township. Within the Project area, Murray CSAH 25 and Pipestone CSAH 18 are the main north-south roads. Murray CSAH 10/Pipestone CSAH 7 and Murray CSAH 18/Pipestone CSAH 10 are the main east-west roads in the Project area. TH 30 is one mile south of the Project area.

The existing traffic volumes on the area's county highways are documented in Table 5-2 and Figure 5-5. For purposes of comparison, the functional capacity of a two-lane paved rural highway is in excess of 5,000 vehicles per day, or Annual Average Daily Traffic (AADT). The existing AADT in or near the Project area is between 15 and 3,450 vehicles per day.

Table 5-2
Existing Daily Traffic Levels

Roadway Segment Description	Existing Annual Average Daily Traffic (AADT)
Along TH 30 between County Line to Lake Wilson [1]	1,250
Along TH 23 North of Pipestone CSAH 18 [2]	3,450
Along TH 23 South of Pipestone CSAH 18 [2]	2,660
Murray CSAH 25 between TH 30 and CSAH 10 [1]	125
Murray CSAH 25 between CSAH 10 and CSAH 18 [1]	40
Murray CSAH 10 between County Line and TH 91 [1]	115
Murray CSAH 26 between CSAH 5 and TH 30 [1]	15
Murray CSAH 18 between County Line and TH 91 [1]	190
Murray County Road 80 between County Line and TH 91 [1]	30
Pipestone CSAH 18 between TH 23 and CSAH 7 [2]	460
Pipestone CSAH 18 between CSAH 7 and Woodstock [2]	455
Pipestone County Road 8 between County Line and Holland [2]	145
Pipestone CSAH 7 between County Line and CSAH 18 [2]	180
Pipestone CSAH 10 between TH 23 and County Line [2]	240

1. Source: 2005 Traffic Volume General Highway Map, Murray County, MN
2. Source: 2005 Traffic Volume General Highway Map, Pipestone County, MN

Xcel Energy provides electrical service to the area. Near the Project area, Xcel Energy owns the Chanarambie Substation. A 115 kV transmission line runs south through the Project area, then turns west to Pipestone, connecting the substation to Xcel Energy's system.

There are no active railroads in the Project area, although there is a railroad adjacent to TH 23 at the northwest corner of the Project area.

Telephone service is provided by Qwest and other local telephone companies to the homes and businesses in the area.

5.5.2 IMPACTS

The Moraine II Project is expected to have a minimal effect on the existing infrastructure. The following is a brief description of the impacts that may occur during the construction and operation of the Project at the proposed Project area.

- Electrical Service: Construction of the Project will add up to 33 wind turbines, a pad-mounted transformer at the base of each turbine, an underground and aboveground electrical collection system including an occasional aboveground junction box that will deliver power to the Project substation. The power will then be transmitted to the point of interconnection at Xcel's Chanarambie Substation where it will enter the grid.
- Roads: Constructing the Project will require approximately 3 to 8 miles of gravel access roads, depending on the size of turbine selected and final design. In addition, during operation of the Project, the access roads will be used by operation and maintenance crews while inspecting and servicing the wind turbines. The access roads will be between towers and one road will be required for each string. The roads will be approximately 16 feet wide and low profile to allow cross-travel by farm equipment. The Applicant will work closely with the landowners to locate these access roads to minimize land-use disruptions. Construction traffic will use the existing county and state roadway system to access the Project area and deliver construction materials and personnel. During the peak of construction it is anticipated that there will be an additional 275 vehicle trips per day to area roadways. Since the current traffic levels on the roadways in the Project area are well below roadway capacities, construction traffic will be perceptible but similar to seasonal variations in traffic such as that encountered during autumn harvest. Construction is not anticipated to result in adverse traffic impacts. Operation and maintenance activities will not noticeably increase traffic in the Project area.
- Railroads: The Project will not affect any active railroad.
- Water Supply: Construction and operation of the proposed wind farm Project will not significantly impact area water supplies. No installation or abandonment of any wells is anticipated for the Project. However, in the event wells are abandoned, they will be capped

as required by Minnesota Regulations. The Project will not require the appropriation of surface water or permanent dewatering. Temporary dewatering may be required during construction for specific turbine foundations and/or electrical trenches. A water supply will be necessary for the operations and maintenance facility. The preferred source is Rural Water Services. Water usage during the operating period will be similar to household volume; less then 5 gallons per minute. Water use during construction will occur at a higher rate to provide dust control and water for concrete mixes. The Applicant will coordinate with the Rural Water Services to avoid their water lines in the Project area during construction.

- Telephone: Construction and operation of the proposed wind farm will not impact the telephone service to the Project area. Gopher One Call will be contacted prior to construction to located and avoid all underground facilities. To the extent Project facilities cross or otherwise affect existing telephone lines or equipment, the Applicant will enter into agreements with service providers so as to avoid interference with their facilities.
- Federal Communication Commission (FCC) Registered Towers: the Applicant will conduct a microwave beam path analysis of the Project area prior to construction. The Applicant will not operate the wind farm so as to cause microwave, radio, telephone, or navigation interference contrary to FCC regulations or other law. In the event the wind farm or its operation causes such interference, the Applicant shall take the measures necessary to correct the problem.
- Television Reception: the Applicant will conduct an off-air television reception analysis of the Project. The Applicant will not operate the wind farm in a way that causes television interference contrary to FCC regulations or other law. In the event of problems after construction, the Applicant will work with affected residents to determine the cause of interference and, where necessary, reestablish acceptable reception quality in a timely fashion.

5.5.3 MITIGATIVE MEASURES

Construction and operation of the proposed wind Project will be in accordance with all associated federal and state permits and laws, as well as industry construction and operation standards. Due to the minor impacts expected on the existing infrastructure during Project construction and operation, extensive mitigation measures are not anticipated.

5.6 CULTURAL AND ARCHAEOLOGICAL RESOURCES

5.6.1 DESCRIPTION OF RESOURCES

The proposed Project area lies within the Southwest Riverine and Prairie Lake South Archaeological Regions (Anfinson 1990). The Southwest Riverine Archaeological Region is located in southwestern

Minnesota and includes much of Pipestone County and the extreme southwestern corner of Murray County. The Southwest Riverine region was not glaciated during the Late Wisconsin and soils within this portion of the Project area consist of fine silty loams. This region featured tallgrass prairie vegetation and streams, but was devoid of lakes. While there are few sources of lithic materials of suitable quality for stone tools, this region does contain outcrops of Catlinite, a soft stone mined by Native Americans to make pipes and other ceremonial objects. Habitation sites in this region are commonly located near wooded areas along major streams.

The topography of the Prairie Lakes South region includes typical swell and swale topography of a ground moraine. Soils within the Project area consist of medium to fine textured prairie soils. Habitation sites in this region are commonly located near wooded areas, near major lakes or river valleys. Resource procurement sites may be located in upland settings, but more commonly would be found along areas near waters edge.

Buffalo Ridge extends into the one-mile search area for the Project. Buffalo Ridge is a 62-mile segment of the Bemis Moraine that runs diagonally, northwest to southeast, along the eastern edge of the Coteau des Prairies, a 200-mile long plateau that separates the Missouri and Mississippi River watersheds. Buffalo Ridge is identified as both a broad geomorphic region and a more specific landform with historical and cultural significance to the Native Americans of the region (the Dakota). While twentieth-century geological definitions identify Buffalo Ridge as the larger section of the Bemis Moraine, historical and cultural interpretations define the Ridge specifically as the highest point of the Coteau des Prairies, running two to three miles from the northwest corner of Section 16 to the southeast corner of Section 21 of Township 106, Range 43.

The Minnesota State Register of Historic Places lists Buffalo Ridge as a Historic Place under Minnesota Statutes 138.664.13. The State Historic Preservation Office (SHPO) Geographic Features of Cultural and Historic Significance Inventory Form records Buffalo Ridge in Sections 16 and 21, Township 106, Range 43, but also suggests that the Ridge may extend into the southeastern corner of Section 8 and the southwestern corner of Section 9 of the same township. These sections are within the one-mile search area for this Project area. First identified as "Buffalo Ridge" in the historical record by T.H. Lewis in American Anthropologist (1890), the name was said to have been translated from the Dakota term for the ridge and related to a stone buffalo effigy that was located on the crest of the landform. The effigy is still visible on Buffalo Ridge in Section 21, Township 106, Range 43, which is outside the one-mile search area for this Project area. While a portion of Buffalo Ridge may extend into the one-mile search area for this Project, no previously identified cultural sites associated with Buffalo Ridge exist within the Project area or one-mile search area.

HDR collected data from the SHPO in St. Paul, Minnesota on known cultural resources information, derived from previous professional cultural resources surveys and reported site leads. Collected data

includes archaeological site files and previous cultural resources studies and reports. In addition, HDR reviewed 19th-century Public Land Survey (PLS) maps to identify potential historic-period cultural features that may yet exist in the Project area. Based on this information HDR prepared a Phase Ia Inventory (Appendix B) which reports on the results of the literature review described above and recommends a course of action for further analysis, such as a Phase I archaeological field survey of the site. The Phase Ia Inventory documented eight previous cultural resources reports which includes three cultural resources investigations within the Project area. Four of these reports pertain to investigations conducted in support of other wind farm construction.

Previous investigations in the Project area documented 21 archaeological resources, including lithic scatters (sites containing waste flakes associated with stone tool-making), and pre-contact and post-contact artifact scatters. Five resources are within the Moraine II Wind Project area and 16 resources are within one mile.

The PLS maps for the Project areas illustrate environmental conditions, including elevation variations across the landscape and watercourses, during the early 1880s. The maps indicate historic-period land use near the Project area, including roads, active farmsteads and cultivated acreages.

5.6.2 IMPACTS

Cultural resources could be impacted directly during the construction of a wind energy facility. Construction within the turbine footprint, cable trenching, access roads, and borrow areas could impact cultural resources. In addition, construction of turbines may impact viewshed integrity from existing standing structures.

A letter was sent to the Minnesota SHPO on January 22, 2007 requesting a review of the proposed Project area and potential impacts to cultural resources. HDR received a response dated March 6, 2007, stating that the SHPO recommended the completion of a cultural resources survey prior to project construction (Appendix A).

5.6.3 MITIGATIVE MEASURES

After review of the recorded archaeological site information and the information in previous survey reports, it appears that the Project area has a relatively high potential for pre-contact archaeological resources on elevated landforms and areas within close proximity to permanent water sources.

In concurrence with the SHPO recommendation, HDR recommends a Phase I archaeological resources survey for areas proposed for Project construction, including wind turbine locations, associated access roads and other construction elements. These investigations must be conducted by a professional archaeologist meeting the Secretary of the Interior's Standards for Archeology as published in Title 36

Code of Federal Regulations (CFR) Part 6. Survey strategies would depend on surface exposure and the characteristics of the landforms proposed for development. These areas will most likely include portions of the Project construction areas within close proximity to a permanent water source, areas of higher elevation, and areas near previously identified cultural resources.

If cultural resources are identified during the survey, HDR archaeologists will provide recommendations for National Register eligibility, and offer recommendations for site avoidance, impact minimization, or mitigation if necessary.

5.7 RECREATIONAL RESOURCES

5.7.1 DESCRIPTION OF RESOURCES

Recreational opportunities in Murray and Pipestone counties include hiking, biking, boating, fishing, camping, swimming, horseback riding, skiing, hunting, and nature viewing. Figure 5-4 depicts the locations of county parks, Minnesota Department of Natural Resources (DNR) Wildlife Management Areas (WMAs) and Scientific and Natural Areas (SNA) near the proposed Project area. There are no U.S. Fish and Wildlife Service (USFWS) lands within five miles of the Project area.

WMAs are managed to provide wildlife habitat, improve wildlife production, and provide public hunting and trapping opportunities. These Minnesota DNR lands were acquired and developed primarily with hunting license fees. WMAs are closed to all-terrain vehicles and horses because of potential detrimental effects on wildlife habitat. WMAs located within five miles of the Project are:

- Lange WMA located in Section 29 of Ellsborough Township in the Project area;
- Tutt WMA located in Section 35 of Ellsborough Township in the Project area;
- Woodstock WMA located in Section 1 of Rock Township in the Project area;
- Van Beek WMA located in Section 24 of Rock Township in the Project area;
- Degroot WMA located in Section 3 of Cameron Township in the Project area;
- Klinker WMA located in Sections 9 & 10 of Cameron Township in the Project area;
- Salt and Pepper WMA located 3.7 miles south of the Project area;
- Terrace WMA located 4.5 miles southwest of the Project area;
- Gromer's Draw WMA located 1 mile west of the Project area;
- Holland WMA located 3.8 miles west of the Project area;
- Buffalo Ridge WMA located 2.0 miles west of the Project area;
- Chandler WMA located 4.5 miles southeast of the Project area;
- Leeds WMA located 2.7 miles southeast of the Project area;

- Peters WMA located 4.75 miles southeast of the Project area;
- McCord-Liable WMA located 1 mile east of the Project area;
- Reinhold WMA located 1 mile east of the Project area;
- Vaneck WMA located 1 mile northeast of the Project area;
- Ruthton WMA located 1.25 miles north of the Project area;
- Hjermstad WMA located 2.75 miles northeast of the Project area;
- Ellsborough WMA located 2.5 miles northeast of the Project area;
- Current WMA located 3 miles northeast of the Project area;
- Bergman WMA located 3.5 miles northeast of the Project area;
- Nelson WMA located 4.0 miles northeast of the Project area; and
- Sherburne WMA located 4.75 miles northeast of the Project area.

SNAs are areas designated to protect rare and endangered species habitat, unique plant communities, and significant geologic features that possess exceptional scientific or educational values. There are no SNAs within the Project area. There is one SNA within five miles of the Project area, the Prairie Coteau SNA, located approximately two miles west of the Project area.

Lakes in the vicinity of the Project, such as Current Lake, Hjermstad Slough, and Klinker Slough, are used for recreational boating and fishing. East and West Twin Lakes, approximately 3.5 miles north of the Project area in Lyon County, are stocked with walleye, bluegill and smallmouth bass.

There is one county park in the vicinity of the Project. In Murray County, Swensen Park is approximately 3.0 miles northeast of the Project area on the east side of Current Lake. It is a 10-acre park with public boat access, picnic shelters, playground, ball field, and campground.

There is one snowmobile trail located approximately 600 feet southwest of the Project area.

5.7.2 IMPACTS

The Project will avoid all WMAs, SNAs and public parks. In general, recreational impacts will be visual in nature affecting individuals using public land near the Project area for recreation. See Section 5.4 for additional discussion of visual impacts and proposed mitigative measures. Visual impacts will be most evident to visitors using the WMAs within the Project area, and the recreational resources within a four-mile radius of the site. However, existing wind farms are already operating near these recreational resources. No significant impacts to recreational resources are anticipated.

5.7.3 MITIGATIVE MEASURES

Project turbines and facilities will not be located within public parks, WMAs or SNAs.

5.8 HUMAN HEALTH AND SAFETY

5.8.1 DESCRIPTION OF RESOURCES

5.8.1.1 Air Traffic

There are no airports located within the vicinity of the Project area. The nearest airports are Slayton Municipal Airport located approximately 10 miles east of the Project and Pipestone Municipal Airport located approximately 11 miles west of the Project. Slayton Municipal Airport is a single paved runway 3,005 feet in length, whereas the Pipestone Municipal airport has two runways 4,302 and 2,539 feet in length, the longest of which is paved. Air traffic may be present near the Project area for aerial spraying of agricultural fields. Crop dusting is typically carried out during the day by highly maneuverable airplanes or helicopters. The installation of wind turbine towers in active croplands and installation of overhead distribution lines will create a potential for collisions with crop-dusting aircraft. However, collection lines are expected to be underground or similar to existing distribution lines that are located along the edges of fields and roadways. The turbines would be visible from a distance and lighted according to the 2007 revised FAA guidelines.

5.8.1.2 Electromagnetic Fields

The term electromagnetic fields (EMF) refers to electric and magnetic fields that are present around any electrical device. Electric fields arise from the voltage or electrical charges and magnetic fields arise from the flow of electricity or current that travels along transmission lines, power collection (feeder) lines, substation transformers, house wiring, and electrical appliances. The intensity of the electric field is related to the voltage of the line and the intensity of the magnetic field is related to the current flow through the conductors (wire). EMF can occur indoors and outdoors. However, there are no discernible health impacts from power lines. Wind turbine generators will be no closer than 623 to 850 feet from occupied residences where EMF will be at background levels.

5.8.1.3 Security

The proposed wind farm site is located in an area that has a low population density. Construction and operation of the Project will have minimal impacts on the security and safety of the local populace.

5.8.1.4 Traffic

The existing traffic levels for the state THs, CSAHs, and CRs in the Project area are shown in Table 5-2 and Figure 5-5.

5.8.2 IMPACTS

5.8.2.1 Air Traffic

The proposed wind farm will have no significant impacts on air traffic in the region because there are no airports in the Project area and the wind and meteorological towers will have lighting to comply with FAA requirements. The Applicant will notify local airports about the Project and new towers in the area to reduce the risk to crop dusters.

5.8.2.2 Electromagnetic Fields

While the general consensus is that electric fields pose no risk to humans, the question of whether exposure to magnetic fields potentially can cause biological responses or even health effects continues to be the subject of research and debate. Based on the most current research on electromagnetic fields, and the distance between any turbines or collector lines and houses, the Project will have no impact to public health and safety due to EMF.

5.8.2.3 Security

Project construction and operation will have no significant impact to security and safety of the local residents.

5.8.2.4 Traffic

The maximum construction workforce is expected to generate approximately 275 additional vehicle trips per day. The functional capacity of a two-lane paved rural highway is in excess of 5,000 vehicles per day. Currently, the heaviest traffic is in the northwest corner of the Project along TH 23, which is at 2,660 AADT south and 3,450 AADT north of the junction of CSAH 18 and TH 23. However, within the Project boundaries, traffic is highest on CSAH 25, and traffic decreases north of CSAH 10. Since many of the area roadways have AADTs currently well below capacity, the addition of 275 vehicle trips would be perceptible, but similar to seasonal variations such as that encountered during autumn harvest.

Truck access to the Project area is generally served by TH 30 and TH 23. Specific additional truck routes will be dictated by the location required for delivery. Additional operating permits will be obtained for over-sized truck movements.

The operations phase of the new Project will require a two-person maintenance crew driving through the area to monitor and maintain the wind turbines. The maintenance crew will monitor the wind turbines as needed. There would be a slight increase in traffic for occasional turbine and substation repair.

5.8.3 MITIGATIVE MEASURES

5.8.3.1 Air Traffic

The Applicant will mark and light the turbines to comply with the most recent FAA requirements approved in February 2007. The Applicant will paint meteorological towers red at the top to improve visibility and will notify local airports about the Project and new towers in the area to reduce the risk to crop dusters. Permanent meteorological towers will be free-standing with no guy wires. Temporary meteorological towers will have supporting guy wires which will be marked with safety shields (colored balls) for increased visibility.

5.8.3.2 Electromagnetic Fields

No impacts due to electromagnetic fields are anticipated and no mitigation is necessary.

5.8.3.3 Security

The Applicant will implement the following security measures to reduce the chance of physical and property damage, as well as personal injury, in the Project area:

- The towers will be placed 250 feet from public roads and a minimum of 623 feet (1.5 MW turbines) to 850 feet (2.1 MW turbines) from occupied homesteads. These distances are considered to be safe based on previous project experiences, and are consistent with prior LWECS site permits;
- Security measures will be taken during the construction and operation of the Project, including temporary (safety) and permanent fencing, warning signs, and locks on equipment and wind power facilities; and
- Turbines will sit on solid steel enclosed tubular towers in which all electrical equipment will be located, except for the pad-mounted transformer. Access to the tower is only through a solid steel door that will be locked when not in use.
- Permanent meteorological towers will be free-standing. The guy wires on temporary meteorological towers will have color sleeves at ground level to increase visibility to people at ground level.

Where necessary or requested by landowners, the Applicant will construct gates or fences.

5.8.3.4 Traffic

No impacts to traffic are anticipated. No mitigation will be necessary.

5.9 HAZARDOUS MATERIALS

5.9.1 DESCRIPTION OF RESOURCES

The Applicant is not aware of any significant recognized environmental conditions within the Project area. The land is primarily rural and used for agriculture. Potential hazardous materials within the Project area would be associated with agricultural activities, and include petroleum products (fuel and lubricants), pesticides, and herbicides. Older farmsteads may also have lead-base paint, asbestos shingles, and polychlorinated biphenyls (PCBs) in transformers. Trash and farm equipment dumps are common in rural settings

Three types of petroleum products are necessary for the operation of turbines and include synthetic gear box oil, hydraulic fluid, and gear grease.

5.9.2 IMPACTS

The Applicant will conduct a Phase I Environmental Site Assessment prior to construction to avoid hazardous waste sites.

All fluids will be contained within the wind turbine structure. Fluids will be monitored during maintenance at each turbine. When fluids are replaced, the waste products will be handled according to regulations and disposed of through an approved waste disposal firm.

5.9.3 MITIGATIVE MEASURES

Because there are no proposed impacts to hazardous waste sites, no mitigative measures are necessary. If any wastes, fluids or pollutants are generated during any phase of the operation of the Project, they will be handled, processed, treated, stored and disposed of in accordance with Minnesota Rules Chapter 7045.

5.10 EFFECTS ON LAND-BASED ECONOMIES

5.10.1 AGRICULTURE/FARMING/FORESTRY/MINING

5.10.1.1 Description of Resources

Agriculture/Farming

The majority of the Project area is farmland and grassland, as shown in the Land Cover Map, Figure 5-6. Cultivated land and grassland comprise approximately 23,450 acres (88 percent) and 2,627 acres (10 percent) of the Project area, respectively. Essentially, the entire Project area is used for agricultural purposes. Corn, soybeans, small grains, and forage crops are grown throughout Murray and Pipestone Counties. Feeding cattle and hogs, raising livestock, and dairy farming are major sources of income in

the Project area. Within the general area, the trend is toward fewer and larger farms. Converting cropland to the Conservation Reserve Program (CRP) and the Reinvest in Minnesota (RIM) program is another source of farm income. CRP and RIM lands are cropland planted to conservation grasses and legumes to protect and improve the soil and cannot be harvested or pastured. CRP is enrolled for 10-year periods, whereas RIM easements are permanent conservation easements.

Based on 2002 data, the majority of croplands are planted in soybeans and corn in Murray and Pipestone Counties. Alfalfa, small grains, forage, and pasture are additional crops in the Project area.

Large-scale animal production has been a growing component of the agricultural industry in recent years. Feedlots used for the confined feeding, breeding or holding of animals are a common practice for animal production. There are 471 registered feedlots in Pipestone County and 406 registered feedlots in Murray County that have 50 or more (10 in shoreland districts) animal units.

Most of the soil within the Project area is prime farmland. The U.S. Department of Agriculture (USDA) Natural Resource Conservation Service (NRCS) identifies prime farmland as the land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops and is available for these uses. It could be cultivated land, pasture land, forestland, or other land. Important farmlands consist of prime farmland, unique farmland, and farmland of statewide or local importance. Appendix D lists the soils considered Prime and other Important Farmlands for Murray and Pipestone Counties, Minnesota.

Forestry

Murray and Pipestone Counties are in the region of Minnesota historically known for its prairie grasslands. Economically important forestry resources are not found in this region of Minnesota. Forested areas are primarily associated with homes in the form of woodlots and along the creeks within the Project area.

Mining

Mineral deposits in southwestern Minnesota consist of sand and gravel from unconsolidated surficial deposits, building stone from quartzite rock units, and scattered clay/shale deposits for brick making.

Sand and gravel resources occur in glacial till and outwash deposits. Many of the pits are inactive, abandoned or their use is limited to the landowner. Other than a few commercial sand and gravel operations, there are no active industrial pits or quarries in the Project area. There may be inactive clay/shale pits, brickyards, and stone quarries in the area.

Based on MnDOT County Pit Maps and topographic maps for the Project area, there is one gravel pit located within the Project area, in Section 27 of Aetna Township (Township 108 N, Range 44 W). Three other gravel pits in the vicinity of the Project are located approximately 0.75 miles west of the Project in

Section 11 of Rock Township (Township 107 N, Range 44 W), 1.0 mile west of the Project in Section 3 of Rock Township, and 1.5 miles southeast of the Project area in Section 14 of Chanarambie Township (Township 106 N, Range 43 W). There are small sand pits located in Section 33 of Ellsborough Township (Township 108 N, Range 43 W).

5.10.2 IMPACTS

5.10.2.1 Agriculture/Farming

Specific impacts to agricultural lands (approximately 21 to 27 acres) will be determined once turbine and road placement have been finalized. Most of the soil within the Project area is considered prime farmland. The loss of agricultural land to the construction of the wind farm will reduce the amount of land that can be cultivated. Less than one half of one percent of the Project area will be converted to non-agricultural land use. This will not significantly alter crop production in the Project area or Murray or Pipestone Counties.

Turbine and facility siting will include discussions with property owners to identify features on their property, including drain tile, which should be avoided. Impacts to drain tile due to Project construction and operation are not anticipated. However, in the event that there is damage to drain tile as a result of construction activities or operation of the LWECS, the tile will be repaired according to the agreement between the Applicant and the owner of any damaged tile.

The Applicant will avoid all impacts to RIM land, and will minimize impacts to CRP land.

5.10.2.2 Forestry

No impacts are anticipated to forestry resources. Since a majority of the woodlots is associated with homesteads, no impacts are anticipated to woodlots.

5.10.2.3 Mining

Impacts to mining are not anticipated. Sand and gravel operations tend to be small and other occurrences of these materials are likely to be present in nearby areas, including large commercial operations in the general area.

5.10.3 MITIGATIVE MEASURES

5.10.3.1 Agriculture/Farming

The wind turbines and access roads will be located so that the most productive farmland (prime farmland) will be avoided as much as possible. Only land for the turbine, certain electrical equipment, and access roads will be taken out of crop production. Once the wind turbines are constructed, all land surrounding the turbines and access roads could still be farmed.

In the event that there is damage to drain tile as a result of construction activities or operation of the LWECS, the Applicant will work with affected property owners to repair the damaged drain tile in accordance with the agreement between the Project Owner and the owner of any damaged tile.

If CRP land is impacted, the Applicant will work with the landowner to remove it from the CRP program if necessary. There will be no impacts to RIM land; therefore no mitigation will be necessary.

5.10.3.2 Forestry

Because no impacts to forestry resources are anticipated, no mitigation will be necessary.

5.10.3.3 Mining

Turbines will not be located within sand and gravel operations.

5.11 TOURISM AND COMMUNITY BENEFITS

5.11.1 DESCRIPTION OF RESOURCES

Tourism in Pipestone and Murray Counties focuses on promoting the area's abundant game and wildlife, lakes, farms, and villages. Also publicized are culture (museums, art, and antiques) and recreation activities (parks, hiking trails, camping, canoeing, horseback riding, fishing, wildlife refuges, snowmobiling, golf courses, swimming pools, tennis courts, and skiing). The counties host a variety of festivities and cultural events throughout the year.

Wind development in southwest Minnesota is becoming a significant tourism attraction, bringing more visitors to the community. Wind generation is being promoted in local tourism and literature.

5.11.2 IMPACTS

No impacts are anticipated to local tourism.

5.11.3 MITIGATIVE MEASURES

No impacts to tourism are anticipated; as such, no mitigation is necessary.

5.12 TOPOGRAPHY

5.12.1 DESCRIPTION OF RESOURCES

The Project is proposed to be located at one of the highest elevations in Minnesota along Buffalo Ridge, which runs northwest to southeast along the western side of the Project area. The relief of Buffalo Ridge is predominantly hilly, with slopes that are rolling to steep. Buffalo Ridge is a glacial moraine landform also referred to as the Bemis Moraine. The moraine was deposited by the outer reaches of the Des

Moines Lobe about 14,000 years ago. The crest of Buffalo Ridge forms the watershed divide between the Missouri and Mississippi River basins. Subsection boundaries delineate a significant regional change in geology, topography, and vegetation.

Areas southwest of the divide, just west of the Project area, drain to the Missouri River drainage basin. Up to 500 feet of glacial till is capped by 6 to 15 feet of loess (wind-blown silt), which has filled in irregularities of the glacial till plain. Broad, hilly terrain incised by steams typifies this area.

Northeast of the divide, in the Project area, streams drain into the Mississippi River drainage basin. At the proposed site, topography is rolling moraine ridges covered with loess 1 to 3 feet thick. Much of the site consists of broad ridge tops with long gentle side slopes that end in drainageways. Some of these side slopes are short and steep.

The elevation in the Project area ranges from about 1,660 to 1,860 feet above sea level. An elevation map of the Project area is shown in Figure 5-8.

5.12.2 IMPACTS

No impacts to topography are anticipated. Wind turbines and access roads will not require significant excavation or fill.

5.12.3 MITIGATIVE MEASURES

No impacts to topography are anticipated, as such, no mitigative measures are necessary.

5.13 SOILS

5.13.1 DESCRIPTION OF RESOURCES

Mollisols are dominant in this area. Bedrock is covered by up to 500 feet of glacial till. Soils tend to be loamy, well-drained, and have thick dark surface horizons that formed under centuries of prairie vegetation.

Four soil associations are found within the Project area (Table 5-3). Soil associations are mapped in Figure 5-7. A soil association has a distinctive pattern of soils, relief, and drainage. Each is a unique natural landscape consisting of one or more major soils and other minor soils. The association is named after its major soils.

Table 5-3
Soil Associations in Project Area

Soil Association	Area (acres)
Barnes-Langhei-Hamerly (MN 043)	17,257
Barnes-Flom-Buse (MN 119)	7,124
Arvilla-Egeland-Marysland (MN 112)	1,517
Kranzburg-Vienna-Hidewood (MN 122)	1,028
Other	65

The Barnes-Langhei-Hamerly Association formed under prairie vegetation in loamy glacial till. Soils are found on upland sites and are generally well drained to moderately well drained. Relief is gently undulating to very steep. This association is found mainly on irregular slopes on glacial moraine deposits where slopes range from 2 to 55 percent. Topsoil ranges from 6 to 10 inches thick with a loamy texture. Water erosion is the primary management concern.

The Barnes-Flom-Buse Association has a nearly level to undulating relief marked by swells and swales, where depressions are common. Slopes can be steep along streams and drainageways. Soils were formed under prairie vegetation in medium to moderately fine textured glacial till. Drainage ranges from poorly drained to well drained. Topsoil is 7 to 20 inches thick with a clay loam to loamy texture. Management concerns include water erosion of Barnes and Buse soils and wetness of Flom soils.

The Arvilla-Egeland-Marysland Association is represented in convex and plane areas on river terraces, in overflow channels, on outwash planes, and on moraines. These soils formed under prairie vegetation in loamy material over sandy and gravelly glacial outwash and alluvium deposits. Relief is nearly level to sloping on stream terraces and outwash plains, and is undulating on moraines. Drainage ranges from poorly drained to excessively drained. Topsoil is 8 to 17 inches thick with a sandy loam to loamy texture. Slopes range from 0 to 15 percent. Management concerns include droughtiness and blowing soil, and water erosion in sloping and steep areas.

The Kranzburg-Vienna-Hidewood Association comprises well drained to excessively drained soils found on gentle slopes, and poorly drained soils in drainageways. Along broad ridge tops and side slopes, the upland soils of this association formed in loess and loamy glacial till, while the soils in the drainageways formed in loess or loess-derived alluvium. Most areas of the association are covered by a thin mantle of loess that overlies glacial till. Slopes are long, smooth, and gentle because most irregularities in the glacial till have been filled in and leveled by wind-deposited silty material. Topsoil ranges from 10 to 23 inches thick with clay loam to silty clay loam texture. Management concerns include water erosion of upland and sloping soils, and wetness of soils in drainageways and depressions.

5.13.2 IMPACTS

Construction of the wind turbines, access roads, electrical collection lines and other project facilities will increase the potential for soil erosion during construction and convert prime farmland from agricultural uses to industrial uses. The amount of land that will be converted to wind turbines, transformer pads and access roads will be determined once the site layout has been finalized. See Section 5.10.3 for a discussion of impacts to prime farmland.

5.13.3 MITIGATIVE MEASURES

A National Pollutant Discharge Elimination System (NPDES) permit application to discharge storm water from construction activities will be acquired by the Applicant from the MPCA. Best Management Practices (BMP) will be used during construction and operation of the Project to protect topsoil and adjacent resources and to minimize soil erosion. Practices may include containing excavated material, protecting exposed soil, and stabilizing restored material.

5.14 GEOLOGIC AND GROUNDWATER RESOURCES

5.14.1 DESCRIPTION OF RESOURCES

The Coteau des Prairies (Coteau) dominates the regional topography of the Project area. This flatriron-shaped plateau extends from eastern South Dakota into southwestern Minnesota. The eastern flank of the plateau, where the Project area is located, consists of two prominent belts of high, hilly terrain. These belts were created by moraines deposited during the last southeastward advance of the Des Moines Lobe. The Bemis Moraine, which forms the outermost belt, creates the high crest of the Coteau and provides an imposing topographic barrier. The Altamont Moraine is wider than the Bemis and represents a standstill during deglaciation.

The surficial geology of the Project area consists of glacial deposits derived from end and ground moraines, outwash, and loess. The majority of glacial material in the Project area is classified as Bemis End Moraine deposits. These deposits are described as a silty, calcareous shale-rich till. The shale present in the till is mainly sand-sized. A loess covered extra morainic till is present along the western edge of the site. These deposits consist of silty, calcareous, shale-rich till and unweathered, bouldery gravel, overlain by thin loess. Ground moraine deposits cover the eastern portions of the Project area in the region between both the Bemis and Altamont end moraines. It is described as an unsorted, unstratified, silty, calcareous till, composed of a mixture of clay, silt, sand, and gravel. Glacial outwash deposits are found in thin local bands across the site and are composed of shallow, bouldery sand and gravel deposited in glacial meltwater channels.

A large variance of glacial cover exists across the site. It can range anywhere from 100 to 500 feet in thickness.
Two types of bedrock underlie the glacial deposits of the Project area, Cretaceous Sedimentary Rocks and PreCambrian Sioux Quartzite.

Where present in the Project area, the Cretaceous sedimentary rocks overlie the Sioux Quartzite. Undifferentiated crystalline rocks may also be present in small areas of the Project area.

Geologic-related mineral resources in the Project area include minor sand and gravel deposits. Mining of Sioux Quartzite and Pipestone may be found in the surrounding area.

Groundwater resources in the Project area are derived from three general hydrogeologic units:

- Weathered and fractured quartzite;
- Cretaceous sandstones; and
- Glacial outwash deposits.

Groundwater resources in the vicinity of the Project area are generally derived from buried glacial outwash deposits of sand and gravel where the glacial drift is thick. Water in this unit tends to be plentiful and of good quality. The sensitivity of this resource to surficial pollutants can range from moderate to very high due to shallow water table and soil permeability.

The County Well Index was reviewed for the Project area and it identified twenty-six domestic wells well completed in a combination of both the glacial sand and gravel lenses and underlying bedrock aquifers. Based on the age of many of the homesteads, the majority of the existing wells at the site are probably not recorded in the County Well Index. This may indicate more domestic wells in the area than what is documented. Domestic groundwater supply appears to be fairly accessible in the Project area.

5.14.2 IMPACTS

Impacts to geologic and groundwater resources are not anticipated. Water supply needs will be quite limited and local supplies are abundant. It is probable that operations and maintenance water requirements will be satisfied with rural water service.

5.14.3 MITIGATIVE MEASURES

Wind turbine locations will not impact the use of existing domestic water wells because the turbines will not be sited within 623 to 850 feet of occupied structures.

5.15 SURFACE WATER AND FLOODPLAIN RESOURCES

5.15.1 DESCRIPTION OF RESOURCES

Surface water and floodplain resources for the Project area were identified by reviewing U.S. Geological Survey topographic maps, Flood Insurance Rate Maps (FIRM) produced by the Federal Emergency Management Agency (FEMA), and Minnesota Public Waters Inventory (PWI) maps. The major watersheds located within the Project area include those associated with the Des Moines River, Redwood River and Rock River. There are 10 water bodies within the Project area that are Public Waters (Table 5-4). There are two creeks with multiple tributaries in the Project area that are Public Waters: Beaver Creek and Klinker Slough. Also within the Project area are a number of unnamed intermittent and perennial streams that are designated waters of the U.S. Figure 5-9 shows the locations of surface waters and Minnesota Public Waters within the site.

Table 5-4
DNR Public Waters Inventory (PWI) Lakes in Project Area

PWI ID	PWI Name	PWI Class	Area in Project Boundary (Acres)
51-130 P	Tutt WMA	P	51.23
51-132 P	Unnamed	P	54.89
51-83 P	Klinker's Marsh	P	130.53
51-99 P	Unnamed	P	4.13
59-3 P	Unnamed	P	0.25
59-4 P	Engbarth Slough	P	27.04
51-121 W	Unnamed	W	13.02
51-148 W	Unnamed	W	22.39
51-168 W	Unnamed	W	8.10
51-98 W	Unnamed	W	8.74

Review of the FEMA floodplain map (Figure 5-10) indicates that there is a 100-year floodway in the area around Klinker's Slough and a small, unnamed lake in the Tutt Wildlife Management Area to the north of Klinker's Slough. The 100-year floodway area within the Project boundaries is 212 acres in size.

5.15.2 IMPACTS

Construction of the wind turbines, transformer pads, and access roads will disturb land within the Project area. The wind turbines will be built on ridges, and this will avoid lakes and streams located in the lower positions in the landscape. Access roads will be designed to minimize impacts to streams.

5.15.3 MITIGATIVE MEASURES

If the Project will impact waters of the U.S. or Minnesota Public Waters, the Applicant will apply for the necessary permits prior to construction. Access roads constructed adjacent to streams and drainageways will be designed in a manner so runoff from the upper portions of the watershed can flow unrestricted to the lower portion of the watershed. A Storm Water Pollution Prevention Plan (SWPPP) will be prepared, and an NPDES permit will be obtained prior to the construction of the Project.

5.16 WETLANDS

5.16.1 DESCRIPTION OF RESOURCES

Wetlands near the Project area were identified by reviewing National Wetland Inventory (NWI) Maps and Minnesota PWI Maps. The wetlands in the Project area are associated with creeks and intermittent streams, isolated basins, or part of large lacustrine basins. The NWI wetland types and their acreage for the site are presented in Table 5-5.

Table 5-5
NWI Wetland Type and Acreage

Circular 39	Type 1	Type 2	Type 3	Type 4	Type 5	Type 6	Type 7	N/A
Cowardin Classification	PEMA	PEMB	PEMC	PEMF	PUBF, PUBG	PSS1A, PSS1C	PFO1A, PFO1C	L1UBH, L2UBG
Acres[1]	98.6	18.0	640.5	243.6	37.2	32.8	21.6	124.8

[1] Wetland acreage is calculated using USFWS NWI data.

There is a total of 1,217 acres of NWI wetlands in the Project area: 1000.7 acres of palustrine emergent wetlands, 37.2 acres of palustrine unconsolidated bottom wetlands, 32.8 acres of palustrine scrub/shrub wetlands, 21.6 acres of palustrine forested wetlands and 124.8 acres of lacustrine wetlands in the Project area. See Figure 5-11 for locations of wetlands within the Project area.

5.16.2 IMPACTS

Wind turbines will be built on ridges and which tends to avoid wetlands that are generally located in lower positions in the landscape. Access roads and electrical collection lines will be designed to minimize impacts on the wetlands.

5.16.3 MITIGATIVE MEASURES

Wetlands will be avoided during the construction phase of the Project. If wetland impacts cannot be avoided, the Applicant will submit Section 404 and Minnesota Wetland Conservation Act permit applications to the U.S. Army Corps of Engineers and the State prior to construction.

5.17 VEGETATION

5.17.1 DESCRIPTION OF RESOURCES

The map of the natural vegetation of Minnesota (Coffin and Pfannmuller, 1988) identifies the areas of Pipestone and Murray counties as historically upland prairie and prairie wetland. The upland prairie vegetation includes bluestems, Indian grass, needle grass, grama grasses, composites, and other forbs. The prairie wetland vegetation includes blue-joint grass, cord grass, cattails, rushes, and sedges. Tallgrass prairie developed with periodic fires that were either started by natural causes (i.e., lightning) or by Native Americans.

As a result of settlement in the mid-1800s, the area was converted into farmland. During this process, the wetland areas were frequently ditched and drained. Only a small fraction of the original prairie and wetlands remain as relic habitats. With the settlement of the area, periodic burning of the land halted. Fires caused by natural means were suppressed and human fire starting was controlled. Trees were able to establish in the area. Trees were planted by landowners for shelter belts (windrows and homestead groves) or were established by natural means – transported to the area by animals, birds or winds (wooded ravines).

Today, managed native prairie areas occur inside the four Wildlife Management Area boundaries in the Project area. These areas are high-quality remnant or restored native prairie areas often associated with adjacent wetlands. There may also be a few small tracts of native prairie located on private lands in the Project area.

Based on review of aerial photographs, land use database information, and a visit to the Project area, HDR determined that the majority of the land area at the site is cultivated. The grassland and wetland areas at the site may contain potential remnant native prairie areas. Native prairie is identified as lands that have never been plowed, with less than 10 percent tree cover, and presence of native prairie vegetation. Unplowed fields of native grassland or pasture, with 10 or more prairie plant indicator

species, are considered to be prairie for the purposes of this site permit application. A list of prairie indicator species can be found in Appendix 3 and Supplement to Appendix 3 in Minnesota's Native Vegetation: A Key to Natural Communities, Minnesota Department of Natural Resources Natural Heritage Program, 1993.

The relative abundances of the major habitats in the Project area are shown in Table 5-6.

Table 5-6
Major Habitats and their Relative Abundance in the Project Area

Habitat	Acreage	Percent of Project Area
Cultivated Land	23,450	87.9 %
Grassland[1]	2,627	9.9 %
Aquatic/Marsh[2]	435	1.6 %
Shrub	112	0.4%
Wooded	49	0.2 %

[1] Native prairie area will be determined by a field survey prior to construction.
[2] Wetland area will be determined by a wetland delineation prior to construction.

Crops include corn, soybeans, alfalfa, clover, wheat, oats, and hay. Range and pasture lands are used to graze cattle, sheep, and horses. Heavily grazed range/pasture lands contain Kentucky bluegrass, quack grass, and brome grasses. Lightly grazed or undisturbed range land may contain native grass species including big blue stem, needle grass, and grama grass. CRP land is typically covered by brome grasses, orchard grass, and alfalfa. Land is typically put into CRP for 10-year cycles. Additional information on agriculture and farming can be found in Section 5.10.

Approximately 161 acres of the Project area is shrubs or trees, according to U.S.G.S. GAP land cover data. This can be further broken down as 46 acres of oak, 3 acres of cottonwood, and 112 acres of upland shrub. Generally, the wooded areas are isolated groves or windrows established by the landowner/farmers to prevent wind erosion and shelter dwellings. Typical tree species include bur oak, cottonwood, American elm, silver maple, poplar, and willow.

5.17.2 IMPACTS

The amount of vegetation that will be removed as a result of the Project will be determined once a permanent site layout is determined. It is anticipated that approximately 22 acres of the Project area will be affected if 1.5 MW turbines are used, 20 acres will be affected with 2.1 MW turbines, 18 acres with 2.5 MW turbines and 16 acres with 3.0 MW turbines. An additional 5 acres of land will be affected by

construction of the Project substation and O&M facility. The vegetation will be permanently removed and replaced by wind turbines, access roads, and transformers. The Project will likely also involve building a new operations and maintenance facility and Project substation, which would involve disturbing approximately five acres. Additional areas may also be disturbed for underground power lines during construction. Approximately three acres of land will be temporarily impacted for contractor staging and lay down areas. Temporarily disturbed areas will be reseeded to blend in with existing vegetation. The turbines will be constructed at a distance from forests and groves to maximize turbine output and reduce tree removal. Avoidance and minimization of impacts to wetlands and native prairies will reduce impacts to those vegetated areas.

5.17.3 MITIGATIVE MEASURES

The Applicant will implement the following measures to avoid and minimize potential impacts to the vegetation of the Project area during selection of the individual turbine sites, construction and operation of the Project:

- Conduct a pre-construction inventory of the Project area for existing wildlife management areas, scientific and natural areas, recreation areas, wetlands, native prairie, and forests. The preconstruction inventories will have varying levels of detail with the most specific detail in the vicinity of construction;
- Exclude established wildlife management, recreation and scientific and natural areas from consideration for wind turbine, access road, or electrical line placement;
- Avoid disturbance of wetlands during construction and operation of the Project. If jurisdictional wetland impacts are proposed, then the Applicant will apply for wetland permits;
- Minimize the need to clear existing trees and shrubs;
- Use BMPs during construction and operation of the Project to protect topsoil and adjacent resources and to minimize soil erosion. Practices may include containing excavated material, protecting exposed soil and stabilizing restored material, revegetating non-cropland and range areas with wildlife conservation species and, wherever feasible, planting native tall grass prairie species in cooperation with landowners; and
- If native prairie impacts are anticipated, the Applicant shall, with the advice of the DNR, and any others selected by the Applicant, prepare a prairie protection and management plan. The plan will be submitted to the PUC and DNR after issuance of the site permit and prior to construction. The plan shall address steps to be taken to identify native prairie within the Project area, measures to avoid impacts to native prairie, and measures to minimize and mitigate for impacts if unavoidable. Wind turbines and all associated facilities, including foundations, access roads, underground cable, and transformers, shall not be placed in native prairie unless addressed in the prairie management plan. Measures to be taken to mitigate unavoidable impacts to native prairie will be agreed to by the Applicant and DNR.

5.18 WILDLIFE

5.18.1 DESCRIPTION OF RESOURCES

Information on the general existing wildlife in the proposed wind farm area was obtained from a variety of sources including the DNR, USFWS, and avian and bat monitoring studies at Buffalo Ridge prepared for Xcel Energy. Section 5.19 includes a discussion of wildlife that are considered by the state to be threatened or endangered or of special concern, including a discussion of Topeka shiners.

Wildlife in the Project area consists of birds, mammals, fish, reptiles, amphibians, and insects, both resident and migratory, which utilize the Buffalo Ridge area habitat for forage, breeding and/or shelter. The resident species are representative of Minnesota game and non-game fauna that are associated with upland grass and farmlands with few wetland and forested areas. The majority of the migratory wildlife species are birds including waterfowl, raptors, and songbirds.

Six WMAs are found within the Project area, totaling approximately 728 acres. Four WMAs are located within 1 mile of the Project area. WMAs are state-owned and managed by the DNR to protect and enhance wildlife habitat. WMAs provide habitat, breeding area, and food source for many types of wildlife. Animal populations are expected to be denser in these areas, including bird and bat populations. Please see Section 5.7 for further discussion on WMAs in the Project area.

Included below is a discussion of migratory and resident birds, mammals, reptiles, amphibians, and insects that are expected to exist in the Project area.

5.18.1.1 Birds

Various migratory and resident bird species utilize the Project area during their life cycle. Migratory bird species are those that may use the Project area for resting, foraging, or breeding activities for only a portion of the year. Resident bird species occupy the proposed wind farm site throughout the year. A list of 218 bird species observed in the vicinity of Buffalo Ridge during the four-year wind avian study is presented in Appendix C.

The site vicinity on Buffalo Ridge is not a major waterfowl staging area or migration route, and passerines usually migrate at high altitudes through the area. State survey data for the immediate area indicate small breeding populations of mallards, blue-winged teal, and wood ducks.

Upland gamebirds in the region include pheasant and gray partridge. Common raptors in the region include red-tailed hawk, American kestrel, northern harrier, and Swainson's hawk.

In a March 23, 2007 response letter (Appendix A), the USFWS identified known waterfowl and grassland birds that utilize the Project vicinity, including American bitterns, sedge wrens, black terns, blue

grosbeak, upland sandpiper, Swainson's hawk, black-billed cuckoo, western kingbird, sedge wren, grasshopper sparrow and dickcissel. The USFWS identified two wetlands in the project area, Klinker Slough in Murray County and Engbarth Slough in Pipestone County, as important habitat for migrating birds.

5.18.1.2 Mammals

The Minnesota DNR conducts annual surveys in southwestern Minnesota to collect information on species abundance and distribution of white-tailed deer, cottontail rabbits, and white-tailed jackrabbits as a part of a statewide program. They also collect status information on fox, skunk, and squirrel. The avian studies also collected preliminary information on bats in the Buffalo Ridge Area. A list of species compiled from various sources is presented in Appendix C.

These species use the food and cover available from agricultural fields, grasslands, farm woodlots, wetland areas, and wooded ravines. Grassland areas and woody vegetation are habitat for a variety of small mammals including house and deer mice, least and long-tailed weasels, and prairie and meadow voles. White-tailed deer, an economically important species, have a strong affinity for agricultural crops and use farm woodlots, wooded ravines, and intermittent stream bottoms for shelter.

5.18.1.3 Reptiles and Amphibians

Reptile and amphibian species, which may be present in the Project vicinity, include the western plains garter snake, red-sided garter snake, western hognose snake, snapping turtle, western painted turtle, American toad, northern leopard frog, and western chorus frog. A list of reptile and amphibian species which may use the grassland and forested areas is presented in Appendix C.

5.18.1.4 Insects

While many insect species are important to the indigenous vegetation and wildlife, honeybees are the only species economically important in the Project area. As of July 2006, Minnesota Department of Agriculture no longer requires apiary licensing, and no record of current beekeeping locations exists. Honeybees are considered a small but important part of southwestern Minnesota economy. Statewide, production from 120,000 colonies was valued at almost $7.4 million in 2005 (NASS 2006). Butterfly species are associated with native prairie plants.

5.18.2 IMPACTS

Development of the wind farm, including the construction and operation of the Project, is expected to produce a minimal impact to wildlife. Based on studies of existing wind power projects in the United States and Europe, the impact to wildlife would primarily occur to avian and bat populations. The final report (WEST 2000) on avian monitoring studies at Buffalo Ridge, Minnesota identified the following impacts:

- Following construction of the wind turbines there is a reduction in use of the area within

100 meters of the turbines by about 32% of species of grassland breeding birds. It was hypothesized that lower avian use may be associated with avoidance of turbine noise, maintenance activities, and less available habitat. The researchers stated, "On a large scale basis, reduced use by birds associated with wind power development appears to be relatively minor and would not likely have any population consequences on a regional level."

- Avian mortality appears to be low on Buffalo Ridge, compared to other wind facilities in the United States, and is primarily related to nocturnal migrants. They found an overall avian mortality of 0.98 birds per turbine per year. Resident bird mortality is very low and involves common species. The researchers stated that "based on the estimated number of birds that migrate through Buffalo Ridge each year, the number of wind plant related avian fatalities at Buffalo Ridge is likely inconsequential from a population standpoint."
- Bat mortality was studied at the Buffalo Ridge, Minnesota Wind Resource Area in 2001 and 2002 by WEST. They found an overall mortality average of 2.16 bats/turbine/year. Approximately 82 percent of the bat mortality occurred from mid-July to the end of August. WEST found that "both the bat detector and mist net data indicate there are relatively large breeding populations of bats in close proximity to the wind plant that experienced little to no wind plant related collision mortality." It appears that most bat mortality at Buffalo Ridge involves migrating bats.
- Researchers highlighted that bat mortality increased with reduced distance between turbines and wetlands or woodlands. Turbines in this study were 750 kW turbines with a 50 m tower and rotor diameter 46 m or 48 m depending on blade length. Turbines would be larger at Moraine II.

The impact of the proposed Project on wildlife is expected to be minimal. There is potential for avian and bat collisions with facility turbines or meteorological towers. Additional impacts may include a small reduction in the available habitat that some of the wildlife uses for forage or cover. Operation of the wind farm will not change the existing land use.

5.18.3 MITIGATIVE MEASURES

The Applicant will implement the following measures, to the extent practicable, to help avoid potential impacts to wildlife in the Project area during selection of the turbine locations and subsequent Project development and operation:

- Conduct a pre-construction inventory of existing biological resources, native prairie, and wetlands in the Project area;
- Exclude established wildlife management, recreation, scientific and natural areas, and Klinker and Engbarth Sloughs from consideration for wind turbine, access road, or feeder/collector line placement;
- Avoid or minimize disturbance of individual wetlands or drainage systems during

construction of the Project;

- Avoid or minimize placement of turbines in high quality native prairie tracts;
- Protect existing trees and shrubs that are important to the wildlife present in the area;
- Avoid construction activities within deer-wintering yards during winter;
- Maintain sound water and soil conservation practices during construction and operation of the Project to protect topsoil and adjacent resources and to minimize soil erosion. To minimize erosion during and after construction, BMPs for erosion and sediment control will be utilized. These practices include temporary seeding, permanent seeding, mulching, filter strips, erosion blankets, grassed waterways, and sod stabilization;
- Construct wind turbines using tubular monopole towers;
- Minimally light turbines according to FAA requirements;
- Revegetate non-cropland and pasture areas disturbed during construction or operation with an appropriate native seeding mix;
- Design the facility to minimize avian impacts by avoiding high use wildlife habitat, using tubular towers to minimize perching, placing electrical collection lines underground as practicable, and minimizing infrastructure; and
- Inspect and control noxious weeds in areas disturbed by the construction and operation of the Project.

5.19 RARE AND UNIQUE NATURAL RESOURCES

5.19.1 DESCRIPTION OF RESOURCES

Agency correspondence

The USFWS and the DNR were contacted to review the Project for threatened and endangered (T&E) species and unique habitats. Response letters from the USFWS and the DNR are included in Appendix A.

In a March 23, 2007 response letter, the USFWS identified the following federally-listed threatened and endangered species as potentially occurring in the Project area:

- Bald Eagle (*Haliaeetus leucocephalus*) - Threatened

The Bald Eagle may use the area for migration and wintering. Currently there are no known eagle nests within the Project boundaries.

The USFWS has identified portions of Rock River and the East Branch of the Rock River downstream of the Project area as Topeka shiner critical habitat (Figure 5-12). The Topeka shiner is a federally

endangered small, silvery minnow that is approximately 3 inches in length. It is found in small to mid-size prairie streams with relatively high water quality and cool-to-moderate temperatures. Critical habitat designates areas that contain habitat essential for the conservation of a threatened or endangered species and which may require special management considerations. The DNR Natural Heritage Information System (NHIS) data shows occurrences of Topeka shiners in portions of the Rock River and the East Branch of the Rock River, the closest of which are approximately two miles downstream (southwest) of the Project area.

In a February 13, 2007 response letter, the DNR indicated that there are four occurrences of rare species or plant communities with a one-mile radius of the Project area (listed above). The response letter also discussed a documented site of high biodiversity significance in the Project area that has dry hill prairie communities in the vicinity of the Woodstock WMA. Additionally, the DNR indicated that a survey for native prairie remnants in Murray County is scheduled to occur in the 2007 field season; particularly, there are areas in Sections 20 and 21 of Cameron Township that may contain native prairie remnants. The DNR expressed a preference for components of the wind project to avoid native prairie tracts.

Natural Heritage Information System Data

The DNR maintains a NHIS database through their Natural Heritage Program and Nongame Game Wildlife Program, which is the most complete source of data on Minnesota's rare, endangered, or otherwise significant plant and animal species, plant communities, and other natural features. NHIS data shows that there are four recorded occurrences of special status species, plant communities or other unique natural features within a one-mile radius of the Project area (Figure 5-12). These four occurrences include:

- Forster's tern (*Sterna forsteri*) – State special concern species;
- Small white lady's slipper (*Cypripedium candidum*) – State special concern species;
- Dry Hill Prairie (Southern) Type Natural Community; and
- Colonial Waterbird Nesting Site

Forster's tern

Forster's tern is a state special concern species that typically nests in large emergent prairie marshes primarily in the southwest portion of Minnesota. Special concern species are extremely uncommon in Minnesota, or have specific or unique habitat requirement. Therefore, the DNR carefully monitors their populations. In the Project area, there are several large marsh complexes associated with WMAs that could provide tern habitat, although no sightings have been recorded by the DNR in the area for over 30 years.

Small white lady's slipper

The small white lady's slipper is a state special concern species found in wet to wet-mesic prairies and calcareous fens. Native prairie remnants in the Project area could contain the lady's slipper, although there have been no DNR-recorded occurrences in the area for over 40 years.

Natural Communities

The NHIS indicates the presence of a dry hill prairie (southern) type natural community within one mile of the Project area. The DNR classifies this plant community as dry-to-dry mesic prairies on well-drained soils on slopes and hilltops on glacial till. Dominant grasses are little blue stem, side-oats grama, big bluestem, porcupine grass and prairie dropseed. Typical forbs include prairie smoke, purple prairie clover, prairie phlox, silverleaf scurfpea, buffalo bean, sky blue aster and wild licorice. It is possible that native prairie remnants may occur in pastures or other untilled areas in the Project area.

Additionally, there are two DNR-listed railroad prairies within one mile of the Project area. Railroad prairies, in general, occur on rights-of-way between roadways and railbeds, where the land has not been farmed or significantly disturbed. Both railroad prairies are a mix of mesic and wet prairie communities in fair condition. The communities are 0.3 to 0.5 miles away from the Project area.

Colonial Waterbird Nesting Site

There is one recorded colonial waterbird nesting site within a mile north of the Project area, used by eared grebes.

5.19.2 IMPACTS

No impacts to rare and unique resources, including the bald eagle and Topeka shiners, are anticipated for the Project construction or operation. Impacts to the Topeka shiner are not anticipated as construction activities for wind turbines and access roads will, in general, be limited to ridges and will avoid area streams and wetlands. BMPs will be implemented during construction to control erosion, specifically in the Rock River watershed, where tributaries drain towards Topeka shiner critical habitat streams. Operation of the Project is not anticipated to affect the federal and state-listed species.

In their response letter, the DNR indicated that they did not anticipate the Project to impact the four NHIS-documented occurrences of rare or unique species or communities.

Because of the high density of birds at colonial waterbird nesting sites (such as the eared grebe nesting site north of the Project area), any disturbance to these sites has the potential to impact the reproductive

success of large portions of a species' population. However, construction associated with the Project will be at least a mile away from the eared grebe nesting site, avoiding any disturbance to this colony.

As discussed in Section 5.18.2, avian impacts are expected to be fairly minimal, although collisions may occur. The Applicant will avoid direct impacts to large marshes that could serve as habitat for the tern.

The DNR-listed railroad prairies are outside of the Project area and will not be affected.

A pre-construction inventory of existing native prairie, woodland, and wetland habitats will be conducted in the Project area, including the documented dry hill prairie communities and high biodiversity significance sites. Any observed occurrences of rare or unique species and communities will be recorded, and the Applicant will avoid the resources identified to the extent practicable. Species-specific surveys are not an anticipated component of the preconstruction inventory.

5.19.3 MITIGATIVE MEASURES

The Applicant will implement the following measures to avoid potential impacts to federal and state-listed species and rare or sensitive habitat in the area during selection of the wind turbines and access roads and the subsequent development and operation of the Project:

- Conduct a pre-construction inventory of existing biological resources, native prairie, and wetlands in the Project area;
- Avoid or minimize disturbance of individual wetlands or drainage systems during construction of the Project; and
- Avoid or minimize placement of turbines in high quality native prairie;
- Consult with the USFWS and DNR regarding Topeka shiner habitat if waterway crossings of tributaries to the Rock River are necessary; and
- Consult with the DNR regarding the potential prairie remnants in Murray County after the DNR conducts a survey in the 2007 field season.

5.20 SUMMARY OF IMPACTS

Included below is a summary of the impacts to key resources found within the Project area, including visual resources, land use, noise, and wildlife.

The wind turbine arrays will be prominent features in the landscape. By design, these structures are placed in open areas of higher elevations. Some mitigative measures, as described in Section 5.4, can be implemented to somewhat limit visual impacts. However, there is no way to make these structures

unnoticeable. The degree to which the visual impacts are considered adverse is subjective, and can be expected to vary depending, for example, on how often the viewer sees the turbines.

The Project area includes a total of 26,992 acres of land. Of the 26,992 acres, less than one half of one percent will be converted from natural vegetation or agricultural field to wind turbines, access roads, and transformer pads. Approximately 22 acres of land will be converted for the 1.5 MW turbines, 20 acres of land will be converted for 2.1 MW turbines, 18 acres for 2.5 MW turbines and 16 acres of land will be converted for the 3.0 MW turbines and access roads. An additional 5 acres of land will be used for the O&M facility and Project substation. The existing land use will continue on the remainder of the land.

When in motion, the wind turbines emit a perceptible sound. The level of this noise varies with the speed of the turbine and the distance of the listener to the turbine. On relatively windy days, the turbines create more noise. However, the ambient or natural, noise level from the wind tends to override the turbine noise as distance from the turbines increases. Turbines will be located at least 623 to 850 feet from occupied homes to meet the MPCA noise standard.

Birds and bats occasionally collide with wind turbines. The mortality associated with these collisions has been identified as inconsequential from a population standpoint on Buffalo Ridge. In addition, turbines may result in reduced use of habitat by grassland bird species within 100 m (328 feet) of the turbine.

The impact of the proposed Project on wildlife is expected to be minimal. Roughly 21 to 27 acres of land will be converted for the access roads, turbine pads, maintenance facility, and substation. This will reduce available habitat that some of the wildlife uses for nesting, forage or cover.

5.21 SUMMARY OF PRECONSTRUCTION INVENTORIES

The Applicant will conduct the following resource inventories for the Project area prior to construction. The Applicant will submit copies of these preconstruction inventories to the PUC at the preconstruction meeting:

- Biological Preservation Survey – inventory of existing WMAs, SNAs, recreation areas, wetlands, native prairies, forests, and other biologically sensitive areas within the Project area;
- Archaeological Reconnaissance Survey; and
- Electromagnetic Interference Study – inventory of microwave beams and television signal reception within the Project area.

5.22 EXCLUSION AND AVOIDANCE CRITERIA AND SITE DESIGNATION SUMMARY

State law governing the siting of traditional electric generating facilities requires that certain environmental features be avoided. These requirements will be applied in determining the location of the proposed wind turbines and related appurtenances on the Moraine II site. Table 5-7 identifies these features to be avoided and whether or not such features exist within the Project Area. For those categories where these exclusion/avoidance features are present within the site boundaries, the final locations of the turbines will be selected to not interfere with them. Hence, this table reflects the ease, or degree of flexibility, in siting the turbines, for a given type of environmental feature.

Table 5-7
Exclusion/Avoidance Features Relative to Project Area

Exclusion/Avoidance Feature	Presence in Project Area
National Parks	None
National Historic Sites	None
National Historic Districts	None
National Wildlife Refuges	None
National Monuments	None
National Wild, Scenic and Recreational Riverways	None
National Wilderness Areas	None
State Wild, Scenic and Recreational Rivers	None
State Parks	None
Nature Conservancy Preserves	None
State Scientific and Natural Areas	None
State Wilderness Areas	None
Registered Historic Sites/Dist.	21 archaeological resources within one mile - 3 are in Project area
State Wildlife Mgmt. Areas	6 in Project area

Exclusion/Avoidance Feature	Presence in Project Area
County and Municipal Parks	None
State and Federal Rec. Trails	None
Designated Trout Streams	None
DNR Canoe/Boating Routes	None
Prime Farmlands	Present
Wetlands	Present (Figure 5-11)
Streams Within Site Boundaries	Present (Figure 5-9)
Residences	Present

6.0 IDENTIFICATION OF REQUIRED PERMITS/APPROVALS

The potential federal and state permits or approvals that have been identified as being required for the construction and operation of the Project are shown in Table 6-1.

Table 6-1
Permits and Approvals

Agency	Type of Approval
Federal Permits	
Federal Aviation Administration	Notice of Proposed Construction or Alteration within 6 miles of Public Aviation Facility and structures over 200 feet to complete a 7460 Proposed Construction or Alteration Form
U.S. Army Corps of Engineers	Section 404 Permit
State of Minnesota Permits	
Minnesota Public Utilities Commission	LWECS Site Permit
Minnesota Board of Water and Soil Resources	Wetland Conservation Act Approval
Minnesota Department of Natural Resources	Public Water Works Permit
	License to Cross Public Land and Waters
Minnesota Pollution Control Agency	NPDES Permit: Construction
	License for Very Small-Quantity Generator of Hazardous Waste
	Section 401 Water Quality Certification
Minnesota Department of Health	Water Well Permit
	Plumbing Plan Review
Minnesota Department of Transportation	Utility Access Permit
	Highway Access Permit
	Oversize and Overweight Permit
Local Permits	
Murray and Pipestone Counties	Utility Permit for Feeder Lines Constructed Along Corridor Road Right of Ways
	Access Permit Application
	Application for Permit to Move Loads on Restricted Highways

7.0 REFERENCES

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8.0 ABBREVIATIONS

ANSI	American National Standards Institute
BMP	Best Management Practices
CON	Certificate of Need
CRP	Conservation Reserve Program
CSAH	County State Aid Highway
dBA	A-weighted Decibels
DNR	Minnesota Department of Natural Resources
DOC	Minnesota Department of Commerce
DOE	Department of Energy
DPS	Department of Public Service
ELF-EMF	Extremely Low Frequency – Electric and Magnetic Field
EPC	Engineering Procurement Construction
FAA	Federal Aviation Administration
FCC	Federal Communications Commission
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
ft	Feet
Kg	Kilogram
kV	Kilovolt
kVA	Kilovolt ampere
kW	Kilowatt
LWECS	Large Wind Energy Conversion System
m	Meter
m/s	Meters per second
MISO	Midwest Independent Transmission System Operator
MPCA	Minnesota Pollution Control Agency
mph	Miles per hour
MW	Megawatt
MWh	Megawatt hour
NIEHS	National Institute of Environmental Health Sciences
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Program

NRHP	National Register of Historic Places
NSP	Northern States Power
NWI	National Wetland Inventory
O & M	Operations and Management
PCB	Polychlorinated Biphenyls
PPA	Power Purchase Agreement
PUC	Public Utilities Commission
PWI	Public Waters and Wetlands Inventory
RD	Rotor Diameter
RIM	Reinvest in Minnesota
SCADA	Supervisory Control and Data Acquisition System
SHPO	State Historic Preservation Office
SNA	Scientific and Natural Area
SWPPP	Storm Water Pollution Prevention Plan
T&E	Threatened and Endangered
USFWS	United States Fish and Wildlife Service
V	Volts
VAR	Reactive Power Flow
WMA	Wildlife Management Area
WTG	Wind Turbine Generators