office of energy security

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March 7, 2011

Dr. Burl W. Haar:
Executive Secretary
Minnesota Public Utilities Commission
127 7th Place East, Suite 350
St. Paul, MN 55101-2147

RE: **Comments and Recommendation of the Office of Energy Security Energy Facility Permitting Staff on a Sound Monitoring Protocol (Docket No. et-6656/WS-08-573)**

Dear Dr. Haar:

Attached are the Comments and Recommendation of the Office of Energy Security Energy Facility Permitting (EFP) Staff:

> **In the Matter of the Site Permit issued to Wisconsin Power and Light Company for the Bent Tree Wind Farm Project Phase I for a Large Wind Energy Conversion System in Freeborn County.**

The amended Application for a Large Wind Energy Conversion System Site Permit was filed on August 22, 2008 by:

Arshia Javaherian
Regulatory Attorney
Wisconsin power and Light Company
4902 North Biltmore Lane
Madison, WI 53718

EFP recommends approval of the proposed Sound Monitoring Protocol with some additional requirements as described in the attached comments and recommendations.

EFP staff is available to answer questions from the Commission.

Sincerely,

Larry B. Hartman
EFP Staff

Attachments

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BEFORE THE MINNESOTA PUBLIC UTILITIES COMMISSION

COMMENTS AND RECOMMENDATIONS OF THE MINNESOTA OFFICE OF ENERGY SECURITY ENERGY FACILITY PERMITTING STAFF

DOCKET NO. ET-6657/WS-08-573

Meeting Date: March 10, 2011 .....Agenda Item # _____

Company: Wisconsin Power and Light Company (WPL)

Docket No. **PUC Docket Number: ET-6657/WS-08-573**

In the Matter of the Site Permit issued to Wisconsin Power and Light Company for the Bent Tree Wind Project Phase I for a Large Wind Energy Conversion System in Freeborn County.

Issue(s): Should the Commission approve the "Operational Sound Level Survey Test Protocol," submitted by Wisconsin Power and Light Company for Phase I (201.3 MW) of the 400 MW Bent Tree Wind Project?

OES EFP Staff: Larry B. Hartman 651-296-5089

Relevant Documents [eDocket ID Number]

Operational Sound Level Survey Protocol [20112-59117-01] ..... February 1, 2011
Pre-Construction Background Sound Level Survey [20107-52557-01].....July 14, 2010
Background Sound Survey Test Protocol [200910-43044-01, item F.2] ..... March 17, 2010
Commission Order for WPL Bent Tree Wind Farm [20103-48127-01] .....October 20, 2009
Site Permit Application & Appendix A-Exh.4 [5463931 & 5298350] .....August 22, 2008

The enclosed materials are work papers of the Office of Energy Security (OES) Energy Facility Permitting (EFP) Staff. They are intended for use by the Public Utilities Commission and are based on information already in the record unless otherwise noted. This document can be made available in alternative formats; i.e., large print or audio by calling 651-296-0392 (voice). Persons with hearing or speech disabilities may call us through Minnesota Relay at 1-800-627-3529 or by dialing 711.

Documents Attached:
1. Graphic B Project Area & Potential Remote Ambient Measurement Locations
2. Graphic A Sound monitoring positions
3. Wisconsin Public Service Commission "Measurement Protocol for Sound and Vibration Assessment of Proposed and Existing Wind Electric Generation Plants" May, 2010
4. Minnesota Pollution Control Agency Memo

(Note: see eDockets (08-573) or the PUC Facilities Permitting website for additional documents: http://energyfacilities.puc.state.mn.us/Docket.html?Id=19665.

Statement of the Issue

Should the Commission approve of the "Operational Sound Level Survey Test Protocol" submitted by Wisconsin Power and Light for Phase I of the Bent Tree Wind Farm in Freeborn County?

Introduction and Background

Wisconsin Power and Light Company (WPL) applied to the Commission for a LWECS site permit on August 22, 2008, to develop the proposed 400 megawatt Bent Tree Wind Project located in Freeborn County in two phases. On October 20, 2009, a Commission Order issued a site permit for Phase I (201.3 MW), consisting of 122 Vestas V82-1.65 MW wind turbines. Phase I, built in 2010 on a 19,560 acre site, and went into commercial operation on February 7, 2011.

One of the concerns raised by the public, both in this project and in other projects recently permitted by the Commission, is the noise levels produced by wind turbines when in operation. In order to address this issue, some of the recently issued Commission site permits for large wind energy conversion systems have required post-construction noise surveys in order to gather base line information on wind turbine noise, compare modeled noise limits with actual noise measurements for verification purposes and insure compliance with Minnesota Pollution Control Agency state noise standards.

Project Location

The proposed Bent Tree Wind Project is located in northwestern Freeborn County, approximately four miles northwest of Albert Lea, as shown on the accompanying map (See Attachment 1 in Commissioner's packet). The Project area includes portions of Hartland, Manchester, Bath and Bancroft townships. The proposed site, approximately 32,500 acres in size, is comprised primarily of agricultural lands (crops and pasture), and scattered woodlots. Site terrain is flat to gently rolling and has both long and short vistas due to the nature of the topography and landscape features. WPL controlled, at the time of its application, approximately 24,000 acres of land and wind rights within the proposed 32,500 acre Project Area.

The Bent Tree Wind Project Phase I, at the time of the Commission's decision, included approximately 294 parcels of land and owners of 195 parcels are Project participants. The Phase II portion of the Bent Tree Wind Project contains 168 parcels of land and owners of 118 parcels

are Project participants. In total, there are 462 parcels of land in the 400 MW Project and owners of 313 parcels are Project participants. However, these numbers may change with time.

Bent Tree Wind Project

Phase I of the Bent Tree Wind Project is comprised of 122 Vestas V82-1.65 megawatt wind turbines, mounted on 80-meter (262 feet) high freestanding tubular steel towers. The blades on the Vestas wind turbines are 41 meters (134 feet) long. The rotor diameter is 82 meters (269 feet). The generator cut in speed is 8 mph (3.5 meters per second m/s) and the cut out is 47 mph (21 m/s). The Vestas V82 reaches its rated capacity (1.65 MW) when the wind is about 29.1 mph (13 m/s). The blades will make 14.4 revolutions per minute under maximum wind speed, with a blade tip speed of 138 mph. The V82 turbine is designed for sites with low and medium wind conditions. More than 1,500 V82 turbines have been installed worldwide in climates that range from tropical to arctic.

Associated facilities include approximately 26 miles of all-weather class 5 (gravel or similar materials) turbine access roads and 44 miles of 34.5 kV collector system electrical cables that carry power from the turbines to the project substation. Other project components include pad-mounted step-up transformers, concrete and steel tower foundations, an underground supervisory control and data acquisition (SCADA) system, two permanent reference meteorological towers, a 4.1 mile long 161 kV interconnect line, a project substation, and an operations and maintenance building in the city of Hartland.

Wind Turbine Noise

Noise produced by wind turbines, when operating, has been one of the most studied environmental impacts of this technology.

The more contemporary (upwind) wind turbines produce two types of noise: mechanical noise from gearboxes and generators, and aerodynamic noise from blades. Current wind turbine design has eliminated much of the mechanical noise through design improvements and more use of insulating material in the nacelle, leaving aerodynamic noise as the biggest contributor. The aerodynamic noise is produced by the rotation of the blades generating broad-band swishing sound and is also a function of the speed of the blade at its tip. By optimizing wind turbine and airfoil design, aerodynamic noise can be reduced in one of two ways: 1) decreasing rotational speeds to fewer than 65 meters per second (m/s) or 145.6 miles per hour; and 2) using pitch control on upwind turbines, which permit the rotation of the blades along their long axis.

At any given location, the noise within or around a wind farm can vary considerably depending on a number of factors including the layout of the wind farm, the model of turbine installed, topography, the speed and direction of the wind, background noise, time of year, and atmospheric conditions, as well as other factors. The factors with the most influence on noise propagation are the distance between the observer and the source and the type of noise source.

The sound emissions of a wind turbine do increase as the wind speed increases before leveling off. However, the background noise will typically increase faster than the sound of the wind

turbine, which tends to mask the wind turbine noise in higher winds. Sound levels decrease as the distance from the wind turbine increases.

Noise levels can be measured and predicted, but public attitude toward noise depends heavily on perception. Sound emissions can be accurately measured using standardized acoustic equipment and methodologies measurements (International Organization for Standardization – ISO Standards, International Electrotechnical Commission – IEC Standards and others). Levels of sound are most commonly expressed in decibels (dB). The predictions of sound levels are of importance in order to insure compliance with existing standards.

When there are people living near a wind farm, noise levels are factored into the design and layout of a project. Rural areas are quieter than cities, so the background noise is usually lower. However, there also are noisy activities in rural areas associated with agricultural operations, transportation and industrial activities. Wind farms are located in windy areas, where background noise is higher, and as the wind speeds increase, ambient background noise levels also increase. As wind speeds increase, the wind itself tends to mask the noise produced by the turbines.

Because of the wide variation in the levels of individual tolerance for noise, there is no completely satisfactory way to measure its subjective effects or the corresponding reactions of annoyance and dissatisfaction. The individual annoyance for noise is a very complicated and complex topic, but dose-response relationship studies have demonstrated a correlation between noise annoyance with visual interference and the presence of intrusive sound characteristics.

Site permits for wind farms in Minnesota, authorized by the Environmental Quality Board or the Commission, have always required that projects be designed to comply with Minnesota Pollution Control Agency noise standards in Minn. Rule Chapter 7030, as contained in site permit condition III.E.2 (see Site Permit Requirements below).

In the 1990s, post-construction noise surveys were carried out on at least two wind projects in the Lake Benton area on Buffalo Ridge in Lincoln County. Those surveys, done by Hersh Acoustical Engineering, concluded that the turbines were in compliance with Minnesota's noise standards.

However, those turbines, specifically tower height and rotor diameter were considerably smaller than the commercial turbines now available. Considerable research has been and continues to be incorporated into blade design in order to improve operating efficiency, while at the same time reducing noise levels.

Nonetheless, the topic of turbine noise is often an issue that comes up in review of wind projects, in Minnesota and elsewhere. The Commission, in its review of the record in recent LWECS site permit proceedings, has included requirements for noise surveys, in part to address public concerns about wind turbine noise, but also to provide baseline information that allows for review of modeled sound emission levels against actual field measurements for correlation, to help determine compliance with MPCA noise standards, and to provide decision-makers with objective information that will assist them in evaluating noise levels.

Site Permit Requirements [Noise]
For the Bent Tree Wind Project, wind turbine noise is addressed in the Commission issued site permit (October 20, 2009) in two separate locations.

Site permit condition III.E.2 [Noise] addresses compliance with the Minnesota Pollution Control Agency noise standards (Minn. Rule Chapter 7030) and reads as follows:

> The wind turbine towers shall be placed such that the Permittee shall comply with noise standards established as of the date of this Permit by the Minnesota Pollution Control Agency at all times at all appropriate locations. The noise standards are found in Minnesota Rules Chapter 7030. Turbine operation shall be modified or turbines shall be removed from service if necessary to comply with this condition. The Permittee or its contractor may install and operate turbines, as close as the minimum setback required in this permit but in all cases shall comply with PCA noise standards. The Permittee shall be required to comply with this condition with respect to all homes or other receptors in place as of the time of construction, but not with respect to such receptors built after construction of the towers.

Site Permit condition III.F.2 [Studies/Noise] is the requirement for a post-construction noise survey and reads as follows:

> The Permittee shall submit a proposal to the Commission for the conduct of a noise study. Upon the approval of the Commission, the Permittee shall carryout the study. The study shall be designed to determine the noise levels at different frequencies and at various distances from the turbines at various wind directions and speeds.

It should be noted that pursuant to site permit condition III.M.2. Wisconsin Power and Light Company did not locate any of the 122 turbines within 1,000 feet of a residence.

Site Permit Application − Noise Information
The topic of wind turbine noise was discussed in WPL's site permit application (See Relevant Documents, pages 26 – 27, and Appendix A, Exhibit A-4). Information in the application indicated that background noise levels in the Project Area are typical of those in rural settings, where existing noise levels are commonly in the low to mid-30 dBA range. The dBA scale represents 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.

WPL performed an assessment of noise levels at residences (i.e. receivers) across the Project Area. Noise levels were calculated using the Windfarmer program and a representative wind turbine for the site. The program assumed all turbines in the Project Area were operating

simultaneously and wind speeds of 8 meters per second (m/s) or 17.9 mph were occurring. 8m/s represents the wind speed when maximum noise levels are expected.

Noise levels predicted by Windfarmer were compared to the Minnesota Pollution Control Agency (MPCA) Daytime and Nighttime L10 and L50 limits as stated in Minn. Rule7030.0040. These standards describe the limiting levels of sound established on the basis of present knowledge for the preservation of public health and welfare. These standards are consistent with speech, sleep, annoyance and hearing conservation requirements for receivers within areas grouped according to land activities by the Noise Area Classification (NAC) system established in Minn. Rule, part 7030.0050. The NAC-1 was chosen for receivers in the Project Area since this classification includes farm houses as household units. Daytime and nighttime limits for this classification are (1) L50 limit of 60 dBA and L10 limit of 65 dBA in daytime, and (2) L50 limit of 50 dBA and L10 limit of 55 dBA at nighttime. The nighttime L50 limit of 50 dBA is the most stringent limit.

Because the noise level for the representative wind turbine used for the analysis reached a maximum at 8 m/s and the wind is stronger that 8 m/s more than 10 percent of the time, the predicted L10 noise level is the same as the predicted maximum noise level, and the predicted L50 level is just slightly below the predicted maximum. Coupled with the minimum setback distance of 1,000 feet from residences, WPL believes they will be below the predicted maximum noise level to ensure compliance with the MPCA nose standards.

WPL Background Sound Survey [March 2010]

WPL in complying with condition III.F.2 initiated a two phase noise survey. The first phase, which did not require Commission approval, took place in March of 2010 (see Relevant Documents, eFiled on March 17, 2010), when WPL's noise consultant (Hessler Associates, Inc.) provided a "Background Sound Survey Test Protocol" that was specifically designed to understand the relationship between the natural background sound level at ground level and wind speed well above ground surface. "This approach essentially correlates the wind speed that the turbine rotors will see to the sound level at ground level − where the wind speed is often negligible."

The "Background Sound Survey Test Protocol" prepared by Hessler Associates, Inc., pointed out that the typical methodology for noise measurements are not applicable to sound produced by wind turbines because of the noise produced by the wind, as noted in the following statement:

> This general procedure, out of necessity, goes far beyond the survey procedures outlined by the Minnesota Pollution Control Agency (MPCA) in *A Guide to Noise Control in Minnesota, Acoustical Properties, Measurement, Analysis and Regulation* [1] which is perfectly suitable for conventional situations like the evaluation of noise from a fossil-fuel power plant but was never intended to address the very special circumstances surrounding noise from wind turbines. For example, measurements are prohibited in wind exceeding 11 mph (4.9 m/s) but wind turbine noise, by its very nature, needs to be evaluated over a much higher

range of wind speeds. The recommended procedure also calls for a total monitoring duration of at least one hour – but a much longer period of about 2 weeks is actually needed to correlate the background level to the wind speed.

A test protocol for evaluating background sound levels at the Bent Tree site is presented below that combines everything that is applicable and relevant from the MPCA guidelines with the long-term monitoring approach mentioned above, which is based on extensive field experience with numerous wind projects.

Hessler's protocol states that the following principal procedures were planned for the Bent Tree Wind Farm background survey:

- Establish 10 to 12 measurement locations evenly distributed over the site area. (Proposed locations are shown in Graphic A)
- Locate all monitors away from any large reflective surfaces
- Continuously measure A-weighted LA90, LA50 and LA10 and C-weighted LCeq sound levels in 10 minute increments for a total survey period of approximately 14 days
- Use the "fast" response setting
- Use ANSI Type 2 or better Rion NL series long-term environmental sound level monitors, or similar, in weather-proof cases
- Calibrate all instruments at the beginning of the survey and recheck their calibration at the end
- Measure wind speed and direction at one or more on-site met towers also in 10 minute increments for the entire survey period. Use the highest mast top anemometer.
- Position the microphones no more than 1 m above local grade to minimize self-generated wind noise
- Set up an anemometer at microphone height (1 m) at the windiest measurement position to record wind speed and direction in 10 minute increments over the survey period
- Use high density, rainproof wind screens (ACO Model WS7-80T) to further minimize self-generated wind noise
- Perform a regression analysis to determine what the L90, L50 and L10 sound levels are as a function of wind speed for later comparison to operational sound levels
- Describe the survey methodology, precise measurement positions, weather conditions and survey results in a detailed report

This two week survey was carried out over a 14 day period from March 17 to 31, 2010. The results of this survey are summarized in the "Pre-Construction Background Sound Level Survey" document dated June 1, 2010 (See Relevant Documents, July 14, 2010). The conclusions in this study are stated as follows:

A field survey of existing sound levels during leaf-off, late winter conditions was carried out at the Bent Tree Wind Farm site in March of 2010 prior to the commencement of construction. The objective of the survey was to document existing sound levels in terms of the L90, L50, L10 and LCeq levels for later comparison to sound levels with the project in operation. The survey was two weeks in length and correlated ground level sound levels to wind speed as measured by two high elevation (58 m) anemometers. All the sound levels show a distinct dependence on wind speed or, more specifically, wind-induced sounds.

The mean sound levels for each of the A-weighted statistical measures and the *apparent* C-weighted sound levels are tabulated below.

Table 4.0.1 *Summary of Measured Sound Levels at Integer Wind Speeds*

Wind speed at 10 m, m/s	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
L90 Sound Level, dBA	25	27	29	32	35	38	41	45	48
L50 Sound Level, dBA	28	30	32	35	38	41	44	47	50
L10 Sound Level, dBA	35	36	38	40	43	46	49	52	55
Apparent LCeq Sound Level, dBC	49	51	54	57	61	64	68	72	76

One can see from the table above that increases in wind speed also lead to higher levels of noise. Having good baseline information about existing ambient noise levels and noise levels when the wind is present will be a useful metric in evaluating noise levels without and with operating wind turbines under a variety of conditions.

WPL Operational Sound Level Survey Test Protocol [March 2011]

As noted above, condition III.F.2 in the Bent Tree Site Permit requires the Permittee to submit a proposal to the Commission for the conduct of a noise study and, upon approval of the Commission; the Permittee shall carryout the study.

In complying with this requirement, WPL submitted a "Operational Sound Level Survey Test Protocol" dated December 6, 2010 (see Relevant Documents, February 1, 2011, prepared by its noise consultant "Hessler Associates, Inc., summarizing the field test procedures to be used in evaluating sound emissions from the Bent Tree Wind Project relative to applicable regulatory noise limits once the project is fully operational. The proposed "Operational Sound Level Survey Test Protocol" is comprised of eight separate components listed below as stated by Hessler:

1.0 Introduction

This protocol summarizes the field test procedures to be used in evaluating sound emissions from the Wisconsin Power and Light Bent Tree Wind relative to applicable Minnesota Pollution Control Agency regulatory noise limits, once the project is fully operational.

Table 1.0.1 *Project Sound Level Limits*

Daytime (7a.m. to 10 p.m.		Nighttime (10 p.m. to 7 a.m.)	
L10	L50	L10	L50
65 dBA	60 dBA	55 dBA	50 dBA

The term L10 and L50 are the statistical sound levels exceeded 10% and 50% of the time over the course of the measurement period. As such the L10 generally captures near maximum or peak levels and the L50 is usually similar to the "average" sound level – although the actual average is a slightly different quantity, Leq, or the equivalent energy sound level.

It is important to note that these limits apply exclusively to sound levels produced by the project and do not include any background noise from unrelated sources, such as cars passing by, trees rustling the wind, planes flying over, etc. Consequently, the aim of the survey is to quantify the project-only sound level, which will involve generally involve subtracting the likely concurrent background sound level from the total measured level at measurement locations within the project area.

…it is also important to note that many customary techniques that have long been successfully used to test, say, a conventional fossil fueled power plant either cannot, be applied to wind turbine projects or must be modified in recognition of the fact that the sound emissions from the project are wholly dependent on, rather than independent of, the wind, weather, and general atmospheric conditions. For instance, the usual approach of taking sound measurements during quiet, low wind conditions to avoid contamination from wind-induced background sounds cannot be employed because the project is likely to be idle during such circumstances. Almost by definition one is required to measure during wind conditions so a number of special measurement techniques are needed that are applicable on to the unique circumstances of wind turbine projects.

The general concept of the test is to measure continuously over a roughly two week period with automated monitors at a number of key test points both on and off the site to record sound levels during a range of wind and atmospheric conditions. The off-site measurements will be used to estimated the background level during any given measurement interval so the on-site

measurements can be corrected. It is essential in wind turbine surveys to use the background level recorded at the same time as the operational sound measurement so that all the weather parameters – such as wind speed, wind direction, wind gradient, thermal gradient, turbulence, cloud cover, precipitation, etc. – are the same. Both wind turbine and background sound levels are highly variable with time and the specific atmospheric conditions occurring at that instant and it is not practical to generalize about the background sound level based solely on wind speed and correct a measurement of operational sound with a background level measured at some other time.

2.0 Instrumentation and Set up

The selected measurement position should be representative of the sound environment experienced at and around nearby houses and away from any sources if local contaminating noise, such as HVAC systems, farm equipment, on-going human activity., etc.

In addition to the sound measurement equipment a temporary weather station shall be set up at least one measurement position to record in 10 minute increments the wind speed 3 feet above ground level (microphone height), wind direction and rainfall during the survey. This selected location(s) shall be at measurement stations that are fairly open end exposed to the wind.

Arrangements shall be made to obtain, once the survey is completed, the wind speed and direction data (in 10 minute increments) from all on-site met towers for the survey period. In addition, a time history of the operating parameters of the project as a whole and each turbine shall be recorded by the SCADA system and made available after the survey for correlation to the measured sound levels.

3.0 Measurement Quantities and Duration

The instruments shall be set up to store at least the L10, L50, L90 and Leq A-weighted statistical measures in 10 minute increments over the survey, which shall run for approximately 14 days. The survey may be carried out at any time under cold season conditions when no insect noise is present and all deciduous trees are bare (minimizing background noise contamination). Replication of the pre-construction survey dates (the last two weeks of March, 2010) is desirable but not imperative, since the background sound levels used to correct the operational survey results will be measured simultaneously with the operational sound levels. The background levels measured in the pre-construction survey shall be generally compared to the new background data to help validate the results.

4.0 On-site Measurement Locations

The seven measurement positions selected for the background survey were generally chosen because they were representative of the residences in closest

proximity to turbine, or where the highest project sound levels at were expected to occur. Consequently, the seven original survey positions, illustrated in Graphic A (See Attachment in Commissioner's packet), shall be replicated to the extent practicable in the operational survey. In addition, up to three other measurement positions may be used representing locations where homes are in relatively close proximity to turbines and/or where concerns about project noise have been expressed by homeowners.

5.0 Off-Site Measurement Locations and Background Noise Correction

In addition to the on-site measurements locations, four background monitor stations shall be established at off-site locations North, South, East and West of the project area that are at least 1.5 miles from the nearest turbine but no more than 2.5 miles. The selected locations shall be similar in setting and general circumstances to typical on-site positions, the objective being to record the "proxy" background sound level that would have probably existed at the on-site locations at any given time during the survey.

Because the proxy background level is, for practical reason, an inexact estimation of the site wide background level, there will usually be instances when the background levels exceeds the total measured level at certain on-site positions. Under this circumstance, and when the background level is below but within 3 dB of the total level, the project-only sound level shall be considered indeterminate. Equations to account for logarithmic subtraction of like quantities shall be performed when the background level is between 3 and 10 dB below the total measured level. When this difference is greater than 10 dB the background level is inconsequential and no correction is needed.

6.0 Correction for Wind-induced Distortion

One of the principal errors in measuring wind turbine noise is false signal noise from wind blowing through the windscreen and over the microphone tip, which is manifested in the form of artificially elevated sound levels in the lower frequency bands. Some degree of distortion is essentially inevitable in any measurement taken above ground level when the wind is blowing, even when using an extra-large windscreen as required for this survey.

For a specific windscreen it is possible to estimate for any reasonable wind speed the overall A-weighted sound level of distortion and then subtract it from the total measured level to reverse the error.

7.0 Compliance Determination

Once the on-site L10 and L50 sound levels have been corrected for spurious noise events, rain, background noise and microphone distortion the results shall be compared to the regulatory limits in Table 1.0.1. In order to reasonably allow for this possibility the project shall be considered in compliance with the regulatory limits if the corrected project-only noise is equal to or below the stated limits at least 95 percent of the time.

In the event that a clear result cannot be obtained from the L10 and L50 statistical measures the L90 level may be used. Experience with wind turbine survey of this type suggest that it may be quite difficult to identify the project-only sound level from the L10 and L50 metrics because they are highly susceptible to contamination from spurious noise events and the background level may well be comparable in magnitude to the total measured level – making it impossible to subtract the two to derive the project-only normally used to measure long-term wind turbine project sound levels.

8.0 Reporting

A report shall be prepared summarizing the survey set up and methodology, data analysis and results. Any deviation from the protocol shall be explained along with the rationale for the alternate approach or interpretation. The report shall state whether the project was found to be in or out of compliance with the applicable regulatory noise limits

The proposed survey, if approved of by the Commission, is expected to be carried out the last two weeks of March, 2011.

OES EFP Staff Comments and Analysis

WPL modeled and evaluated noise impacts during the planning stages of the Bent Tree Wind Project Phase I and II to make informed decisions about turbine placement. (See Relevant Documents Appendix A-Exh 4).

As discussed above, the permit for the Bent Tree Wind Project contains two specific conditions that address noise, one a requirement to comply with the existing state noise conditions: one a requirement to comply with the existing noise standard, and two the conduct of a noise study, upon Commission approval of the proposal (Protocol).

While the current MPCA Noise Survey Protocols provide some applicable guidance on designing a noise survey and reporting the results, they are not specifically designed to account for noises associated with wind turbines. In reviewing various other noise studies and reports, OES EFP staff became aware of the requirements for noise studies adopted by the Wisconsin Public Service Commission. While these standards were initially designed to measure noise from more traditional electrical generating sources, as is Minnesota's, they were amended to account for noise from wind turbine generators on November 17, 2008, and adapted on May 26, 2010 (See Attachment 3 in Commissioner's packet). The Wisconsin Public Service Commission's. "Measurement Protocol for Sound and Vibration Assessment of Proposed and Existing Wind Electric Generation" adopted on May 26, 2010, by the Wisconsin Public Service Commission, specifically addresses wind electric generation plants. This protocol contains five sections:

I. Objectives
II. PSC Staff Contacts
III. Introduction

IV. Measurements of the Existing Sound and Vibration Environment
   A. Sites With No Existing Generation
   B. Sites With Existing Wind Electric Generation Facilities
   C. Sound Level Estimates for proposed Wind Turbine (s)
V. Post Construction Measurements

The Wisconsin Protocol identifies four primary objectives:

1. To measure and characterize the existing sound and vibration environment in the area of the proposed development.
2. To predict the incremental increase in sound and vibration levels that would occur as a result of operation of the proposed development.
3. To verify that the predicted incremental increase in sound and vibration levels is reasonable by taking post-construction sound level measurements.
4. To verify compliance with applicable sound and vibration level limitations by taking post-construction sound level measurements.

As the focus of site permit condition III.F.2 is on post-construction noise, staff draws the Commission's attention to the "Post-Construction Measurements" portion of the Wisconsin Protocol:

V. Post-Construction Measurements

1. Within twelve months of the date when the project is fully operational, and within two weeks of the anniversary date of the pre-construction ambient noise measurements, repeat the existing sound and vibration environmental measures taken before project approval.

2. Post-construction sound level measurement should be taken under two wind conditions:

   a. Under calm conditions without the wind turbine rotors rotating. These measurements shall be taken with the entire wind generating development offline.
   b. Under wind conditions just above the cut-in speed for the wind turbines with as many of the wind turbines in the development operating as possible.

3. Notes regarding post-construction sound level measurements for wind project developments:

   a. Measurements taken as required under section V.2.b may be taken prior to measurements taken under section V.2.a.
   b. Because of the variability of wind speeds, post-construction measurement may be taken outside of the measurement periods listed in section IV.B3.* However, measurements taken under

section V.2.a, above, must be taken during the same time of day as the corresponding measurements taken under item V.2.b.

c. For each MP at which pre-construction noise measurements were taken, a minimum of three sets of measurements shall be taken under sections V.2.a and 2.b. The three sets of measurements should correspond to at least two different times of day. Any or all of the measurements may be taken outside of the measurement periods listed in Section IV.B.3.
d. Measurements taken to fulfill the requirements of sections V.2.a and 2.b must be taken within as few consecutive days as practicable.
e. Measurements taken under sections V.2.a and 2.b must include a measurement of the 16 Hz octave band, as described in section IV.B.4.a.**

4. The post construction sound level measurements must include an evaluation of whether the wind development meets any and all state and local sound level requirements.

5. File a copy of the post-construction noise measurement report with the Public Service Commission including pre- and post-construction measurement data and using the same report format as used for the pre-construction sound land vibration study reports.

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*.....Section IV.B.3 specifies that measurements should be for a minimum of ten continuous minutes for each criterion (see section IV.B.4 below) at each location. Times of day recommended for measurements are as follows: Morning (6 – 8 a.m.); Midday (12 noon – 2 p.m.); Evenings (6 – 8 p.m.); and Night (10 p.m. – 12 midnight).

** ..... For each measurement point and for each measurement period, provide each of the following measurement criteria: (a) At a minimum, unweighted octave-band analysis (16, 31.5, 63, 125, 250, 500, 1K, 2K, 4K, & 8K Hz), one-third octave band analysis is encouraged. PSC staff acknowledges that few sound level meters are capable of measurement of the 16 Hz center frequency octave band. However, because noise complaints from the public most likely involve low frequency noise associated with proposed plants, we encourage applicants to pursue the collection of this important ambient noise data.

The "Operational Sound Level Survey Test Protocol" submitted by Wisconsin Power and Light Company, along with a copy of the State of Wisconsin's "Measurement Protocol for Sound and Vibration Assessment of Proposed and Existing Electric Power Plants" [November 2008, and adopted May 8, 2010], (See Attachment 3) was sent by OES EFP staff to MPCA staff (Anne Claflin) for review and comment. Ms. Claflin's comments are provided in Attachment 4.

With regard to WP&L's "Operational Sound Level Survey Test Protocol," the MPCA staff comments noted that: "The work you have from Hessler is really well done. Their methods make a better protocol that the (Wisconsin) methods, but (Wisconsin) wouldn't be a bad place to start."

As noted above, Wisconsin's Measurement Protocol calls for a pre-construction/operation survey of noise levels. With respect to this requirement, this work has already been completed for the Bent Tree Wind. The protocol for the pre-construction/operation survey was efiled in March of 2010; the study itself was carried out in the last two weeks of March and the report submitted and efiled in June of 2010.

Ms. Claflin also noted: "The Hessler protocol that sets up separate off-site monitoring and correction based on many measurements is the most thorough I have seen. Ms Claflin noted that Hessler nicely balanced multiple locations selection with a widely dispersed project, as opposed to multiple locations around a given turbine, and that the seasonal recommendations are valuable. She further notes that "Not all consultants may be able to do the 14-day studies, and will have to do shorter monitoring. The information that Hessler was able to gather, through, doing 10-minute increments for 14 days straight from the 2010 survey, is really great for setting up a regression to remove some of the variability."

It should be pointed out that much of the concern regarding noise is about "low frequency noise." MPCA's memo indicated that "If the equipment is capable of measuring A and C weighting simultaneous, having that information can only help." However, low frequency noise (16 Hz) is very difficult to measure, as acknowledged by footnote number 2 in the Wisconsin protocol. Hessler's "Background Sound Survey Test Protocol" also noted that:

> Wind speeds below about 4 m/s (9 mph) generally result in negligible corrections. It is only at much higher wind speeds that significant distortion occurs with respect to the A-weighted sound level because the false-signal noise is almost entirely confined to the low frequency end of the spectrum, to which A-weighting is not particularly sensitive. C-weighted sound levels, on the other hand, are extremely sensitive to the low frequency content of the measured spectrum and are easily distorted to the point where they become meaningless by even the slightest breeze. In general, C-weighted sound levels can only be accurately measured under dead calm conditions – conditions that are of no relevance to wind turbine noise. Even in light winds a C-weighted sound level is dominated by the falsely elevated low frequencies and is nothing more than a quantification of the internal measurement error rather than a measurement of the source of interest. This error, which is not widely known or understood, is the principal reason wind turbines are *mistakenly* believed to produce high levels of low frequency noise. Typically, the same apparently elevated C-weighted sound level would be measured in a wind field if a wind turbine were present of not.

Table 4.0.1, above illustrates this point. See Relevant Document dated July 14, 2010, for the full report.

Because noise complaints are most likely to involve low frequency noise, permit condition III.F.2 [Studies/Noise] requires that the study shall de designed to determine the noise levels at different frequencies and at various distances from the turbines at various wind directions and speeds as does the Wisconsin protocol, despite monitoring difficulties.

However, the "Operational Sound Level Survey Test Protocol" does not include frequency analysis. The type of instrumentation used to record unweighted one-third octave band-analysis data is not the type of equipment normally used by Hessler in conducting long-term noise surveys; however, David Hessler has indicated that it would be possible to rent this instrumentation to capture a representative sample of this type of data where it is likely to represent a worst case scenario. Staff agrees that a representative sample of unweighted one-third octave band-analysis should be sufficient to satisfy the intent of the study requirement in condition III.F.2.

Finally, the WPL protocol speaks to "project-only" sound levels and the need to correct or subtract background noise from unrelated sources from measurements. It also speaks to how compliance with standards should be judged. While it is important to correct for anomalous and spurious noises, such as planes flying over or passing cars, and to locate monitoring sites away from existing rural noise sources, such as corn driers, the objective of post-construction monitoring, as noted in the Wisconsin protocol, is to document the incremental increase in sound occurring as a result of the project. Likewise, Ms. Claflin notes that "measurements with and without the turbines operating is a good practice to establish the background sound and the contribution to increased noise from the turbines." Thus, staff concludes that WPL should present the results of its efforts, including the incremental increase in sound with the project, and leave the basis for and determination of compliance with state standards to the state.

OES EFP staff sought out standards for noise protocol surveys for wind turbines. While staff is aware that the global wind industry, in response to concerns and questions about wind turbine noise, is initiating efforts to standardize noise protocols for wind turbines staff believes the State of Wisconsin's noise survey protocol for wind turbines provides an appropriate backdrop for evaluating noise survey protocols submitted for Commission approval. OES EFP staff finds that elements of the Wisconsin Public Service Commission Sound and Vibration Assessment Protocol Standards serve to augment the Minnesota Noise Monitoring Guidelines, which were not specifically designed for monitoring sound created by the operation of wind farms, and together provide an acceptable base for designing a protocol to address the Commission's permit conditions.

As noted in MPCA's comments, the noise protocol submitted for the Bent Tree Wind Project was found to be "well done." Staff concludes that the proposed protocol with the addition of the representative sample of unweighted one-third octave band-analysis for fulfills the requirements of the site permit for condition III.F.2.

Therefore, OES EFP staff recommends that the Commission approve the "Operational Sound Level Survey Test Protocol" prepared by Hessler Associates, Inc., and submitted by Wisconsin Power and Light Company for the Bent Tree Wind Project Phase I, with the inclusion of the additional data requests detailed by OES EFP staff to fulfill the requirement of site permit condition III.F.2. The survey results and report will be submitted to the Commission and e-filed for docket number 08-573.

Commission Decision Options

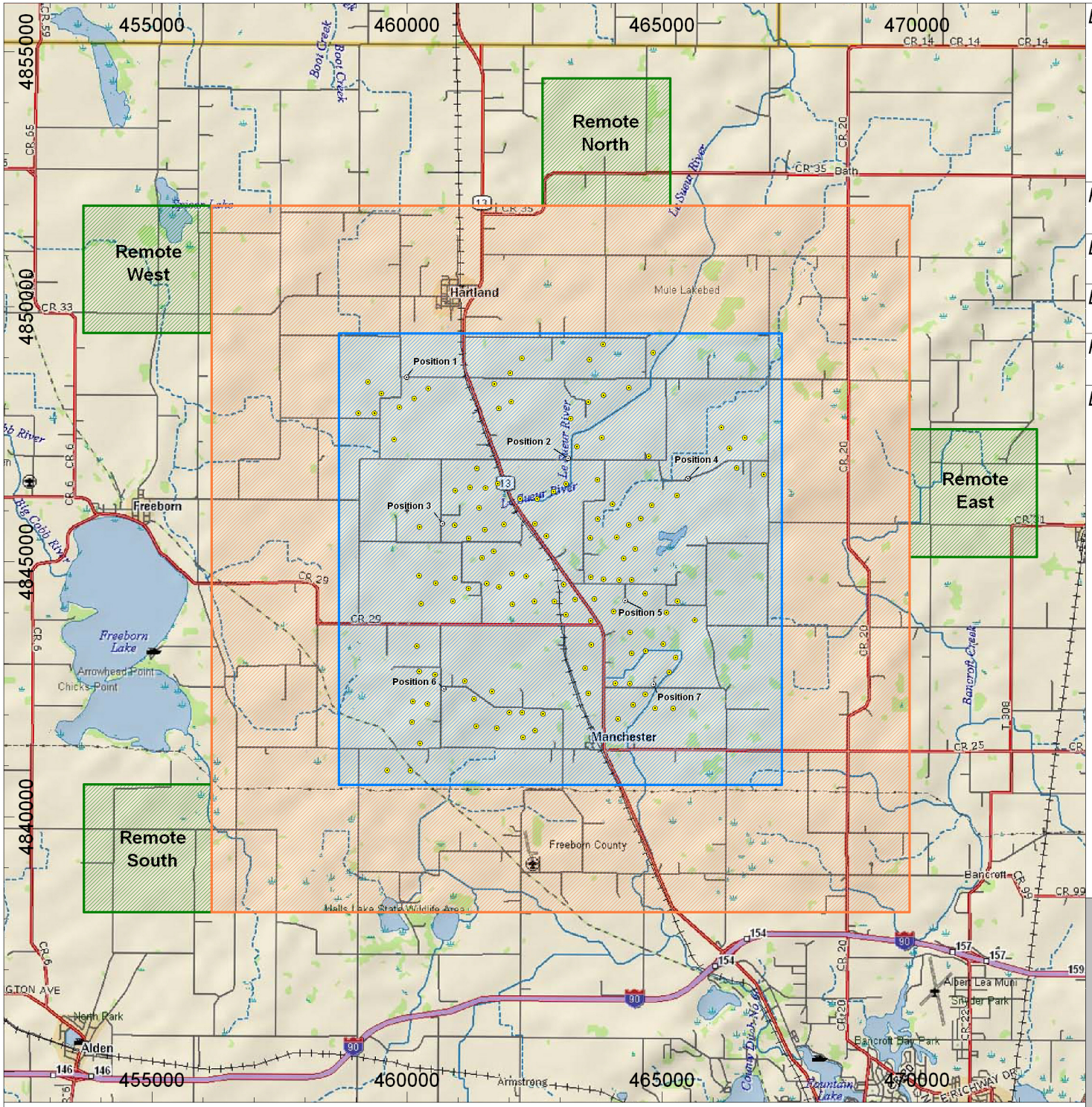
A. Approve the "Operational Sound Level Survey Test Protocol" as proposed for Phase I (201.3 MW) of the 400 MW Bent Tree Wind Project in Freeborn County pursuant to site permit condition III.F.2.

B. Approve the "Operational Sound Level Survey Test Protocol" as proposed for Phase I (201.3 MW) of the 400 MW Bent Tree Wind Project in Freeborn County pursuant site permit condition III.F.2. with the following additional data requirements:

1. representative sample of unweighted one-third octave band-analysis
2. post-construction sound measurement data documenting impacts of the project on the existing environment.
3. Upon completion of the study, survey results will be reported to the Commission

C. Make some other decision deemed more appropriate.

OES EFP Staff Recommendation: The staff recommends Option B.



Border Scale in meters, units are UTM NAD83 coordinates

Description:

Graphic B

Project Area and Potential Remote Ambient Measurement Location Areas

Project:

Bent Tree Wind Park

Drawing Number:

ABT-Rev-B-1B-1

Date:

December 6, 2010

Prepared for:

Alliant

Legend:

- Turbine Location
- Project Area
- Buffer Zone (@1.5 miles)
- Potential Remote Ambient Measurement Area

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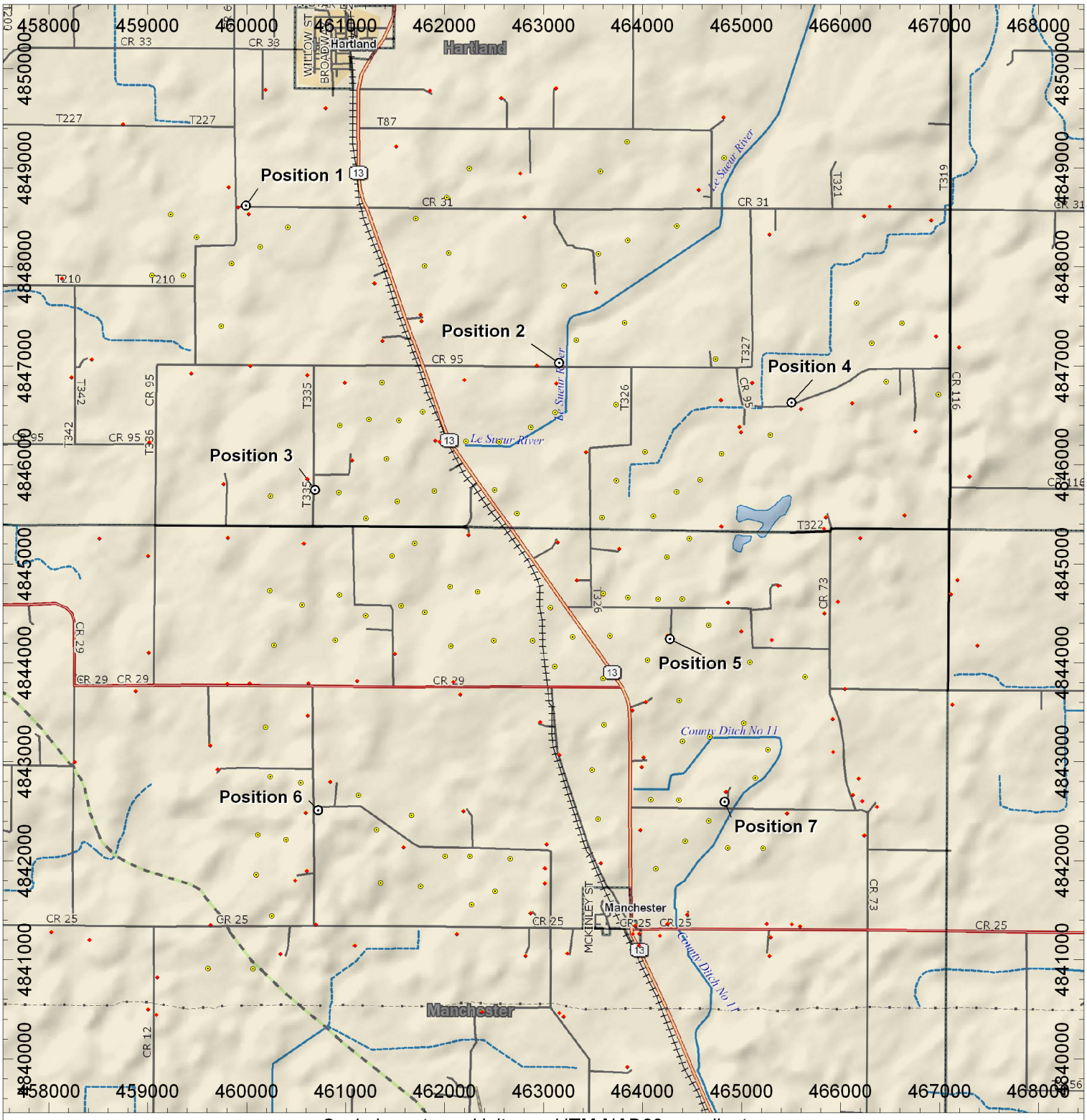

Scale in meters - Units are UTM NAD83 coordinates

Project: **Bent Tree Wind Park**	*Description:* **Graphic A**	*Legend:*
Prepared for: **Alliant**	**Sound Monitoring Positions**	Sound Monitoring Location
Date: April 12, 2010 / *Drawing #:* AA-Rev-B-1A-1		Turbine Location
		Nearby Residence

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N W E S

MEASUREMENT PROTOCOL FOR SOUND AND VIBRATION ASSESSMENT OF PROPOSED AND EXISTING WIND ELECTRIC GENERATION PLANTS

May, 2010

Note: Consult with Commission staff prior to conducting any sound and vibration measurements.

I. Objectives

The primary objectives of this protocol include:

1. To measure and characterize the existing sound and vibration environment in the area of the proposed development.
2. To predict the incremental increase in sound and vibration levels that would occur as a result of operation of the proposed development.
3. To verify that the predicted incremental increase in sound and vibration levels is reasonable by taking post-construction sound level measurements.
4. To verify compliance with applicable sound and vibration level limitations by taking post-construction sound level measurements.

II. PSC Staff Contacts

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III. Introduction

The potential sound and vibration impact associated with the operation of wind electric generation developments is often a primary concern for citizens living in the areas of the developments. This is especially true of projects located near homes, residential neighborhoods, schools, and hospitals. Determining the likely sound and vibration impacts is a highly technical undertaking and requires a serious effort in order to collect reliable and meaningful data for both the public and decision-makers.

This protocol is based, in part, on criteria published in the Standard Guide for Selection of Environmental Noise Measurements and Criteria.[i] The purpose of this protocol is to establish a consistent and scientifically sound procedure for estimating existing sound and vibration levels in a project area.

The layout of the proposed development and the features of the surrounding environment will influence the design of the sound and vibration study. Site layout and the existence of significant local sound and vibration sources and sensitive receptors must be taken into consideration when designing a sound and vibration study. It may be necessary to hire a qualified consultant to conduct the sound and vibration study.

Note: Consult with Commission staff prior to conducting any sound and vibration measurements.

These guidelines are meant to be general in nature and may need to be modified to accommodate unique site characteristics. Consult with Commission staff assigned to the project for guidance on study design before you begin the sound and vibration study. During consultation, good quality maps and diagrams of the site will be necessary. Maps and diagrams should show the site layout on an aerial photogragh base and identify important landscape features as well as significant local sound and vibration sources and sensitive receptors.

IV. Measurement of the Existing Sound and Vibration Environment

An estimate of the project area's existing sound and vibration environment is necessary in order to predict the likely impact resulting from a proposed project. The following guidelines must be used in developing a reasonable estimate of an area's existing sound and vibration environment.

A. Sites With No Existing Generation

1. At a minimum, sound level measurements should be taken at three locations or measurement points (MPs). Because each site is unique, more than three MPs may be necessary. **Consult with Commission staff regarding the quantity and location of the MPs.**

   MPs selected in consultation with Commission staff will generally be selected to provide information on the range of noise environments in a wind project area. Some examples of areas commonly selected for measurements include: areas with residences, areas with industrial noises, quiet areas, and public areas.

   All MPs should be located so that no significant obstruction (building etc.) blocks sound and vibration from existing wind facilities.

2. Duration of measurements should be a minimum of ten continuous minutes for each criterion (See item 4 below) at each location. Measurements should be taken during each of the following four periods:
   a. Morning (6 - 8 a.m.)
   b. Midday (12 noon – 2 p.m.)
   c. Evening (6 - 8 p.m.)
   d. Night (10 p.m. – 12 midnight)

The use of unattended continuous sound level measurement devices is encouraged. If these measurements are collected, qualitative sound recordings of the ambient noise environment should be collected for the duration of the measurements.

Sound level measurements must be made on a weekday of a non-holiday week.

3. For each MP and for each measurement period, provide each of the following measurement criteria:
    a. At a minimum, unweighted octave-band analysis (16,[ii] 31.5, 63, 125, 250, 500, 1K, 2K, 4K, & 8K Hz), one-third octave band analysis is encouraged
    b. L_{ave}, L_{10}, L_{50}, and L_{90}, in dBA
    c. L_{ave}, L_{10}, L_{50}, and L_{90}, in dBC
    d. A narrative description of sounds audible during each measurement

4. Identify all major sources of sound and vibration (i.e. highways, factories etc.) and where they are located in relation to MPs.

5. Provide a map on an aerial photo base clearly showing:
    a. the layout of the site
    b. the location of MPs
    c. the distance between MPs and the nearest proposed wind turbine generators
    d. the location of significant local sound and vibration sources
    e. the distance between all MPs and significant local sound and vibration sources
    f. the location of all sensitive receptors (schools, day-care centers, hospitals, and residences or residential neighborhoods) within the project area
    g. the distance to all major infrastructure (major roads, transmission lines, gas pipelines) in project area

B. Sites With Existing Wind Electric Generation Facilities

1. Two complete sets of sound level measurements must be taken under two wind conditions:
    a. Under calm conditions without the existing wind turbine rotors rotating. These measurements shall be taken with the entire wind generating development off line.
    b. Under wind conditions just above the cut-in speed for the wind turbines with as many of the wind turbines in the development operating as possible.

2. At a minimum, sound level measurements should be taken at three MPs. Because each site is unique, more than three MPs may be necessary. **Consult with Commission staff regarding the quantity and location of the MPs.**

    MPs selected in consultation with Commission staff will generally be selected to provide information on the range of noise environments in a wind project area. Some examples of areas commonly selected for measurements include: areas with residences, areas with industrial noises, quiet areas, and public areas.

    All MPs should be located so that no significant obstruction (building etc.) blocks sound and vibration from existing wind facilities.

3. Duration of measurements should be a minimum of ten continuous minutes for each criterion (see section IV.B.4 below) at each location. Measurements should be taken during each of the following four periods:
    a. Morning (6 - 8 a.m.)
    b. Midday (12 noon – 2 p.m.)
    c. Evening (6 - 8 p.m.)
    d. Night (10 p.m. – 12 midnight)

    The use of unattended continuous sound level measurement devices is encouraged. If these measurements are collected, qualitative sound recordings of the ambient noise environment should be collected for the duration of the measurements.

    Sound level measurements must be taken on a weekday of a non-holiday week.

4. For each MP and for each measurement period, provide each of the following measurement criteria:
    a. At a minimum, unweighted octave-band analysis (16,[ii] 31.5, 63, 125, 250, 500, 1K, 2K, 4K, & 8K Hz), one-third octave band analysis is encouraged
    b. L_{ave}, L_{10}, L_{50}, and L_{90}, in dBA
    c. L_{ave}, L_{10}, L_{50}, and L_{90}, in dBC
    d. A narrative description of sounds audible during each measurement

5. Identify all major sources of sound and vibration (e.g. highways, factories etc.) and where they are located in relation to each MP.

6. Provide a map or diagram clearly showing:
    a. the layout of the site
    b. the location of MPs
    c. the distance between MPs and the nearest existing wind turbine generators
    d. the location of significant local sound and vibration sources
    e. the distance between all MPs and significant local sound and vibration sources
    f. the location of all sensitive receptors (schools, day-care centers, hospitals, and residences or residential neighborhoods) within the project area
    g. the distance to all major infrastructure (major roads, transmission lines, gas pipelines) in project area

C. Sound Level Estimates for Proposed Wind Turbine(s)

In order to estimate the sound and vibration impact of the proposed wind development on the existing environment, an estimate of the sound and vibration produced by the proposed turbine(s) must be provided.

1. Provide the manufacturer's sound level characteristics for the proposed turbine model operating at full capacity. Include an **unweighted** octave band (16,[ii] 31.5, 63, 125, 250, 500, 1K, 2K, 4K, & 8K Hz) analysis for the unit at full capacity.

2. Provide a contour map of the expected sound levels from the wind energy development, in 5dBA increments, extending out to the 30 dBA contour.

3. Determine the impact of the new sound and vibration source on the existing environment. For each MP used in the ambient study:
    a. Report expected changes to existing sound levels for L_{ave}, L_{10}, L_{50}, and L_{90}, in dBA.
    b. Report expected changes to existing sound levels for L_{ave}, L_{10}, L_{50}, and L_{90}, in dBC.

    At least one MP should be located at the nearest sensitive receptors, as required by sections IV.A.1 and IV.B.2.

4. Clearly report all assumptions made in arriving at the estimates of impact and any conclusions reached regarding the potential effects on people living in the project area.

V. Post-Construction Measurements

1. Within twelve months of the date when the project is fully operational, and within two weeks of the anniversary date of the pre-construction ambient noise measurements, repeat the existing sound and vibration environment measurements taken before project approval.

2. Post-construction sound level measurements should be taken under two wind conditions:
    a. Under calm conditions without the wind turbine rotors rotating. These measurements shall be taken with the entire wind generating development off line.
    b. Under wind conditions just above the cut-in speed for the wind turbines with as many of the wind turbines in the development operating as possible.

3. Notes regarding post-construction sound level measurements for wind project developments:
    a. Measurements taken as required under section V.2.b may be taken prior to measurements taken under section V.2.a.
    b. Because of the variability of wind speeds, post-construction measurements may be taken outside of the measurement periods listed in section IV.B.3. However, measurements taken under section V.2.a, above, must be taken during the same time of day as the corresponding measurements taken under section V.2.b.
    c. For each MP at which pre-construction noise measurements were taken, a minimum of three sets of measurements shall be taken under sections V.2.a and 2.b. The three sets of measurements should correspond to at least two different times of day. Any or all of the measurements may be taken outside of the measurement periods listed in section IV.B.3.
    d. Measurements taken to fulfill the requirements of items sections V.2.a and 2.b must be taken within as few consecutive days as practicable.
    e. Measurements taken under sections V.2.a and 2.b must include a measurement of the 16 Hz octave band, as described in section IV.B.4.a.

4. The post-construction sound level measurement analysis must include an evaluation of whether the wind development meets any and all state and local sound level requirements.

5. File a copy of the post-construction noise measurement report with the Public Service Commission including pre- and post-construction measurement data and using the same report format as used for the pre-construction sound and vibration study reports.

Revision History

Revisions of May 26, 2010:

- Adapted the November 17, 2008, version of the PSC Noise Protocol to apply specifically to wind energy developments.

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[i] Standard Guide for Selection of Environmental Noise Measurements and Criteria (Designation E 1686-96). July 1996. American Society for Testing and Measurements.

[ii] PSC staff acknowledges that few sound level meters are capable of measurement of the 16 Hz center frequency octave band. However, because noise complaints from the public most likely involve low frequency noise associated with proposed plants, we encourage applicants to pursue the collection of this important ambient noise data.

If obtaining the 16 Hz data is beyond the capabilities of the sound level measurement apparatus, contact PSC staff prior to collection of any field ambient measurement data.

MPCA comments on State of Wisconsin's "Measurement Protocol for Sound and Vibration Assessment of Proposed and Existing Electric Power Plants" and the Bent Tree (WPL) Post-construction Sound Monitoring Protocol proposal (Hessler & Associates)

The work you have from Hessler is really well done. Their methods make a better protocol than the WI methods, but WI wouldn't be a bad place to start. If Hessler agrees, I would share their work as an example of what you are looking for.

Measurements with and without the turbines operating is a good practice to establish the background sound and the contribution to increased noise from the turbines. To avoid including noise from the wind itself, both sessions should be under similar conditions, and wind speed should be low (<~11 mph), if possible. Because noise and wind are not independent, there will be interference. The Hessler protocol that sets up separate off-site monitoring and correction based on many measurements is the most thorough I have seen. I was actually a bit surprised not to see higher wind speeds in the Hessler results.

Multiple locations are generally a good idea, but might be used differently than the WI methods in this case. Multiple homes will give a better description of the impact of such a dispersed project, rather than multiple location around a given turbine. Also, our standards are for areas receiving normal outdoor use, which is not necessarily the property line. Land is classified based on how it is used, so it would be inappropriate to apply the residential standards to agricultural land. I would recommend choosing locations near the homes, rather than property lines, so that you get measurements where the neighbors would be most affected, except where access is an issue, of course. Hessler seems to balance this well with representative sites.

I don't know that the multiple times of day are as necessary, but given different wind patterns, sensitivities, and standards, a day time and a night time session would be appropriate.

Hessler's seasonal recommendation is valuable – I have had interference from corn rustling.

We do not have frequency based standards, but the information may be very useful to the project managers, especially for answering questions about low frequency noise. If the equipment is capable of measuring A and C weighting simultaneously, having that information also can only help. L(ave) is often referred to as the L(eq), and along with the L90 helps describe the sound, and an L5 can help if there are complaints about short term noise. The more information like this that you can gather, the better, but I would recommend asking an AG about what you can require beyond showing compliance with the standards. I would strongly recommend doing full hour measurements, even if a few show compliance with the standards and they want to do shorter spot checks. Spot checks might help for noise from specific actions, like rotating the nacelles, but the concern is more about the constant drone type of noise. When noise is constant, you can sometimes shorten monitoring, but you want good information and evidence of compliance.

Not all consultants may be able to do the 14-day studies, and will have to do shorter monitoring. The information that Hessler was able to gather, though, doing 10-minute increments for 14 days straight, is really great for setting up a regression to remove some of the variability. The equipment I have doesn't come close to being able to do that.

I didn’t see frequency analysis from Hessler, but their C-weighted measurements do indicate lower frequency noise that is getting discounted in the A-weighting network. It might have been too much information to gather in 2000+ periods.

MN PCA comments on ECII Post-construction Sound Monitoring Protocol proposal

It looks like they will be collecting data under a similar scheme to the Hessler analysis, so I would assume that their analytical methods would also be similar.

Collecting ~1000 measurements from each of 4 sites over the course of a week and being able to compare to a simultaneous background sample and meteorological data will provide a lot of data from which to derive a profile of noise against wind speed for the state standards and for frequency analysis. This proposal includes an octave band analysis to capture measurements of noise at various frequencies, which will help to answer some of the questions posed about noise impacts from wind projects. They do not specifically say that they will include a C-weighted result, which might be desirable given concerns about appropriate weighting networks, but the information would be captured in the frequency analysis.

Again, what they need to show as evidence of compliance with the state standards doesn’t necessarily match up with the additional data desired, or the recommended monitoring protocols. As long as they can balance these needs against the constraints of a complicated system, they should be able to provide useful information about noise impacts from wind energy projects.

Using four locations on site and one off site is a smaller sample than used by Hessler, but may be representative of the project and an appropriate scale for the project. The locations chosen should represent sound levels heard at homes.