ICETHROWER

Mapping and tool for risk analysis

Winterwind, Skellefteå 7 February 2017
Jenny Lundén, Pöyry Sweden

PÖYRY

WHAT IS THE PROBLEM?

Photo: Vattenfall

WHAT IS THE PROBLEM?

1. Wind turbines drop ice pieces occasionally

2a. The emotional conclusion is “often” and “long distance” (km!)
2b. The pragmatic approach is ”now and then” and “within 1D”

3. Risk level is generally poorly investigated and hard to calculate

IS THERE A SOLUTION TO THE PROBLEM?

Level of confidence can be increased by more observations

Discrepancies between different turbines can be investigated

A generic tool to increase the possibility to calculate and communicate risk both for service personnel and for the public

Photo: B. Göransson

ICETHROWER – mapping and tool for risk analysis

Project:

- Mapping ice throws in Sweden
- Develop a model to simulate ice throw and assess health & safety risks
- Client: Swedish Energy Authority
- Partners: Dala Vind, Vattenfall Vindkraft and Skellefteå Kraft
- Location: 3 wind farms in Sweden
- Field study: 2013 – 2016


Photo: Vattenfall

WHICH IS OUR APPROACH?

Joint research project within Energimyndigheten's research program "Wind power in cold climate"

Pöyry Sweden
Project leader
Data analysis / development of statistical ice throw model

ProgramoGrafik
Validation KASTIS model

Dala Vind
Field study
1 turbine in mid-Sweden
forest
without blade heating

Skellefteå Kraft
Field study
2 turbines in northern Sweden
mountain terrain
with blade heating

Vattenfall Vindkraft
Field study
1 turbine in northern Sweden
forest
without blade heating

THE ICETHROWER PROJECT

The project is divided into three parts:

- Field study to collect ice data from 3 wind farms in Sweden and create a database for common use
- Verify and integrate the existing tool KASTIS into a common tool box
- Develop a usable simulation tool for risk evaluation based on collected data

Photo: B. Göransson

THE FIELD STUDY - METHOD

Three wind farms in Sweden

Collect information:

- Physical properties of ice lumps
- Throwing distance
- Meteorological data at the time of ice throw

Data collection during winter 2013 - 2016

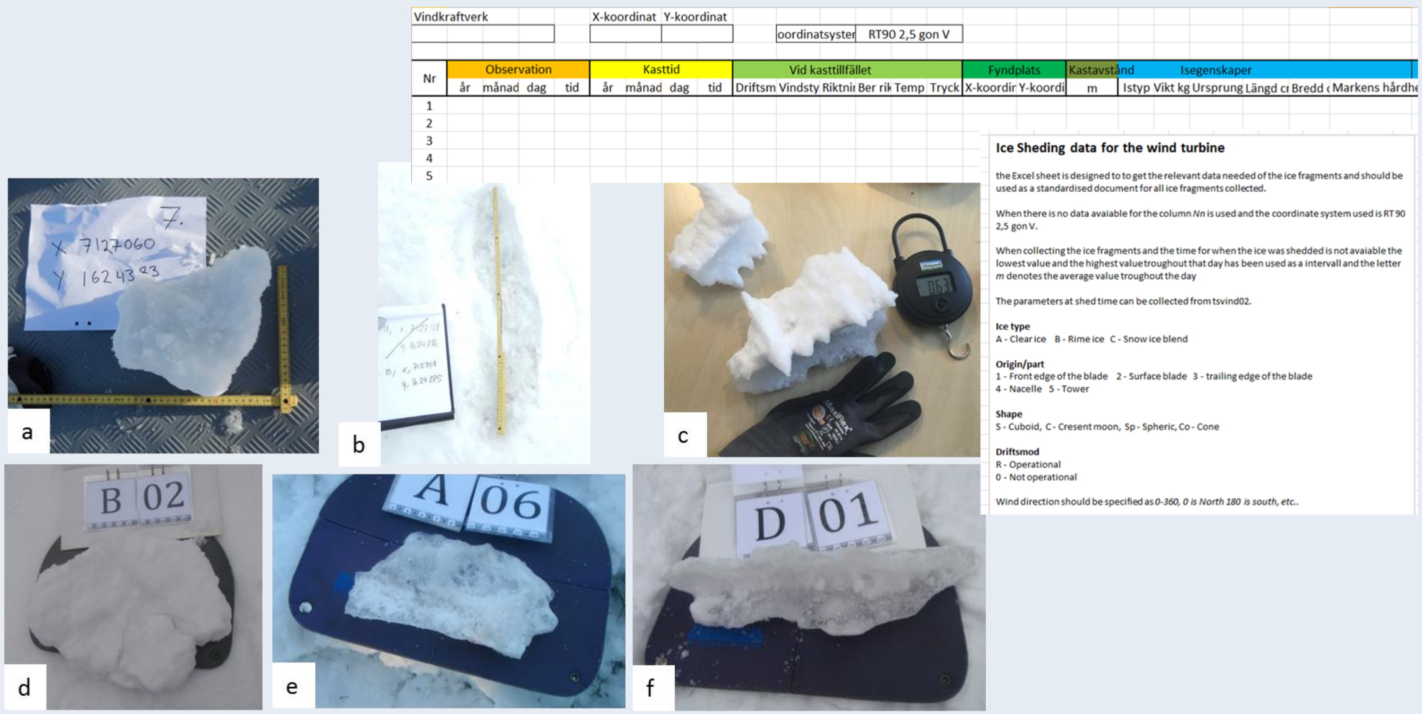
Challenges in field work:

- Severe winters -> increased risk
- Mild winters -> less data

THE FIELD STUDY - METHOD

Systematic approach in the search for ice lumps

- Ice lump measurement and classification
- Location of ground impact and throwing distance
- Photographs



Vindkraftverk				X-koordinat	Y-koordinat		oordinatsyster	RT90 2,5 gon V

Nr	Observation				Kasttid				Vid kasttillfället						Fyndplats		Kastavstånd	Isegenskaper					
	år	månad	dag	tid	år	månad	dag	tid	Driftsm	Vindsty	Riktni	Ber rik	Temp	Tryck	X-koordir	Y-koordi	m	Istyp	Vikt kg	Ursprung	Längd cı	Bredd (	Markens hårdhe
1																							
2																							
3																							
4																							
5																							

Ice Sheding data for the wind turbine

the Excel sheet is designed to to get the relevant data needed of the ice fragments and should be used as a standardised document for all ice fragments collected.

When there is no data avaiable for the column *Nn* is used and the coordinate system used is RT 90 2,5 gon V.

When collecting the ice fragments and the time for when the ice was shedded is not avaiable the lowest value and the highest value troughout that day has been used as a intervall and the letter *m* denotes the average value troughout the day

The parameters at shed time can be collected from tsvind02.

Ice type
A - Clear ice B - Rime ice C - Snow ice blend

Origin/part
1 - Front edge of the blade 2 - Surface blade 3 - trailing edge of the blade
4 - Nacelle 5 - Tower

Shape
S - Cuboid, C - Cresent moon, Sp - Spheric, Co - Cone

Driftsmod
R - Operational
0 - Not operational

Wind direction should be specified as *0-360, 0 is North 180 is south, etc..*

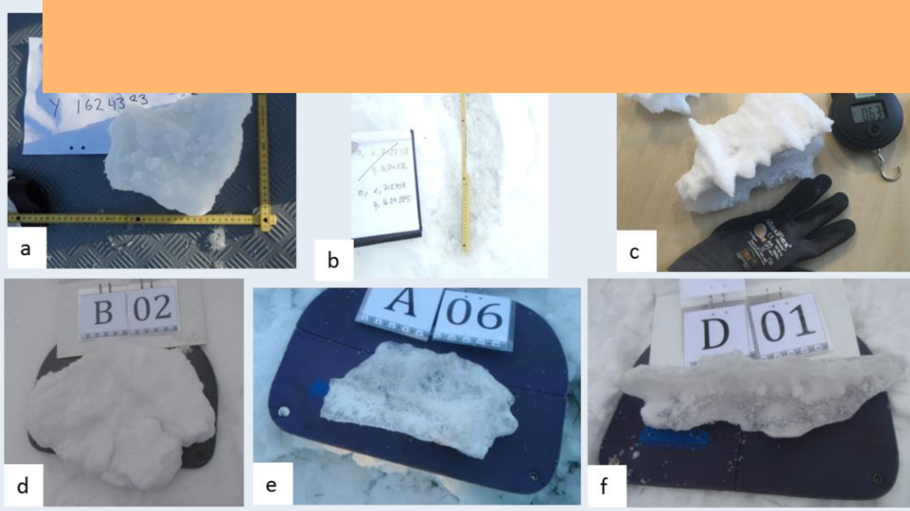
THE FIELD STUDY - METHOD

Three wind farms in Sweden

Collect information:

- Physical properties of ice lumps
- Throwing distance

Over all data from 530 ice lumps was collected!



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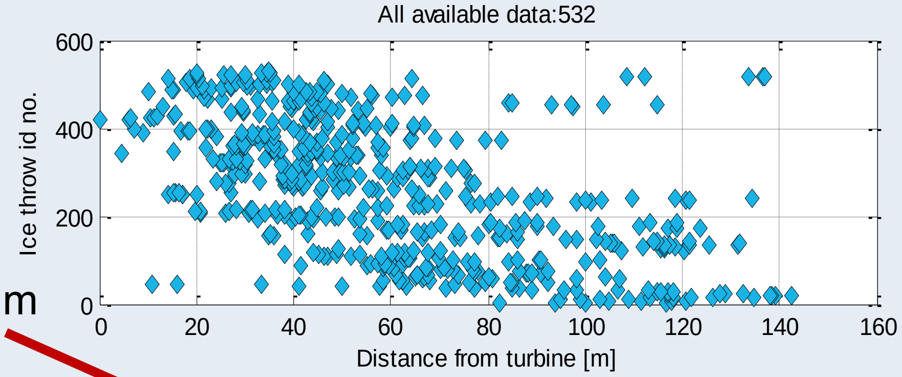
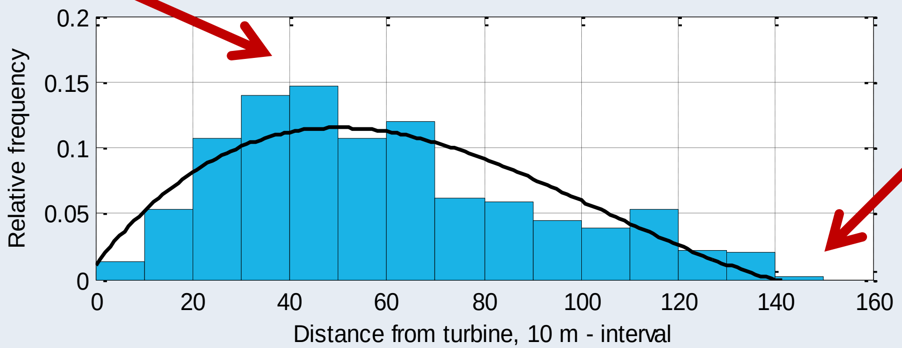
THE FIELD STUDY – RESULTS (ALL DATA)

75% of ice lumps between 20 – 90 m

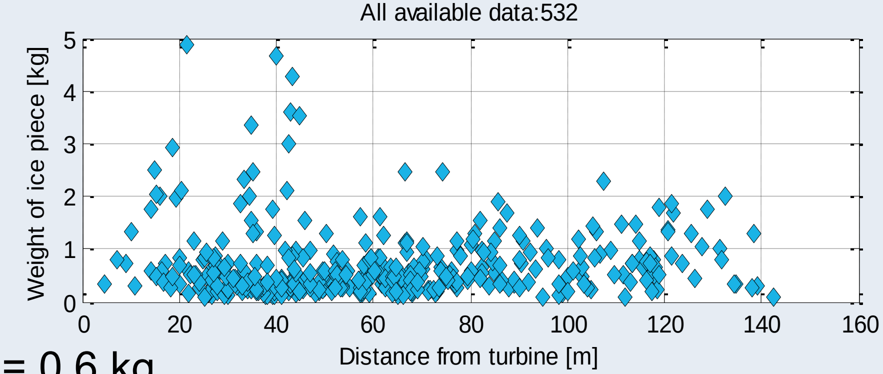


140 m = 1.55 RD



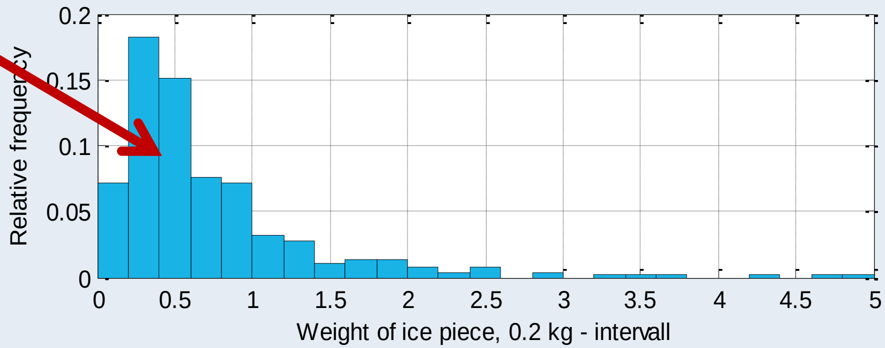
Turbines in the field study had 90 m rotor and 95 m tower (no de-icing system)

THE FIELD STUDY – RESULTS (ALL DATA)



No trend between distance and ice mass

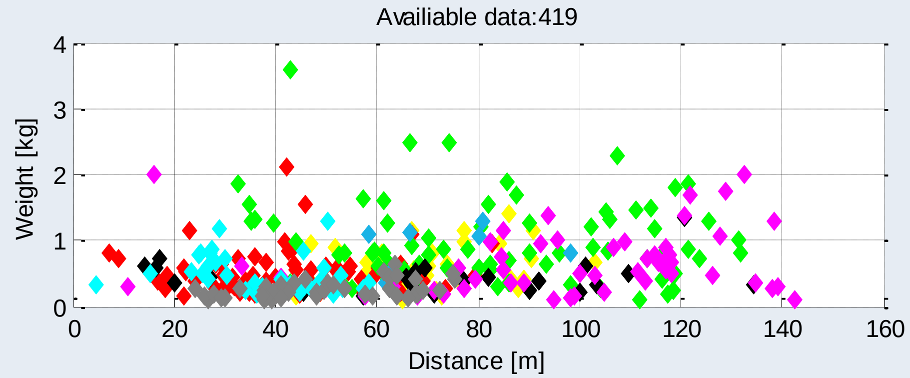
Average ice mass = 0.6 kg



Turbines in the field study had 90 m rotor and 95 m tower (no de-icing system)

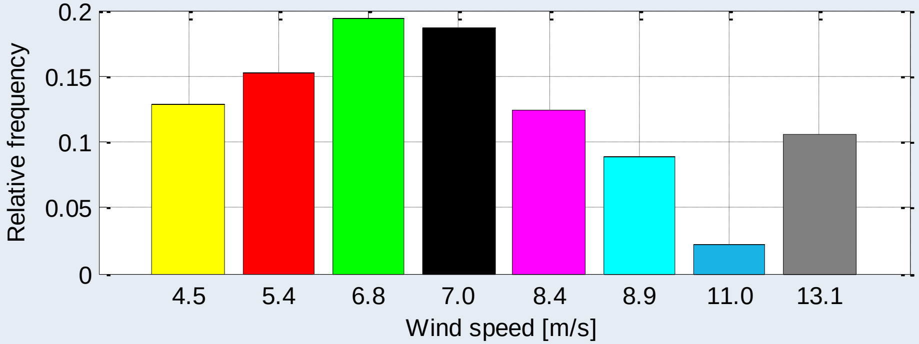
THE FIELD STUDY – RESULTS (CASE STUDY)

No trend between
- distance and wind speed
- distance and ice mass



2013: 2 ice days
2014: 2 ice days
2015: 1 ice day
2016: 3 ice days

10 – 80 ice lumps / ice event

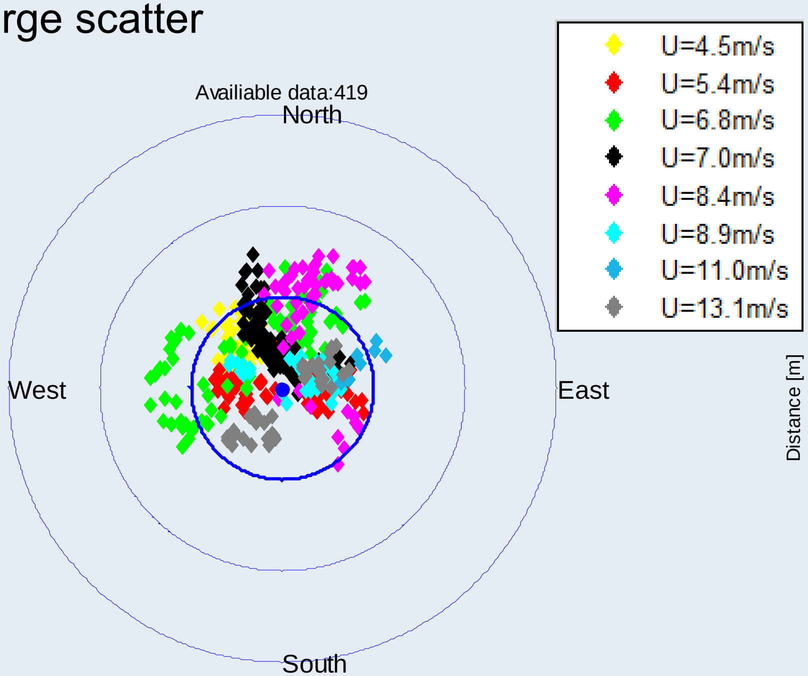


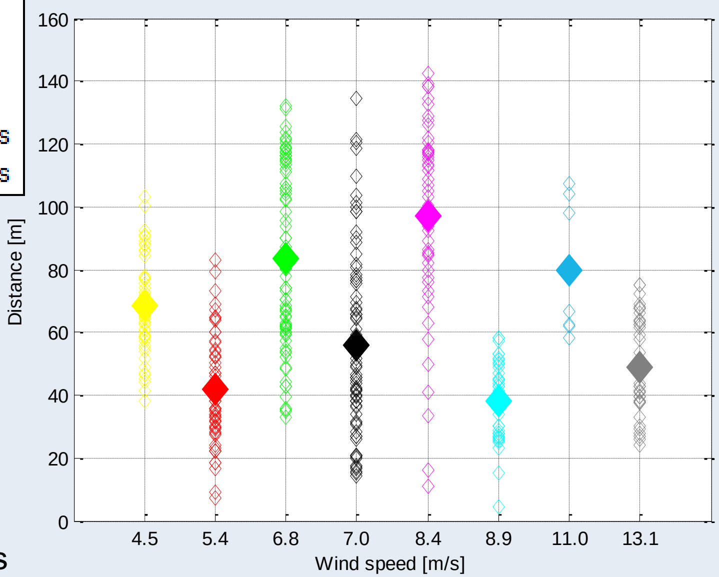
Turbine in the case study had 90 m rotor and 95 m tower (no de-icing system)

THE FIELD STUDY - RESULTS (CASE STUDY)

Ice lumps fall in the wind ward direction.
All ice lumps were found within 2 RD
Large scatter

Wind speed between 4.5 – 13 m/s
at the time of ice release





The blue circles show one, two respective three rotor diameters (e.g. 90, 180 and 270 m)

Turbine in the case study had 90 m rotor and 95 m tower (no de-icing system)

THE KASTIS MODEL – SELECTED OUTCOME

Purpose: calibrate and tune the previously developed model KASTIS.

- A developed version of KASTIS was derived in the project, called iceThrow
- The program calculates trajectories for ice lumps released from wind turbine blades during operation using very detailed information of the ice lump

Result:

- The iceThrow model showed that most of the ice lumps in the range 0.1 – 0.4 kg hit the ground with a speed, converted to energy, in the potential lethal region i.e. in excess of 40 J


Photo: B. Göransson

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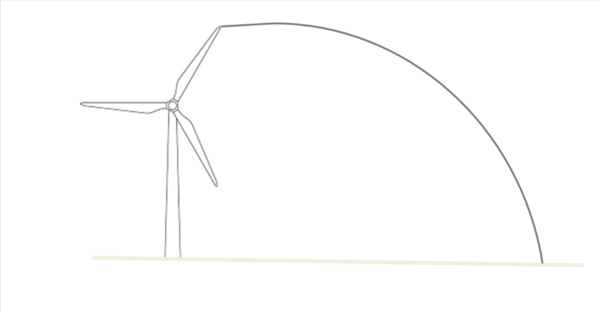
THE ICE THROW MODEL - METHOD

A statistical ice throw model was developed using the equations of motion in combination with Monte Carlo simulations.



$$M\frac{d^2x}{dt^2} = -\frac{1}{2}\rho C_D A\left(\frac{dx}{dt} - U\right)|V| \; Eq.3$$

$$M\frac{d^2y}{dt^2} = -\frac{1}{2}\rho C_D A\left(\frac{dy}{dt}\right)|V| \; Eq.4$$

$$M\frac{d^2z}{dt^2} = -Mg - \frac{1}{2}\rho C_D A\left(\frac{dz}{dt}\right)|V| \; Eq.5$$

The relative wind speed is given by,

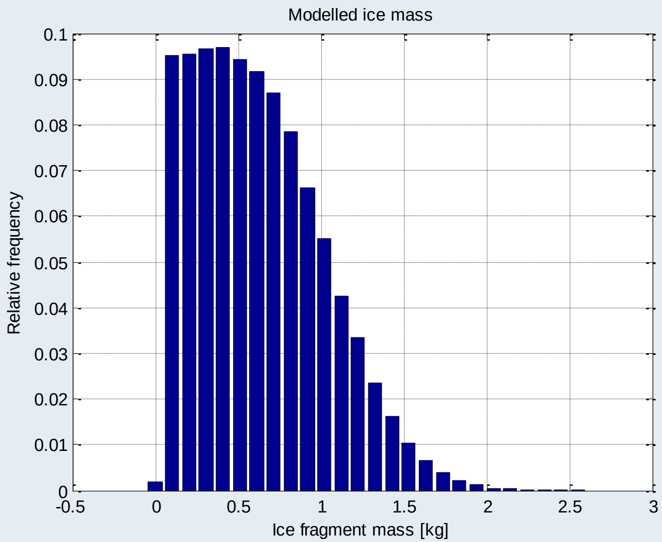
$$|V| = \sqrt{\left[\left(\frac{dx}{dt} - U\right)^2 + \left(\frac{dy}{dt}\right)^2 + \left(\frac{dz}{dt}\right)^2\right]} \; \textit{Eq. 6}$$

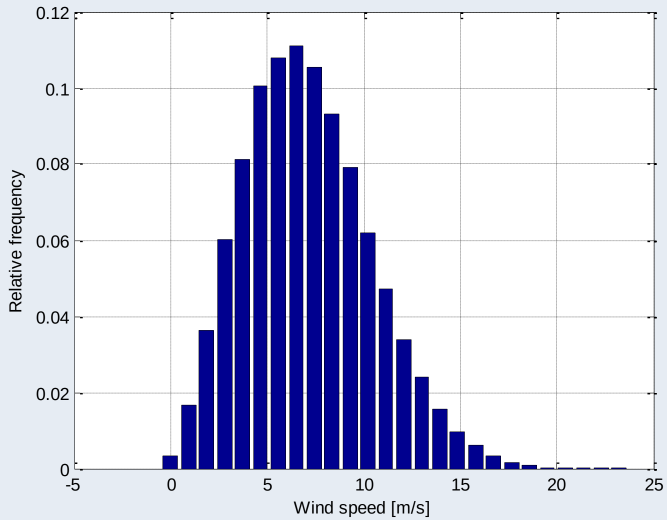
Where *M* is the mass of the ice fragment, C_D is the drag coefficient, ρ is air density, *U(z)* is the wind speed with x-axis parallel to the wind and *g* is the gravity.

THE ICE THROW MODEL - ASSUMPTIONS

Assumptions used in the ice throw simulations

- Random normal distribution of mass
- Random Weibull distribution based on wind speed and direction
- Turbine specifics (rotor radius, hub height, rotor revolution)

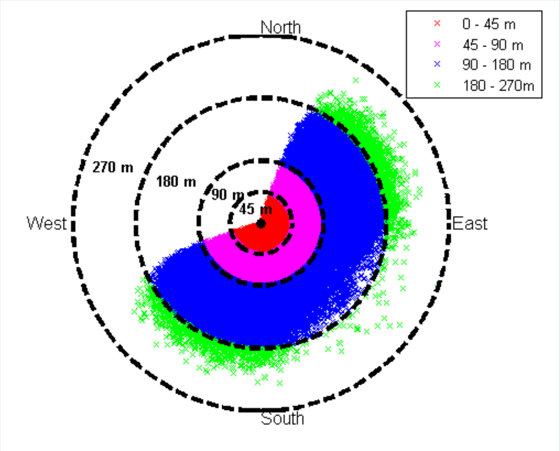




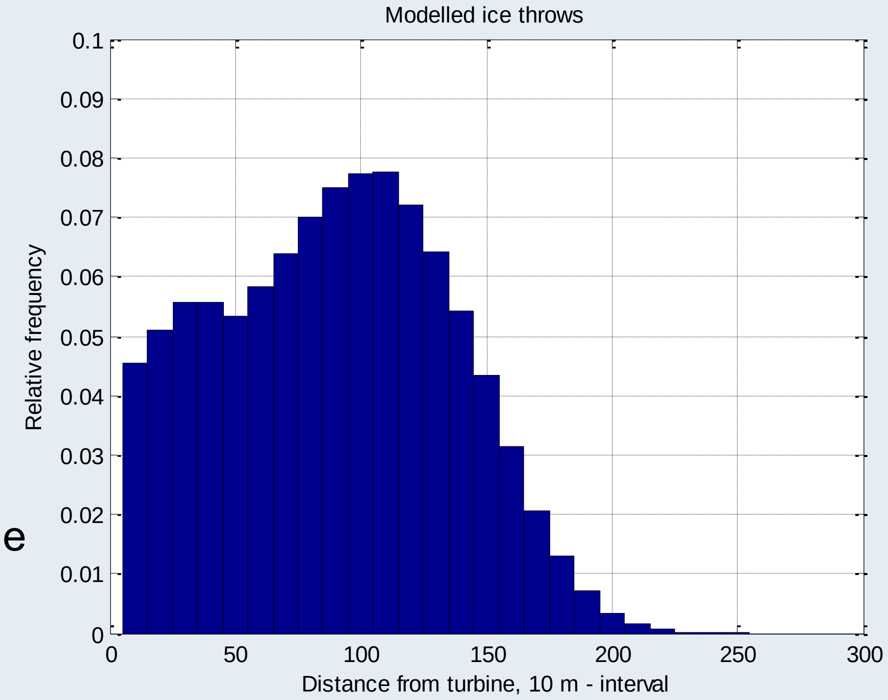
Turbine used in the simulation had 90 m rotor and 95 m tower

THE ICE THROW MODEL - RESULTS

Example:
Turbine with 90 m rotor diameter and 95 m hub height
Only using wind from the prevailing wind direction (WNW & NNW)

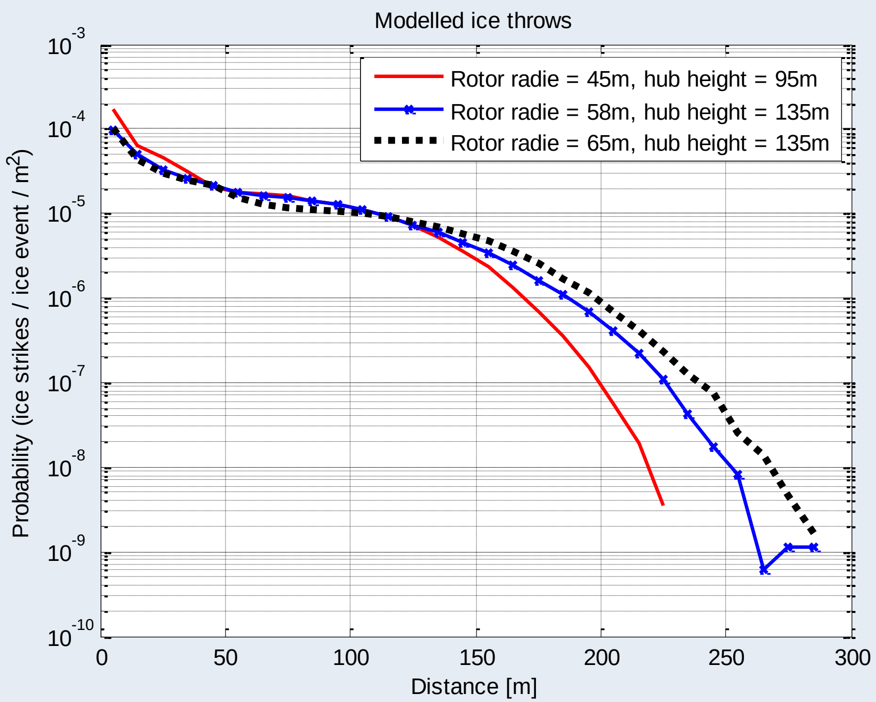


Ice lumps land on the wind ward side



The furthest modelled throwing distance: 250 m

THE ICE THROW MODEL - RESULTS



Larger wind turbine -> longer throwing distance
However the probability rapidly decreases with distance

Based on 100 000 simulated ice throws, all wind directions included

EXAMPLE OF RISK ESTIMATE

Two service personnel visit wind farm after indication of icing on the turbines.

- Park the car 10 m from entrance
- Get tools, walk to the turbine (5 min)
- Work for 1 hour inside the turbine
- Walk back to the car, load tools (5 min)

During a working day they visit 5 turbines.

The estimated total risk is then

- 0.009 for the car or 1 in 115 year
- $1.5*10^{-4}$ for 2 service personnel on one working day or 1 in 6 900 years.

Photo: Vattenfall

Assumptions: car = $10m^2$, one person = 0.5 m^2
70 ice lumps released per icing day and turbine.
Probability from the red curve on previous slide.

EXAMPLE OF RISK ESTIMATE CONT.

High or low risk?

In the example the total risk (one working day)

- $1.5*10^{-4}$ for 2 service personnel
  or 1 in 6 900 years.
- In comparison the risk of car accident is $5*10^{-5}$

The estimated risk is considerable high and not acceptable without certain safety provisions.

For the public the risk is lower since they do not know if the turbine are affected by ice.

(e.g. the number of ice day / the winter season)

It is important to have warnings signs at the wind farm entrance to alert the public of the potential hazard.

Photo: Vattenfall

Thank you!

PÖYRY
Engineering balanced sustainability™

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May 30, 2019

NextEra Energy Resources, LLC
700 Universe Blvd.
Juno Beach, FL 33408

Subject: Crowned Ridge Wind Project – Setback Requirements

Reference:

1. Safety Manual 2015 (GE Reference: Operating_Manual_1-2MW_Safety_EN_r02
2. Setback Considerations for Wind Turbine Siting 2018 (GE Reference: Setback_Considerations_Generic_xxHz_EN_r04)

To Whom It May Concern:

This is to confirm that the GE document Setback Considerations for Wind Turbine Siting, 2018, supersedes the GE document titled Safety Manual 2015 for purposes of ice throw safety and GE setback standards.

Please feel free to contact me if any additional information is required.

Sincerely,

Kevin Burns
Commercial Director

CC: Donald Karwisch, Integrated Supply Chain, NextEra Energy Resources, LLC

BEFORE
THE OHIO POWER SITING BOARD

In the Matter of the Application of	)	
Champaign Wind LLC, for a	)	
Certificate to Install Electricity	)	**Case No. 12-0160-EL-BGN**
Generating Wind Turbines in	)	
Champaign County	)	

MOTION FOR LEAVE TO FILE *INSTANTER* AMENDED TESTIMONY OF DAVID M. HESSLER

Champaign Wind LLC, the Applicant, respectfully moves for leave to file *Instanter* the attached Amended Testimony of David M. Hessler. Mr. Hessler was unreachable prior to filing the testimony on October 29, 2012 as a result of the October 29, 2012 storm which hit the East Coast. Champaign Wind filed Mr. Hessler's direct testimony on October 29, 2012 and included correspondence reserving the right to amend the testimony due to the his unavailability. Accordingly, Champaign Wind requests that leave be granted and that the attached Amended Testimony of David M. Hessler be accepted for filing on the docket in this proceeding. A Memorandum in Support of this Motion is attached.

Respectfully submitted,

Miranda Leppla

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Attorneys for Champaign Wind LLC

MEMORANDUM IN SUPPORT OF MOTION FOR LEAVE TO FILE *INSTANTER* AMENDED TESTIMONY OF DAVID M. HESSLER

Champaign Wind LLC, the Applicant, respectfully moves for leave to file *Instanter* the attached Amended Testimony of David M. Hessler. In support of this Motion, Champaign Wind states as follows:

1. On October 29, 2012, Champaign Wind LLC filed the Direct Testimony of David M. Hessler in this matter.

2. Prior to filing that testimony, counsel for Champaign Wind LLC attempted to communicate with Mr. Hessler with respect to some additional language for Answer 16. Because Mr. Hessler resides in Virginia, and given the storm which approached the East Coast of the United States on October 29, 2012, Mr. Hessler was not available to be reached.

3. Subsequent to October 29, communication with Mr. Hessler was re-established and Mr. Hessler agreed that a change in the language in Answer 16 should be made.

4. Champaign Wind now moves to file the attached Amended Direct Testimony of David M. Hessler in order to amend the language in Answer 16. No other portion of Mr. Hessler's testimony is being amended through this filing.

5. This amendment is for the purpose of ensuring that the record is accurate; it would be preferable for Champaign Wind to be permitted to amend Mr. Hessler's testimony now rather than awaiting the hearing, at which Mr. Hessler would make the same correction.

6. No party will be prejudiced by the granting of this Motion.

WHEREFORE, Champaign Wind LLC respectfully requests that the Board grant its Motion for Leave to File *Instanter* the attached Amended Direct Testimony of David M. Hessler.

Respectfully submitted,

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Attorneys for Champaign Wind LLC

CERTIFICATE OF SERVICE

I hereby certify that a copy of the foregoing document was served upon the following parties of record via e-mail on this 31st day of October, 2012.

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Miranda Leppla
Miranda Leppla

BEFORE
THE OHIO POWER SITING BOARD

In the Matter of the Application of Champaign Wind LLC, for a Certificate to Construct a Wind-Powered Electric Generating Facility in Champaign County, Ohio	)))))	**Case No. 12-0160-EL-BGN**

AMENDED DIRECT TESTIMONY OF DAVID M. HESSLER

Q.1. Please state your name and business address?

A.1. My name is David Hessler. I am a principal consultant and vice president of Hessler Associates, Inc., an acoustical engineering firm located at 3862 Clifton Manor Place, Haymarket, Virginia.

Q.2. What is your educational background?

A.2. I have a Bachelor of Arts Degree from the University of Hartford in Hartford, CT where I graduated in 1982, and a Bachelor of Science degree in Mechanical Engineering from the University of Maryland, College Park where I graduated *summa cum laude* in 1997.

Q.3. What is your professional background?

A.3. I have been employed as an acoustical engineer with Hessler Associates, Inc. for over 21 years. I am a licensed Professional Engineer and a member of the Institute of Noise Control Engineering (INCE). The firm is a member of the National Council of Acoustical Consultants (NCAC). Since its founding in 1976, the company has specialized almost exclusively in the prediction and measurement of noise from power generation facilities. Consequently, I have been the principal acoustical designer of hundreds of power stations all over the world; most commonly combustion turbine combined cycle plants along with coal, gas fired and diesel facilities. Typical projects involve field surveys to establish baseline background sound level conditions - usually for the purpose of determining appropriate project design goals, computer modeling and the development acoustical design specifications. Follow-up surveys of completed projects are commonly carried out so the validity of the modeling and design can be verified. Over roughly the last 7 years, wind energy projects have emerged as one of the more dominant types of new power generation and throughout that period about 75% of my work load has involved performing noise assessments and operational surveys for wind farms. At this point I have worked on approximately 70 (usually large) wind projects all over North America. Based largely on my field experience measuring numerous operational projects, I have contributed to the professional literature with a number of articles and technical papers on the subject and have authored the chapter on measuring and analyzing wind turbine sound emissions in the recently published book *Wind Turbine Noise*[1]. I have attended all of the bi-annual Wind Turbine Noise conferences since the series began as a small gathering in Berlin in 2005. These important conferences bring together all of the top experts in the field, who are mostly from Europe, and essentially summarize the current state of knowledge on the subject.

Q.4. On whose behalf are you offering testimony?

A.4. I am testifying on behalf of the Applicant, Champaign Wind, LLC.

Q.5. What is the purpose of your testimony?

A.5. The purpose of my testimony is to summarize the results of the noise impact assessment I carried out with respect to the Champaign Wind (or Buckeye II) Wind Project.

Q.6. Please describe the history of your involvement with the Buckeye II Wind project and the studies that you and your firm undertook on behalf of the Applicant.

A.6. A field survey was carried out in November of 2011 to establish what the existing environmental sound levels were within the Buckeye II project area. The potential impact of any project is generally related to how much, if at all, its sound level exceeds the background level.

A pre-construction background survey for a wind project is unique in the sense that the noise source that the study is concerned with fundamentally requires moderate to strong winds in order to operate and begin to produce any sound emissions. When the winds are light at hub height the project is completely inert and silent. Consequently, the background sound levels that are of relevance to wind turbine projects are not the absolute quietest levels that occur during calm conditions but rather the sound levels that exist under the wind conditions associated with normal project operation. An apples-to-apples comparison is required. At the present time, no ANSI or ISO standard exists for this specific type of field survey for the simple reason that these test protocols were written with conventional, non-wind dependent noise sources, such as fossil fueled power stations or industrial facilities, in mind. Existing standards correctly limit measurements to low wind conditions because the operation of a "conventional" source is utterly unrelated to the wind conditions and, in fact, such sources are most apt to be prominent during calm and quiet conditions. In a wind turbine analysis, however, it is essential, almost by definition, to measure during moderately windy conditions. Therefore, standards, such as ANSI S12.9-1992/Part 2[ii], were followed to extent that they were relevant in the field survey but additional techniques and analyses, such as a correlation between the measured sound levels and the concurrent high elevation wind speed, were required to obtain a sensible and meaningful result.

In brief, the survey measured a variety of statistical sound levels on a continuous basis day and night for 18 days at 10 positions distributed over the project area. These positions were selected to:

- be located at or near residences with the maximum proximity to proposed Buckeye II turbine locations
- cover the project area in a more or less uniform manner
- be located in open areas remote from any significant sources of man-made noise
- be located away from any reflective vertical surfaces

Over 2500 measurements were made in 10 minute increments at each position, resulting in over 25,000 measurements collected in a wide variety of wind and weather conditions. These sound measurements were then compared to the concurrent wind speed over each 10 minute period as measured by the highest anemometers, ranging from 58 m to 80 m (190 ft. to 260 ft.), on all 6 met towers then operational across the site area. Thus, the high elevation wind speeds that the turbines would see were directly related to the sound levels measured at the same time near ground level (where the local wind speed is often negligible) at typical residences and farms throughout the project area.

Q.7. Please explain why you used an evaluation threshold of 44 dBA as a relative design goal for operational noise levels at non-participating residences?

A.7. The wind speed and average (Leq) sound levels measured exclusively at night (10 p.m. to 7 a.m.) were compared to find the conditions when the project would theoretically be most audible relative to the background level. Substantially higher daytime sound levels were neglected. This critical wind analysis indicated that the nighttime background level would be lowest relative to the project sound level at a wind speed of 6 m/s (at a standard reference elevation of 10 m). The mean nighttime Leq sound level measured under those wind conditions was 39 dBA. Moreover, a simple average of all the nighttime Leq sound levels measured throughout the survey at all positions *irrespective* of wind speed was also 39 dBA. Consequently, a 5 dBA relative increase due to the project would put the nominal noise impact threshold at 44 dBA. This design approach has been used since it is my understanding that the OPSB has approved a metric of Leq + 5 dBA for other projects in Ohio.

Q.8. Setting aside for the moment a relative increase of Leq + 5 dBA as a design basis, do you think a project design goal of 44 dBA is appropriate for a wind project in a rural area?

A.8. Yes. My experience conducting the field surveys of similar newly completed wind projects in very comparable settings indicates that the likelihood of complaints is quite small whenever the average project sound level is below 45 dBA, regardless of the actual background sound level, and we recommend a mean, long-term project sound level of 45 dBA as a regulatory limit for any new wind project in a rural environment. The relative limit of 44 dBA derived from the site-specific field survey performed for this project is consistent with, and even a slight improvement on, this recommendation.

Q.9. Has this recommendation been publicized in any way that is unrelated to a specific project?

A.9. Yes. Our suggestion of 45 dBA as a regulatory limit that fairly balances the interests of all parties first appeared in a peer-reviewed article[iii] in the January 2011 issue of the *Noise Control Engineering Journal* and was subsequently included in a set of best practices guidelines[iv] for siting new wind projects prepared under a federal grant for the

National Association of Regulatory Utility Commissioners (NARUC) on behalf of the Minnesota Public Utilities Commission.

Q.10. Please explain why you used an evaluation threshold of 50 dBA as a design goal for operational noise levels at non-participating property boundaries?

A.10. At the boundaries of the project, or, more specifically, at the property lines of adjoining non-participating land parcels, a relatively low project sound level is generally unnecessary because no one is usually permanently present at the fringe of a land parcel, particularly at night, to be potentially affected by noise. Consequently, an evaluation criterion of 50 dBA has been used as a reasonable impact threshold at property lines. In the rare instances where property line noise limits have been imposed on wind turbine developments (based on our experience with dozens of other wind projects), nothing lower than an absolute noise limit of 50 dBA has typically been used.

Q.11. What were the results of your modeling as to non-participating residences and non-participating boundaries considering only the Buckeye II project?

A.11. Initial modeling, with all of the units operating normally, showed that there were a number of non-participating residences with predicted levels slightly above the 44 dBA design goal. However, subsequent iterative modeling indicates that if certain units (16 out of the 56 total) are set up to operate in low noise mode (5 dBA lower than normal) at night, then a mean sound level of 44 dBA can be met at all non-participating residences. My understanding is that Champaign Wind intends to operate the 16 units identified as requiring low noise operating mode in the modeling study in low noise mode. Consequently, I expect that the mean project sound level will meet the design goal with respect to non-participating residences.

With this same restriction (16 of 56 units operating in low noise mode) it is anticipated that the assumed 50 dBA property line design goal will also be met in the vast majority of cases, although in rare instances the predicted level in odd corners of various land tracts may exceed the goal by 1 or 2 dBA. Such a small overage has no tangible meaning in terms of audibility (i.e. 52 dBA sounds essentially the same as 50 dBA) and would not affect the probability of an adverse reaction due to noise.

Q.12. What were the results of your modeling as to non-participating residences and non-participating boundaries considering the cumulative impacts of both the Buckeye II and Buckeye Wind projects?

A.12. In general, the combined sound emissions from both projects would have an ostensible effect on the community that is similar to that of the Buckeye II project operating by itself in the sense that all non-participating residences remain outside of the 44 dBA sound contour (the nominal design limit) and the assumed design goal of 50 dBA is met at nearly all adjoining property lines. As with the case of the Buckeye II project operating alone, 16 of the turbines would need to be operated in low noise mode to achieve this result. In this or any scenario, low noise operation is not required from any of the Buckeye I turbines to meet the 44 dBA design goal.

Q.13. Do you believe that the Buckeye II project as designed will result in acceptable operational noise levels at non-participating properties?

A.13. Yes, for the reasons alluded to above where I describe our recommendation that a mean sound level of 45 dBA is a fair and reasonable regulatory noise limit for wind projects in rural areas. Our study of operating projects[iii] suggests that the rate of complaints for a project sound level between 40 and 45 dBA is about 2% of the total population (i.e. those within 2000 ft. of a turbine), meaning, inversely, that the apparent acceptance rate is on the order of 98%.

Q.14. Does this opinion remain the same if both the Buckeye II and Buckeye Wind projects are constructed?

A.14. Yes.

Q.15. Have you reviewed the Staff Report of Investigation issued in this proceeding?

A.15. Yes.

Q.16. On Page 59 of the Report, Staff recommends a condition (Condition 49) that in effect limits the project sound level to 44 dBA at night at non-participating receptors. Do you believe that the Applicant can comply with this condition?

A.16. As our modeling indicates, the mean project sound level is predicted to be less than 44 dBA (39 dBA plus 5 dBA) at all non-participating residences at the critical wind speed. Consequently, when measured over a period of days or weeks, as wind project sound levels typically are during compliance tests, I would expect the mean level to agree with the predictions. However, it is critical to understand that it is impractical for any wind project to maintain a sound level below a given threshold all of the time under all conditions. The actual sound level will vary above and below the mean predicted level due to naturally unsteady and uncontrollable wind and weather conditions with the result that there may be intermittent, short-term excursions, usually lasting no more than 10 to 20 minutes, that exceed 44 dBA by some amount. It is also important to realize that the models indicates that the mean project sound levels are predicted to be less than 44 dBA (39 dBA plus 5 dBA) at all non-participating residences at the critical wind speed. This means that at higher wind speeds, the project sound levels may be higher than 44 dBA, but they would be less than 5 dBA above the Leq for that higher wind speed. In fact, at 9 m/s, the mean nighttime Leq, without project generated sound, is 45 dBA. Consequently, while fully meeting the intent and spirit of Condition 49, the project would most likely be unable to meet a strict reading of the condition as it is currently, and probably unintentionally, written. As a concession to the simple realities of the situation, I would suggest amending the condition to read: "The facility shall be operated so that the facility noise contribution, other than during short-term excursions, does not result in noise levels at the exterior of any currently existing non-participating residence that exceed the greater of: (a) the project area ambient nighttime L*eq* (39 dBA) plus five dBA; or, (b) the validly measured ambient L*eq* plus five dBA at the exterior of any currently non-participating residence. After commencement of commercial operation, the Applicant shall conduct further review of the impact and possible mitigation of all project-related noise complaints through its complaint resolution process." Note that this suggested revision more clearly defines the point of application as at 'non-participating residences' rather than at 'sensitive receptors', which is somewhat vague.

Q.17. Does this conclude your direct testimony?

A.17. Yes.

References

[i] Bowdler, R. & Leventhall, G. Editors, "Wind Turbine Noise", Multi-Science Press, Essex, UK, 2011, Chapter 7 *Measuring and Analyzing Wind Turbine Noise.*

[ii] *American Nation Standard Quantities and Procedures for Description and Measurement of Environmental Sound – Part 2: Measurement of Long-term, Wide-Area Sound*, ANSI S12.9-1992/Part 2 (R2008), Acoustical Society of America, New York, NY, 2008.

[iii] Hessler, D. M., Hessler, G. F., "Recommended noise level design goals and limits at residential receptors for wind turbine developments in the United States", *Noise Control Engineering Journal*, J. 59 (1), Jan-Feb 2011.

[iv] National Association of Regulatory Utility Commissioners (NARUC), *Best Practices Guidelines for Assessing Sound Emissions from Proposed Wind Farms & Measuring the Performance of Completed Projects*, Oct. 2011 (http://www.naruc.org/Grants/default.cfm?page=10).

CERTIFICATE OF SERVICE

I hereby certify that a copy of the foregoing document was served upon the following parties of record via electronic mail on this 31st day of October, 2012.

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BEFORE THE

PUBLIC SERVICE COMMISSION OF WISCONSIN

Application of Highland Wind Farm, LLC, for a Certificate of Public Convenience and Necessity to Construct a 102.5 Megawatt Wind Electric Generation Facility and Associated Electric Facilities, to be Located In the Towns of Forest and Cylon, St. Croix County, Wisconsin

Docket No. 2535-CE-100

EX.-CW-HESSLER-4

Please enter the attached exhibit, previously marked as Ex.-CW-Hessler-4, *Low frequency noise and infrasound from wind turbines*, by Robert D. O'Neal, Robert D. Hellweg Jr., and Richard M. Lampeter, NOISE CONTROL ENGINEERING JOURNAL, vol. 59, no. 2 (Mar.-Apr. 2011).

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EXHIBIT 48

Low frequency noise and infrasound from wind turbines

Robert D. O'Neal[a], Robert D. Hellweg Jr.[b] and Richard M. Lampeter[b]

(Received: 5 October 2010; Revised: 7 January 2011; Accepted: 8 January 2011)

A common issue raised with wind energy developers and operators of utility-scale wind turbines is whether the operation of their wind turbines may create unacceptable levels of low frequency noise and infrasound. In order to answer this question, one of the major wind energy developers commissioned a scientific study of their wind turbine fleet. The study consisted of three parts: 1) a world-wide literature search to determine unbiased guidelines and standards used to evaluate low frequency sound and infrasound, 2) a field study to measure wind turbine noise outside and within nearby residences, and 3) a comparison of the field results to the guidelines and standards. Wind turbines from two different manufacturers were measured at an operating wind farm under controlled conditions with the results compared to established guidelines and standards. This paper presents the results of the low frequency noise and infrasound study. Since the purpose of this paper is to report on low frequency and infrasound emissions, potential annoyance from other aspects of wind turbine operation were not considered, and must be evaluated separately.

Primary subject classification: 14.5.4; Secondary subject classification: 21.8.1

1 INTRODUCTION

Early down-wind wind turbines in the US created low frequency noise; however current up-wind wind turbines generate considerably less low frequency noise. Epsilon Associates, Inc. ("Epsilon") was retained by NextEra Energy Resources, LLC ("NextEra"), formerly FPL Energy, to investigate whether the operation of their wind turbines may create unacceptable levels of low frequency noise and infrasound. This question has often been posed to NextEra, and other wind energy developers and operators of utility-scale wind turbines. NextEra is one of the world's largest generators of wind power with approximately 7,600 net megawatts (MW) in operation as of July 2010.

The project was divided into three tasks: 1) literature search, 2) field measurement program, and 3) comparison to criteria. Epsilon conducted an extensive literature search of the technical and scientific literature on the effects of low-frequency noise and infrasound and existing criteria in order to evaluate low-frequency noise and infrasound from wind turbines. After completion of the literature search and selection of criteria, a field measurement program was developed to measure wind turbine noise to compare to the selected criteria.

The frequency range 20–20,000 Hz is commonly described as the range of "*audible*" noise. The frequency range of low frequency sound is generally from 20 Hertz (Hz) to 200 Hz, and the range below 20 Hz is often described as "*infrasound*". However, audibility extends to frequencies below 20 Hz.

Low frequency sound has several definitions. American National Standards ANSI/ASA S12.2[1] and ANSI S12.9 Part 4[2] have provisions for evaluating low frequency noise, and these special treatments apply only to sounds in the octave bands with 16, 31.5, and 63-Hz mid-band frequencies. For these reasons, in this paper on wind turbine noise, we use the term "low frequency noise" to include 12.5 Hz–200 Hz with emphasis on the 16 Hz, 31 Hz and 63 Hz octave bands with a frequency range of 11 Hz to 89 Hz.

International Electrotechnical Commission (IEC) standard 60050-801:1994[3] defines "*infrasound*" as "Acoustic oscillations whose frequency is below the low frequency limit of audible sound (about 16 Hz)." This definition is *incorrect* since sound remains audible at frequencies well below 16 Hz provided that the sound level is sufficiently high. In this paper we define infrasound to be below 20 Hz, which is the limit for the standardized threshold of hearing. Since there is no sharp

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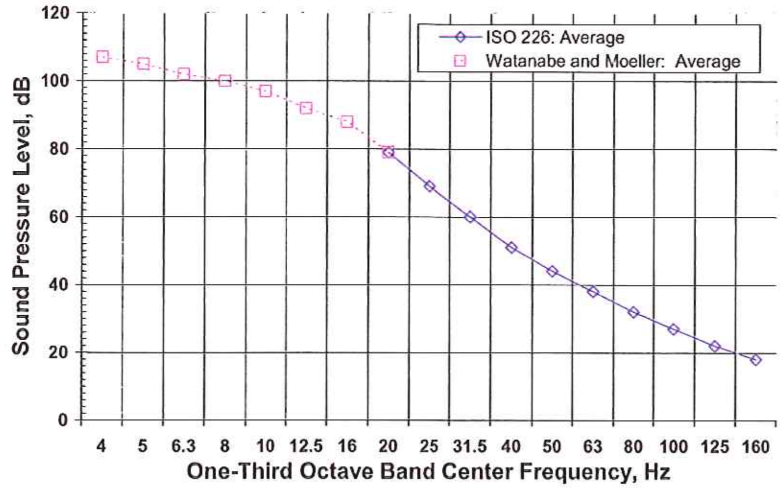

Fig. 1—Low frequency average threshold of hearing from ISO 226[6] and Watanabe and Moeller[7].

change in hearing at 20 Hz, the division into "low-frequency sound" and "infrasound" should only be considered "practical and conventional."

2 EFFECTS AND CRITERIA OF LOW FREQUENCY SOUND AND INFRASOUND

We performed an extensive world-wide literature search of over 100 scientific papers, technical reports and summary reports on low frequency sound and infrasound—hearing, effects, measurement, and criteria. Leventhall[4] presents an excellent and comprehensive study on low frequency noise from all sources and its effects. The Leventhall report also presents criteria in place at that time, which does not include some of the more recently developed ANSI/ASA standards on outdoor environmental noise and indoor sounds.

The United States government does not have specific criteria for low frequency noise. The US Environmental Protection Agency (EPA) has guidelines for the protection of public health with an adequate margin of safety in terms of annual average A-weighted day-night average sound level (L_{dn}), but there are no corrections or adjustments for low frequency noise. The US Department of Transportation (DOT) has A-weighted sound pressure level criteria for highway projects and airports, but these do not have adjustments for low frequency noise. The following sections describe the low frequency and infrasound criteria to which wind turbine sounds are compared in later sections.

2.1 Threshold of Hearing and Audibility

Moeller and Pedersen[5] present an excellent summary on human perception of sound at frequencies below 200 Hz. The ear is the primary organ for sensing infrasound. Hearing becomes gradually less sensitive for decreasing frequencies. But, humans with a normal hearing organ can perceive infrasound at least down to a few hertz if the sound level is sufficiently high.

The threshold of hearing is standardized for frequencies down to 20 Hz[6]. Based on extensive research and data, Moeller and Pedersen propose normal hearing thresholds for frequencies below 20 Hz; however, their proposed threshold is higher than that obtained by Watanabe and Moeller[7]. To be conservative, we have used the data from Watanabe and Moeller[7] for the region below 20 Hz. (See Fig. 1.) Moeller and Pedersen[5] suggest that the curve for low frequency thresholds for normal hearing is "probably correct within a few decibels, at least in most of the frequency range."

The hearing thresholds show considerable variability from individual to individual with a standard deviation among subjects of about 5 dB independent of frequency between 3 Hz and 1000 Hz with a slight increase at 20–50 Hz. This implies that the audibility threshold for 97.5% of the population is greater than the values in Fig. 1 minus 10 dB and for 84% of the population is greater than the values in Fig. 1 minus 5 dB. Moeller and Pedersen suggest that the "pure-tone threshold can with a reasonable approximation be used as a guideline for the thresholds also for [low frequency] non-sinusoidal sounds"[5]; ISO 226 has thresholds for frequencies at and above 20 Hz and approximately equates the thresholds and equal loudness contours for non-sinusoidal sounds to those in the standard for sinusoidal sounds[6].

As frequency decreases below 20 Hz, if the noise source is tonal, the tonal sensation ceases. Below 20 Hz tones are perceived as discontinuous. Below 10 Hz it is possible to perceive the single cycles of a tone, and the perception changes into a sensation of pressure at the ears.

Below 100 Hz, the dynamic range of the auditory system decreases with decreasing frequency, and the compressed dynamic range has an effect on equal loudness contours: a slight change in sound level can change the perceived loudness from barely audible to loud. This combined with the large variation in individual hearing may mean that a low frequency sound that is inaudible to some may be audible to others, and may be relatively loud to some of those for whom it is audible. Loudness for low frequency sounds grows considerably faster above threshold than for sounds at higher frequencies[5].

Non-auditory perception of low frequency and infrasound occurs only at levels above the auditory threshold. In the frequency range of 4–25 Hz and at "*levels* 20–25 dB *above [auditory] threshold it is possible to feel vibrations* in various parts of the body, e.g., the lumbar, buttock, thigh and calf regions. A feeling of pressure may occur in the upper part of the chest and the throat region" [emphasis added][5].

2.2 ANSI S12.9-Parts 4 and 5—Evaluating Outdoor Environmental Sound

American National Standard ANSI/ASA S12.9-2007/Part 5[8] has an informative annex which provides guidance for designation of land uses compatible with existing or predicted annual average adjusted day-night average outdoor sound level (DNL). Ranges of the DNL are outlined, within which a specific region of compatibility may be drawn. These ranges take into consideration the noise reduction in sound level from outside to inside buildings as commonly constructed in that locality and living habits there. There are adjustments to day-night average sound level to account for the presence of low frequency noise, and the adjustments are described in ANSI S12.9 Part 4, which use a sum of the sound pressure levels in octave bands with center frequencies of 16, 31 and 63 Hz.

ANSI S12.9/Part 4 identifies two thresholds: annoyance is minimal when the 16, 31.5 and 63 Hz octave band sound pressure levels are each less than 65 dB and there are no rapid fluctuations of the low frequency sounds. The second threshold is for increased annoyance which begins when rattles occur, which begins at L_{LF} 70–75 dB. L_{LF} is 10 times the logarithm of the ratio of time-mean square sound pressure in the 16, 31.5, and 63-Hz octave bands divided by the square of the reference sound pressure.

The adjustment procedure for low frequency noise to the average annual A-weighted sound pressure level in ANSI S12.9/Part 4 uses a different and more complicated metric and procedure (Equation D.1) than those used for evaluating low frequency noise in rooms contained in ANSI/ASA S12.2. (See Sec. 2.3). Since we are evaluating low frequency noise and not A-weighted sound levels, we do not recommend using the procedure for adjusting A-weighted levels. Instead we recommend using the following two guidelines from ANSI S12.9/Part 4: a sound pressure level of 65 dB in each of the 16-, 31.5-, and 63 Hz octave bands as an indicator of minimal annoyance, and 70–75 dB for the summation of the sound pressure levels from these three bands as an indicator of possible increased annoyance from rattles.

2.3 ANSI/ASA S12.2—Evaluating Room Noise

ANSI/ASA S12.2-2008[1] discusses criteria for evaluating room noise, and has two separate provisions for evaluating low frequency noise: (1) the potential to cause perceptible vibration and rattles, and (2) meeting low frequency portions of room criteria curves. Since the ANSI S12.2 criteria are for indoor sounds, in order to determine equivalent outdoor criteria for comparison to outdoor measurements, data from Sutherland[9] and Hubbard and Shephard[10] were used to determine typical noise reductions from outdoor to indoor with windows open. (The Appendix of this paper describes the noise reductions used to determine equivalent outdoor criteria to indoor criteria.) Table A1 presents octave band noise reductions applied in this evaluation along with the average low frequency octave band noise reductions from outdoor to indoors from Refs. 9 and 10 for open and closed windows. Table A2 presents the one-third octave band noise reductions applied in the analysis that were determined in the same manner using data from the same references.

Vibration and Rattles: Outdoor low frequency sounds of sufficient amplitude can cause building walls to vibrate and windows to rattle. Homes have low values of transmission loss at low frequencies, and low frequency noise of sufficient amplitude may be audible within homes. Window rattles are not low frequency noise, but may be caused by low frequency noise. ANSI/ASA S12.2 presents limiting levels at low frequencies for assessing (a) the probability of *clearly* perceptible acoustically induced vibration and rattles in lightweight wall and ceiling constructions, and (b) the probability of *moderately* perceptible acoustically induced vibration in similar constructions. The limiting sound pressure levels in the octave bands with center frequencies of 16, 31.5 and 63 Hz are presented in Table 1.

Applying the outdoor to indoor attenuations for wind turbine sources with windows open given in the last row of Table A1 to the ANSI/ASA S12.2 indoor sound pressure levels in Table 1 yields the equivalent

Table A1—Average low frequency octave band home noise reductions from outdoor to indoors in dB (from Ref. 9 and 10).

Noise Source	Window condition	Octave Band Center Frequency 16 Hz	31.5 Hz	63 Hz	125 Hz
Average aircraft and traffic sources	Closed windows	16	15	18	20
Average aircraft and traffic sources	Open windows	(11)*	(10)*	12	11
Average Wind Turbine	Closed windows	8	11	14	18
Average Wind Turbine	Open windows	(3)*+	(6)*+	9+	9+

* No data are available for windows open below 63 Hz octave band. The values for 16 Hz and 31 Hz were obtained by subtracting the difference between the levels for 63 Hz closed and open conditions to the 16 and 31 Hz closed values.
\+ Used in this paper to determine equivalent outdoor criteria from indoor criteria in Tables 2 and 4

outdoor sound pressure levels that are consistent with the indoor criteria and are presented in Table 2.

Room Criteria Curves: ANSI/ASA S12.2 has three primary methods for evaluating the suitability of noise within rooms: a survey method—A-weighted sound levels, an engineering method—noise criteria (NC) curves, and a method for evaluating low-frequency fluctuating noise using room noise criteria (RNC) curves. ANSI/ASA S12.2 states "The RNC method should be used to determine noise ratings when the noise from HVAC systems at low frequencies is loud and is suspected of containing sizeable *fluctuations or surging*." [emphasis added] The NC curves are appropriate to evaluate low frequency noise from wind turbines in homes since wind turbine noise does not have significant fluctuating low frequency noise sufficient to warrant using RNC curves and since A-weighted sound levels do not adequately determine

Table A2—Average low frequency one-third octave band noise reduction in dB for homes from outdoor to indoors.

Condition	One-Third Octave Band Center Frequency, Hz 10	12.5	16	20	25	31.5	40	50	63	80	100	125	160
Open Window*	2	2	3	4	4.5	5	7	8	9	9	9	9	9
Average Closed Window with wind turbines[10] **	8	7	8	8	8	11	13	14	15	12	18	18	18

* Used to determine equivalent outdoor levels as shown in Table 7.
** Used to determine equivalent outdoor levels as shown in Table 9.

Table 1—ANSI/ASA S12.2 measured interior sound pressure levels for perceptible vibration and rattle in lightweight wall and ceiling structures.[1]

Condition	Octave-band center frequency (Hz) 16	31.5	63
Clearly perceptible vibration and rattles likely	75 dB	75 dB	80 dB
Moderately perceptible vibration and rattles likely	65 dB	65 dB	70 dB

Table 2—Equivalent outdoor sound pressure levels to the ANSI/ASA S12.2 indoor sound pressure levels for perceptible vibration and rattle in lightweight wall and ceiling structures for wind turbines.

Condition	Octave-band center frequency (Hz) 16	31.5	63
Clearly perceptible vibration and rattles likely	78 dB	81 dB	89 dB
Moderately perceptible vibration and rattles likely	68 dB	71 dB	79 dB

if there are low frequency problems. [ANSI/ASA S12.2, Sec. 5.3 gives procedures for determining if there are large fluctuations of low frequency noise.]

Annex C.2 of ANSI/ASA S12.2 contains recommended room criteria curves for bedrooms, which are the rooms in homes with the most stringent criteria: NC and RNC criteria curve between 25 and 30. The recommended NC and RNC criteria for schools and private rooms in hospitals are the same. The values of the sound pressure levels in the 16–125 Hz octave bands for NC curves 25 and 30 are shown in Table 3. Applying the outdoor to indoor attenuations for wind turbine sources with windows open given in the last row of Table A1 to the ANSI/ASA S12.2 indoor sound pressure levels for NC-25 and NC-30 in Table 3 yields the equivalent outdoor sound pressure levels that are consistent with the indoor criteria and are presented in Table 4.

ANSI/ASA S12.2 also presents a method to determine if the levels below 500 Hz octave band are too high in relation to the levels in the mid-frequencies which could create a condition of "spectrum imbalance". The method for this evaluation is:

- Calculate the speech interference level (SIL) for the measured spectrum. [SIL is the arithmetic average of the sound pressure levels in the 500, 1000, 2000 and 4000 Hz octave bands.] Select the NC curve equal to the SIL value with a symbol NC(SIL).
- Plot the measured spectra and the NC curve equal to the SIL value on the same graph and determine the differences between the two curves in the octave bands below 500 Hz.
- Estimate the likelihood that the excess low-frequency levels will annoy occupants of the space using Table 5.

Table 3—ANSI/ASA S12.2 low frequency octave band sound pressure levels for noise criteria curves NC-25 and NC-30. [Table 1 from Ref. 1].

NC Criteria	Octave-band-center frequency, Hz 16	31.5	63	125
NC-25	80	65	54	44
NC-30	81	68	57	48

2.4 Other Criteria

2.4.1 World Health Organization (WHO)

No specific low frequency noise criteria are proposed by the WHO. The Guidelines for Community Noise report[11] mentions that if the difference between

Table 4—Equivalent outdoor sound pressure levels to the ANSI/ASA S12.2 low frequency octave band sound pressure levels for noise criteria curves NC-25 and NC-30. [Table 1 from Ref. 1].

NC Criteria	Octave-band-center frequency, Hz 16	31.5	63	125
NC-25 equivalent outdoor	83	71	63	53
NC-30 equivalent outdoor	84	74	66	57

Table 5—Measured sound pressure level deviations from an NC (SIL) curve that may lead to serious complaints[1].

Octave-band frequency, Hz=>	Measured Spectrum—NC(SIL), dB 31.5	63	125	250
Possible serious dissatisfaction	*	6–9	6–9	6–9
Likely serious dissatisfaction	*	>9	>9	>9

* Insufficient data available to evaluate

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Table 6—DEFRA proposed criteria[13] for the assessment of low frequency noise disturbance: Indoor L_{eq} one-third sound pressure levels for non-steady and steady low frequency sounds.

	One-Third Octave Band Center Frequency, Hz												
Location	10	12.5	16	20	25	31.5	40	50	63	80	100	125	160
Non-Steady L_{eq}, dB	92	87	83	74	64	56	49	43	42	40	38	36	34
Steady L_{eq}, dB	97	92	88	79	69	61	54	48	47	45	43	41	39

the C-weighted sound level and A-weighted sound level is greater than 10 decibels, then a frequency analysis should be performed to determine if there is a low frequency issue. A document prepared for the World Health Organization states that "there is no reliable evidence that infrasounds below the hearing threshold produce physiological or psychological effects. Infrasounds slightly above detection threshold may cause perceptual effects but these are of the same character as for 'normal' sounds. Reactions caused by extremely intense levels of infrasound can resemble those of mild stress reaction and may include bizarre auditory sensations, describable as pulsation and flutter"[12].

2.4.2 The UK Department for Environment, Food, and Rural Affairs (DEFRA)

The report prepared by the University of Salford for the UK Department for Environment, Food, and Rural Affairs (DEFRA) on low frequency noise proposed one-third octave band sound pressure level L_{eq} criteria and procedures for assessing low frequency noise[13]. The guidelines are based on complaints of disturbance from low frequency sounds and are intended to be used by Environmental Health Officers.

Existing low frequency noise criteria from several countries were reviewed and experiences with low frequencies complaints were considered in developing the proposed guidelines. The criteria are "based on 5 dB below the ISO 226 average threshold of audibility for steady [low frequency] sounds." However, the DEFRA criteria are at 5 dB lower than ISO 226 only at 20–31.5 Hz; at higher frequencies the criteria are equal to the Swedish criteria which are higher levels than ISO 226 less 5 dB. For frequencies lower than 20 Hz, DEFRA uses the thresholds from Ref. 7 less 5 dB.

The DEFRA criteria are based on measurements in an unoccupied room, and it was noted by a practicing consultant that measurements should be made with windows closed[14]. However, we conservatively used windows open conditions for our assessment to determine equivalent outdoor criteria since the DEFRA measurement procedure does not explicitly state measurements are with windows closed. If the low frequency sound is "steady" then the criteria may be relaxed by 5 dB. A low frequency noise is considered steady if either $L_{10}-L_{90}<5$ dB or the rate of change of sound pressure level (Fast time weighting) is less than 10 dB per second in the third octave band which exceeds the criteria by the greatest margin.

Applying indoor to outdoor one-third octave band transfer functions for open windows (as presented in Table A2 from analysis of data in Refs. 9 and 10) yields *equivalent* one-third octave band sound pressure level proposed DEFRA criteria for outdoor sound levels. Table 6 presents the indoor DEFRA proposed criteria for non-steady and steady low-frequency sounds. Table

Table 7—Equivalent outdoor L_{eq} one-third sound pressure levels for non-steady and steady sounds to the DEFRA indoor criteria[13] for the assessment of low frequency noise disturbance.

	One-Third Octave Band Center Frequency, Hz												
Location	10	12.5	16	20	25	31.5	40	50	63	80	100	125	160
Non-Steady Equivalent outdoor * L_{eq}, dB	94	89	86	78	68.5	61	56	51	51	49	47	45	43
Steady Equivalent Outdoor* L_{eq},	99	94	91	83	73.5	66	61	56	56	54	52	50	48

* With windows open

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Table 8—Japan Ministry of Environment Guidance for evaluating complaints of low frequency noise: Reference one-third octave band sound pressure level values for complaints of rattling.

	One-Third Octave Band Center Frequency, Hz										
Location	5	6.3	8	10	12.5	16	20	25	31.5	40	50
Outdoor L_{eq}, dB	70*	71*	72*	73	75	77	80	83	87	93	99

* The reference values are several dB lower than the supporting data contained in Ref. 15. At 5 Hz, window rattles started at about 74 dB in one study and 79 dB in another; at 6.3 Hz, rattles started at 74 dB in the first study and at 78 dB in the second; and at 8 Hz, window rattle started at 74 dB in the first study and 77 dB in the second study.

7 presents the DEFRA equivalent outdoor criteria for non-steady and steady low frequency sounds.

2.4.3 Japan Ministry of Environment

The Japan Ministry of Environment has published a handbook to deal with low frequency noise problems and has established reference values for guidance in dealing with complaints of rattling windows and doors and complaints of "mental and physical discomfort"[15]. It was noted that traditional Japanese houses have relatively light-weight and sensitive windows and partitions[16].

Table 8 presents the Japanese reference outdoor one-third octave band sound pressure level values for guidance in dealing with complaints of rattling from environmental sounds from 5 Hz to 50 Hz. From 10 Hz to 50 Hz the guidance levels are equal to the observed threshold of rattles from two studies with a total of 78 samples. However, for the bands centered at 5, 6.3 and 8 Hz, the reference values are several dB lower than the supporting data contained in these two studies[15]. At 5 Hz, the lowest observed window rattle was at 74 dB in one study and 79 dB in another; at 6.3 Hz, rattles started at 74 dB in the first study and at 78 dB in the second; and at 8 Hz, window rattle started at 74 dB in the first study and 77 dB in the second study. Thus the reference values at 5, 6.3 and 8 Hz in Table 8 are conservative in comparison to the other values by 4, 3, and 2 dB respectively.

Table 9 presents the Japanese reference one-third octave band sound pressure level values for guidance in dealing with complaints of mental and physical discomfort from environmental sounds when evaluated indoors. Evaluation measurements are to be performed with windows closed to the outside. The values in Table 9 are less stringent than the DEFRA values in Table 6 for non-steady sounds but more stringent than the DEFRA values for steady sounds in some one-third octave bands. In order to obtain equivalent outdoor sound levels, the average noise reduction from wind turbine noise with windows closed from Ref. 10 was applied to the Japan reference values. Table 9 presents the Japanese indoor reference values, the noise reductions for windows closed[10] and the equivalent outdoor reference values. These equivalent outdoor values are less stringent than the equivalent outdoor DEFRA values in Table 7 for both non-steady sounds and steady sounds except for the 80 Hz band in which the Japanese level is 1 dB more stringent than the DEFRA level for steady sounds.

2.4.4 C-weighted minus A-weighted ($L_{pC}-L_{pA}$)

Leventhall[4] and others indicate that the difference in C-weighted and A-weighted sound pressure levels can be a predictor of annoyance. Leventhall states that if ($L_{pC}-L_{pA}$) is greater than 20 dB there is "a potential for a low frequency noise problem." He further states that ($L_{pC}-L_{pA}$) cannot be a predictor of annoyance but is a simple indicator that further analysis may be needed. This is due in part to the fact that the low frequency noise may be inaudible even if ($L_{pC}-L_{pA}$) is greater than 20 dB.

3 LITERATURE REVIEW

The authors performed an extensive literature search of over 100 scientific papers, technical reports and summary reports on low frequency sound and infrasound—hearing, effects, measurement, and criteria. The following paragraphs briefly summarize the findings from some of these papers and reports.

3.1 Leventhall

Leventhall[4] presents an excellent study on low frequency noise from all sources and its effects. The report presents criteria in place at that time and includes data relating cause and effects. Leventhall[17] reviewed data and allegations on alleged problems from low frequency noise and infrasound from wind turbines, and concluded the following: "It has been shown that there is insignificant infrasound from wind turbines and that there is normally little low frequency noise." "Turbulent air inflow conditions cause enhanced levels of low frequency noise, which may be disturbing, but the overriding noise from wind turbines is the fluctuating audible swish, mistakenly referred to

Table 9—Japan Ministry of Environment Guidance for evaluating complaints of low frequency noise: Reference one-third octave band sound pressure level values for complaints of mental and physical discomfort.

	One-Third Octave Band Center Frequency, Hz									
Location	10	12.5	16	20	25	31.5	40	50	63	80
Indoor L_{eq}, dB	92	88	83	76	70	64	57	52	47	41
Noise Reduction*, dB	8	7	8	8	8	11	13	14	15	12
Equivalent Outdoor L_{eq}, dB	100	95	91	84	78	75	70	66	62	53

* from Hubbard[10] windows closed condition

as "infrasound" or "low frequency noise". "Infrasound from wind turbines is below the audible threshold and of no consequence". Other studies have shown that wind turbine generated infrasound levels are below threshold of perception and threshold of feeling and body reaction.

3.2 DELTA

The Danish Energy Authority project on "low frequency noise from large wind turbines" comprises a series of investigations in the effort to give increased knowledge on low frequency noise from wind turbines[18]. One of the conclusions of the study is that wind turbines do not emit audible infrasound, with levels that are "far below the hearing threshold." Audible low frequency sound may occur both indoors and outdoors, "but the levels in general are close to the hearing and/or masking level." "In general the noise in the critical band up to 100 Hz is below both thresholds". The final report notes that for road traffic noise (in the vicinity of roads) the low frequency noise levels are higher [than wind turbine] both indoors and outdoors.

3.3 Hayes McKenzie Partnership

Hayes McKenzie Partnership Ltd performed a study for the UK Department of Trade & Industry (DTI) to investigate complaints of low frequency noise that came from three of the five farms with complaints out of 126 wind farms in the UK[14]. The study concluded that:

- Infrasound associated with modern wind turbines is not a source which will result in noise levels that are audible or which may be injurious to the health of a wind farm neighbor.
- Low frequency noise was measureable on a few occasions, but below DEFRA criteria. Wind turbine noise may result in indoor noise levels within a home that is just above the threshold of audibility; however, it was lower than that of local road traffic noise.
- The common cause of the complaints was not associated with low frequency noise but the occasional audible modulation of aerodynamic noise, especially at night.
- The UK Department of Trade and Industry, which is now the UK Department for Business Enterprise and Regulatory Reform (BERR), summarized the Hayes McKenzie report: "The report concluded that there is no evidence of health effects arising from infrasound or low frequency noise generated by wind turbines."[19].

3.4 Howe

Howe performed extensive studies on wind turbines and infrasound and concluded that infrasound was not an issue for modern wind turbine installations—"while infrasound can be generated by wind turbines, it is concluded that infrasound is not of concern to the health of residences located nearby."[20]. Since then Gastmeier and Howe[21] investigated an additional situation involving the alleged "perception of infrasound by individual." In this additional case, the measured indoor infrasound was at least 30 dB below the audibility threshold given by Ref. 7 as presented in Fig. 1.

3.5 Branco

Branco and other Portuguese researchers have studied possible physiological affects associated with high amplitude low frequency noise and have labeled these alleged effects as "Vibroacoustic Disease" (VAD)[22]. "Vibroacoustic disease (VAD) is a whole-body, systemic pathology, characterized by the abnormal proliferation of extra-cellular matrices, and caused by excessive exposure to low frequency noise."

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Hayes[23,24] concluded that levels from wind farms are not likely to cause VAD after comparing noise levels from alleged VAD cases to noise levels from wind turbines in homes of complainers. Noise levels in aircraft in which VAD has been hypothesized are considerably higher than wind turbine noise levels. Hayes also concluded that it is "unlikely that symptoms will result through induced internal vibration from incident wind farm noise."[23]. Other studies have found no VAD indicators in environmental sound that have been alleged by VAD proponents[25].

3.6 French National Academy of Medicine

In 2006, the French National Academy of Medicine recommended[26] "*as a precaution* construction should be suspended for wind turbines with a capacity exceeding 2.5 MW located within 1500 m of homes." [emphasis added] However, this precaution is not because of definitive health issues but because:

- Sound levels one km from some wind turbine installations "occasionally exceed allowable limits" for France (note that the allowable limits are long term averages).
- French prediction tools for assessment did not take into account sound levels created with wind speeds greater than 5 m/s.
- Wind turbine noise has been compared to aircraft noise (even though the sound levels of wind turbine noise are significantly lower), and exposure to high level aircraft noise "involves neurobiological reactions associated with an increased frequency of hypertension and cardiovascular illness. Unfortunately, no such study has been done near wind turbines."[27].

In March 2008, the French Agency for Environmental and Occupational Health Safety (AFSSET) published a report on "the health impacts of noise generated by wind turbines", commissioned by the Ministries of Health and Environment in June 2006 following the report of the French National Academy of Medicine in March 2006[28]. The AFSSET study recommends that one does not define a fixed minimum distance between wind farms and homes, but rather to model the acoustic impact of the project on a case-by-case basis. One of the conclusions of the AFSSET report is: "The analysis of available data shows: The absence of identified direct health consequences concerning the auditory effects or specific effects usually associated with exposure to low frequencies at high level." ("L'analyse des données disponibles met en évidence: L'absence de conséquences sanitaires directes recensées en ce qui concerne les effets auditifs, ou les effets spécifiques généralement attachés à l'exposition à des basses fréquences à niveau élevé.").

4 FIELD PROGRAM

Two types of utility-scale wind turbines were studied for this field program. These two turbines are among the most commonly used in the NextEra fleet: General Electric (GE) 1.5sle (1.5 MW), and Siemens SWT-2.3-93 (2.3 MW).

Sound levels for these wind turbine generators (WTGs) vary as a function of wind speed from cut-in wind speed to maximum sound level. Cut-in wind speed for the GE 1.5sle wind turbine is 3.5 m/s while the Siemens wind turbine has a cut-in wind speed of 4 m/s. Maximum reference sound power levels for the GE 1.5sle and Siemens 2.3-93 are approximately 104 dB and 105 dB respectively as provided by the manufacturer. These sound power levels are reached at electrical output levels of approximately 924 kW and 1767 kW for the GE and Siemens units, respectively. Under higher wind speeds, the sound levels from the wind turbines do not increase although electrical power output does continue to increase up to the rated power of each wind turbine (1500 kW and 2300 kW respectively).

Each wind turbine manufacturer has an uncertainty factor "K" of 2 dB to guarantee the turbine's sound power level. (K accounts for both measurement variations and production variation[29].) The results presented later in this paper include sound power values which have added the manufacturer's K value to the reference values, that is, 2 dB above the expected reference levels for the measured wind conditions and power output.

Real-world data were collected from operating wind turbines to compare to the low frequency noise guidelines and criteria discussed previously in Sec. 2. These data sets consisted of outdoor measurements at various reference distances, and concurrent indoor/outdoor measurements at residences within the wind farm.

NextEra provided access to the Horse Hollow Wind Farm in Taylor and Nolan Counties, Texas in November 2008 to collect data on the GE 1.5sle and Siemens SWT-2.3-93 wind turbines. The portion of the wind farm used for testing is relatively flat with no significant terrain. The land around the wind turbines is rural and primarily used for agriculture and cattle grazing. The siting of the sound level measurement locations was chosen to minimize local noise sources except the wind turbines and the wind itself. Hub height for these wind turbines is 80 meters above ground level (AGL).

Two of the authors collected sound level and wind speed data over the course of one week under a variety of operational conditions. Weather conditions were dry the entire week with ground level winds ranging from calm to 12.5 m/s (28 mph) over a 1-minute average. In order to minimize confounding factors, the data collection tried to focus on periods of maximum sound levels from

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the wind turbines (moderate to high hub height winds) and light to moderate ground level winds.

Ground level (2 meters AGL) wind speed and direction were measured continuously at one representative location. Wind speeds near hub height were also measured continuously using the permanent meteorological towers maintained by the wind farm.

A series of simultaneous interior and exterior sound level measurements were made at four houses owned by participating landowners within the wind farm. Two sets were made of the GE WTGs, and two sets were made of the Siemens WTGs. Data were collected with both windows open and windows closed. Due to the necessity of coordinating with the homeowners in advance, and reasonable restrictions on time of day to enter their homes, the interior/exterior measurement data sets do not always represent ideal conditions. However, enough data were collected to compare to the criteria and draw conclusions on low frequency noise.

Sound level measurements were also made simultaneously at two reference distances from a string of wind turbines under a variety of wind conditions. Using the manufacturer's sound power level data, calculations of the sound pressure levels as a function of distance in flat terrain were made to aid in deciding where to collect data in the field. Based on this analysis, two distances from the nearest wind turbine were selected—305 meters (1,000 feet) and 457 meters (1,500 feet)—and were then used where possible during the field program. Distances much larger than 457 meters (1,500 feet) were not practical since an adjacent turbine string could then be closer and affect the measurements, or would put the measurements beyond the boundaries of the wind farm property owners. Brief background sound level measurements were conducted several times during the program whereby the Horse Hollow Wind Farm operators were able to shutdown the nearby WTGs for a brief (20 minutes) period. This was done in real time using cell phone communication.

All the sound level measurements described above were attended. One series of unattended overnight measurements was made at two locations for approximately 15 hours to capture a larger data set. One measurement was set up approximately 305 meters (1,000 feet) from a GE 1.5sle WTG and the other was set up approximately 305 meters (1,000 feet) from a Siemens WTG. The location was chosen based on the current wind direction forecast so that the sound level equipment would be downwind for the majority of the monitoring period. By doing this, the program was able to capture periods of strong hub-height winds and moderate to low ground-level winds.

All sound levels were measured using two Norsonic Model Nor140 precision sound analyzers, equipped with a Norsonic-1209 Type 1 Preamplifier, a Norsonic-1225 half-inch microphone and a 7-inch Aco-Pacific untreated foam windscreen Model WS7. The instrumentation meets the "Type 1—Precision" requirements set forth in American National Standards Institute (ANSI) S1.4 for acoustical measuring devices[30]. The microphone was tripod-mounted at a height of 1.5 meters (five feet) above ground. The measurements included simultaneous collection of broadband (A-weighted) and one-third-octave band data (3.15 hertz to 20,000 hertz bands). Sound level data were primarily logged in 10-minute intervals to be consistent with the wind farm's Supervisory Control And Data Acquisition (SCADA) system which provides electrical power output (kW) in 10-minute increments. A few sound level measurements were logged using 20-minute intervals for use in determining home transmission loss values. The meters were calibrated and certified as accurate to standards set by the National Institute of Standards and Technology. These calibrations were conducted by an independent laboratory within the past 12 months. Ground level wind speed and direction were measured with a HOBO H21-002 micro weather station (Onset Computer Corporation). The wind data were sampled every three seconds and logged every one minute.

5 RESULTS AND COMPARISON TO CRITERIA

Results from the field program are organized by wind turbine type. For each wind turbine type, results are presented per location type (outdoor or indoor) with respect to applicable criteria. Results are presented for 305 meters (1,000) feet from the nearest wind turbine. Data were also collected at 457 meters (1,500 feet) from the nearest wind turbine which showed lower sound levels. Therefore, wind turbines that met the criteria at 305 meters also met it at 457 meters. Data were collected under both high turbine output and moderate turbine output conditions (defined as sound power levels 2 or 3 dB less than the maximum sound power levels), and low ground-level wind speeds. The sound level data under the moderate conditions were equivalent to or lower than the high turbine output scenarios, thus confirming the conclusions from the high output cases. None of the operational sound level data were corrected for background noise. A-weighted sound power levels presented in this section (used to describe turbine operation) were estimated from the actual measured power output (kW) of the wind turbines and the sound power levels as a function of wind speed plus an uncertainty factor K of 2 dB.

Outdoor measurements are compared to criteria for audibility, for UK DEFRA disturbance using equivalent outdoor levels, for rattle and annoyance criteria as

Table 10—Summary of operational parameters—Siemens SWT-2.3-93 (Outdoor).

Parameter	Sample #34	Sample #39
Distance to nearest WTG	305 meters	305 meters
Time of day	22:00-22:10	22:50-23:00
WTG power output	1,847 kW	1,608 kW
A-weighted sound power level*	107 dB	106.8 dB
Measured wind speed @ 2 m	3.3 m/s	3.4 m/s
L_{Aeq}	49.4 dB	49.6 dB
L_{A90}	48.4 dB	48.6 dB
L_{Ceq}	63.5 dB	63.2 dB

* Includes K, uncertainty factor of 2 dB

contained in ANSI S12.9/Part 4, for evaluating complaints of rattling using Japan Ministry of Environment guidance, and for perceptible vibration using equivalent outdoor levels from ANSI/ASA S12.2. Indoor measurements are compared to criteria for audibility, for UK DEFRA disturbance, for evaluating complaints of mental and physical discomfort using Japan Ministry of Environment guidance, and for suitability of bedrooms, hospitals and schools and perceptible vibration from ANSI/ASA S12.2.

5.1 Siemens SWT-2.3-93

5.1.1 Outdoor measurements—Siemens SWT-2.3-93

Sound levels during six 10-minute periods of high wind turbine output and relatively low ground wind speed (which minimized effects of wind noise) were measured outdoors approximately 305 meters (1,000 feet) from the closest Siemens WTG. This site was actually part of a string of 15 WTGs, four of which were within 610 meters (2,000 feet) of the monitoring location. Representative sound level data from two 10-minute periods are presented herein and include contributions from all wind turbines as measured by the recording equipment. One data set is representative of time periods with low frequency sound level values near the maximum measured and the other data set is representative of the mean. The standard deviations for the low frequency one-third octave band levels for the six measurement periods were between 0.2–0.7 dB. The key operational and meteorological parameters during these two measurement periods are listed in Table 10.

Figure 2 plots the one-third octave band sound levels (L_{eq}) for both samples of high output conditions. The results show that infrasound is inaudible to even the most sensitive people 305 meters (1,000 feet) from these wind turbines (more than 20 dB below the median thresholds of hearing). Low frequency sound above 40 Hz may be audible depending on background sound levels.

Figure 3 plots the one-third octave band sound levels (L_{eq}) for both samples of high output conditions. The low frequency sound was "steady" according to DEFRA procedures, and the results show that all outdoor equivalent DEFRA disturbance criteria are met.

Figure 4 compares the one-third octave band sound levels (L_{eq}) for both samples of high output conditions to the Japan Ministry of Environment levels for evaluating complaints on rattle. The rattle criteria is met at all frequencies except at 5 Hz where the mean value is 1 dB (standard deviation of 0.4 dB) higher than the Japanese evaluation value. When one considers that the 5 Hz sound level is 3 dB lower than the observed threshold of rattle, one concludes that the Japanese criteria are met.

The measured outdoor sound levels also meet the outdoor equivalent Japan Ministry of Environment

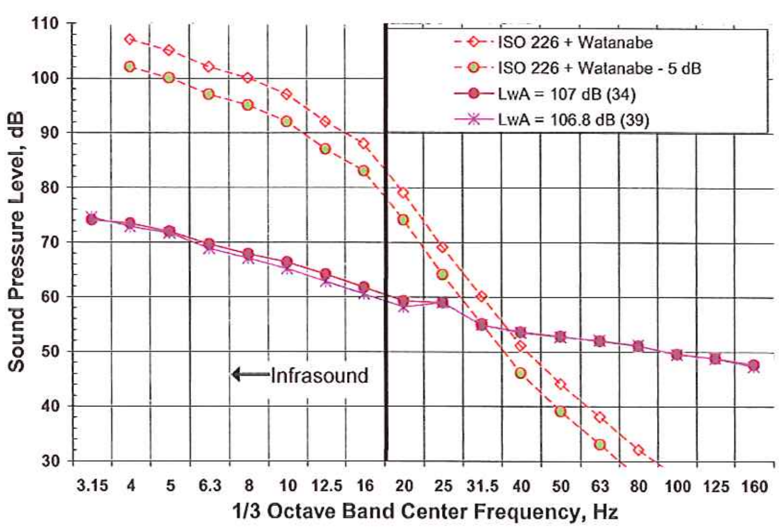

Fig. 2—Siemens SWT-2.3-93 wind turbine outdoor sound levels at 305 meters compared to audibility criteria.

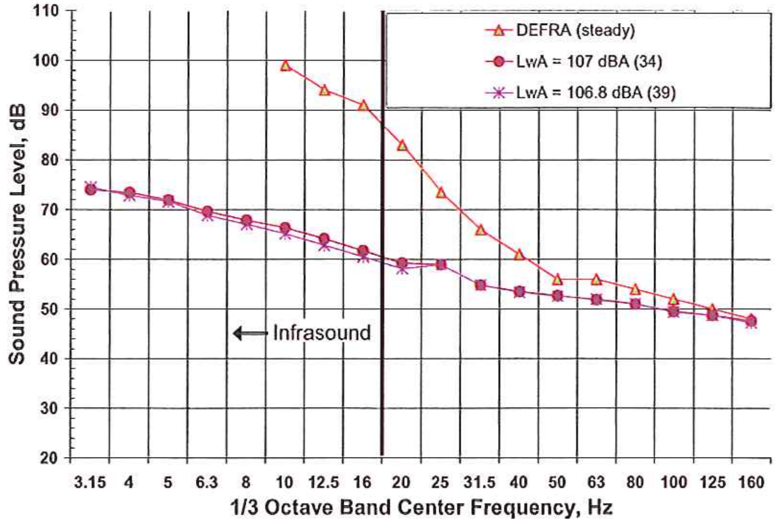

Fig. 3—Siemens SWT-2.3-93 wind turbine outdoor sound levels at 305 meters compared to outdoor equivalent DEFRA criteria.

criteria for evaluating complaints of mental and physical discomfort. This comparison is not presented in a figure since these criteria are generally less stringent than the DEFRA criteria.

Figure 5 plots the 16, 31.5, 63, and 125 Hz octave band sound levels (L_{eq}) for both samples of high output conditions. The results show that all outdoor equivalent ANSI/ASA S12.2 perceptible vibration criteria are met. In addition, the results show that all outdoor equivalent ANSI/ASA S12.2 low frequency NC-25 and NC-30 criteria for bedrooms are met. The low frequency sound levels are below the ANSI S12.9 Part 4 thresholds for the beginning of rattles (16, 31.5, 63 Hz total less than 70 dB). The 31.5 and 63 Hz sound levels are below the level of 65 dB identified for minimal annoyance in ANSI S12.9 Part 4, and the 16 Hz sound level is within 1.5 dB of this level, which is an insignificant increase since the levels were not rapidly fluctuating.

5.1.2 Indoor measurements—Siemens SWT-2.3-93

Simultaneous outdoor and indoor measurements were made at two residences at different locations within the wind farm to determine indoor audibility of low frequency noise from Siemens WTGs. In each house a 10-minute measurement was made in a room facing the wind turbines with a window both open and closed. Results from the testing at one of the homes are not presented due to the very high ground level winds

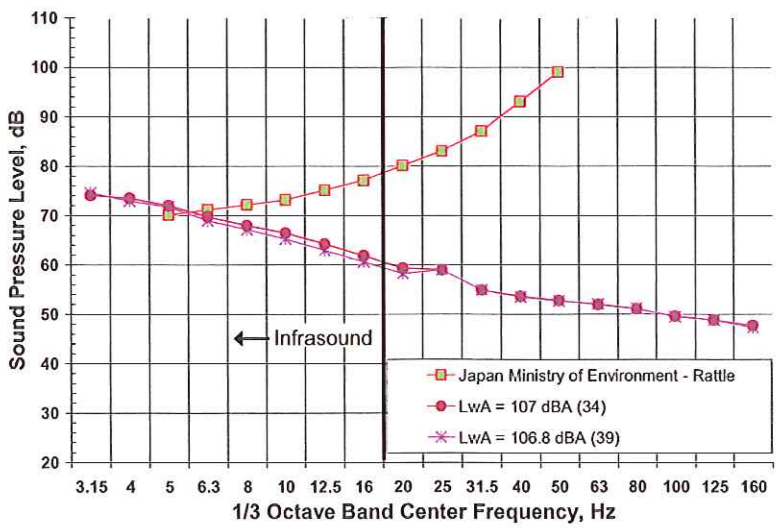

Fig. 4—Siemens SWT-2.3-93 wind turbine outdoor sound levels at 305 meters compared to Japan Ministry of Environment rattle criteria.

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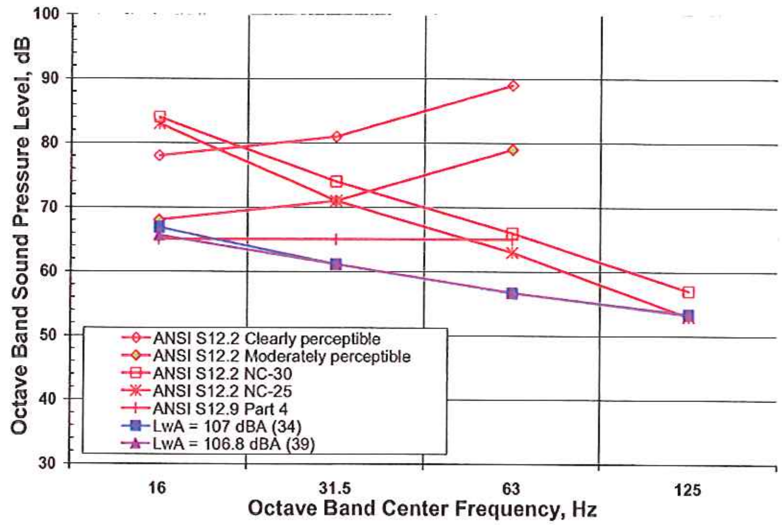

Fig. 5—Siemens SWT-2.3-93 wind turbine outdoor sound levels at 305 meters compared to ANSI criteria.

(~9 m/s) which dominated the sound environment. The remaining residence is designated Home "A" and was approximately 323 meters (1,060 feet) from the closest Siemens WTG. The home was near a string of multiple WTGs, four of which were within 610 meters (2,000 feet) of the house. The sound level data presented herein include contributions from all wind turbines as measured by the recording equipment. The key operational and meteorological parameters during these measurements are listed in Table 11.

The room in Home "A" where interior measurements were made had the following characteristics: approximately 3.6 meters wide (12 feet) by 4.9 meters long (16 feet), no furniture, carpeted flooring, two relatively new double-hung windows (no storm windows), sheetrock interior walls, and clapboard exterior walls. The sound level meter was located in the center of the room.

Figure 6 plots the indoor one-third octave band sound levels (L_{eq}) for Home "A". The results show that infrasound is inaudible to even the most sensitive people approximately 1,000 feet from these wind turbines with

Table 11—Summary of operational parameters—Siemens SWT-2.3-93 (Indoor).

Parameter	Home "A" (closed/open)
Distance to nearest WTG	323 meters
Time of day	07:39-07:49/07:51-08:01
WTG power output	1,884 kW/1564 kW
A-weighted sound power level*	107 dB/106.7 dB
Measured wind speed @ 2 m	3.2 m/s/3.7 m/s
L_{Aeq}	33.8 dB/38.1 dB
L_{A90}	28.1 dB/36.8 dB
L_{Ceq}	54.7 dB/57.1 dB

* Includes K, uncertainty factor of 2 dB

the windows open or closed (more than 20 dB below the median thresholds of hearing). Low frequency sound at or above 50 Hz may be audible depending on background sound levels.

Figure 7 plots the indoor one-third octave band sound levels (L_{eq}) for Home "A". The low frequency sound was "steady" according to DEFRA procedures under the window open condition, and the results show that all indoor DEFRA disturbance criteria are met.

Although not shown in Fig. 7, the one-third octave band levels meet the Japan Ministry of Environment criteria for evaluating complaints of mental and physical discomfort since in the frequency range of the Japan criteria both samples meet the more stringent DEFRA criteria for "non-steady" sounds, which is more stringent than the Japan criteria.

Figure 8 plots the indoor 16 Hz to 125 Hz octave band sound levels (L_{eq}) for Home "A". The results show the ANSI/ASA S12.2 low frequency criteria for perceptible vibration were easily met for both windows open and closed scenarios. The ANSI/ASA S12.2 low frequency NC-25 and NC-30 criteria for bedrooms, classrooms and hospitals were met, the spectrum was balanced, and the criteria for moderately perceptible vibrations in lightweight walls and ceilings were also met.

5.2 GE 1.5sle

5.2.1 Outdoor measurements—GE 1.5sle

Sound level data during twelve 10-minute periods of high wind turbine output and relatively low ground wind speed (which minimized effects of wind noise) were measured outdoors approximately 305 meters (1,000 feet) from the closest GE 1.5sle WTG. This site was actually part of a string of more than 30 WTGs, four of which were within 610 meters (2,000 feet) of the

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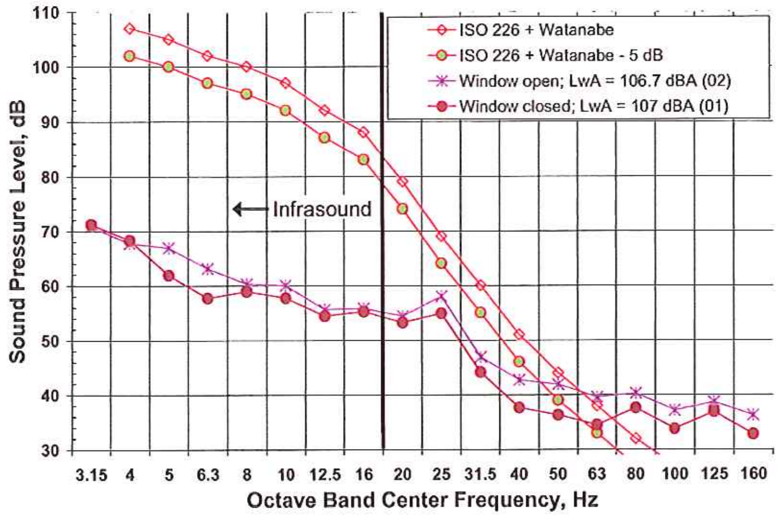

Fig. 6—Siemens SWT-2.3-93 wind turbine indoor sound levels at 323 meters compared to audibility criteria (Home "A").

monitoring location. Representative sound level data from two 10-minute periods are presented herein and include contributions from all wind turbines as measured by the recording equipment. One data set is representative of time periods with low frequency sound level values near the maximum and the other data set is representative of the mean. The standard deviations for the low frequency one-third octave band levels for the twelve measurement periods were between 0.3–1.9 dB with the largest variation in the 10–16 Hz bands and the lowest at 160 Hz. The key operational and meteorological parameters for these two measurement periods are listed in Table 12.

Figure 9 plots the one-third octave band sound levels (L_{eq}) for both samples of high output conditions. The results show that infrasound is inaudible to even the most sensitive people 305 meters (1,000 feet) from these wind turbines (more than 20 dB below the median thresholds of hearing). Low frequency sound at and above 31.5–40 Hz may be audible depending on background sound levels.

Figure 10 plots the one-third octave band sound levels (L_{eq}) for both samples of high output conditions. The low frequency sound was "steady" according to DEFRA procedures, and the results show the low frequency sound meet or are within 1 dB of outdoor equivalent DEFRA disturbance criteria.

Figure 11 compares the one-third octave band sound levels (L_{eq}) for both samples of high output conditions to the Japan Ministry of Environment levels for evaluating complaints on rattle. The rattle criteria is met at all

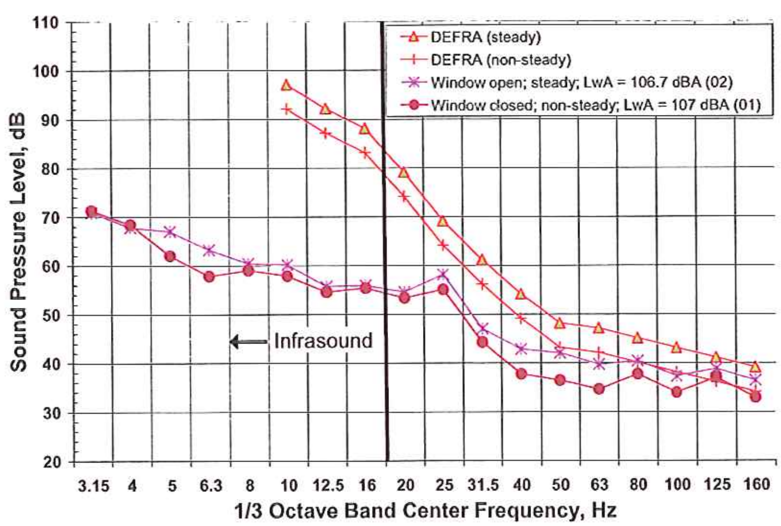

Fig. 7—Siemens SWT-2.3-93 wind turbine indoor sound levels at 323 meters compared to DEFRA criteria (Home "A").

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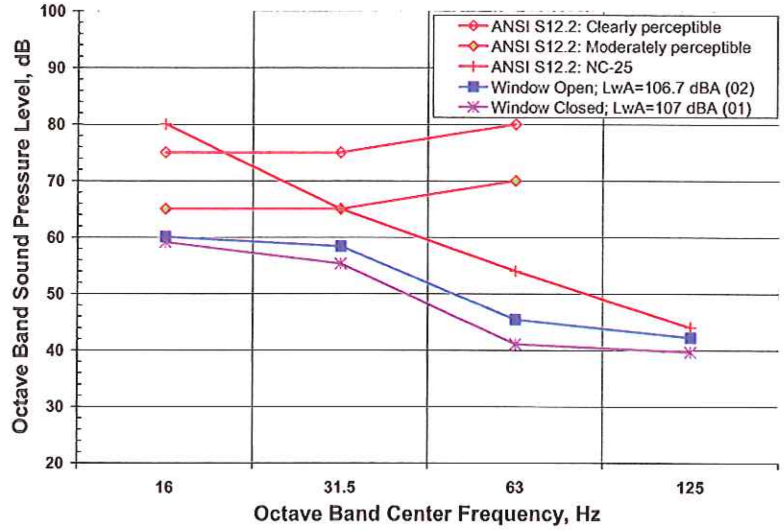

Fig. 8—Siemens SWT-2.3-93 wind turbine indoor sound levels at 323 meters compared to ANSI 12.2 criteria for perceptible vibrations and NC-25 (Home "A").

frequencies; at 5 Hz the mean value is 70 dB (standard deviation=0.9 dB), while the two presented measurements are approximately 1 dB higher, an insignificant increase. When one considers that the 5 Hz sound level is 3 dB lower than the observed threshold of rattle, one concludes that the Japanese criteria are met.

Table 12—Summary of operational parameters—GE 1.5sle (Outdoor).

Parameter	Sample #46	Sample #51
Distance to nearest WTG	305 meters	305 meters
Time of day	23:10-23:20	00:00-00:10
WTG power output	1,293 kW	1,109 kW
A-weighted sound power level*	106 dB	106 dB
Measured wind speed @ 2 m	4.1 m/s	3.3 m/s
L_{Aeq}	50.2 dB	50.7 dB
L_{A90}	49.2 dB	49.7 dB
L_{Ceq}	62.5 dB	62.8 dB

* Includes K, uncertainty factor of 2 dB

The measured outdoor sound levels also meet the outdoor equivalent Japan Ministry of Environment criteria for evaluating complaints of mental and physical discomfort. This comparison is not presented in a figure since these criteria are generally less stringent than the DEFRA criteria.

Figure 12 plots the 16, 31.5, 63 and 125 Hz octave band sound levels (L_{eq}) for both samples of high output conditions. The results show that all outdoor equivalent ANSI/ASA S12.2 perceptible vibration criteria are met. The results show that all outdoor equivalent ANSI/ASA S12.2 low frequency NC-25 and NC-30 criteria for

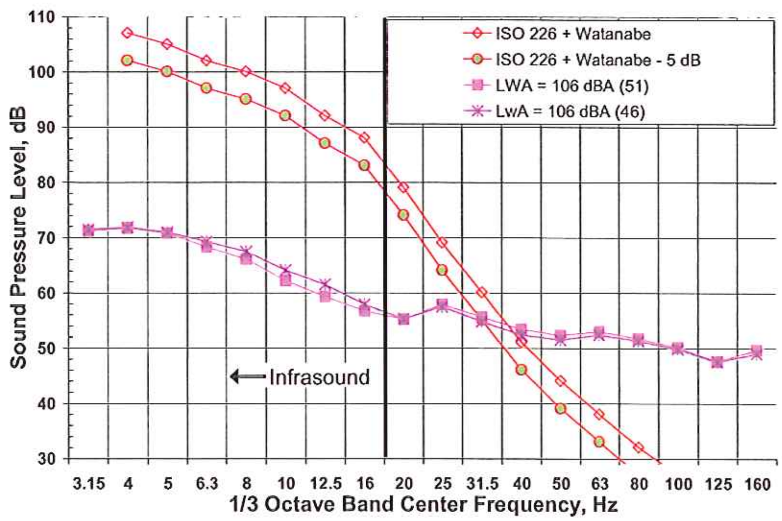

Fig. 9—GE 1.5sle wind turbine outdoor sound levels at 305 meters compared to audibility criteria.

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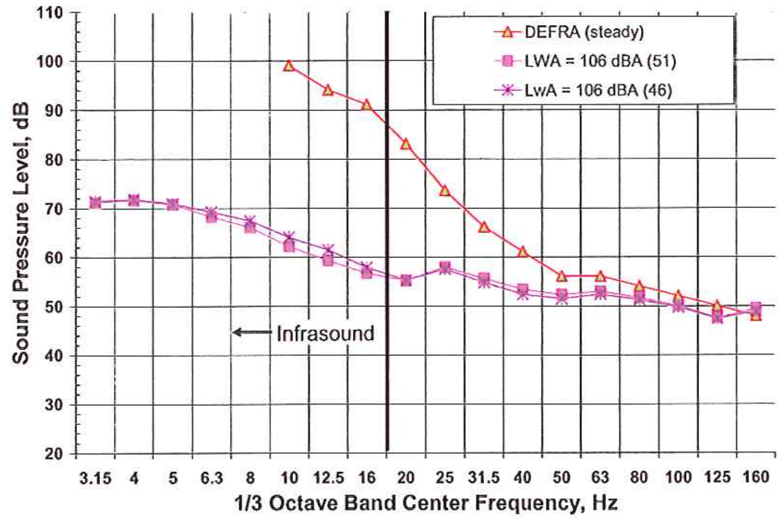

Fig. 10—GE 1.5sle wind turbine outdoor sound levels at 305 meters compared to outdoor equivalent DEFRA criteria.

bedrooms are met. The low frequency sound levels are below the ANSI S12.9 Part 4 thresholds for the beginning of rattles (16, 31.5, 63 Hz total less than 70 dB). The 16, 31.5, 63 Hz sound levels are below the level of 65 dB identified for minimal annoyance in ANSI S12.9 Part 4.

5.2.2 Indoor measurements—GE 1.5sle

Simultaneous outdoor and indoor measurements were made at two residences at different locations within the wind farm to determine indoor audibility of low frequency noise from GE 1.5sle WTGs. In each house, measurements were made in a room facing the wind turbines, and were made with a window both open and closed. These residences are designated Homes "B" and "C" and were approximately 305 meters (1,000 feet) from the closest GE WTG. Operational conditions were maximum turbine noise and high ground winds at Home "B", and within 1.5 dB of maximum turbine noise and high ground level winds at Home "C". Home "B" was near a string of multiple WTGs, four of which were within 610 meters (2,000 feet) of the house, while Home "C" was at the end of a string of WTGs, two of which were within 610 meters of the house. The sound level data presented herein include contributions from all wind turbines as measured by the recording equipment. The key operational and meteorological parameters during these measurements are listed in Table 13.

The room in Home "B" where interior measurements were made had the following characteristics:

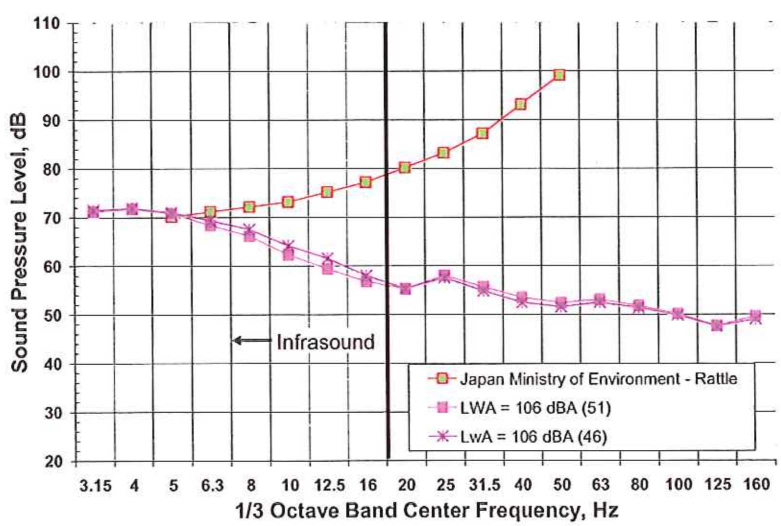

Fig. 11—GE 1.5sle wind turbine outdoor sound levels at 305 meters compared to Japan Ministry of Environment rattle criteria.

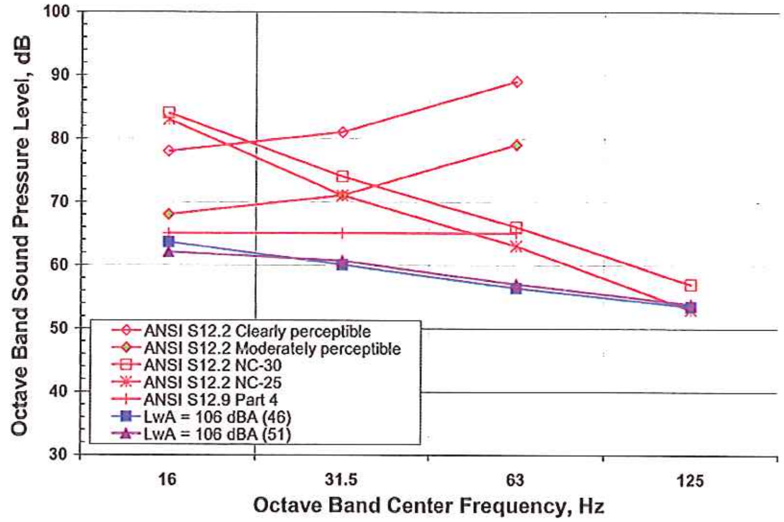

Fig. 12—GE 1.5sle wind turbine outdoor sound levels at 305 meters compared to ANSI criteria.

approximately 3.0 meters wide (10 feet) by 3.6 meters long (12 feet), bedroom furniture, carpeted flooring, two relatively new double-hung windows (no storm windows), paneling on the interior walls, and bricked exterior walls. The sound level meter was located just off-center in the room. The room in Home "C" where interior measurements were made had the following characteristics: approximately 2.4 meters wide (8 feet) by 3.6 meters long (12 feet), bathroom fixtures, linoleum flooring, one old casement window (no storm window), paneling on the interior walls, and wooden exterior walls. The sound level meter was located in the center of the room.

Figure 13 plots the indoor one-third octave band sound levels (L_{eq}) for Home "B", and Fig. 14 plots the indoor one-third octave band sound levels for Home "C". The results show that infrasound is inaudible to even the most sensitive people at around 305 meters (1,000 feet) from these wind turbines with the windows open or closed (more than 20 dB below the median thresholds of hearing). Low frequency sound at and above 63 Hz may be audible depending on background sound levels.

Figure 15 plots the indoor one-third octave band sound levels (L_{eq}) for Home "B", and Fig. 16 plots the indoor one-third octave band sound levels (L_{eq}) for Home "C". The results show the DEFRA disturbance criteria were met for steady and non-steady low frequency sounds.

Although not shown in Figs. 15 and 16, the one-third octave band levels meet the Japan Ministry of Environment criteria for evaluating complaints of mental and physical discomfort since both samples meet the more stringent DEFRA criteria for "non-steady" sounds, which is more stringent than the Japan criteria.

Figure 17 plots the indoor 16 Hz to 125 Hz octave band sound levels (L_{eq}) for Home "B", and Fig. 18 plots the indoor 16 Hz to 125 Hz octave band sound levels (L_{eq}) for Home "C". The results show the ANSI/ASA S12.2 low frequency criteria for perceptible vibration were met for both windows open and closed scenarios. The ANSI/ASA S12.2 low frequency NC-25 and NC-30 criteria for bedrooms, classrooms and hospitals were met,

Table 13—Summary of operational parameters—GE 1.5sle (Indoor).

Parameter	Home "B" (closed/open)	Home "C" (closed/open)
Distance to nearest WTG	290 meters	312 meters
Time of day	09:29-09:39/09:40-09:50	11:49-11:59/12:00-12:10
WTG power output	1,017 kW/896 kW	651 kW/632 kW
A-weighted sound power level	106 dB/105.8 dB	104.7 dB/104.6 dB
Measured wind speed @ 2 m	6.2 m/s/6.8 m/s	6.4 m/s/5.9 m/s
L_{Aeq}	27.1 dB/36.0 dB	33.6 dB/39.8 dB
L_{A90}	23.5 dB/33.7 dB	27.6 dB/34.2 dB
L_{Ceq}	47.1 dB/54.4 dB	50.6 dB/55.1 dB

* Includes K, uncertainty factor of 2 dB

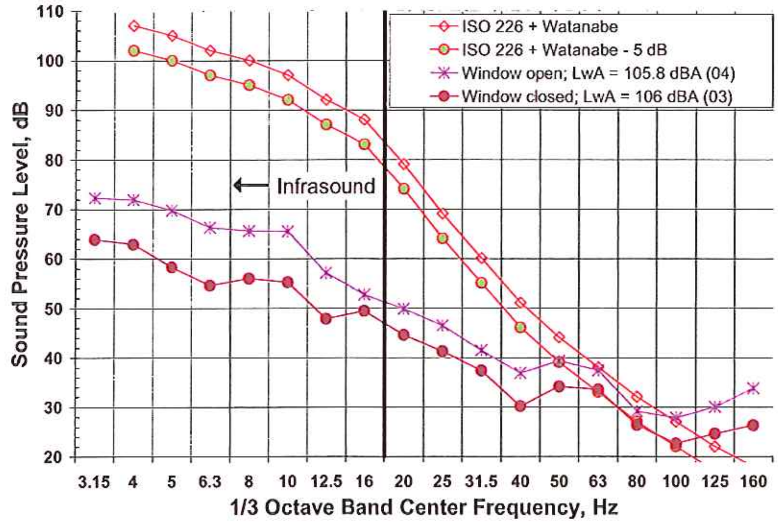

Fig. 13—GE 1.5sle wind turbine indoor sound levels at 290 meters compared to audibility criteria (Home "B").

the spectrum was balanced, and the criteria for moderately perceptible vibrations in light-weight walls and ceilings were also met.

5.3 Noise Reduction from Outdoor to Indoor

Simultaneous outdoor and indoor measurements made at the three residences within the Horse Hollow Wind Farm discussed above, were used to determine noise reductions of the homes for comparison to that used in the determination of equivalent outdoor criteria for indoor criteria, such as ANSI/ASA S12.2 and DEFRA. Indoor measurements were made with windows open and closed. Tables 11 and 13 list the conditions of measurement for these houses.

Figures 19 and 20 present the measured one-third octave band noise reduction for the three homes with windows closed and open, respectively. Also presented in these same figures are the one-third octave noise reductions discussed in the Appendix of this paper to obtain equivalent outdoor criteria for the indoor DEFRA criteria as well as the equivalent outdoor criteria for the Japanese mental and physical discomfort indoor criteria. It can be seen that for the window closed condition in Fig. 19, the measured noise reductions for all houses were greater than that used in our analysis for determining the equivalent outdoor criteria for the Japanese mental and physical discomfort indoor criteria. For the open window case in Fig. 20, which

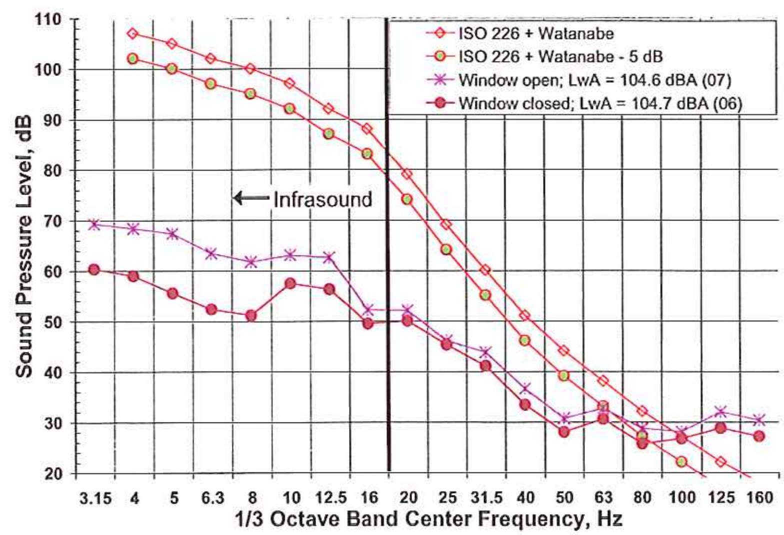

Fig. 14—GE 1.5sle wind turbine indoor sound levels at 312 meters compared to audibility criteria (Home "C").

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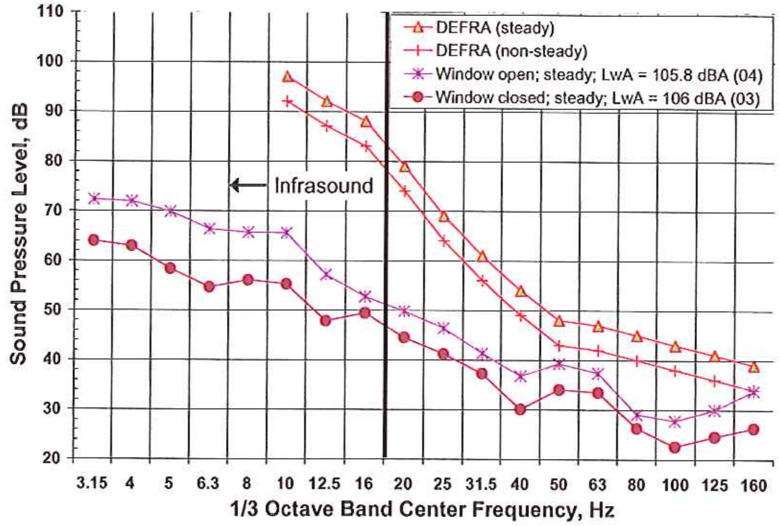

Fig. 15—GE 1.5sle wind turbine indoor sound levels at 290 meters compared to DEFRA criteria (Home "B").

was used in our analysis for obtaining the equivalent outdoor DEFRA criteria, the average of the three homes has a greater noise reduction than assumed in the Appendix and all houses at all frequencies have higher values with one minor exception. Only Home "A" at 25 Hz had a lower noise reduction (3 dB), and this difference is not critical since the measured indoor sounds at 25 Hz at each of these home was significantly lower than the indoor DEFRA criteria and the indoor Japanese criteria. Furthermore, the outdoor measurements for both Siemens and GE wind turbines at 305 meters (1,000 feet) under high output/high noise levels met the equivalent outdoor DEFRA criteria at 25 Hz.

Table 14 presents the measured octave band noise reduction for the three homes with windows closed and open, respectively. Also presented in Table 14 are the octave band noise reductions used in Table 2 of this paper to obtain equivalent outdoor criteria for the indoor ANSI/ASA S12.2 criteria for perceptible vibration and for NC-25 and NC-30. It can be seen that for the window closed condition, the measured noise reductions for all houses were greater than that used in our analysis. For the open window case, the average of the three homes has a greater noise reduction than the values from Table A1, and all houses at all frequencies have higher values with one minor exception. Only Home "A" at 31 Hz (which contains the 25 Hz one-third octave band) had a lower noise reduction (3 dB), and this difference is not critical since the measured indoor sounds at 31 Hz at each of these homes was significantly lower than the indoor ANSI/ASA S12.2 criteria. Furthermore, the outdoor measurements for both Siemens and GE wind

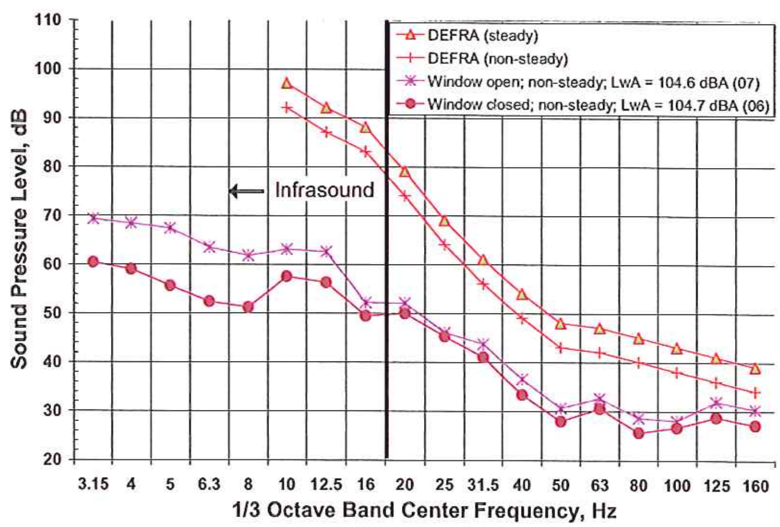

Fig. 16—GE 1.5sle wind turbine indoor sound levels at 312 meters compared to DEFRA criteria (Home "C").

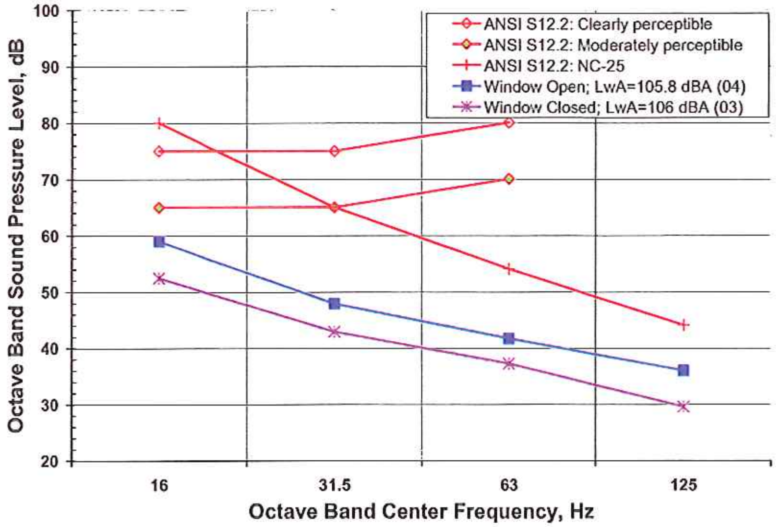

Fig. 17—GE 1.5sle wind turbine indoor sound levels at 290 meters compared to ANSI 12.2 criteria for perceptible vibrations and NC-25 (Home "B").

turbines at 305 meters (1,000 feet) under high output/ high noise levels met the equivalent outdoor ANSI/ASA S12.2 criteria at 31 Hz.

6 CONCLUSION

Sound levels from Siemens SWT 2.93-93 and GE 1.5sle wind turbines under maximum noise conditions at a distance more than 305 meters (1,000 feet) from the nearest residence meet the low frequency and infrasound standards and criteria published by several independent agencies and organizations. At this distance the wind farms:

- meet ANSI/ASA S12.2 indoor levels for low frequency sound for bedrooms, classrooms and hospitals;
- meet ANSI/ASA S12.2 indoor levels for moderately perceptible vibrations in light-weight walls and ceilings;
- meet ANSI/ASA S12.2 criteria for balanced spectrum from low frequency sounds;
- meet ANSI S12.9/Part 4 thresholds for annoyance from low frequency sound and beginning of rattles;
- meet UK DEFRA disturbance based guidelines for low frequency sound;
- meet Japan Ministry of Environment Guidance for evaluating complaints of rattling from low frequency noise;
- meet Japan Ministry of Environment Guidance for evaluating complaints of mental and physi-

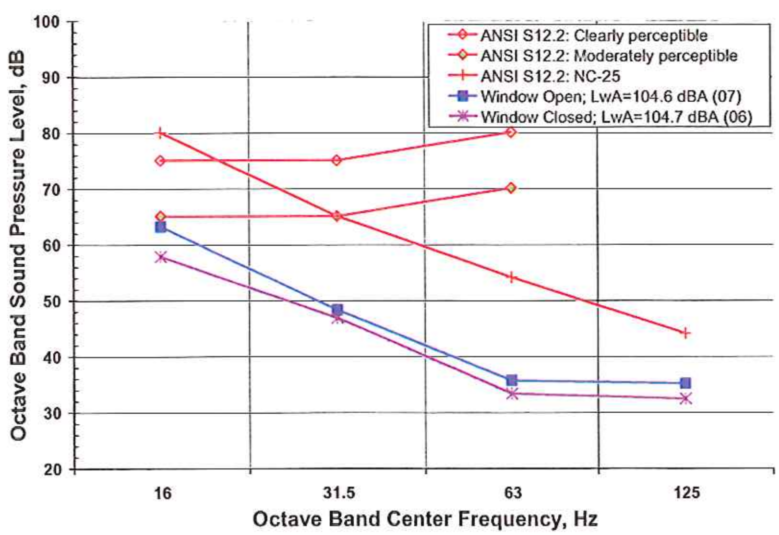

Fig. 18—GE 1.5sle wind turbine indoor sound levels at 312 meters compared to ANSI 12.2 criteria for perceptible vibrations and NC-25 (Home "C").

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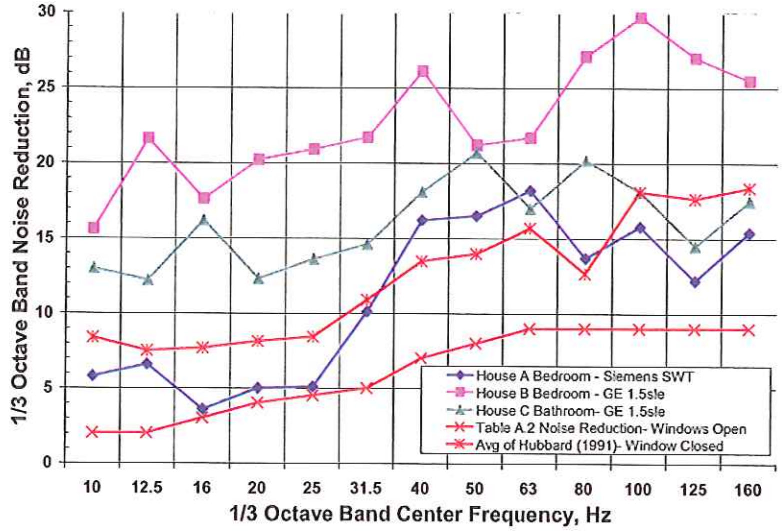

Fig. 19—One-third octave band interior noise reduction—Windows closed.

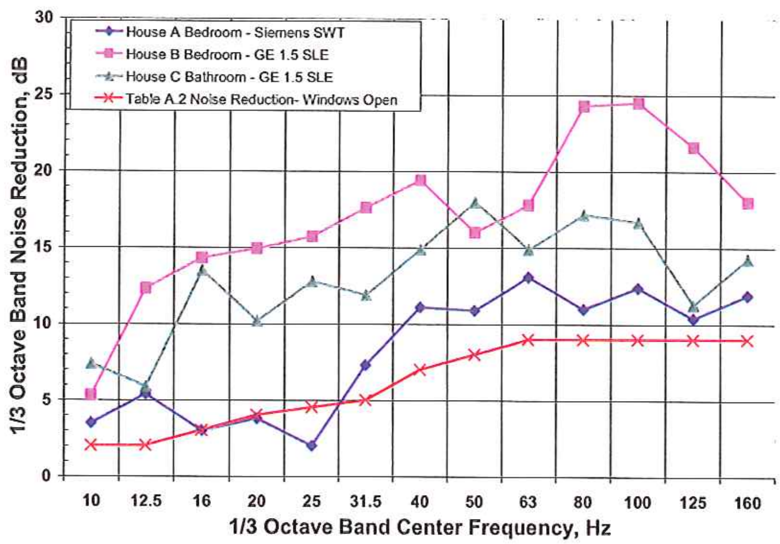

Fig. 20—One-third octave band interior noise reduction—Windows open.

cal discomfort from low frequency noise;

- have no audible infrasound to the most sensitive listeners; and
- might have slightly audible low frequency noise at frequencies at 50 Hz and above depending on other sources of low frequency noises in homes, such as refrigerators or external traffic or airplanes.

In accordance with the above findings, and in conjunction with our extensive literature search of

Table 14—Summary of octave band noise reduction—Interior measurements.

Home	Wind Turbine	Windows	16 Hz	31.5 Hz	63 Hz	125 Hz
A	Siemens SWT-2-3-93	Closed	5	6	16	14
A	Siemens SWT-2-3-93	Open	4	3	12	12
B	GE 1.5sle	Closed	20	22	22	27
B	GE 1.5sle	Open	13	17	18	21
C	GE 1.5sle	Closed	13	14	19	17
C	GE 1.5sle	Open	8	13	17	14
Table A1 Noise Reduction		Open	3	6	9	9

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scientific papers and reports, there should be no adverse public health effects from infrasound or low frequency noise at distances greater than 305 meters (1,000 feet) from the wind turbine types measured: GE 1.5sle and Siemens SWT 2.3-93.

7 ACKNOWLEDGMENTS

Acknowledgement is made to NextEra Energy Resources, LLC ("NextEra"), formerly FPL Energy, for providing financial support for the study, allowing access to the wind farm, and supplying critical operational data. Epsilon determined all means, methods, and the testing protocol without interference or direction from NextEra. No limitations were placed on Epsilon by NextEra with respect to the testing protocol or upon the analysis methods; the conclusions are those of the authors.

8 APPENDIX: HOME NOISE REDUCTION USED TO DETERMINE EQUIVALENT OUTDOOR SOUND PRESSURE LEVEL CRITERIA BASED ON INDOOR CRITERIA

Since indoor measurements are not always possible, for comparison to outdoor sound levels the indoor criteria from ANSI/ASA S12.2 should be adjusted. Outdoor to indoor low frequency noise reductions have been reported by Sutherland for aircraft and highway noise for open and closed windows[9] and by Hubbard and Shepherd for aircraft and wind turbine noise for closed windows[10]. Table A1 presents the average low frequency octave band noise reductions from outdoor to indoors from these two papers for open and closed windows. Sutherland only reported values down to 63 Hz; whereas Hubbard and Shepherd presented values to less than 10 Hz. The closed window conditions of Ref. 10 were used to estimate noise reductions less than 63 Hz by applying the difference between values for open and closed windows from Ref. 9 data at 63 Hz. It should be noted that the attenuation for wind turbines in Ref. 10 is based on only three homes at two different wind farms, whereas the traffic and aircraft data are for many homes. The wind turbine open window values were determined from the wind turbine closed window values by subtracting the difference in values between windows closed and open obtained by Ref. 9.

To be conservative, we use the open window case instead of closed windows except for the adjustments to the Japanese guideline which specifically called for closed windows. To be further conservative, we use the wind turbine noise reduction data in Ref. 10 (adjusted to open windows). However, it should be noted that it is possible for some homes to have some slight amplification at low frequencies with windows open due to possible room resonances.

The average one-third octave band noise reductions used to determine equivalent outdoor one-third octave band criteria were determined in a similar manner. The first row of Table A2 and Fig. 20 present the average one-third octave band noise reductions values for *windows open* that were used to determine the equivalent outdoor one-third octave band criteria levels in Table 7 from the indoor criteria. The second row of Table A2 and Fig. 19 presents the one-third octave band noise reductions for windows closed determined by Ref. 10 for homes exposed to wind turbine sounds—these higher closed window noise reduction values were only used to determine equivalent outdoor levels for determining the equivalent Japanese guidance one-third octave band sound pressure level values for dealing with complaints of mental and physical discomfort from environmental sounds.

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Ex.-CW-Hessler-4

October 17, 2012

Michael E. Newmark
Administrative Law Judge
Public Service Commission
P.O. Box 7854
Madison, WI 53707

Re: PSC Docket No. 2535-CE-100, Application of Highland Wind Farm, LLC, for a Certificate of Public Convenience and Necessity to Construct a 102.5 Megawatt Wind Electric Generation Facility and Associated Electric Facilities, to be Located in the Towns of Forest and Cylon, St. Croix County, Wisconsin

Dear Judge Newmark:

Clean Wisconsin respectfully requests admission of the exhibit marked as Ex.-Clean Wisconsin-Hessler-4 in the above-mentioned proceeding into the record. This exhibit consists of a scientific, peer-reviewed article by Robert D. O'Neal, Robert D. Hellweg Jr., and Richard M. Lampeter, *Low frequency noise and infrasound from wind turbines*, NOISE CONTROL ENGINEERING JOURNAL, vol. 59, no. 2 (Mar.-Apr. 2011).

Clean Wisconsin's expert witness Mr. David Hessler testified to the accuracy and probative value of this exhibit at the technical hearing on October 10, 2012. Admission of this exhibit was initially denied pending the resolution of Clean Wisconsin's requests to conduct independent low-frequency noise testing at the Glacier Hills Wind Park or the Shirley Wind project in the Town of Glenmore, Wisconsin.

This proposed exhibit represents the most recent and comprehensive scientific information on low frequency noise and infrasound from wind turbines. It consists of three parts: 1) a comprehensive literature review to determine unbiased guidelines and standards used worldwide to test low frequency sound and infrasound; 2) a field study measuring low frequency noise and infrasound and collecting data from two models of operating wind turbines, one of which, the Siemens SWT-2.3-93 (2.3 MW), is similar in size to turbine models being considered by Highland Wind; and 3) a comparison of the field study data to the guidelines and standards. The site of the field study, Horse Hollow Wind Farm in Texas, is a 735.5 MW capacity facility, more than seven times the proposed capacity of the Highland Wind Farm. The authors conducted measurements outdoors at 1,000-feet and 1,500-feet setback distances from the turbines and concurrent indoor/outdoor measurements at four residences within the footprint of the wind farm.

Although Mr. Hessler intends to conduct low frequency and infrasound noise measurements at the homes of a few residents near Shirley Wind and will enter the results as a separate exhibit in this docket, Mr. Hessler and Clean Wisconsin were unable to obtain permission from either Duke Energies or WEPCO to conduct outdoor measurements at set reference distances comparable to the measurements discussed in this proposed exhibit. Additionally, due to time constraints, Mr. Hessler will not duplicate the thorough review of guidelines and standards for low frequency noise and infrasound worldwide that the exhibit contains.

Because Mr. Hessler's Shirley Wind study will be limited to data which can be collected without the express cooperation of the wind facility owner, this exhibit properly supplements the record on low frequency noise and infrasound in the present case. All parties received copies of this article at the hearing and have since had a full and fair opportunity to review it and share it with their own noise experts. Therefore, Clean Wisconsin respectfully requests that Ex.-Clean Wisconsin-Hessler-4 be admitted into the record at this time.

Sincerely,

/s/ Katie Nekola

Katie Nekola
General Counsel
Clean Wisconsin

EXHIBIT 49

ISSN 0736-2501

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EXHIBIT 49

EXHIBIT 49

Low frequency noise and infrasound from wind turbines

Robert D. O'Neal[a], Robert D. Hellweg Jr.[b] and Richard M. Lampeter[b]

(Received: 5 October 2010; Revised: 7 January 2011; Accepted: 8 January 2011)

A common issue raised with wind energy developers and operators of utility-scale wind turbines is whether the operation of their wind turbines may create unacceptable levels of low frequency noise and infrasound. In order to answer this question, one of the major wind energy developers commissioned a scientific study of their wind turbine fleet. The study consisted of three parts: 1) a world-wide literature search to determine unbiased guidelines and standards used to evaluate low frequency sound and infrasound, 2) a field study to measure wind turbine noise outside and within nearby residences, and 3) a comparison of the field results to the guidelines and standards. Wind turbines from two different manufacturers were measured at an operating wind farm under controlled conditions with the results compared to established guidelines and standards. This paper presents the results of the low frequency noise and infrasound study. Since the purpose of this paper is to report on low frequency and infrasound emissions, potential annoyance from other aspects of wind turbine operation were not considered, and must be evaluated separately.

Primary subject classification: 14.5.4; Secondary subject classification: 21.8.1

1 INTRODUCTION

Early down-wind wind turbines in the US created low frequency noise; however current up-wind wind turbines generate considerably less low frequency noise. Epsilon Associates, Inc. ("Epsilon") was retained by NextEra Energy Resources, LLC ("NextEra"), formerly FPL Energy, to investigate whether the operation of their wind turbines may create unacceptable levels of low frequency noise and infrasound. This question has often been posed to NextEra, and other wind energy developers and operators of utility-scale wind turbines. NextEra is one of the world's largest generators of wind power with approximately 7,600 net megawatts (MW) in operation as of July 2010.

The project was divided into three tasks: 1) literature search, 2) field measurement program, and 3) comparison to criteria. Epsilon conducted an extensive literature search of the technical and scientific literature on the effects of low-frequency noise and infrasound and existing criteria in order to evaluate low-frequency noise and infrasound from wind turbines. After completion of the literature search and selection of criteria, a field measurement program was developed to measure wind turbine noise to compare to the selected criteria.

The frequency range 20–20,000 Hz is commonly described as the range of "*audible*" noise. The frequency range of low frequency sound is generally from 20 Hertz (Hz) to 200 Hz, and the range below 20 Hz is often described as "*infrasound*". However, audibility extends to frequencies below 20 Hz.

Low frequency sound has several definitions. American National Standards ANSI/ASA S12.2[1] and ANSI S12.9 Part 4[2] have provisions for evaluating low frequency noise, and these special treatments apply only to sounds in the octave bands with 16, 31.5, and 63-Hz mid-band frequencies. For these reasons, in this paper on wind turbine noise, we use the term "low frequency noise" to include 12.5 Hz–200 Hz with emphasis on the 16 Hz, 31 Hz and 63 Hz octave bands with a frequency range of 11 Hz to 89 Hz.

International Electrotechnical Commission (IEC) standard 60050-801:1994[3] defines "*infrasound*" as "Acoustic oscillations whose frequency is below the low frequency limit of audible sound (about 16 Hz)." This definition is *incorrect* since sound remains audible at frequencies well below 16 Hz provided that the sound level is sufficiently high. In this paper we define infrasound to be below 20 Hz, which is the limit for the standardized threshold of hearing. Since there is no sharp

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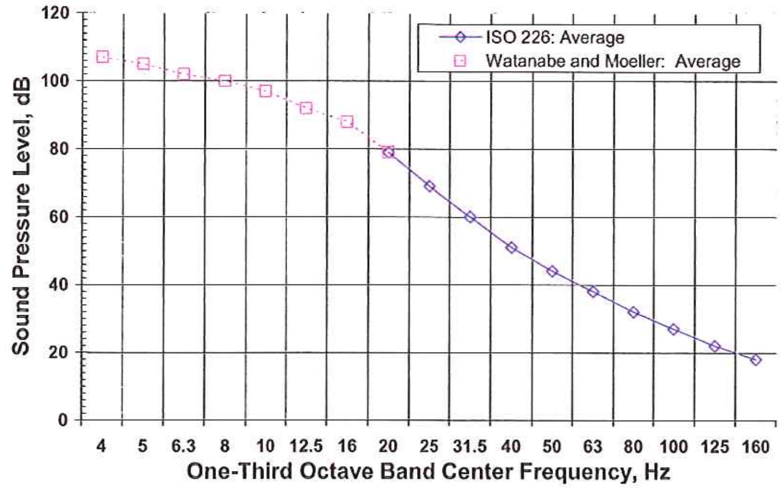

Fig. 1—Low frequency average threshold of hearing from ISO 226[6] and Watanabe and Moeller[7].

change in hearing at 20 Hz, the division into "low-frequency sound" and "infrasound" should only be considered "practical and conventional."

2 EFFECTS AND CRITERIA OF LOW FREQUENCY SOUND AND INFRASOUND

We performed an extensive world-wide literature search of over 100 scientific papers, technical reports and summary reports on low frequency sound and infrasound—hearing, effects, measurement, and criteria. Leventhall[4] presents an excellent and comprehensive study on low frequency noise from all sources and its effects. The Leventhall report also presents criteria in place at that time, which does not include some of the more recently developed ANSI/ASA standards on outdoor environmental noise and indoor sounds.

The United States government does not have specific criteria for low frequency noise. The US Environmental Protection Agency (EPA) has guidelines for the protection of public health with an adequate margin of safety in terms of annual average A-weighted day-night average sound level (L_{dn}), but there are no corrections or adjustments for low frequency noise. The US Department of Transportation (DOT) has A-weighted sound pressure level criteria for highway projects and airports, but these do not have adjustments for low frequency noise. The following sections describe the low frequency and infrasound criteria to which wind turbine sounds are compared in later sections.

2.1 Threshold of Hearing and Audibility

Moeller and Pedersen[5] present an excellent summary on human perception of sound at frequencies below 200 Hz. The ear is the primary organ for sensing infrasound. Hearing becomes gradually less sensitive for decreasing frequencies. But, humans with a normal hearing organ can perceive infrasound at least down to a few hertz if the sound level is sufficiently high.

The threshold of hearing is standardized for frequencies down to 20 Hz[6]. Based on extensive research and data, Moeller and Pedersen propose normal hearing thresholds for frequencies below 20 Hz; however, their proposed threshold is higher than that obtained by Watanabe and Moeller[7]. To be conservative, we have used the data from Watanabe and Moeller[7] for the region below 20 Hz. (See Fig. 1.) Moeller and Pedersen[5] suggest that the curve for low frequency thresholds for normal hearing is "probably correct within a few decibels, at least in most of the frequency range."

The hearing thresholds show considerable variability from individual to individual with a standard deviation among subjects of about 5 dB independent of frequency between 3 Hz and 1000 Hz with a slight increase at 20–50 Hz. This implies that the audibility threshold for 97.5% of the population is greater than the values in Fig. 1 minus 10 dB and for 84% of the population is greater than the values in Fig. 1 minus 5 dB. Moeller and Pedersen suggest that the "pure-tone threshold can with a reasonable approximation be used as a guideline for the thresholds also for [low frequency] non-sinusoidal sounds"[5]; ISO 226 has thresholds for frequencies at and above 20 Hz and approximately equates the thresholds and equal loudness contours for non-sinusoidal sounds to those in the standard for sinusoidal sounds[6].

As frequency decreases below 20 Hz, if the noise source is tonal, the tonal sensation ceases. Below 20 Hz tones are perceived as discontinuous. Below 10 Hz it is possible to perceive the single cycles of a tone, and the perception changes into a sensation of pressure at the ears.

Below 100 Hz, the dynamic range of the auditory system decreases with decreasing frequency, and the compressed dynamic range has an effect on equal loudness contours: a slight change in sound level can change the perceived loudness from barely audible to loud. This combined with the large variation in individual hearing may mean that a low frequency sound that is inaudible to some may be audible to others, and may be relatively loud to some of those for whom it is audible. Loudness for low frequency sounds grows considerably faster above threshold than for sounds at higher frequencies[5].

Non-auditory perception of low frequency and infrasound occurs only at levels above the auditory threshold. In the frequency range of 4–25 Hz and at "*levels* 20–25 dB *above [auditory] threshold it is possible to feel vibrations* in various parts of the body, e.g., the lumbar, buttock, thigh and calf regions. A feeling of pressure may occur in the upper part of the chest and the throat region" [emphasis added][5].

2.2 ANSI S12.9-Parts 4 and 5—Evaluating Outdoor Environmental Sound

American National Standard ANSI/ASA S12.9-2007/Part 5[8] has an informative annex which provides guidance for designation of land uses compatible with existing or predicted annual average adjusted day-night average outdoor sound level (DNL). Ranges of the DNL are outlined, within which a specific region of compatibility may be drawn. These ranges take into consideration the noise reduction in sound level from outside to inside buildings as commonly constructed in that locality and living habits there. There are adjustments to day-night average sound level to account for the presence of low frequency noise, and the adjustments are described in ANSI S12.9 Part 4, which use a sum of the sound pressure levels in octave bands with center frequencies of 16, 31 and 63 Hz.

ANSI S12.9/Part 4 identifies two thresholds: annoyance is minimal when the 16, 31.5 and 63 Hz octave band sound pressure levels are each less than 65 dB and there are no rapid fluctuations of the low frequency sounds. The second threshold is for increased annoyance which begins when rattles occur, which begins at L_{LF} 70–75 dB. L_{LF} is 10 times the logarithm of the ratio of time-mean square sound pressure in the 16, 31.5, and 63-Hz octave bands divided by the square of the reference sound pressure.

The adjustment procedure for low frequency noise to the average annual A-weighted sound pressure level in ANSI S12.9/Part 4 uses a different and more complicated metric and procedure (Equation D.1) than those used for evaluating low frequency noise in rooms contained in ANSI/ASA S12.2. (See Sec. 2.3). Since we are evaluating low frequency noise and not A-weighted sound levels, we do not recommend using the procedure for adjusting A-weighted levels. Instead we recommend using the following two guidelines from ANSI S12.9/Part 4: a sound pressure level of 65 dB in each of the 16-, 31.5-, and 63 Hz octave bands as an indicator of minimal annoyance, and 70–75 dB for the summation of the sound pressure levels from these three bands as an indicator of possible increased annoyance from rattles.

2.3 ANSI/ASA S12.2—Evaluating Room Noise

ANSI/ASA S12.2-2008[1] discusses criteria for evaluating room noise, and has two separate provisions for evaluating low frequency noise: (1) the potential to cause perceptible vibration and rattles, and (2) meeting low frequency portions of room criteria curves. Since the ANSI S12.2 criteria are for indoor sounds, in order to determine equivalent outdoor criteria for comparison to outdoor measurements, data from Sutherland[9] and Hubbard and Shephard[10] were used to determine typical noise reductions from outdoor to indoor with windows open. (The Appendix of this paper describes the noise reductions used to determine equivalent outdoor criteria to indoor criteria.) Table A1 presents octave band noise reductions applied in this evaluation along with the average low frequency octave band noise reductions from outdoor to indoors from Refs. 9 and 10 for open and closed windows. Table A2 presents the one-third octave band noise reductions applied in the analysis that were determined in the same manner using data from the same references.

Vibration and Rattles: Outdoor low frequency sounds of sufficient amplitude can cause building walls to vibrate and windows to rattle. Homes have low values of transmission loss at low frequencies, and low frequency noise of sufficient amplitude may be audible within homes. Window rattles are not low frequency noise, but may be caused by low frequency noise. ANSI/ASA S12.2 presents limiting levels at low frequencies for assessing (a) the probability of *clearly* perceptible acoustically induced vibration and rattles in lightweight wall and ceiling constructions, and (b) the probability of *moderately* perceptible acoustically induced vibration in similar constructions. The limiting sound pressure levels in the octave bands with center frequencies of 16, 31.5 and 63 Hz are presented in Table 1.

Applying the outdoor to indoor attenuations for wind turbine sources with windows open given in the last row of Table A1 to the ANSI/ASA S12.2 indoor sound pressure levels in Table 1 yields the equivalent

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Table A1—Average low frequency octave band home noise reductions from outdoor to indoors in dB (from Ref. 9 and 10).

Noise Source	Window condition	Octave Band Center Frequency 16 Hz	31.5 Hz	63 Hz	125 Hz
Average aircraft and traffic sources	Closed windows	16	15	18	20
Average aircraft and traffic sources	Open windows	(11)*	(10)*	12	11
Average Wind Turbine	Closed windows	8	11	14	18
Average Wind Turbine	Open windows	(3)*+	(6)*+	9+	9+

* No data are available for windows open below 63 Hz octave band. The values for 16 Hz and 31 Hz were obtained by subtracting the difference between the levels for 63 Hz closed and open conditions to the 16 and 31 Hz closed values.
\+ Used in this paper to determine equivalent outdoor criteria from indoor criteria in Tables 2 and 4

outdoor sound pressure levels that are consistent with the indoor criteria and are presented in Table 2.

Room Criteria Curves: ANSI/ASA S12.2 has three primary methods for evaluating the suitability of noise within rooms: a survey method—A-weighted sound levels, an engineering method—noise criteria (NC) curves, and a method for evaluating low-frequency fluctuating noise using room noise criteria (RNC) curves. ANSI/ASA S12.2 states "The RNC method should be used to determine noise ratings when the noise from HVAC systems at low frequencies is loud and is suspected of containing sizeable *fluctuations or surging*." [emphasis added] The NC curves are appropriate to evaluate low frequency noise from wind turbines in homes since wind turbine noise does not have significant fluctuating low frequency noise sufficient to warrant using RNC curves and since A-weighted sound levels do not adequately determine

Table A2—Average low frequency one-third octave band noise reduction in dB for homes from outdoor to indoors.

Condition	One-Third Octave Band Center Frequency, Hz 10	12.5	16	20	25	31.5	40	50	63	80	100	125	160
Open Window*	2	2	3	4	4.5	5	7	8	9	9	9	9	9
Average Closed Window with wind turbines[10] **	8	7	8	8	8	11	13	14	15	12	18	18	18

* Used to determine equivalent outdoor levels as shown in Table 7.
** Used to determine equivalent outdoor levels as shown in Table 9.

Table 1—ANSI/ASA S12.2 measured interior sound pressure levels for perceptible vibration and rattle in lightweight wall and ceiling structures.[1]

Condition	Octave-band center frequency (Hz) 16	31.5	63
Clearly perceptible vibration and rattles likely	75 dB	75 dB	80 dB
Moderately perceptible vibration and rattles likely	65 dB	65 dB	70 dB

Table 2—Equivalent outdoor sound pressure levels to the ANSI/ASA S12.2 indoor sound pressure levels for perceptible vibration and rattle in lightweight wall and ceiling structures for wind turbines.

Condition	Octave-band center frequency (Hz) 16	31.5	63
Clearly perceptible vibration and rattles likely	78 dB	81 dB	89 dB
Moderately perceptible vibration and rattles likely	68 dB	71 dB	79 dB

if there are low frequency problems. [ANSI/ASA S12.2, Sec. 5.3 gives procedures for determining if there are large fluctuations of low frequency noise.]

Annex C.2 of ANSI/ASA S12.2 contains recommended room criteria curves for bedrooms, which are the rooms in homes with the most stringent criteria: NC and RNC criteria curve between 25 and 30. The recommended NC and RNC criteria for schools and private rooms in hospitals are the same. The values of the sound pressure levels in the 16–125 Hz octave bands for NC curves 25 and 30 are shown in Table 3. Applying the outdoor to indoor attenuations for wind turbine sources with windows open given in the last row of Table A1 to the ANSI/ASA S12.2 indoor sound pressure levels for NC-25 and NC-30 in Table 3 yields the equivalent outdoor sound pressure levels that are consistent with the indoor criteria and are presented in Table 4.

ANSI/ASA S12.2 also presents a method to determine if the levels below 500 Hz octave band are too high in relation to the levels in the mid-frequencies which could create a condition of "spectrum imbalance". The method for this evaluation is:

- Calculate the speech interference level (SIL) for the measured spectrum. [SIL is the arithmetic average of the sound pressure levels in the 500, 1000, 2000 and 4000 Hz octave bands.] Select the NC curve equal to the SIL value with a symbol NC(SIL).
- Plot the measured spectra and the NC curve equal to the SIL value on the same graph and determine the differences between the two curves in the octave bands below 500 Hz.
- Estimate the likelihood that the excess low-frequency levels will annoy occupants of the space using Table 5.

Table 3—ANSI/ASA S12.2 low frequency octave band sound pressure levels for noise criteria curves NC-25 and NC-30. [Table 1 from Ref. 1].

NC Criteria	Octave-band-center frequency, Hz 16	31.5	63	125
NC-25	80	65	54	44
NC-30	81	68	57	48

2.4 Other Criteria

2.4.1 World Health Organization (WHO)

No specific low frequency noise criteria are proposed by the WHO. The Guidelines for Community Noise report[11] mentions that if the difference between

Table 4—Equivalent outdoor sound pressure levels to the ANSI/ASA S12.2 low frequency octave band sound pressure levels for noise criteria curves NC-25 and NC-30. [Table 1 from Ref. 1].

NC Criteria	Octave-band-center frequency, Hz 16	31.5	63	125
NC-25 equivalent outdoor	83	71	63	53
NC-30 equivalent outdoor	84	74	66	57

Table 5—Measured sound pressure level deviations from an NC (SIL) curve that may lead to serious complaints[1].

Octave-band frequency, Hz=>	Measured Spectrum—NC(SIL), dB 31.5	63	125	250
Possible serious dissatisfaction	*	6–9	6–9	6–9
Likely serious dissatisfaction	*	>9	>9	>9

* Insufficient data available to evaluate

Table 6—DEFRA proposed criteria[13] for the assessment of low frequency noise disturbance: Indoor L_{eq} one-third sound pressure levels for non-steady and steady low frequency sounds.

	One-Third Octave Band Center Frequency, Hz												
Location	10	12.5	16	20	25	31.5	40	50	63	80	100	125	160
Non-Steady L_{eq}, dB	92	87	83	74	64	56	49	43	42	40	38	36	34
Steady L_{eq}, dB	97	92	88	79	69	61	54	48	47	45	43	41	39

the C-weighted sound level and A-weighted sound level is greater than 10 decibels, then a frequency analysis should be performed to determine if there is a low frequency issue. A document prepared for the World Health Organization states that "there is no reliable evidence that infrasounds below the hearing threshold produce physiological or psychological effects. Infrasounds slightly above detection threshold may cause perceptual effects but these are of the same character as for 'normal' sounds. Reactions caused by extremely intense levels of infrasound can resemble those of mild stress reaction and may include bizarre auditory sensations, describable as pulsation and flutter"[12].

2.4.2 The UK Department for Environment, Food, and Rural Affairs (DEFRA)

The report prepared by the University of Salford for the UK Department for Environment, Food, and Rural Affairs (DEFRA) on low frequency noise proposed one-third octave band sound pressure level L_{eq} criteria and procedures for assessing low frequency noise[13]. The guidelines are based on complaints of disturbance from low frequency sounds and are intended to be used by Environmental Health Officers.

Existing low frequency noise criteria from several countries were reviewed and experiences with low frequencies complaints were considered in developing the proposed guidelines. The criteria are "based on 5 dB below the ISO 226 average threshold of audibility for steady [low frequency] sounds." However, the DEFRA criteria are at 5 dB lower than ISO 226 only at 20–31.5 Hz; at higher frequencies the criteria are equal to the Swedish criteria which are higher levels than ISO 226 less 5 dB. For frequencies lower than 20 Hz, DEFRA uses the thresholds from Ref. 7 less 5 dB.

The DEFRA criteria are based on measurements in an unoccupied room, and it was noted by a practicing consultant that measurements should be made with windows closed[14]. However, we conservatively used windows open conditions for our assessment to determine equivalent outdoor criteria since the DEFRA measurement procedure does not explicitly state measurements are with windows closed. If the low frequency sound is "steady" then the criteria may be relaxed by 5 dB. A low frequency noise is considered steady if either $L_{10}-L_{90}<5$ dB or the rate of change of sound pressure level (Fast time weighting) is less than 10 dB per second in the third octave band which exceeds the criteria by the greatest margin.

Applying indoor to outdoor one-third octave band transfer functions for open windows (as presented in Table A2 from analysis of data in Refs. 9 and 10) yields *equivalent* one-third octave band sound pressure level proposed DEFRA criteria for outdoor sound levels. Table 6 presents the indoor DEFRA proposed criteria for non-steady and steady low-frequency sounds. Table

Table 7—Equivalent outdoor L_{eq} one-third sound pressure levels for non-steady and steady sounds to the DEFRA indoor criteria[13] for the assessment of low frequency noise disturbance.

	One-Third Octave Band Center Frequency, Hz												
Location	10	12.5	16	20	25	31.5	40	50	63	80	100	125	160
Non-Steady Equivalent outdoor * L_{eq}, dB	94	89	86	78	68.5	61	56	51	51	49	47	45	43
Steady Equivalent Outdoor* L_{eq},	99	94	91	83	73.5	66	61	56	56	54	52	50	48

* With windows open

Table 8—Japan Ministry of Environment Guidance for evaluating complaints of low frequency noise: Reference one-third octave band sound pressure level values for complaints of rattling.

	One-Third Octave Band Center Frequency, Hz										
Location	5	6.3	8	10	12.5	16	20	25	31.5	40	50
Outdoor L_{eq}, dB	70*	71*	72*	73	75	77	80	83	87	93	99

* The reference values are several dB lower than the supporting data contained in Ref. 15. At 5 Hz, window rattles started at about 74 dB in one study and 79 dB in another; at 6.3 Hz, rattles started at 74 dB in the first study and at 78 dB in the second; and at 8 Hz, window rattle started at 74 dB in the first study and 77 dB in the second study.

7 presents the DEFRA equivalent outdoor criteria for non-steady and steady low frequency sounds.

2.4.3 Japan Ministry of Environment

The Japan Ministry of Environment has published a handbook to deal with low frequency noise problems and has established reference values for guidance in dealing with complaints of rattling windows and doors and complaints of "mental and physical discomfort"[15]. It was noted that traditional Japanese houses have relatively light-weight and sensitive windows and partitions[16].

Table 8 presents the Japanese reference outdoor one-third octave band sound pressure level values for guidance in dealing with complaints of rattling from environmental sounds from 5 Hz to 50 Hz. From 10 Hz to 50 Hz the guidance levels are equal to the observed threshold of rattles from two studies with a total of 78 samples. However, for the bands centered at 5, 6.3 and 8 Hz, the reference values are several dB lower than the supporting data contained in these two studies[15]. At 5 Hz, the lowest observed window rattle was at 74 dB in one study and 79 dB in another; at 6.3 Hz, rattles started at 74 dB in the first study and at 78 dB in the second; and at 8 Hz, window rattle started at 74 dB in the first study and 77 dB in the second study. Thus the reference values at 5, 6.3 and 8 Hz in Table 8 are conservative in comparison to the other values by 4, 3, and 2 dB respectively.

Table 9 presents the Japanese reference one-third octave band sound pressure level values for guidance in dealing with complaints of mental and physical discomfort from environmental sounds when evaluated indoors. Evaluation measurements are to be performed with windows closed to the outside. The values in Table 9 are less stringent than the DEFRA values in Table 6 for non-steady sounds but more stringent than the DEFRA values for steady sounds in some one-third octave bands. In order to obtain equivalent outdoor sound levels, the average noise reduction from wind turbine noise with windows closed from Ref. 10 was applied to the Japan reference values. Table 9 presents the Japanese indoor reference values, the noise reductions for windows closed[10] and the equivalent outdoor reference values. These equivalent outdoor values are less stringent than the equivalent outdoor DEFRA values in Table 7 for both non-steady sounds and steady sounds except for the 80 Hz band in which the Japanese level is 1 dB more stringent than the DEFRA level for steady sounds.

2.4.4 C-weighted minus A-weighted ($L_{pC}-L_{pA}$)

Leventhall[4] and others indicate that the difference in C-weighted and A-weighted sound pressure levels can be a predictor of annoyance. Leventhall states that if ($L_{pC}-L_{pA}$) is greater than 20 dB there is "a potential for a low frequency noise problem." He further states that ($L_{pC}-L_{pA}$) cannot be a predictor of annoyance but is a simple indicator that further analysis may be needed. This is due in part to the fact that the low frequency noise may be inaudible even if ($L_{pC}-L_{pA}$) is greater than 20 dB.

3 LITERATURE REVIEW

The authors performed an extensive literature search of over 100 scientific papers, technical reports and summary reports on low frequency sound and infrasound—hearing, effects, measurement, and criteria. The following paragraphs briefly summarize the findings from some of these papers and reports.

3.1 Leventhall

Leventhall[4] presents an excellent study on low frequency noise from all sources and its effects. The report presents criteria in place at that time and includes data relating cause and effects. Leventhall[17] reviewed data and allegations on alleged problems from low frequency noise and infrasound from wind turbines, and concluded the following: "It has been shown that there is insignificant infrasound from wind turbines and that there is normally little low frequency noise." "Turbulent air inflow conditions cause enhanced levels of low frequency noise, which may be disturbing, but the overriding noise from wind turbines is the fluctuating audible swish, mistakenly referred to

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Table 9—Japan Ministry of Environment Guidance for evaluating complaints of low frequency noise: Reference one-third octave band sound pressure level values for complaints of mental and physical discomfort.

	One-Third Octave Band Center Frequency, Hz									
Location	10	12.5	16	20	25	31.5	40	50	63	80
Indoor L_{eq}, dB	92	88	83	76	70	64	57	52	47	41
Noise Reduction*, dB	8	7	8	8	8	11	13	14	15	12
Equivalent Outdoor L_{eq}, dB	100	95	91	84	78	75	70	66	62	53

* from Hubbard[10] windows closed condition

as "infrasound" or "low frequency noise". "Infrasound from wind turbines is below the audible threshold and of no consequence". Other studies have shown that wind turbine generated infrasound levels are below threshold of perception and threshold of feeling and body reaction.

3.2 DELTA

The Danish Energy Authority project on "low frequency noise from large wind turbines" comprises a series of investigations in the effort to give increased knowledge on low frequency noise from wind turbines[18]. One of the conclusions of the study is that wind turbines do not emit audible infrasound, with levels that are "far below the hearing threshold." Audible low frequency sound may occur both indoors and outdoors, "but the levels in general are close to the hearing and/or masking level." "In general the noise in the critical band up to 100 Hz is below both thresholds". The final report notes that for road traffic noise (in the vicinity of roads) the low frequency noise levels are higher [than wind turbine] both indoors and outdoors.

3.3 Hayes McKenzie Partnership

Hayes McKenzie Partnership Ltd performed a study for the UK Department of Trade & Industry (DTI) to investigate complaints of low frequency noise that came from three of the five farms with complaints out of 126 wind farms in the UK[14]. The study concluded that:

- Infrasound associated with modern wind turbines is not a source which will result in noise levels that are audible or which may be injurious to the health of a wind farm neighbor.
- Low frequency noise was measureable on a few occasions, but below DEFRA criteria. Wind turbine noise may result in indoor noise levels within a home that is just above the threshold of audibility; however, it was lower than that of local road traffic noise.
- The common cause of the complaints was not associated with low frequency noise but the occasional audible modulation of aerodynamic noise, especially at night.
- The UK Department of Trade and Industry, which is now the UK Department for Business Enterprise and Regulatory Reform (BERR), summarized the Hayes McKenzie report: "The report concluded that there is no evidence of health effects arising from infrasound or low frequency noise generated by wind turbines."[19].

3.4 Howe

Howe performed extensive studies on wind turbines and infrasound and concluded that infrasound was not an issue for modern wind turbine installations—"while infrasound can be generated by wind turbines, it is concluded that infrasound is not of concern to the health of residences located nearby."[20]. Since then Gastmeier and Howe[21] investigated an additional situation involving the alleged "perception of infrasound by individual." In this additional case, the measured indoor infrasound was at least 30 dB below the audibility threshold given by Ref. 7 as presented in Fig. 1.

3.5 Branco

Branco and other Portuguese researchers have studied possible physiological affects associated with high amplitude low frequency noise and have labeled these alleged effects as "Vibroacoustic Disease" (VAD)[22]. "Vibroacoustic disease (VAD) is a whole-body, systemic pathology, characterized by the abnormal proliferation of extra-cellular matrices, and caused by excessive exposure to low frequency noise."

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Hayes[23,24] concluded that levels from wind farms are not likely to cause VAD after comparing noise levels from alleged VAD cases to noise levels from wind turbines in homes of complainers. Noise levels in aircraft in which VAD has been hypothesized are considerably higher than wind turbine noise levels. Hayes also concluded that it is "unlikely that symptoms will result through induced internal vibration from incident wind farm noise."[23]. Other studies have found no VAD indicators in environmental sound that have been alleged by VAD proponents[25].

3.6 French National Academy of Medicine

In 2006, the French National Academy of Medicine recommended[26] "*as a precaution* construction should be suspended for wind turbines with a capacity exceeding 2.5 MW located within 1500 m of homes." [emphasis added] However, this precaution is not because of definitive health issues but because:

- Sound levels one km from some wind turbine installations "occasionally exceed allowable limits" for France (note that the allowable limits are long term averages).
- French prediction tools for assessment did not take into account sound levels created with wind speeds greater than 5 m/s.
- Wind turbine noise has been compared to aircraft noise (even though the sound levels of wind turbine noise are significantly lower), and exposure to high level aircraft noise "involves neurobiological reactions associated with an increased frequency of hypertension and cardiovascular illness. Unfortunately, no such study has been done near wind turbines."[27].

In March 2008, the French Agency for Environmental and Occupational Health Safety (AFSSET) published a report on "the health impacts of noise generated by wind turbines", commissioned by the Ministries of Health and Environment in June 2006 following the report of the French National Academy of Medicine in March 2006[28]. The AFSSET study recommends that one does not define a fixed minimum distance between wind farms and homes, but rather to model the acoustic impact of the project on a case-by-case basis. One of the conclusions of the AFSSET report is: "The analysis of available data shows: The absence of identified direct health consequences concerning the auditory effects or specific effects usually associated with exposure to low frequencies at high level." ("L'analyse des données disponibles met en évidence: L'absence de conséquences sanitaires directes recensées en ce qui concerne les effets auditifs, ou les effets spécifiques généralement attachés à l'exposition à des basses fréquences à niveau élevé.").

4 FIELD PROGRAM

Two types of utility-scale wind turbines were studied for this field program. These two turbines are among the most commonly used in the NextEra fleet: General Electric (GE) 1.5sle (1.5 MW), and Siemens SWT-2.3-93 (2.3 MW).

Sound levels for these wind turbine generators (WTGs) vary as a function of wind speed from cut-in wind speed to maximum sound level. Cut-in wind speed for the GE 1.5sle wind turbine is 3.5 m/s while the Siemens wind turbine has a cut-in wind speed of 4 m/s. Maximum reference sound power levels for the GE 1.5sle and Siemens 2.3-93 are approximately 104 dB and 105 dB respectively as provided by the manufacturer. These sound power levels are reached at electrical output levels of approximately 924 kW and 1767 kW for the GE and Siemens units, respectively. Under higher wind speeds, the sound levels from the wind turbines do not increase although electrical power output does continue to increase up to the rated power of each wind turbine (1500 kW and 2300 kW respectively).

Each wind turbine manufacturer has an uncertainty factor "K" of 2 dB to guarantee the turbine's sound power level. (K accounts for both measurement variations and production variation[29].) The results presented later in this paper include sound power values which have added the manufacturer's K value to the reference values, that is, 2 dB above the expected reference levels for the measured wind conditions and power output.

Real-world data were collected from operating wind turbines to compare to the low frequency noise guidelines and criteria discussed previously in Sec. 2. These data sets consisted of outdoor measurements at various reference distances, and concurrent indoor/outdoor measurements at residences within the wind farm.

NextEra provided access to the Horse Hollow Wind Farm in Taylor and Nolan Counties, Texas in November 2008 to collect data on the GE 1.5sle and Siemens SWT-2.3-93 wind turbines. The portion of the wind farm used for testing is relatively flat with no significant terrain. The land around the wind turbines is rural and primarily used for agriculture and cattle grazing. The siting of the sound level measurement locations was chosen to minimize local noise sources except the wind turbines and the wind itself. Hub height for these wind turbines is 80 meters above ground level (AGL).

Two of the authors collected sound level and wind speed data over the course of one week under a variety of operational conditions. Weather conditions were dry the entire week with ground level winds ranging from calm to 12.5 m/s (28 mph) over a 1-minute average. In order to minimize confounding factors, the data collection tried to focus on periods of maximum sound levels from

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the wind turbines (moderate to high hub height winds) and light to moderate ground level winds.

Ground level (2 meters AGL) wind speed and direction were measured continuously at one representative location. Wind speeds near hub height were also measured continuously using the permanent meteorological towers maintained by the wind farm.

A series of simultaneous interior and exterior sound level measurements were made at four houses owned by participating landowners within the wind farm. Two sets were made of the GE WTGs, and two sets were made of the Siemens WTGs. Data were collected with both windows open and windows closed. Due to the necessity of coordinating with the homeowners in advance, and reasonable restrictions on time of day to enter their homes, the interior/exterior measurement data sets do not always represent ideal conditions. However, enough data were collected to compare to the criteria and draw conclusions on low frequency noise.

Sound level measurements were also made simultaneously at two reference distances from a string of wind turbines under a variety of wind conditions. Using the manufacturer's sound power level data, calculations of the sound pressure levels as a function of distance in flat terrain were made to aid in deciding where to collect data in the field. Based on this analysis, two distances from the nearest wind turbine were selected—305 meters (1,000 feet) and 457 meters (1,500 feet)—and were then used where possible during the field program. Distances much larger than 457 meters (1,500 feet) were not practical since an adjacent turbine string could then be closer and affect the measurements, or would put the measurements beyond the boundaries of the wind farm property owners. Brief background sound level measurements were conducted several times during the program whereby the Horse Hollow Wind Farm operators were able to shutdown the nearby WTGs for a brief (20 minutes) period. This was done in real time using cell phone communication.

All the sound level measurements described above were attended. One series of unattended overnight measurements was made at two locations for approximately 15 hours to capture a larger data set. One measurement was set up approximately 305 meters (1,000 feet) from a GE 1.5sle WTG and the other was set up approximately 305 meters (1,000 feet) from a Siemens WTG. The location was chosen based on the current wind direction forecast so that the sound level equipment would be downwind for the majority of the monitoring period. By doing this, the program was able to capture periods of strong hub-height winds and moderate to low ground-level winds.

All sound levels were measured using two Norsonic Model Nor140 precision sound analyzers, equipped with a Norsonic-1209 Type 1 Preamplifier, a Norsonic-1225 half-inch microphone and a 7-inch Aco-Pacific untreated foam windscreen Model WS7. The instrumentation meets the "Type 1—Precision" requirements set forth in American National Standards Institute (ANSI) S1.4 for acoustical measuring devices[30]. The microphone was tripod-mounted at a height of 1.5 meters (five feet) above ground. The measurements included simultaneous collection of broadband (A-weighted) and one-third-octave band data (3.15 hertz to 20,000 hertz bands). Sound level data were primarily logged in 10-minute intervals to be consistent with the wind farm's Supervisory Control And Data Acquisition (SCADA) system which provides electrical power output (kW) in 10-minute increments. A few sound level measurements were logged using 20-minute intervals for use in determining home transmission loss values. The meters were calibrated and certified as accurate to standards set by the National Institute of Standards and Technology. These calibrations were conducted by an independent laboratory within the past 12 months. Ground level wind speed and direction were measured with a HOBO H21-002 micro weather station (Onset Computer Corporation). The wind data were sampled every three seconds and logged every one minute.

5 RESULTS AND COMPARISON TO CRITERIA

Results from the field program are organized by wind turbine type. For each wind turbine type, results are presented per location type (outdoor or indoor) with respect to applicable criteria. Results are presented for 305 meters (1,000) feet from the nearest wind turbine. Data were also collected at 457 meters (1,500 feet) from the nearest wind turbine which showed lower sound levels. Therefore, wind turbines that met the criteria at 305 meters also met it at 457 meters. Data were collected under both high turbine output and moderate turbine output conditions (defined as sound power levels 2 or 3 dB less than the maximum sound power levels), and low ground-level wind speeds. The sound level data under the moderate conditions were equivalent to or lower than the high turbine output scenarios, thus confirming the conclusions from the high output cases. None of the operational sound level data were corrected for background noise. A-weighted sound power levels presented in this section (used to describe turbine operation) were estimated from the actual measured power output (kW) of the wind turbines and the sound power levels as a function of wind speed plus an uncertainty factor K of 2 dB.

Outdoor measurements are compared to criteria for audibility, for UK DEFRA disturbance using equivalent outdoor levels, for rattle and annoyance criteria as

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Table 10—Summary of operational parameters—Siemens SWT-2.3-93 (Outdoor).

Parameter	Sample #34	Sample #39
Distance to nearest WTG	305 meters	305 meters
Time of day	22:00-22:10	22:50-23:00
WTG power output	1,847 kW	1,608 kW
A-weighted sound power level*	107 dB	106.8 dB
Measured wind speed @ 2 m	3.3 m/s	3.4 m/s
L_{Aeq}	49.4 dB	49.6 dB
L_{A90}	48.4 dB	48.6 dB
L_{Ceq}	63.5 dB	63.2 dB

* Includes K, uncertainty factor of 2 dB

contained in ANSI S12.9/Part 4, for evaluating complaints of rattling using Japan Ministry of Environment guidance, and for perceptible vibration using equivalent outdoor levels from ANSI/ASA S12.2. Indoor measurements are compared to criteria for audibility, for UK DEFRA disturbance, for evaluating complaints of mental and physical discomfort using Japan Ministry of Environment guidance, and for suitability of bedrooms, hospitals and schools and perceptible vibration from ANSI/ASA S12.2.

5.1 Siemens SWT-2.3-93

5.1.1 Outdoor measurements—Siemens SWT-2.3-93

Sound levels during six 10-minute periods of high wind turbine output and relatively low ground wind speed (which minimized effects of wind noise) were measured outdoors approximately 305 meters (1,000 feet) from the closest Siemens WTG. This site was actually part of a string of 15 WTGs, four of which were within 610 meters (2,000 feet) of the monitoring location. Representative sound level data from two 10-minute periods are presented herein and include contributions from all wind turbines as measured by the recording equipment. One data set is representative of time periods with low frequency sound level values near the maximum measured and the other data set is representative of the mean. The standard deviations for the low frequency one-third octave band levels for the six measurement periods were between 0.2–0.7 dB. The key operational and meteorological parameters during these two measurement periods are listed in Table 10.

Figure 2 plots the one-third octave band sound levels (L_{eq}) for both samples of high output conditions. The results show that infrasound is inaudible to even the most sensitive people 305 meters (1,000 feet) from these wind turbines (more than 20 dB below the median thresholds of hearing). Low frequency sound above 40 Hz may be audible depending on background sound levels.

Figure 3 plots the one-third octave band sound levels (L_{eq}) for both samples of high output conditions. The low frequency sound was "steady" according to DEFRA procedures, and the results show that all outdoor equivalent DEFRA disturbance criteria are met.

Figure 4 compares the one-third octave band sound levels (L_{eq}) for both samples of high output conditions to the Japan Ministry of Environment levels for evaluating complaints on rattle. The rattle criteria is met at all frequencies except at 5 Hz where the mean value is 1 dB (standard deviation of 0.4 dB) higher than the Japanese evaluation value. When one considers that the 5 Hz sound level is 3 dB lower than the observed threshold of rattle, one concludes that the Japanese criteria are met.

The measured outdoor sound levels also meet the outdoor equivalent Japan Ministry of Environment

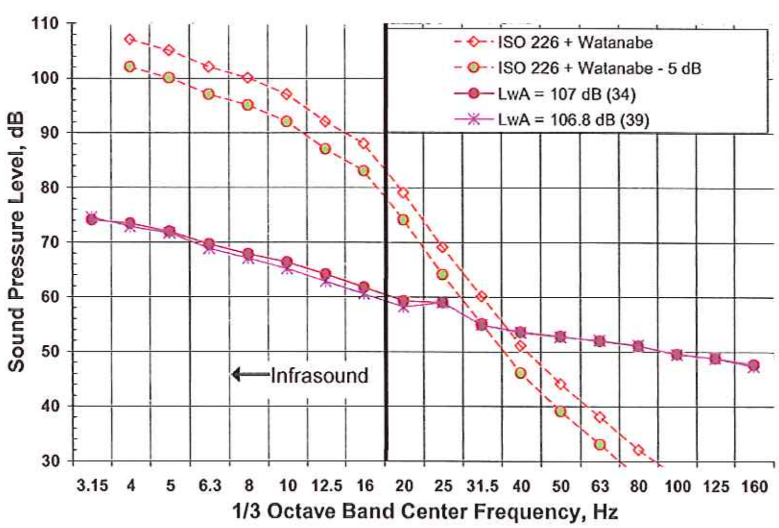

Fig. 2—Siemens SWT-2.3-93 wind turbine outdoor sound levels at 305 meters compared to audibility criteria.

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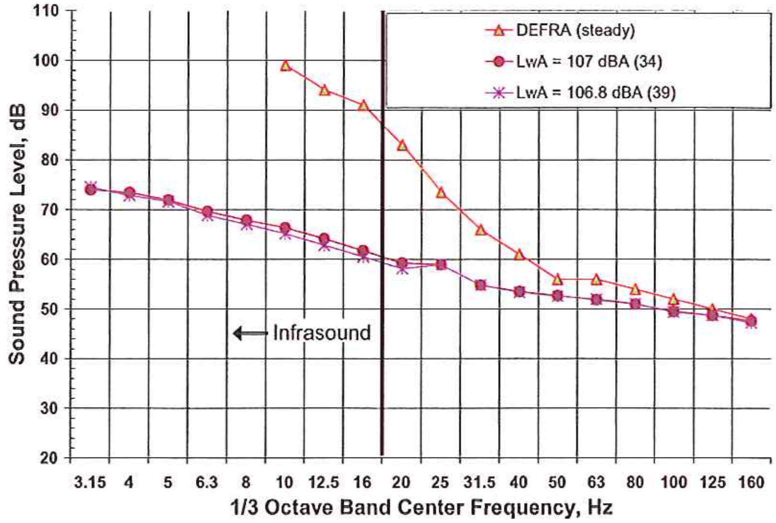

Fig. 3—Siemens SWT-2.3-93 wind turbine outdoor sound levels at 305 meters compared to outdoor equivalent DEFRA criteria.

criteria for evaluating complaints of mental and physical discomfort. This comparison is not presented in a figure since these criteria are generally less stringent than the DEFRA criteria.

Figure 5 plots the 16, 31.5, 63, and 125 Hz octave band sound levels (L_{eq}) for both samples of high output conditions. The results show that all outdoor equivalent ANSI/ASA S12.2 perceptible vibration criteria are met. In addition, the results show that all outdoor equivalent ANSI/ASA S12.2 low frequency NC-25 and NC-30 criteria for bedrooms are met. The low frequency sound levels are below the ANSI S12.9 Part 4 thresholds for the beginning of rattles (16, 31.5, 63 Hz total less than 70 dB). The 31.5 and 63 Hz sound levels are below the level of 65 dB identified for minimal annoyance in ANSI S12.9 Part 4, and the 16 Hz sound level is within 1.5 dB of this level, which is an insignificant increase since the levels were not rapidly fluctuating.

5.1.2 Indoor measurements—Siemens SWT-2.3-93

Simultaneous outdoor and indoor measurements were made at two residences at different locations within the wind farm to determine indoor audibility of low frequency noise from Siemens WTGs. In each house a 10-minute measurement was made in a room facing the wind turbines with a window both open and closed. Results from the testing at one of the homes are not presented due to the very high ground level winds

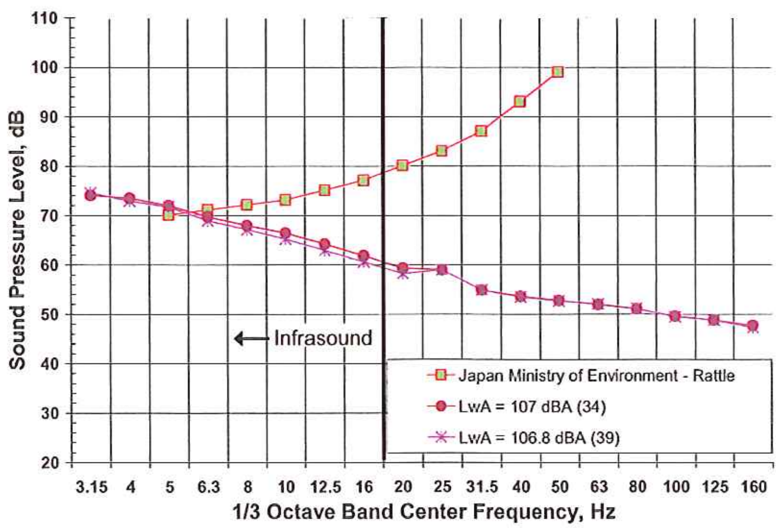

Fig. 4—Siemens SWT-2.3-93 wind turbine outdoor sound levels at 305 meters compared to Japan Ministry of Environment rattle criteria.

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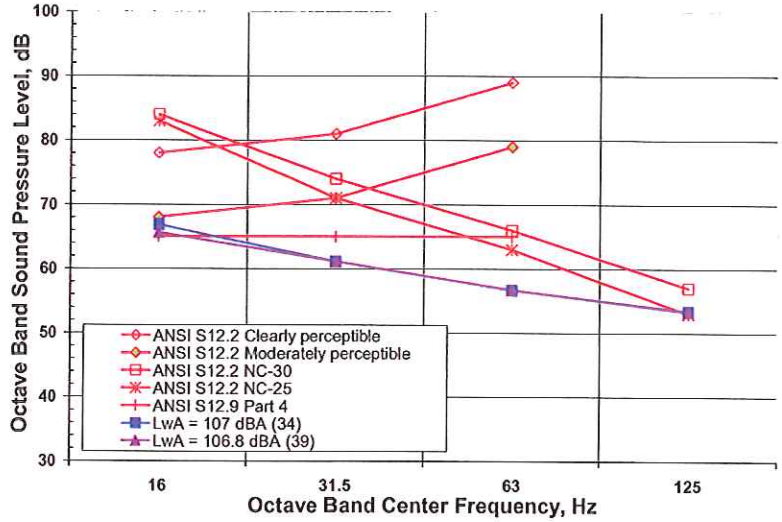

Fig. 5—Siemens SWT-2.3-93 wind turbine outdoor sound levels at 305 meters compared to ANSI criteria.

(~9 m/s) which dominated the sound environment. The remaining residence is designated Home "A" and was approximately 323 meters (1,060 feet) from the closest Siemens WTG. The home was near a string of multiple WTGs, four of which were within 610 meters (2,000 feet) of the house. The sound level data presented herein include contributions from all wind turbines as measured by the recording equipment. The key operational and meteorological parameters during these measurements are listed in Table 11.

The room in Home "A" where interior measurements were made had the following characteristics: approximately 3.6 meters wide (12 feet) by 4.9 meters long (16 feet), no furniture, carpeted flooring, two relatively new double-hung windows (no storm windows), sheetrock interior walls, and clapboard exterior walls. The sound level meter was located in the center of the room.

Figure 6 plots the indoor one-third octave band sound levels (L_{eq}) for Home "A". The results show that infrasound is inaudible to even the most sensitive people approximately 1,000 feet from these wind turbines with the windows open or closed (more than 20 dB below the median thresholds of hearing). Low frequency sound at or above 50 Hz may be audible depending on background sound levels.

Table 11—Summary of operational parameters—Siemens SWT-2.3-93 (Indoor).

Parameter	Home "A" (closed/open)
Distance to nearest WTG	323 meters
Time of day	07:39-07:49/07:51-08:01
WTG power output	1,884 kW/1564 kW
A-weighted sound power level*	107 dB/106.7 dB
Measured wind speed @ 2 m	3.2 m/s/3.7 m/s
L_{Aeq}	33.8 dB/38.1 dB
L_{A90}	28.1 dB/36.8 dB
L_{Ceq}	54.7 dB/57.1 dB

* Includes K, uncertainty factor of 2 dB

Figure 7 plots the indoor one-third octave band sound levels (L_{eq}) for Home "A". The low frequency sound was "steady" according to DEFRA procedures under the window open condition, and the results show that all indoor DEFRA disturbance criteria are met.

Although not shown in Fig. 7, the one-third octave band levels meet the Japan Ministry of Environment criteria for evaluating complaints of mental and physical discomfort since in the frequency range of the Japan criteria both samples meet the more stringent DEFRA criteria for "non-steady" sounds, which is more stringent than the Japan criteria.

Figure 8 plots the indoor 16 Hz to 125 Hz octave band sound levels (L_{eq}) for Home "A". The results show the ANSI/ASA S12.2 low frequency criteria for perceptible vibration were easily met for both windows open and closed scenarios. The ANSI/ASA S12.2 low frequency NC-25 and NC-30 criteria for bedrooms, classrooms and hospitals were met, the spectrum was balanced, and the criteria for moderately perceptible vibrations in lightweight walls and ceilings were also met.

5.2 GE 1.5sle

5.2.1 Outdoor measurements—GE 1.5sle

Sound level data during twelve 10-minute periods of high wind turbine output and relatively low ground wind speed (which minimized effects of wind noise) were measured outdoors approximately 305 meters (1,000 feet) from the closest GE 1.5sle WTG. This site was actually part of a string of more than 30 WTGs, four of which were within 610 meters (2,000 feet) of the

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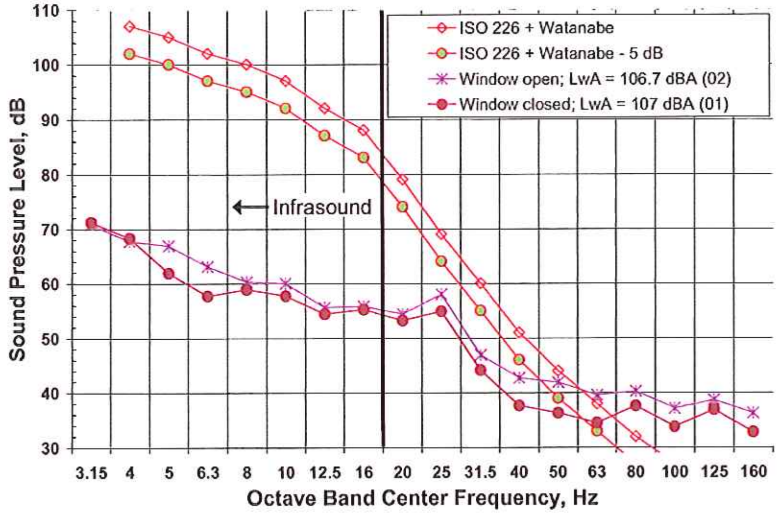

Fig. 6—Siemens SWT-2.3-93 wind turbine indoor sound levels at 323 meters compared to audibility criteria (Home "A").

monitoring location. Representative sound level data from two 10-minute periods are presented herein and include contributions from all wind turbines as measured by the recording equipment. One data set is representative of time periods with low frequency sound level values near the maximum and the other data set is representative of the mean. The standard deviations for the low frequency one-third octave band levels for the twelve measurement periods were between 0.3–1.9 dB with the largest variation in the 10–16 Hz bands and the lowest at 160 Hz. The key operational and meteorological parameters for these two measurement periods are listed in Table 12.

Figure 9 plots the one-third octave band sound levels (L_{eq}) for both samples of high output conditions. The results show that infrasound is inaudible to even the most sensitive people 305 meters (1,000 feet) from these wind turbines (more than 20 dB below the median thresholds of hearing). Low frequency sound at and above 31.5–40 Hz may be audible depending on background sound levels.

Figure 10 plots the one-third octave band sound levels (L_{eq}) for both samples of high output conditions. The low frequency sound was "steady" according to DEFRA procedures, and the results show the low frequency sound meet or are within 1 dB of outdoor equivalent DEFRA disturbance criteria.

Figure 11 compares the one-third octave band sound levels (L_{eq}) for both samples of high output conditions to the Japan Ministry of Environment levels for evaluating complaints on rattle. The rattle criteria is met at all

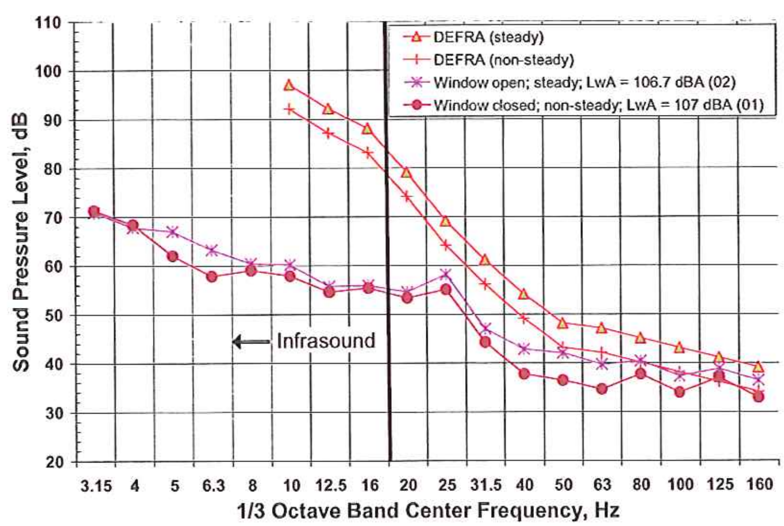

Fig. 7—Siemens SWT-2.3-93 wind turbine indoor sound levels at 323 meters compared to DEFRA criteria (Home "A").

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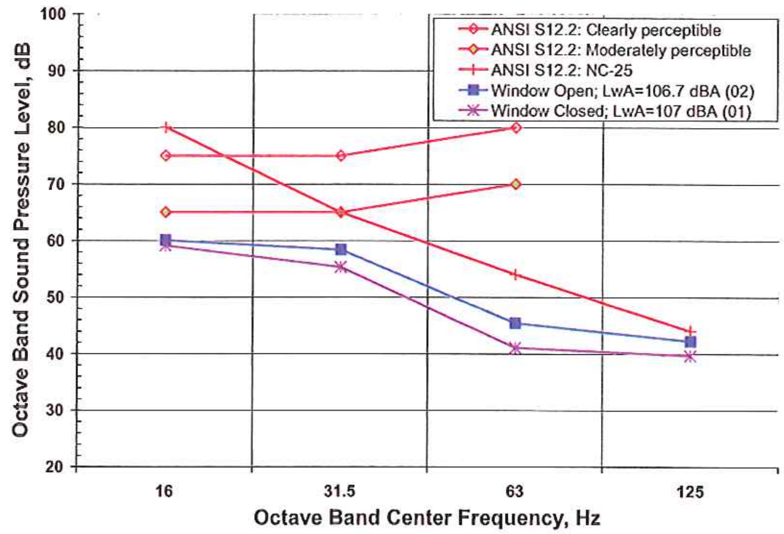

Fig. 8—Siemens SWT-2.3-93 wind turbine indoor sound levels at 323 meters compared to ANSI 12.2 criteria for perceptible vibrations and NC-25 (Home "A").

frequencies; at 5 Hz the mean value is 70 dB (standard deviation=0.9 dB), while the two presented measurements are approximately 1 dB higher, an insignificant increase. When one considers that the 5 Hz sound level is 3 dB lower than the observed threshold of rattle, one concludes that the Japanese criteria are met.

Table 12—Summary of operational parameters—GE 1.5sle (Outdoor).

Parameter	Sample #46	Sample #51
Distance to nearest WTG	305 meters	305 meters
Time of day	23:10-23:20	00:00-00:10
WTG power output	1,293 kW	1,109 kW
A-weighted sound power level*	106 dB	106 dB
Measured wind speed @ 2 m	4.1 m/s	3.3 m/s
L_{Aeq}	50.2 dB	50.7 dB
L_{A90}	49.2 dB	49.7 dB
L_{Ceq}	62.5 dB	62.8 dB

* Includes K, uncertainty factor of 2 dB

The measured outdoor sound levels also meet the outdoor equivalent Japan Ministry of Environment criteria for evaluating complaints of mental and physical discomfort. This comparison is not presented in a figure since these criteria are generally less stringent than the DEFRA criteria.

Figure 12 plots the 16, 31.5, 63 and 125 Hz octave band sound levels (L_{eq}) for both samples of high output conditions. The results show that all outdoor equivalent ANSI/ASA S12.2 perceptible vibration criteria are met. The results show that all outdoor equivalent ANSI/ASA S12.2 low frequency NC-25 and NC-30 criteria for

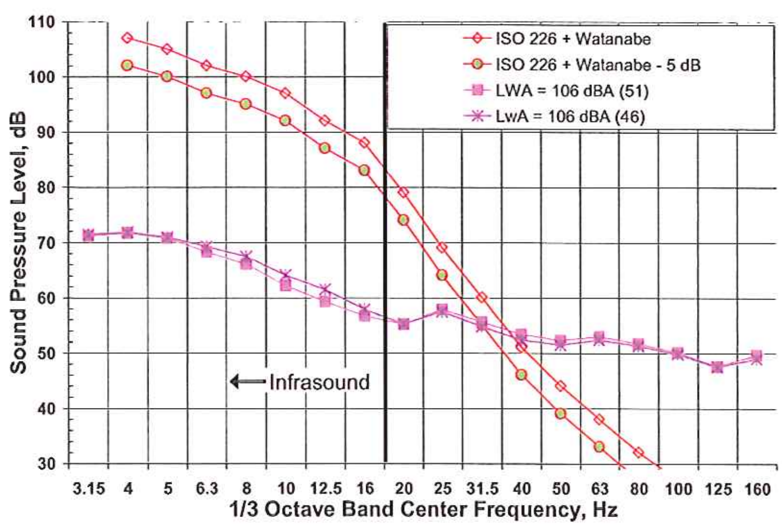

Fig. 9—GE 1.5sle wind turbine outdoor sound levels at 305 meters compared to audibility criteria.

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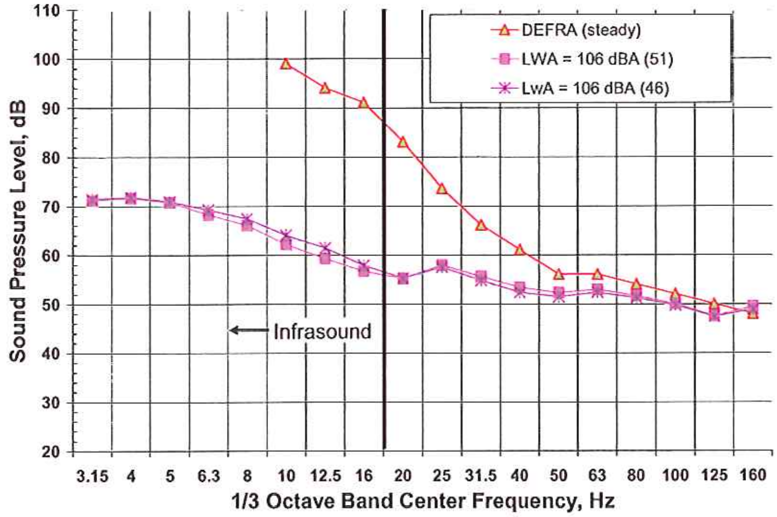

Fig. 10—GE 1.5sle wind turbine outdoor sound levels at 305 meters compared to outdoor equivalent DEFRA criteria.

bedrooms are met. The low frequency sound levels are below the ANSI S12.9 Part 4 thresholds for the beginning of rattles (16, 31.5, 63 Hz total less than 70 dB). The 16, 31.5, 63 Hz sound levels are below the level of 65 dB identified for minimal annoyance in ANSI S12.9 Part 4.

5.2.2 Indoor measurements—GE 1.5sle

Simultaneous outdoor and indoor measurements were made at two residences at different locations within the wind farm to determine indoor audibility of low frequency noise from GE 1.5sle WTGs. In each house, measurements were made in a room facing the wind turbines, and were made with a window both open and closed. These residences are designated Homes "B" and "C" and were approximately 305 meters (1,000 feet) from the closest GE WTG. Operational conditions were maximum turbine noise and high ground winds at Home "B", and within 1.5 dB of maximum turbine noise and high ground level winds at Home "C". Home "B" was near a string of multiple WTGs, four of which were within 610 meters (2,000 feet) of the house, while Home "C" was at the end of a string of WTGs, two of which were within 610 meters of the house. The sound level data presented herein include contributions from all wind turbines as measured by the recording equipment. The key operational and meteorological parameters during these measurements are listed in Table 13.

The room in Home "B" where interior measurements were made had the following characteristics:

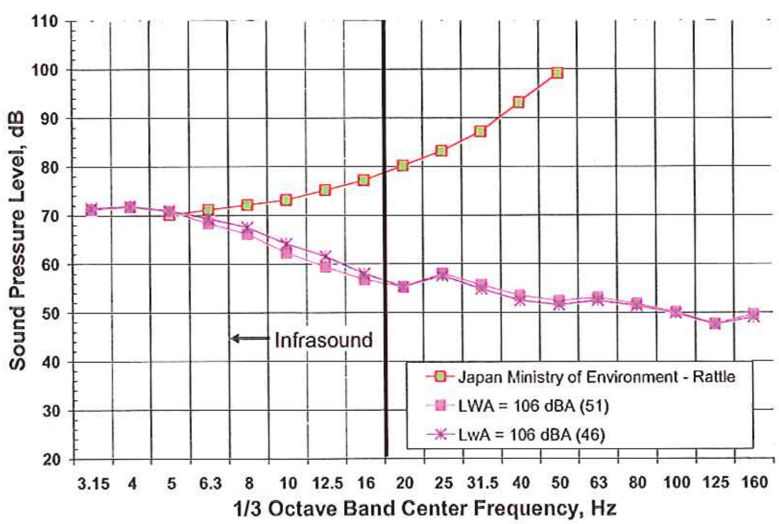

Fig. 11—GE 1.5sle wind turbine outdoor sound levels at 305 meters compared to Japan Ministry of Environment rattle criteria.

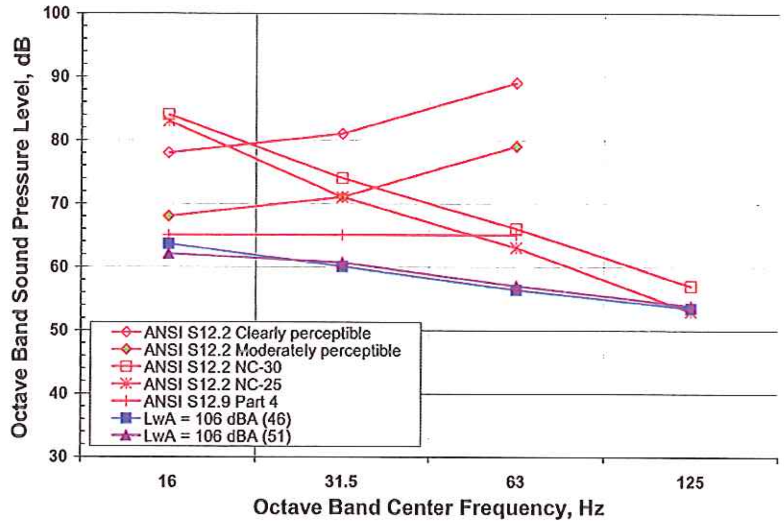

Fig. 12—GE 1.5sle wind turbine outdoor sound levels at 305 meters compared to ANSI criteria.

approximately 3.0 meters wide (10 feet) by 3.6 meters long (12 feet), bedroom furniture, carpeted flooring, two relatively new double-hung windows (no storm windows), paneling on the interior walls, and bricked exterior walls. The sound level meter was located just off-center in the room. The room in Home "C" where interior measurements were made had the following characteristics: approximately 2.4 meters wide (8 feet) by 3.6 meters long (12 feet), bathroom fixtures, linoleum flooring, one old casement window (no storm window), paneling on the interior walls, and wooden exterior walls. The sound level meter was located in the center of the room.

Figure 13 plots the indoor one-third octave band sound levels (L_{eq}) for Home "B", and Fig. 14 plots the indoor one-third octave band sound levels for Home "C". The results show that infrasound is inaudible to even the most sensitive people at around 305 meters (1,000 feet) from these wind turbines with the windows open or closed (more than 20 dB below the median thresholds of hearing). Low frequency sound at and above 63 Hz may be audible depending on background sound levels.

Figure 15 plots the indoor one-third octave band sound levels (L_{eq}) for Home "B", and Fig. 16 plots the indoor one-third octave band sound levels (L_{eq}) for Home "C". The results show the DEFRA disturbance criteria were met for steady and non-steady low frequency sounds.

Although not shown in Figs. 15 and 16, the one-third octave band levels meet the Japan Ministry of Environment criteria for evaluating complaints of mental and physical discomfort since both samples meet the more stringent DEFRA criteria for "non-steady" sounds, which is more stringent than the Japan criteria.

Figure 17 plots the indoor 16 Hz to 125 Hz octave band sound levels (L_{eq}) for Home "B", and Fig. 18 plots the indoor 16 Hz to 125 Hz octave band sound levels (L_{eq}) for Home "C". The results show the ANSI/ASA S12.2 low frequency criteria for perceptible vibration were met for both windows open and closed scenarios. The ANSI/ASA S12.2 low frequency NC-25 and NC-30 criteria for bedrooms, classrooms and hospitals were met,

Table 13—Summary of operational parameters—GE 1.5sle (Indoor).

Parameter	Home "B" (closed/open)	Home "C" (closed/open)
Distance to nearest WTG	290 meters	312 meters
Time of day	09:29-09:39/09:40-09:50	11:49-11:59/12:00-12:10
WTG power output	1,017 kW/896 kW	651 kW/632 kW
A-weighted sound power level	106 dB/105.8 dB	104.7 dB/104.6 dB
Measured wind speed @ 2 m	6.2 m/s/6.8 m/s	6.4 m/s/5.9 m/s
L_{Aeq}	27.1 dB/36.0 dB	33.6 dB/39.8 dB
L_{A90}	23.5 dB/33.7 dB	27.6 dB/34.2 dB
L_{Ceq}	47.1 dB/54.4 dB	50.6 dB/55.1 dB

* Includes K, uncertainty factor of 2 dB

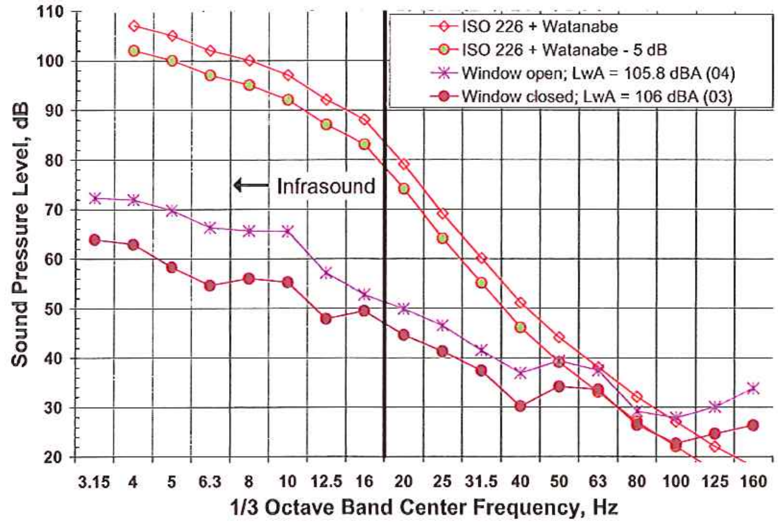

Fig. 13—GE 1.5sle wind turbine indoor sound levels at 290 meters compared to audibility criteria (Home "B").

the spectrum was balanced, and the criteria for moderately perceptible vibrations in light-weight walls and ceilings were also met.

5.3 Noise Reduction from Outdoor to Indoor

Simultaneous outdoor and indoor measurements made at the three residences within the Horse Hollow Wind Farm discussed above, were used to determine noise reductions of the homes for comparison to that used in the determination of equivalent outdoor criteria for indoor criteria, such as ANSI/ASA S12.2 and DEFRA. Indoor measurements were made with windows open and closed. Tables 11 and 13 list the conditions of measurement for these houses.

Figures 19 and 20 present the measured one-third octave band noise reduction for the three homes with windows closed and open, respectively. Also presented in these same figures are the one-third octave noise reductions discussed in the Appendix of this paper to obtain equivalent outdoor criteria for the indoor DEFRA criteria as well as the equivalent outdoor criteria for the Japanese mental and physical discomfort indoor criteria. It can be seen that for the window closed condition in Fig. 19, the measured noise reductions for all houses were greater than that used in our analysis for determining the equivalent outdoor criteria for the Japanese mental and physical discomfort indoor criteria. For the open window case in Fig. 20, which

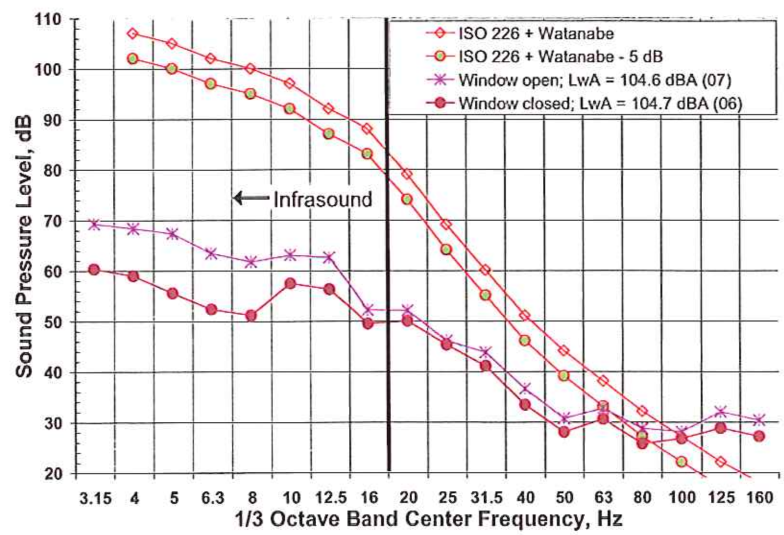

Fig. 14—GE 1.5sle wind turbine indoor sound levels at 312 meters compared to audibility criteria (Home "C").

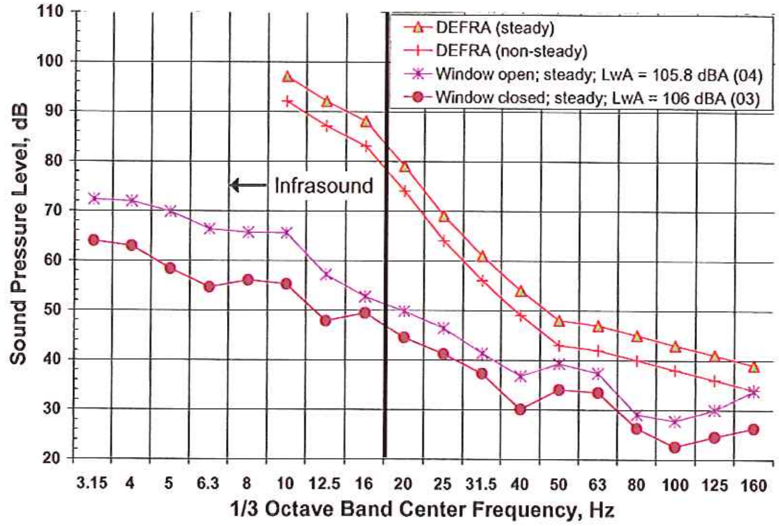

Fig. 15—GE 1.5sle wind turbine indoor sound levels at 290 meters compared to DEFRA criteria (Home "B").

was used in our analysis for obtaining the equivalent outdoor DEFRA criteria, the average of the three homes has a greater noise reduction than assumed in the Appendix and all houses at all frequencies have higher values with one minor exception. Only Home "A" at 25 Hz had a lower noise reduction (3 dB), and this difference is not critical since the measured indoor sounds at 25 Hz at each of these home was significantly lower than the indoor DEFRA criteria and the indoor Japanese criteria. Furthermore, the outdoor measurements for both Siemens and GE wind turbines at 305 meters (1,000 feet) under high output/high noise levels met the equivalent outdoor DEFRA criteria at 25 Hz.

Table 14 presents the measured octave band noise reduction for the three homes with windows closed and open, respectively. Also presented in Table 14 are the octave band noise reductions used in Table 2 of this paper to obtain equivalent outdoor criteria for the indoor ANSI/ASA S12.2 criteria for perceptible vibration and for NC-25 and NC-30. It can be seen that for the window closed condition, the measured noise reductions for all houses were greater than that used in our analysis. For the open window case, the average of the three homes has a greater noise reduction than the values from Table A1, and all houses at all frequencies have higher values with one minor exception. Only Home "A" at 31 Hz (which contains the 25 Hz one-third octave band) had a lower noise reduction (3 dB), and this difference is not critical since the measured indoor sounds at 31 Hz at each of these homes was significantly lower than the indoor ANSI/ASA S12.2 criteria. Furthermore, the outdoor measurements for both Siemens and GE wind

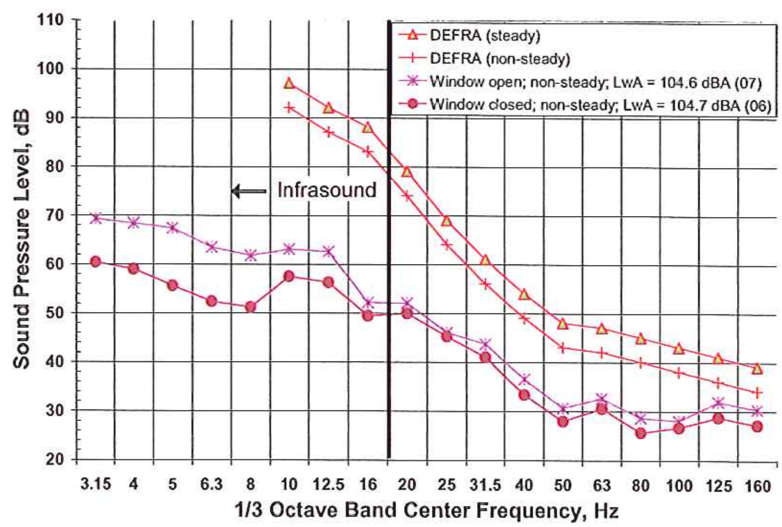

Fig. 16—GE 1.5sle wind turbine indoor sound levels at 312 meters compared to DEFRA criteria (Home "C").

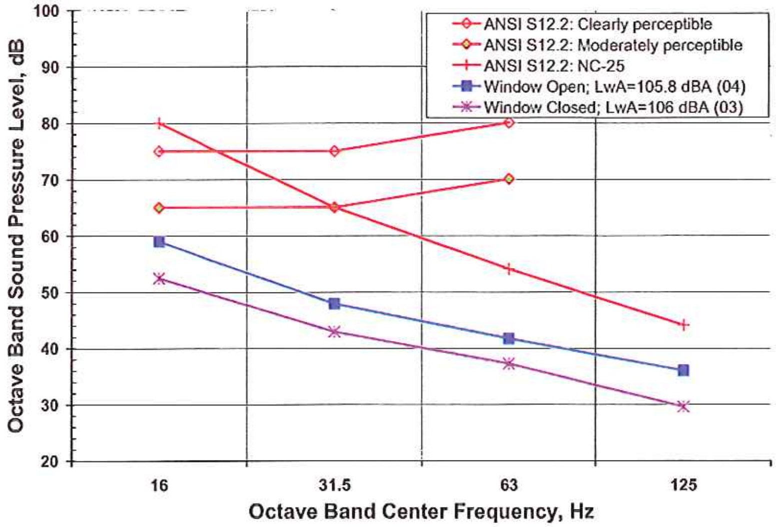

Fig. 17—GE 1.5sle wind turbine indoor sound levels at 290 meters compared to ANSI 12.2 criteria for perceptible vibrations and NC-25 (Home "B").

turbines at 305 meters (1,000 feet) under high output/high noise levels met the equivalent outdoor ANSI/ASA S12.2 criteria at 31 Hz.

6 CONCLUSION

Sound levels from Siemens SWT 2.93-93 and GE 1.5sle wind turbines under maximum noise conditions at a distance more than 305 meters (1,000 feet) from the nearest residence meet the low frequency and infrasound standards and criteria published by several independent agencies and organizations. At this distance the wind farms:

- meet ANSI/ASA S12.2 indoor levels for low frequency sound for bedrooms, classrooms and hospitals;
- meet ANSI/ASA S12.2 indoor levels for moderately perceptible vibrations in light-weight walls and ceilings;
- meet ANSI/ASA S12.2 criteria for balanced spectrum from low frequency sounds;
- meet ANSI S12.9/Part 4 thresholds for annoyance from low frequency sound and beginning of rattles;
- meet UK DEFRA disturbance based guidelines for low frequency sound;
- meet Japan Ministry of Environment Guidance for evaluating complaints of rattling from low frequency noise;
- meet Japan Ministry of Environment Guidance for evaluating complaints of mental and physi-

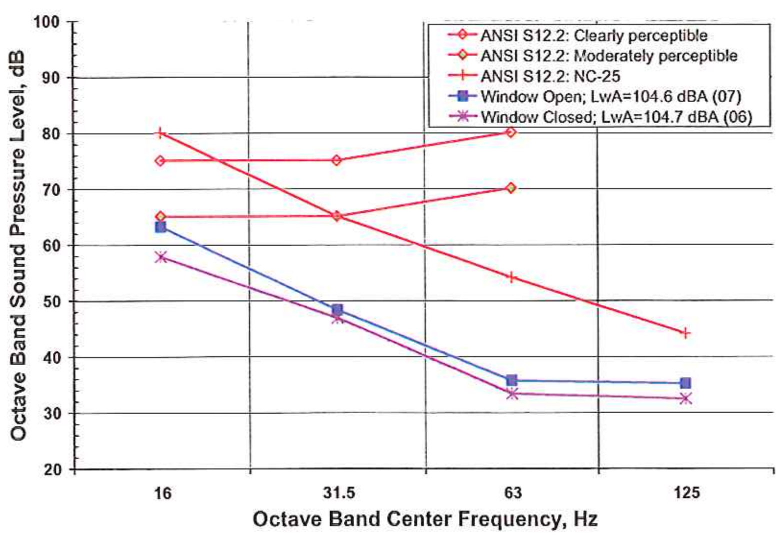

Fig. 18—GE 1.5sle wind turbine indoor sound levels at 312 meters compared to ANSI 12.2 criteria for perceptible vibrations and NC-25 (Home "C").

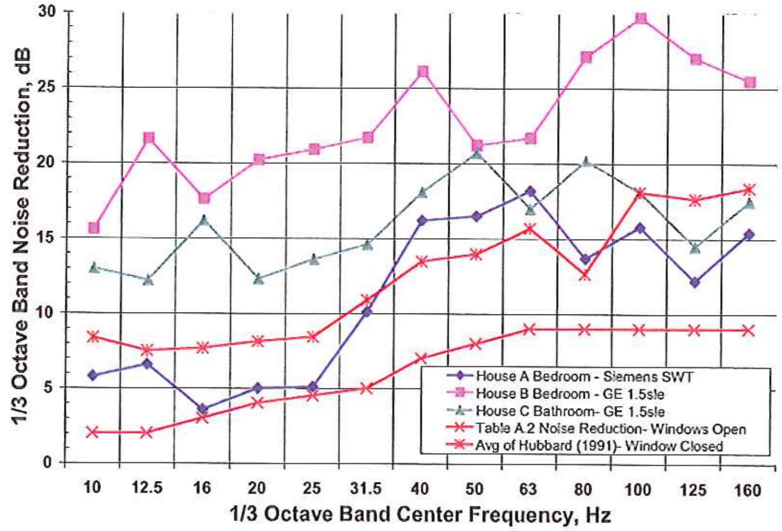

Fig. 19—One-third octave band interior noise reduction—Windows closed.

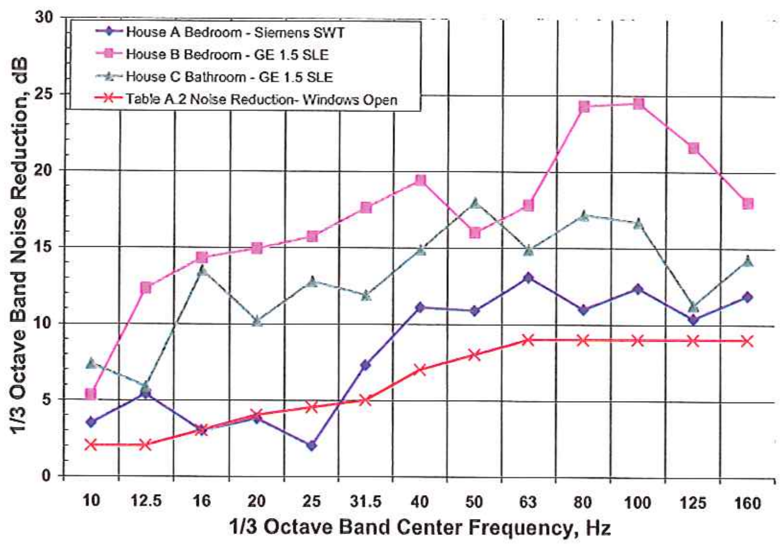

Fig. 20—One-third octave band interior noise reduction—Windows open.

cal discomfort from low frequency noise;
- have no audible infrasound to the most sensitive listeners; and
- might have slightly audible low frequency noise at frequencies at 50 Hz and above depending on other sources of low frequency noises in homes, such as refrigerators or external traffic or airplanes.

In accordance with the above findings, and in conjunction with our extensive literature search of

Table 14—Summary of octave band noise reduction—Interior measurements.

Home	Wind Turbine	Windows	16 Hz	31.5 Hz	63 Hz	125 Hz
A	Siemens SWT-2-3-93	Closed	5	6	16	14
A	Siemens SWT-2-3-93	Open	4	3	12	12
B	GE 1.5sle	Closed	20	22	22	27
B	GE 1.5sle	Open	13	17	18	21
C	GE 1.5sle	Closed	13	14	19	17
C	GE 1.5sle	Open	8	13	17	14
Table A1 Noise Reduction		Open	3	6	9	9

EXHIBIT 49

scientific papers and reports, there should be no adverse public health effects from infrasound or low frequency noise at distances greater than 305 meters (1,000 feet) from the wind turbine types measured: GE 1.5sle and Siemens SWT 2.3-93.

7 ACKNOWLEDGMENTS

Acknowledgement is made to NextEra Energy Resources, LLC ("NextEra"), formerly FPL Energy, for providing financial support for the study, allowing access to the wind farm, and supplying critical operational data. Epsilon determined all means, methods, and the testing protocol without interference or direction from NextEra. No limitations were placed on Epsilon by NextEra with respect to the testing protocol or upon the analysis methods; the conclusions are those of the authors.

8 APPENDIX: HOME NOISE REDUCTION USED TO DETERMINE EQUIVALENT OUTDOOR SOUND PRESSURE LEVEL CRITERIA BASED ON INDOOR CRITERIA

Since indoor measurements are not always possible, for comparison to outdoor sound levels the indoor criteria from ANSI/ASA S12.2 should be adjusted. Outdoor to indoor low frequency noise reductions have been reported by Sutherland for aircraft and highway noise for open and closed windows[9] and by Hubbard and Shepherd for aircraft and wind turbine noise for closed windows[10]. Table A1 presents the average low frequency octave band noise reductions from outdoor to indoors from these two papers for open and closed windows. Sutherland only reported values down to 63 Hz; whereas Hubbard and Shepherd presented values to less than 10 Hz. The closed window conditions of Ref. 10 were used to estimate noise reductions less than 63 Hz by applying the difference between values for open and closed windows from Ref. 9 data at 63 Hz. It should be noted that the attenuation for wind turbines in Ref. 10 is based on only three homes at two different wind farms, whereas the traffic and aircraft data are for many homes. The wind turbine open window values were determined from the wind turbine closed window values by subtracting the difference in values between windows closed and open obtained by Ref. 9.

To be conservative, we use the open window case instead of closed windows except for the adjustments to the Japanese guideline which specifically called for closed windows. To be further conservative, we use the wind turbine noise reduction data in Ref. 10 (adjusted to open windows). However, it should be noted that it is possible for some homes to have some slight amplification at low frequencies with windows open due to possible room resonances.

The average one-third octave band noise reductions used to determine equivalent outdoor one-third octave band criteria were determined in a similar manner. The first row of Table A2 and Fig. 20 present the average one-third octave band noise reductions values for *windows open* that were used to determine the equivalent outdoor one-third octave band criteria levels in Table 7 from the indoor criteria. The second row of Table A2 and Fig. 19 presents the one-third octave band noise reductions for windows closed determined by Ref. 10 for homes exposed to wind turbine sounds—these higher closed window noise reduction values were only used to determine equivalent outdoor levels for determining the equivalent Japanese guidance one-third octave band sound pressure level values for dealing with complaints of mental and physical discomfort from environmental sounds.

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EXHIBIT 49

BEFORE THE

PUBLIC SERVICE COMMISSION OF WISCONSIN

- -

APPLICATION OF HIGHLAND WIND FARM, LLC, FOR A CERTIFICATE OF PUBLIC CONVENIENCE AND NECESSITY TO CONSTRUCT A 102.5 MEGAWATT WIND ELECTRIC GENERATION FACILITY AND ASSOCIATED ELECTRIC FACILITIES, TO BE LOCATED IN THE TOWNS OF FOREST AND CYLON, ST. CROIX COUNTY, WISCONSIN

Docket No. 2535-CE-100

- -

EXAMINER MICHAEL E. NEWMARK, PRESIDING

TRANSCRIPT OF PROCEEDINGS

OCTOBER 10, 2012

VOLUME 4

TECHNICAL SESSION

Reported By:

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A P P E A R A N C E S

HIGHLAND WIND FARM, LLC, Michael Best & Friedrich LLP, by MR. JOHN D. WILSON and MICHAEL P. SCRENOCK, P.O. Box 1806, Madison, Wisconsin 53701-1806.

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TOWN OF FOREST, Reynolds & Associates, by GLENN REYNOLDS, 407 East Main Street, Madison, Wisconsin 53703.

COMMISSIONERS:
Ellen Nowak

OF THE COMMISSION STAFF
JOHN LORENCE, Office of General Counsel
James Lepinski

(FOR INDEX SEE BACK OF TRANSCRIPT.)

(Discussion off the record.)

EXAMINER NEWMARK: Let's get on the record. I think the applicant had questions. Might as well take that one first.

MR. SCRENOCK: Thank you, Your Honor. We just wanted to clarify, based on the prehearing witness and exhibit list and the actions that were taken at the beginning of the hearing yesterday, what exhibits are currently in the record with respect to Mr. Junker and Mr. Carlson.

EXAMINER NEWMARK: Okay. Interesting you should ask about that. Okay. Well, it was my understanding -- well, you know, it was my understanding that all the exhibits were involved and included in the record including the new ones, Carlson 7 and Junker 18. But now that I think about it, I guess they weren't on the list. They're on my list, they're not on your list, the witness/exhibit list. So when I said everything on the list, I guess I should have been referring to the list that you have that was an outdated version by the time we got those two extra exhibits late -- was it Friday or Monday, I'm not sure. So I can entertain, you know, comments about that.

MR. SCRENOCK: I appreciate that. I think at this time our preference would be that you just hold off ruling on those until the witnesses had the opportunity to introduce them. Particularly with Mr. Carlson, there is no -- to my knowledge, there was no testimony in the record at all referring to it or explaining what it is. And pretty much the same thing with Mr. Junker.

So our preference would be we just wait. You know, we may have some objections at that time; but it would probably be more efficient to do it that way than try to have a discussion right now without the benefit of knowing for what purpose they're offered and indeed what they are.

MR. REYNOLDS: Well, let me make a representation, if you're ready for that. I wasn't anticipating calling Mr. Carlson, but I certainly can. Number 7 is basically the same map, same GIS information, that corresponds with Junker Exhibit 18, which is a compilation of the 16 residences that returned health surveys last Thursday indicating the kinds of health problems that I think the Public Service Commission should know about when setting these, including the autistic child that was mentioned. So this is 16 other individuals with various problems with ear --

ear problems, headaches, nausea, vertigo, those kinds of things, that may well be exacerbated with wind turbines. That is the purpose.

The Carlson map simply shows where these folks are, which I think would be very helpful information for the company as well as the Public Service Commission. Because recall in the initial environmental assessment the Commission concluded that there will be a certain small but unknown percentage of people who will suffer, who will have life-style changes and quality of life decreases. And we responded by saying, well, you know, in order to do your job, you must, Public Service Commission, find out who they are.

There was no response. There is still this generic kind of unknown subset of individuals who will suffer. So the town took it upon itself to attempt to do a survey and -- you know, in the interest of protecting its citizens. So I received the results of the survey on Thursday, Mr. Carlson mapped it on I think late Friday, and I sent that to everyone on late Friday. And I've made the -- all the universe of returned surveys available to the applicant and anyone else who wants it and filed redacted and confidential versions.

EXAMINER NEWMARK: Okay. In what form did you make that available to parties?

MR. REYNOLDS: I told all of them that if they wanted -- if they would respect the confidentiality of the individuals, their names, et cetera, I would make it available to them as of last Friday. Received no response. And then I talked to Mr. Lorence who suggested that I file a redacted version and confidential version, which I did on Monday.

EXAMINER NEWMARK: Okay. Let's get off the record just for some housekeeping.

(Discussion off the record.)

EXAMINER NEWMARK: Junker has Exhibit 18 filed October 8th, and I'm assuming when it's filed it's been served on parties by e-mail. Was that done?

MR. REYNOLDS: That's right.

MR. SCRENOCK: That is not always correct, Your Honor.

EXAMINER NEWMARK: It's not always correct. Okay. In this case, did you receive an e-mail?

MR. SCRENOCK: We did receive Exhibit Junker 18. That's the only one of the ones we're discussing right now that we were ever served with.

EXAMINER NEWMARK: Okay. So we have the list of people that were surveyed.

(Document tendered to counsel.)

EXAMINER NEWMARK: I'm having problems getting on ERF. Do you have a copy of 19C that I could take a look at it?

MR. REYNOLDS: I just gave them -- let's see, 19C, those are the surveys?

EXAMINER NEWMARK: I don't know. I need to look at them.

MR. REYNOLDS: I think so.

EXAMINER NEWMARK: I see that there is a corrected exhibit, cover sheet, part 2 of 2; and I guess a 19C, that must be part 1 of 2.

MR. REYNOLDS: Oh, yeah. They wouldn't all go -- they weren't -- we couldn't load them all at once, so I think we did them in spots. So number 1 --

EXAMINER NEWMARK: Okay. Hang on. This was filed -- this is the copy that was filed?

MR. REYNOLDS: That is the unredacted version that was filed.

EXAMINER NEWMARK: Okay. But this is not

as filed, though? There is no confidentiality affidavit on there.

MR. REYNOLDS: Well, that's right. There is no confidentiality affidavit. That's the original document.

EXAMINER NEWMARK: All right. You know, I'm just going to ask simply at this point why wasn't this filed earlier?

MR. REYNOLDS: Didn't have the information.

EXAMINER NEWMARK: Why wasn't the survey done earlier?

MR. REYNOLDS: I mean, look, we got the environmental assessment, we requested the Public Service Commission to do this analysis. The town is doing the best it can. This is very important information, critical for this proceeding. And to exclude it would be putting the public interest on the side because of, in our view, failure of the applicant or the agency to do this investigation.

This is important information that would allow, if it's approved, for mitigation measures to take place before harm occurs. So I don't think there's any dispute about this. It is what it is. It's important information. And Mr. Junker can explain the logistics of sending out 150 applications -- or surveys and getting the information back on time and collating it and getting it in a form that I could supply. But I don't think there is any prejudice to the applicants. I would think that the applicants would be happy to have this information.

EXAMINER NEWMARK: Okay. Well, let's see what the applicants have to say.

MR. SCRENOCK: Just to briefly respond, with all due respect, Mr. Reynolds is aware that there is a dispute over this. When he sent out the e-mail on Friday indicating that he had some sort of survey results and asked if we would all agree to just have it entered in the record, we responded with a request to explain why the information is even relevant. And to my knowledge, we never got a response back from him. So it's inaccurate to suggest that there is no dispute about this information.

We believe it is not relevant and, more to the point, there is no way to verify the information. There's -- these people are not -- you know, looking through the survey, just for instance, there is no -- people have self-selected and identified in very vague terms certain health impact -- or certain health problems that they claim to have at the current time. They're not available for cross-examination. There is no doctor -- I'm not aware of any sort of actual medical diagnosis or anything that's involved here.

So it's -- our understanding is, as Mr. Reynolds just described, it's being offered to prove existing health conditions which, for one, are not relevant to begin with; but even if it was relevant, there is no way to test the validity of it or to explore whether the information that's on these pages has any relevance at all or correlation to the operation of a wind turbine.

And so for those reasons, we don't think it's relevant and we think it is prejudicial. We did object when it was first mentioned as being possibly available.

MR. McKEEVER: Judge, may I be heard on this one?

EXAMINER NEWMARK: Hang on. I just want to give everyone else -- everyone a turn.

MR. SCRENOCK: And even if there were preexisting conditions that were proven to exist, there is no basis to conclude that that would translate into any additional impact or harm that would be caused by the wind turbines once they're operational. There is just no basis to conclude that a preexisting condition today translates into some obligation to mitigate down the road.

EXAMINER NEWMARK: That's your relevance argument.

MR. SCRENOCK: Yes.

EXAMINER NEWMARK: All right. Any other parties wish to comment?

MR. McKEEVER: Thank you, Judge. The applicant just said that the information is not verifiable. Well, frankly, this is the same argument that the wind turbine companies use when people complain after the fact, that their headaches or there is noise or something, well, it's not verifiable, we don't know that this is the cause.

I think this is an opportunity for this Commission to contribute significantly, frankly, to the body of scientific knowledge around this whole issue. If I read Dr. Roberts' testimony correctly, Dr. Phillips, several of the others, Dr. Hessler, I think there is an agreement among everybody that some people are likely to have a complaint, call it an annoyance, call it a health problem, call it what you will. We don't know who those are. We have no idea of who that cohort of people are. We may find that these 16 people don't complain. Okay. That helps contribute to the body of knowledge, and I think it goes directly to the question of public health and safety here.

This is information that, to my knowledge, has not been available in any other proceeding certainly in Wisconsin nor anywhere else; and it's useful information in getting to this whole question of what is public health and safety, what are the sound levels that are appropriate, how do we mitigate these issues. I agree with Mr. Reynolds that I think it's really valuable information to the company. Now they've got it; and whether it's admitted or not, you would hope that they would use it. But I think it ought to be admitted and be part of the record and the Commission ought to have an opportunity to give it whatever weight it wants to in terms of moving forward. Because I think it gets us someplace in the ongoing debate reflected in the literature, reflected in this proceeding, about what is the impact of these things and who do they affect. We don't know.

But back to my first point, we heard one of the witnesses say yesterday that really the company is the one who decides whether a complaint's valid, regardless of the fact that the individual living there has headaches, has nausea, didn't have them before, now has them, doesn't have them when they leave. Health is psychological, it's mental, it's stress. It's not always indicated by something that can be shown up on a test. This is good information that we ought to use because it contributes to the body of knowledge.

EXAMINER NEWMARK: Anyone else?

MR. REYNOLDS: Yeah, just one response, if I may. Number one on the list is a case history of a 20-year-old --

EXAMINER NEWMARK: We don't need to go through what's on the list.

MR. REYNOLDS: Okay. So that's in the record and so when they say --

EXAMINER NEWMARK: There are a number of these surveys that are mentioned on the record already; is that what you're saying? Not the surveys, but the situations of people involved.

MR. REYNOLDS: Well, yes, at least number one. And, number two, this information could be the basis of a condition of the permit that the applicant, who seems to believe that there is absolutely no connection, there is no need to know any of this information, that the Commission could say, oh, yes, there is. So as a condition of your permit, you're going to do a baseline health survey so -- and we're going to require you to do sound studies in the after-condition so that we can see and maybe progress a little bit on the knowledge base. So that if this is approved, that the Commission can move forward with better data. And that's what this is about. This is about finding the right balance between wind turbines and the ability of people to live in their homes.

So we heard some really stunning testimony yesterday about Wisconsin residents who have lived and made commitments to live in one particular place and left because they couldn't stand the presence of turbines. These aren't people that are whacky. I mean, these are just regular people. This is an important issue. And I know the company is going to present its next witness to say that there is no science that backs up these claims, that these guys must be just complaining about everyday annoyances. But from their perspective, it's real. And the Commission has some important public health decisions to make, and this is a step toward that resolution of finding a balance between wind turbines and residential living.

EXAMINER NEWMARK: Yeah, you've made that clear. Okay. I will rule on this. I am going to affirm that objection leaving out -- let's see, it would have to be 18, 19 of Junker and 7 of Carlson. And is there no related testimony to that that --

MR. SCRENOCK: There is no related testimony to Carlson's exhibit. There was --

EXAMINER NEWMARK: I'm -- go ahead.

MR. SCRENOCK: In Mr. Junker's surrebuttal, his last Q and A indicated that he was -- that he had disseminated the health survey and planned to submit the results.

EXAMINER NEWMARK: Right. It doesn't reflect the results.

MR. SCRENOCK: Correct.

EXAMINER NEWMARK: Now, the reason for this, the primary reason is that in terms of best evidence, these people are available tomorrow to come to the public hearing. If they come of their own volition and provide public testimony, such as we've seen lay testimony presented by the parties, that's their right to do so. But the survey, in terms of all the reasons the applicant provided us, I agree with in terms of due process problems. And really, we just really need to stick somehow to -- in some tangential way to the schedule and how we organize this hearing. Having this kind of information come in at this time, it's just not feasible to produce a record that's -- that has validity. So --

MR. REYNOLDS: But, Judge, you know, I understand your ruling; but keep in mind that we got flooded yesterday with ten different witness responses and rebuttals and exhibits. And I think this goes to weight rather than admissibility. I mean, what is the harm of leaving it in? If the applicant wants to --

EXAMINER NEWMARK: All right. Well, I've already ruled, so let's not spend time on it.

MR. REYNOLDS: Okay.

EXAMINER NEWMARK: All right. Any other outstanding?

MS. BENSKY: Your Honor, I sent an e-mail around pretty late last night with a response to the whole Larkin testimony matter. Did you receive that?

EXAMINER NEWMARK: No. And, actually,

well, I really shouldn't be getting your e-mails, but that's another story.

MS. BENSKY: Well, I sent it to everybody.

EXAMINER NEWMARK: Okay. Yeah, I did not -- yesterday. Yes, I do see it here.

MS. BENSKY: As a timesaving measure, I figured I'd just write it out instead of argue today. I have a copy of it. Can I show it to you before you rule?

EXAMINER NEWMARK: Well, I was actually going to just take arguments now. Is that something we -- okay. That is another outstanding issue. Any others that we know of? I have one more. Oh, yeah, I wanted to -- okay, let's -- anything else? All right. Okay. Yeah, why don't you start with your argument.

MS. BENSKY: Well, we request that you deny the oral motion to include the Richard Larkin testimony, and the reason is because it's prejudicial. You just mentioned due process. What they want to do is put in testimony -- put in surrebuttal testimony in an untimely manner from a witness that we don't have the opportunity to cross-examine. Had we known, had Mr. Larkin filed surrebuttal testimony, we would have prepared cross-examination of him. We don't have the opportunity to do that now.

There was a mistake on our part, a procedural mistake, where we only referenced the Exhibit 803 from the docket, we didn't actually physically upload it to ERF. But there was no surprise that Mr. Kielisch was relying on Exhibit 803 to -- as one of the bases of his opinions. It was referenced by PSC number and docket number and he talked about it extensively in his rebuttal testimony. So it was obvious to everyone that it was in there.

The applicant had a full and fair opportunity to cross-examine Mr. Kielisch on that yesterday. He did. The applicant could have filed the testimony of Mr. Larkin as surrebuttal testimony. They could have had Mr. Poletti respond to that in surrebuttal or in sur-surrebutal which he submitted yesterday morning. And they chose not to.

So in terms of fairness, I think it's extremely prejudicial to our clients to allow testimony from a witness that has never been named in this docket and we don't have the opportunity to cross-examine.

EXAMINER NEWMARK: I just had a question, sorry if you covered this in the letter; but the first time Kielisch references Exhibit 803, he does it in a way where he's basically using it as a citation to whatever argument he's making, whatever facts he's trying to lay out. And I think it's clear in the memo that that does not bring that docket into the record.

The second time he does that on surrebuttal, I guess, he actually states, you know, by reference -- I'm incorporating this document by reference. Now, we -- I think, you know, I'm going to rule and I think it's pretty obvious you just can't add documents into the record by reference in that way. It just can't be done.

So with that said, when that document is not on the record at this point, what does he need to reference 803 for? What point is he trying to make?

MS. BENSKY: Well, I guess with that, I would ask that you rule either that everything is -- if you want to leave everything out, that's fine. He discusses the study in his direct testimony and the document is referenced in there. So there is no prejudice to anyone, there is no surprise that he was relying on his prior work in a different docket to help him make an opinion in this docket. That was referenced in his rebuttal testimony.

And the applicant, my understanding was that the applicant wanted that Exhibit 803 in the record because they extensively cross-examined Mr. Kielisch on it yesterday. So if that's the case, that's fine. We don't object to filing Exhibit 803. My understanding was that you had ruled on that yesterday.

Later in the afternoon, the applicant asked to file the testimony of Mr. Larkin. And first they wanted it read through Mr. Poletti, which is not proper because Mr. Poletti did not rely on Mr. Larkin's testimony in that previous docket to form the basis of his opinion. So normally an expert can bring in that kind of stuff if they rely on it. But Mr. Poletti didn't rely on it. He wasn't even familiar with it until he was shown it.

So there is no proper evidentiary basis for admitting the Larkin testimony, whereas I think there is for admitting the Kielisch testimony.

If you want to leave out Kielisch 803 from this docket, that's fine. But, regardless, the Larkin testimony is not proper in this docket.

EXAMINER NEWMARK: Response?

MR. WILSON: Well, there are a number of responses. But let me just start with that Mr. Poletti did rely on this Larkin testimony; in fact, it was Mr. Poletti who provided me the Larkin testimony. So he clearly has reviewed it and it informed his decisions. And he testified yesterday that he agreed with the contents of the Larkin testimony.

EXAMINER NEWMARK: At what point did he do that? Refresh my memory about when he mentioned the Larkin testimony.

MR. WILSON: When he was on the stand yesterday, I asked him questions about the Larkin testimony, his rebuttal and surrebuttal, whether he had reviewed them, whether he agreed with Mr. Larkin's analysis regarding Mr. Kielisch's study, and he agreed to that.

EXAMINER NEWMARK: So he has his own opinion on Exhibit 803; is that correct?

MR. WILSON: Well, his opinion is that he agrees with Mr. Larkin's analysis of 803. I think that's what the record -- if you read back the transcript, that's basically what he said.

EXAMINER NEWMARK: Okay. And how is that different from having him come on the stand and explain his opinion on Exhibit 803?

MR. WILSON: It isn't any different, Your Honor. I mean --

EXAMINER NEWMARK: Well, then why couldn't he have done that? Because I asked -- I'm sorry, I asked if he could come up and explain his opinion, and you didn't want to do that. So why --

MR. WILSON: No, he did, to the extent -- the only thing that we were trying to do yesterday was at your request get the information introduced as an exhibit rather than allowing us to reference sworn testimony in another case before this Commission.

EXAMINER NEWMARK: Right, at that time. Later on I asked, in terms of keeping him available for re-call, can we just now put him on the stand and have him give his own opinion on Exhibit 803. And you said he could not do that, he needed to reference Larkin's testimony.

MR. WILSON: He did need to reference Larkin's testimony. Larkin's testimony informed his opinion of Exhibit 803.

EXAMINER NEWMARK: But he has his own opinion of it, he could not provide that yesterday.

MR. WILSON: I think that's already on the record.

EXAMINER NEWMARK: All right. Well, we're just keeping it all out. 803 is out, any other testimony is out. We just can't be referencing other documents from other dockets or surrebuttal. There may be cross. The documents were not provided to parties. All kinds of reasons. Let's just move on.

MR. WILSON: Your Honor, I --

EXAMINER NEWMARK: So Exhibit 2 --

MR. WILSON: Your Honor, can I ask a clarification?

EXAMINER NEWMARK: Exhibit 2 Kielisch is out. Okay? And anything else -- do you want to take out references to Larkin in the testimony -- in the cross too?

MR. WILSON: I think if you're going to exclude 803, I think we need to expunge that -- any references to the Larkin testimony or his Exhibit 803 from the record.

EXAMINER NEWMARK: Okay.

MR. WILSON: I have no problem with your ruling.

EXAMINER NEWMARK: Right.

MR. WILSON: But there is stuff in the

record that --

EXAMINER NEWMARK: Well, stuff that was prefiled, I agree that you had warning that that was the citation for basically the basis of that person's opinion. And at that point, you could have responded to it in the proper order of testimony filing. So I think that -- at least in direct and rebuttal, does he do that in both direct and rebuttal, reference 803?

MS. BENSKY: I believe he does. I know he does in his -- he did not file direct. He only filed rebuttal. But he referenced 803. And then he described it pretty extensively, he spent several pages talking about what he did for that.

EXAMINER NEWMARK: Right. That's fine. But in terms of process, let's -- we'll take out references to 803 in surrebuttal. There is that footnote --

MS. BENSKY: I mean, Mr. Wilson is pretty much asking that all of his cross-examination of Mr. Kielisch be stricken. That's fine with me if he wants to do that.

MR. WILSON: As long as 803 is not in the record and they cannot brief 803, we can take everything that I asked about 803 out. I'm fine with that.

EXAMINER NEWMARK: Okay. Well, I think his rebuttal testimony is fair reference to 803. So in that sense, you had an opportunity to rebut his rebuttal on 803 at the time when you could file surrebuttal.

MR. WILSON: He put it in for the truth of the matter asserted.

EXAMINER NEWMARK: In surrebuttal.

MR. WILSON: In surrebuttal.

EXAMINER NEWMARK: He attempted --

MR. WILSON: And he testified to it on the phone yesterday. I specifically asked him: Are you putting this 803 before us for the same reasons that you did in Glacier Hills in this docket, to show that there's a property valuation issue? He said yes. So he put it in for the truth of the matter asserted. If you are going to exclude 803 --

EXAMINER NEWMARK: Correct.

MR. WILSON: -- that's fine. But I don't think that anybody ought to be able to brief it or rely on it in argument before the Commission. I mean, there is not much difference, Your Honor, in allowing them to cite 803, to rely on it and brief it. It's an exhibit in another docket. Okay?

Versus bringing in a piece of sworn testimony from another docket. They're both evidence.

So I'm fine with excluding it if we exclude all references, and we can take out all my cross-exam of it. But if you're going to allow them to argue 803, then we need to be able to bring in another piece of testimony -- and I, by the way, will make this offer with respect to the Larkin testimony. I have no problem bringing in any rebuttal testimony that Mr. Kielisch had in that docket, I have no problem bringing in any cross-examination on the record. I can tell you that there was cross-examination of Mr. Kielisch, there was no cross-examination of Mr. Larkin. So if they want a balanced approach to it and you bring in both sides from Glacier Hills, that's fine too.

But however you go, I mean, it's prejudicial to allow them to argue 803 and not allow us to basically respond with the same testimony -- or with information from the same docket.

EXAMINER NEWMARK: Is there a reason why you weren't responding to it on surrebuttal?

MR. WILSON: The whole reason that we're here, Your Honor, is because historically it has been my practice, and I have never been called up on it, to cite to PSC reference dockets -- or documents. So if it's on ERF in an official document, it's got a PSC reference number, we have always been able to cite that. It was not until yesterday that you, you know, informed us that we couldn't do that. Otherwise, I wouldn't have brought it up.

It's their witness. It's their obligation to know what their witness has testified to before and what's out there. The fact that my witness found it and provided it, you know, shouldn't be held against us. They just didn't look at the background of their witness.

MS. BENSKY: That's kind of an unfair characterization. It's very simple. We don't want to argue Glacier Hills. This docket is big enough itself. They have Poletti, he issued the longest report of any witness in this case. So they had a full and fair opportunity to rebut anything that Mr. Kielisch said. Mr. Kielisch gave a very brief rebuttal statement, referenced the PSC number. He explained in the text what he did, and obviously we can cite that.

If they did not choose to file surrebuttal, that was their choice. And at this point, they can't say that they have been prejudiced because they failed to file surrebuttal testimony. We don't want to bring in every single PSC docket that has ever dealt with a wind case into this case. The docket's big enough and it's going to get bigger as the day goes on.

So they haven't shown that they have had any prejudice. And Mr. Wilson can fault us for not doing background research on our witness. That's a non-issue. That has -- it's not helpful to this discussion at all. So why don't we just say no reference to PSC 803 in the text. We can argue and quote to what Mr. Kielisch wrote in his rebuttal, he was referring to that exhibit and he was discussing that exhibit. But we don't have to go back to the actual data. Let's just leave it all out.

MR. WILSON: I have no problem with that --

EXAMINER NEWMARK: Okay.

MR. WILSON: -- with one caveat. We don't need to go in and clean up the record. But if your ruling were that nobody can argue 803 in their briefs, I'm fine with that.

EXAMINER NEWMARK: Okay. Is that -- so do you understand what that means? Because --

MS. BENSKY: I understand what that means. But we need to be able -- we can cite to his testimony that he filed --

EXAMINER NEWMARK: His explanation of it.

MS. BENSKY: -- in which he discusses 803, and that will go to weight and not admissibility when the Commission is looking at it.

EXAMINER NEWMARK: All right. Let's do that.

MR. WILSON: Would you clari -- can you --

EXAMINER NEWMARK: I thought you knew what I was going to say. All right. We'll take out -- well, like I said, Kielisch 2 is out, which is the Hills Exhibit 803. The -- there will be no Larkin testimony coming into the record. The -- in terms of making it available for briefing, the Exhibit 803 is not available for briefing. The testimony provided by the witnesses on that exhibit may be used in briefing. How is that?

MR. WILSON: I don't understand how his testimony on 803 can be used in briefing if you're not bringing in 803.

EXAMINER NEWMARK: Yeah.

MR. WILSON: So, I mean, if there is -- if -- what I meant was, is if you can't argue 803, you can't argue 803 or anything that emanates from it.

MS. BENSKY: Absolutely not. We can't use the --

EXAMINER NEWMARK: Well, I'm holding with what I just said. So we'll move on. I think it's a fair result.

So I think there is one other outstanding issue, it's the Schomer page 6 surrebuttal.

MR. REYNOLDS: Yeah, Mr. Schomer is -- or Dr. Schomer is here, and I think he would explain that it is in response -- that it's proper rebuttal. He'll explain it. That's what I would suggest.

EXAMINER NEWMARK: Okay. Let's see --

MR. REYNOLDS: He understands the issue better than I do, or Mr. Wilson.

EXAMINER NEWMARK: Page 6, right? Okay. If I remember correctly -- well, let me get your -- can you just restate your objection.

MR. SCRENOCK: Yeah. Thank you, Your Honor. I don't suggest you want to sit and read all of these; but the way that this testimony progresses, best I can tell from the record, is that it relates to Schomer's direct testimony on pages 4 and 5 of his direct where he was arguing that or asserting that the Commission ought to apply a 10 decibel adjustment from what would otherwise be an urban area to a quiet rural area.

Mr. Hankard addressed it on rebuttal on page 1 and beginning of page 2, generally talked about urban and rural in rebuttal. And then on surrebuttal, we have for the first time this notion of a day/night sound level, an evening/night sound level; and this comes after Mr. Schomer's addressed the brief rebuttal testimony that Mr. Hankard gave -- on the earlier brief rebuttal on page 5 at the bottom.

And so our only objection is that this reference to it, the day/night sound level and the day/evening/night sound level, and that concept is not responsive to the rebuttal testimony Mr. Hankard gave. It's just -- it's information that he apparently intended to include in his direct. And that would have been the proper place for it. That's our objection.

EXAMINER NEWMARK: Okay. Now, I recall seeing testimony about day/night sound levels yesterday when we were flipping through the pages, and I don't think it was this page. Isn't there references to that concept -- I mean, isn't that part of the rule? No? It's not a 120 day/night sound level?

MR. SCRENOCK: No. This -- the rule provides for different criteria during the day and at night. This is talking about European and other international standards that he's using to bolster his idea that there ought to be a 10 decibel...

MR. REYNOLDS: Well, again, I'm not sure the applicant really understands why Mr. Schomer wrote that out; but it does pertain to circumstances at Highland, it's relevant to the question of conditions that the Commission might put on, and he's available for cross-examination. It's certainly not harmful.

EXAMINER NEWMARK: And in terms of the EU sound level, there was references to the WHO criteria. Was that in earlier testimony?

MR. REYNOLDS: It's been throughout, you know, in terms of health versus annoyance.

EXAMINER NEWMARK: Does that relate to this 10 decibel proposal?

MR. REYNOLDS: I think what it relates to, if I'm not -- look, this sound stuff is rather elusive. But I think what it relates to is the ambient, the difference in -- that will -- from

Mr. Schomer's point of view will occur in Highland because it's so uniquely quiet, that the difference between the background ambient day and night will have a dramatic effect.

So it all goes to rebutting the applicant's version that there will be no effect. And I think it's a mistake to exclude Mr. Schomer's testimony without an understanding of what he's trying to get at. Because I think we're speculating now.

EXAMINER NEWMARK: Well, I think the basis would be timing of filing. That's -- basically it's a procedural argument.

MR. SCRENOCK: It is; and Your Honor, I would just remind you again, as you talked about yesterday, it appeared you had concerns coming into yesterday's hearing about the volume of surrebuttal testimony to begin with. We were able to respond to some of it. There are parts of it that were improper and untimely. And in light of the fact that we had to deal with, you know, a bunch of other surrebuttal that arguably was legitimate, we ought not to be held at the same time to dealing with untimely surrebuttal. And to the extent that we can stick with the schedule that was laid out in the prehearing conference memorandum, we think it ought to be followed.

It appears in his surrebuttal testimony, you know, in the area where he's responding to Mr. Hankard; and our position is it's not responsive to Mr. Hankard's rebuttal.

MR. REYNOLDS: Well, I would say that it is; but, you know, Mr. Schomer can testify one way or the other. I think excluding evidence is really a mistake on that basis.

EXAMINER NEWMARK: I'll think about that. So let's get some witnesses on the stand. I think we can start with Roberts.

MR. WILSON: Yes.

EXAMINER NEWMARK: Let me just make sure, does Hessler have to go anywhere or can he wait for Roberts?

MS. NEKOLA: He can wait.

EXAMINER NEWMARK: Okay. Let's do an applicant witness first.

MARK A. ROBERTS, M.D., APPLICANT WITNESS, DULY SWORN

DIRECT EXAMINATION

BY MR. WILSON:

Q Morning, Dr. Roberts. Can you state your full name and business address for the record.

A   My name is Mark A. Roberts. My business address is 525 West Monroe, Chicago, Illinois, 60 --
                MR. McKEEVER: Doctor, would you pull the mic closer.
                THE WITNESS: If somebody would shut that blind right over there. I can't see you.
                MR. McKEEVER: That might be better.
                EXAMINER NEWMARK: Let's go off the record.
                (Discussion off the record.)
                EXAMINER NEWMARK: Let's get back on.
BY MR. WILSON:
Q   Dr. Roberts, in connection with your appearance today, did you prepare 24 pages of rebuttal testimony?
A   Yes, I did.
Q   And did you prepare six pages of surrebuttal testimony?
A   Yes, I did.
Q   And did you prepare 12 pages of sur-surrebuttal?
A   Yes.
Q   Did you also prepare or cause to be prepared what have been marked as Exhibit HWF Roberts 1, 2 and 3?
A   Could you give me the title of that?
Q   Well, there's three of them. Three exhibits.

A Yes. Oh, the exhibits, yes. I did prepare -- I had them prepared, yes.
Q Okay. You were present yesterday during the hearing?
A I was.
Q Did you hear the testimony concerning the individual with autism?
A I did.
Q Can you tell us what your reaction was to that testimony?
A Well, the discussion about autism is perplexing in the fact that autism has a very, very detrimental effect on the family and on the individual. It's -- epidemiologically it's increasing in the number of cases. There's an unfortunate situation involving where association with thimerosal in childhood immunization -- vaccines was thought to be attributed to autism and so had some public health significance. But the big thing is the fact that there is a huge amount of epidemiology being developed about autism, trying to find a cause.
Q Is there any science, to your knowledge, that links autism with wind turbines or characteristics from a wind turbine?
A Currently, I am not aware of any peer-reviewed published literature that shows -- links autism to

wind turbines or other noise-type activities.

MR. WILSON: Dr. Roberts is available for cross.

EXAMINER NEWMARK: I just want to interrupt for a second. Can we have the staff member remove that sign from the back of the room. I don't allow signs in the hearing room.

GENTLEMAN FROM AUDIENCE: Sorry, I'll get it out of here.

EXAMINER NEWMARK: Okay. Just so it doesn't intimidate anyone. Okay. Go ahead.

CROSS-EXAMINATION

BY MR. McKEEVER:

Q Good morning, Dr. Roberts.

A Good morning.

Q Let's focus on autism for a moment. You have some familiarity with the condition known as autism?

A Yes, sir. I'm not a pediatrician, but yes, sir.

Q But you are a medical doctor?

A That is correct.

Q And you're aware that there are many different forms of autism?

A Growing every day.

Q And that some people with autism react differently to different changes in their environment, different

circumstances?
A Yes.
Q Some react -- or can react very adversely to flashing lights?
A I'm not aware of that.
Q Do you know whether some can react adversely to noise in their -- noise in their environment?
A Changes in their environment, but I don't know literature that shows specifically that noise changes it.
Q But they can react significantly to changes in their environment?
A They can react to changes in their environment, that is correct.
Q So one of the things that some people with autism, let's use the word need, is stability, constancy in their environment, change is difficult for them?
A That is one of the things that, as I understand it, that they work on with the families.
Q Okay. Thank you. Now, you heard -- you were here yesterday and you heard testimony from several people regarding health problems that they've experienced that they attribute to presence of wind turbines?
A I heard a lot of health complaints, that's correct.
Q Now, you have no reason, do you, to disbelieve people

who complain of sleeplessness, headaches, nausea, problems using hearing aids, and similar problems, when they are in their homes near wind turbines and then state that the problems go away when they are not home, even when they leave for a reason other than to simply escape the problem? You have no reason to disbelieve those people, do you?
A Scientifically, I question it. As a physician, I wonder. But I take it at face value.
Q You take it at face value. You, in your experience as a doctor -- and I recognize you're an epidemiologist now. You don't have a private practice where you see patients, I take it?
A I'm still a physician as well and licensed in three states. And, yes, in occupational medicine, I still have occupation -- people come to me with occupational issues. So I still practice occupational medicine in a sense. But the process --
Q You're -- I didn't ask that question.
A All right.
Q The question I asked is whether or not -- I asked you whether you see patients, you said yes; is that correct?
A Yes.
Q Okay. And when patients come to you with a

complaint, you take that at face value and then begin to investigate the nature of that complaint?
A In the occupational setting and environmental setting, that's correct.
Q Thank you. Now, you've never examined Jeffrey Bump who testified yesterday, have you?
A No, sir.
Q You've never been to his home?
A No, sir.
Q You never have examined David Enz?
A No, sir.
Q You've never been to his home?
A No.
Q Never examined Sarah Cappelle?
A No.
Q Never been to her home?
A No.
Q Okay. Now, according to your vita, I want to say 1996 but I might have the date wrong, but you wrote a paper in Oklahoma having to do with the distribution of Rocky Mountain spotted fever and ticks; is that correct?
A I believe so. I don't have my C.V. in front of me. It's been a while ago, but yes.
Q Okay. I'm going to ask you a series of hypothetical

questions that don't talk about wind turbines, but I think they provide an illustrative example here. And I'm going to chase ticks for a minute and Rocky Mountain spotted fever.

If a hundred people came to you complaining of symptoms suggestive of Rocky Mountain spotted fever, or Lyme disease here in the midwest, and you discovered that all of them had been in outdoor areas known to be habitat for the dog tick, the brown tick or the deer tick, that would suggest to you a pattern; is that correct?

A That is correct.

Q Wouldn't you call this, as you state in your testimony, quote, a series of events that catches the attention of a science-minded individual?

A It does.

Q Okay. And that pattern is highly suggestive, is it not?

A Yes.

Q That does not mean that there's a relationship between their symptoms and the fact that they were present in ticks, the public -- the public health problem, regardless of the cause, it's only suggestive?

A That's correct.

Q Now, but wouldn't you be likely to conclude, on the basis of that pattern and your training, that it's highly probable that those 100 people have Rocky Mountain spotted fever or Lyme disease before you learn the results of blood tests?
A Not necessarily, no.
Q You wouldn't be likely to conclude that in this situation?
A As a scientist, I wouldn't conclude that.
Q Okay. What other things might they be -- might their conditions be attributable to?
A Well, the whole thing about it is the set of symptoms for Rocky Mountain spotted fever are similar to others. So one of the things you have to look at is case definition. So it's really important that you look at that 100 and you look at do they meet the case definition. Because one of the things that you've got in your example is we know exactly the epidemiology of Rocky Mountain spotted fever. We know what the symptoms are. It's very dramatic in the fact that it's one of the few diseases that has rashes on the palm of the hands.
So -- but looking at the case definition, it's really important because we don't know that all 100 of those people have Rocky Mountain spotted

fever.
Q No, I'm not suggesting that we know that. All I'm suggesting is that as a doctor, you would conclude that it was likely that that was -- you wouldn't be surprised if that was the diagnosis?
A I would not be surprised.
Q Okay. Thank you. And you would be inclined to think, would you not, that they had been bitten by a tick?
A Because we know the epidemiology of Rocky Mountain spotted fever, yes.
Q Thank you. Now, in fact, wouldn't it be highly improbable to find that this pattern did not lead to tick-borne illnesses in this -- illnesses in this hypothetical population of 100 people?
A I mean, we know the epidemiology, so yes.
Q Okay. Now, I'm going to ask you to assume for a minute that there haven't been the peer-reviewed studies that are undoubtedly in the literature regarding Rocky Mountain spotted fever and Lyme disease. Just assume that that work is not out there, and I understand that's unrealistic, but nevertheless.

Based on what we've learned so far about these hundred people, you would not need a peer-reviewed study, would you, to conclude that there may be a relationship between the symptoms and the ticks?

A Also -- I -- number one is you're stressing peer-reviewed. But you need an adequate epidemiologically study --

Q That's not --

A -- which you've thrown out.

Q That's not what I asked.

A No, you've thrown out the epidemiology --

Q That's not what I asked.

MR. WILSON: Objection, Your Honor. Can he be allowed to answer the question?

MR. McKEEVER: Well, he's answering a question I didn't ask.

EXAMINER NEWMARK: I think he answered his question. Go on.

BY MR. McKEEVER:

Q I asked you if you would conclude that there may be a relationship. I didn't ask you if there was a relationship. In your experience as an epidemiologist and a doctor, given the history that we've put in here, wouldn't you be likely to conclude that there may be a relationship?

A I would certainly evaluate whether or not there was a relationship.

Q Okay. That would be a hypothesis, is that correct, in the scientific process?

A Absolutely.

Q Okay. Now, do you have any idea how long it took to come to a definitive conclusion in epidemiology and medicine that there was, in fact, a relationship between ticks and this series of health problems? Any idea what that period of time was?

A Longer than I've been in the practice of medicine and epidemiology. I don't know.

Q Okay. Now, and the prudent advice to give somebody during that period of time, based on the hypothesis, would have been that they should take precautions against tick bites; isn't that correct? That would have been prudent advice to give to your patients, those 100 people out there?

A At what point? I mean --

Q Well, I mean you've created a hypothesis. Now we're doing the epidemiological studies. I'm talking about during that period of time, wouldn't the prudent advice be to take precautions against tick bites?

A Actually, you would have to go back in time and look and see what else is in the literature. Based on what I know, the answer is yes. But we're evaluating

it based on what we know today and not what was going on back when we didn't know that the Rickettsia was in a tick. It's a different situation.
Q Okay. But good advice: Patient, try to avoid getting bit by a tick?
A But see --
Q During that period of time when all you've got is a hypothesis. That's the point I'm trying to make.
A But you haven't talked about any other hypotheses, and I don't know what the other hypotheses were at that point.
Q But we've got one. Now, wouldn't you agree that the many reports in the literature about health problems in the presence of wind turbines constitutes a hypothesis?
A There is a series of hypotheses out there, yes.
Q But that constitutes at this point at least one of those hypotheses?
A I won't say one. A bunch.
Q Okay. And this is a hypothesis which has not been demonstrated in the peer-reviewed literature at this point, that's your testimony?
A No. My testimony is that it's in the literature. There's hypotheses out there. They haven't been proven.

Q We're agreeing.
A Okay.
Q Your testimony is that this hypothesis has not been proven that there is a relationship?
A And I won't say one. The hypotheses that have been put out there.
Q Now, conversely, that hypothesis has not been disproven, isn't that correct, it's still a hypothesis?
A That is correct.
Q Thank you. Okay. So we can agree, can we not, that there's a problem, we just don't know what causes it; the problem being that some people complain of health problems, as you heard yesterday, in the presence of wind turbines; we can agree there's a problem, but we can't agree on whether or not we know what the cause is?
A I think it's clearly evident that there are problems.
Q Thank you. Now, is there an objective test for headaches?
A The specialist in headaches would say there's a series of questionnaires that they can use. Some types of headaches, there's actually even tests that you can use. But by and large, headache is a subjective complaint that's got to be worked out.

Q This is probably a little bit less clear. Is there an objective test for sleeplessness?
A They use sleep diaries and sleep labs. There's a number of objective -- there is at least one objective test I can think of, and that is to put a person in a sleep lab.
Q And in a sleep lab, there are a variety of conditions in the environment that can be controlled: noise, temperature, smell, all of those things theoretically can be controlled so you can factor some in and some out in a sleep lab?
A Actually, I've seen studies where they reported the sound level in the sleep lab.
Q Now, the absence of a peer-reviewed study on a medical condition does not necessarily indicate that there is not a causal relationship, does it?
A This is the age-old discussion, and that is correct.
Q Okay. Thank you. Now, that could only mean -- I mean it could mean, again, a variety of hypotheses. It could mean that the study has not been done, it's not been funded, it's not been designed, it's not been implemented, or that it's difficult or even impossible to design a study to test that hypothesis if we don't have the peer-reviewed study that shows the cause?

A That's some of the examples. There are others.
Q Okay. Thank you. Now, you've prepared a report that's Exhibit Roberts 2 that's entitled, "The evaluation of the scientific literature on the health effects associated with wind turbines and low frequency sound"; is that correct?
A That is correct.
Q And you prepared that report in 2009, right?
A In 2009, that's correct.
Q Okay. And that report does not cite any literature since 2009?
A It's not been updated.
Q Thank you. Now, what's an annoyance? You knew that question was coming.
A Yes. And you ask everybody in this room, and the annoyance is going to be different, not only to the person, but the time and that sort of thing. It's something that a person doesn't necessarily appreciate, I can't say want. It's just an adverse feeling to that situation.
Q Okay. Now --
A My daughter's music, your questions, whatever.
Q That's a fair response. I don't object. Stoplights can be an annoyance to some people?
A Absolutely.

Q Barking dogs?
A Absolutely.
Q A crying baby on an airplane?
A It might be a concern to some people. So they appreciate it in different ways. But to some people it would be an annoyance.
Q Is it fair to state that typically an annoyance, just in the common vernacular, is relatively short-term?
A Not necessarily.
Q Okay. What's a long-term annoyance?
A A long-term annoyance is something that the stimulus continues to occur.
Q Okay. And what is, in your experience, what would be the normal reaction of somebody exposed to a long-term annoyance? What would they do to avoid it, let's say?
A There's a number of responses that come to mind. One is to accommodate to it.
Q Okay. Another is to try to avoid it?
A Another one is try to avoid it. One would be to modify it. One would be to mask it. Any number of things that they could do.
Q Okay. Thank you. Now, you work in occupational health. Tell me what occupational health is.
A Okay. My -- occupational health is really where you

look at -- it's a population-based aspect of medicine or health. We'll use them interchangeably here. And so it's looking at populations in the workplace and the health conditions that might be associated with the workplace, or health conditions that they bring to the workplace that might affect their ability to work.

Q And so let's assume a factory floor which has machines running. Is it fair to state that some of those employees might find the noise of those machines annoying?

A It could be.

Q And for whatever reason, they choose to continue to work there and put up with that noise, to accommodate to it to use your term?

A As long as it's not above the OSHA standard.

Q Okay. I'll come back to that. In your experience, have you run into people in the workplace who are experiencing what to them is an annoyance who become stressed?

A Not that I recall.

Q Isn't stress a medical term?

A Stress is a lay term. I don't know that it's got any -- anybody's got hold over it, any profession.

Q Okay. Isn't it a common -- maybe it's not common.

Hypothetically, somebody goes to the doctor and the doctor finds that they have high blood pressure, my doctor at least says do you have a stressful occupation?
A Okay. And who in this room says they don't? It's a term that's not well defined. And we lay off a lot of health complaints based on stress.
Q But do we know epidemiologically that stress, however it's defined, can lead to objective determinable health effects such as high blood pressure? We know that, don't we?
A I think there are situations. I haven't looked at the epidemiology of that beyond -- the most recent one I looked at is posttraumatic stress syndrome.
Q Stress syndrome.
A Stress syndrome. And so it's really one of evaluating what -- again, like what is annoyance, what is noise to one person might be music to the other, what might be stress to one person is motivation to the other person.
Q And what might be an annoyance to one person might be just fine to somebody else?
A That is correct.
Q Now, we've talked about health. High blood pressure is a physiological health -- it's measurable, it's a

physiological health effect, is that correct, health problem?
A A health problem. Okay.
Q Okay. But we routinely in medicine and in health also talk about psychological health, mental health.
A Absolutely.
Q Okay. And psychological or mental health epidemiologically is known in some instances to cause physiological health problems; is that correct?
A That is correct.
Q Do you agree that smoking causes health problems?
A Yes, sir, it does. We agree.
Q Epidemiologically we know that?
A The epidemiology is curious.
Q But you would agree that for many years the epidemiology did not show that?
A Early on, maybe so.
Q Okay. Let's try another example. How about black lung disease, do you have any familiarity with black lung?
A It's an occupation-related disease.
Q And was there a period of time in the history of medicine when we didn't know what caused black lung disease in miners?
A You would have to go back a long way, but some of the

very -- I mean, in -- hundreds of years ago, yes.
Q If a patient comes to you complaining of a headache, that's self-reported; isn't that correct?
A That is correct.
Q That's correct. And if I come to you complaining that my elbow's sore, I fell off my bicycle, that's self-reporting?
A That is correct.
Q And we can take an X-ray of my elbow and figure out if I broke it or not?
A That's correct.
Q Okay. But we can't take an X-ray of my headache and figure out if I've got a headache?
A No, we can't.
Q Now, if somebody comes to you and reports a headache, you already testified that you take that at face value, they're not necessarily making that up. You take it at face value, you don't assume that they're just inventing this headache because they like coming to the doctor?
A Well, I'll date myself and say that that is the part we classify in taking -- in documenting a medical encounter, that's the S of a SOAP note, subjective --
Q I'm sorry, I didn't understand you. That's the what?
A That is the first part of a medical note that I would

make about you, that is the subjective evidence, what do you report to me as you come into this encounter today? Then I do a physical exam, I ask you some questions. Take headache, for example. The first question I'm going to ask you is describe it to me.

Q Where is it?

A Where is it? How does it feel? If you say this is the worst headache I've ever had, it's like someone driving a nail in my head, you immediately go for imaging.

Q Okay.

A Because that's a dangerous sign. We know that as an aneurism, stroke, something like that, something. But then other questions, you know, is it a cluster headache, is it -- all those sorts of things. So a physician takes the -- what the patient reports and tries to match it with what we know about medicine.

MR. McKEEVER: Okay. Thank you. I have no other questions. Thank you.

EXAMINER NEWMARK: Other cross?

MR. REYNOLDS: Yes.

CROSS-EXAMINATION

BY MR. REYNOLDS:

Q Dr. Roberts, you have a lot of degrees. You're a physician? Yes?

A Yes.
EXAMINER NEWMARK: That's on the record.
BY MR. REYNOLDS:
Q Okay. But you don't have a clinical practice, do you?
A No, I don't have a clinical -- again, I mean, people come to me. I see -- I don't wear a white coat and carry a stethoscope. My stethoscope is hanging on the back of the door of my office.
Q All right. But you don't see patients?
A In an occupational setting I do, in the fact that --
Q Do you treat patients?
A Well, I repeat, a guy will come in -- one of our employees will come in and say -- one of them came in and said I've got a rash on my stomach. Okay? So I went from being a, you know, consultant to being a physician for that individual, I made a recommendation. So I get periodically -- that is -- that to me is a practice of medicine. I'm licensed to do it.
Q I understand. But you don't make your living as a clinician, do you?
A That is correct, I do not.
Q All right. You make your living as a consultant?
A I make my living by helping people understand about

science.
Q All right. And at least at this point, your work is through Exponent, you stated?
A All of my work is through Exponent.
Q And that is a consulting company mostly for industry, right?
A It's a consulting company.
Q Okay. And it has industrial clients?
A You know, I don't know all the client continuum that they've got. I know that they have some industry clients, yes.
Q All right. And your background is consulting for industry; is that right?
A That is correct.
Q You've consulted for petroleum companies and industry and corporations in Milwaukee on occupational health-type issues, I assume?
A In Milwaukee, if you're talking about while I was at the Medical College of Wisconsin, that was a clinical role. I did a little bit of consulting; but the majority, 99 percent of what I was doing, was in a clinical and teaching role.
Q All right. And I wasn't talking about the academic thing. But you've consulted with industry for your consulting career, is that right, as opposed to

individuals?
A Oh, okay.
Q Yes?
A Yes. I would characterize it that way.
Q All right. And in your teaching role, your major specialty was preventive health?
A Preventive medicine.
Q Preventive medicine. Sorry. So preventive medicine means that you try to avoid health problems before they occur, true?
A That's one aspect, but the point is prevention in populations. That's the other part of that definition. That separates preventive medicine from the other clinical specialties.
Q All right. And so if you can identify a certain group that might be at risk, you as a physician and a public health person would advocate to try to avoid the risk rather than allow the risk to occur?
A I would use the science that's available to help them understand and avoid where they can.
Q All right. Now, you recognize that in this debate that's ongoing right here, there is a debate between risk to the public from wind turbines versus industrial sort of effort for financial gain; is that a fair assessment?

A I see all that going on in this discussion.
Q Yes. And you've seen it before in your professional career, haven't you?
A Not as intensely as I have here.
Q Well, is it your -- in this debate, do you see it as all or nothing, either the turbines go in or they don't? Or is there a potential resolution to find a happy medium between public health and wind farms?
A I would hope there is some sort of medium, yes.
Q All right. So cutting to the chase, if this project could be redesigned to minimize risk, you'd advocate for that as a preventive health person, wouldn't you?
A Well, number one, you have to define risk for me. Because you've got my testimony and you understand what I say about -- what -- my interpretation of science. So if you're talking about risk of complaints, you're not going to get rid of that. If you're talking about noise levels, you could probably redesign. But, again, if the measure of success is eliminating concerns and complaints concerning wind turbines, you're not going to do it.
Q Well, what if the science says, Dr. Roberts, that by minimizing exposure to audible noise levels reduces levels of complaints, we should move in that direction, shouldn't we, if we're going to be in a

preventive care mode?

A But, see, the whole thing is what is audible? And you're asking me -- this is a social question. It's not a science question really. Because the science is there. And so you're asking me to actually go into a social issue that I'm not real comfortable getting into.

Q Well, but you're in a social issue, aren't you?

A I am not advocating for or against wind turbines.

Q All right. But you're pretty much, are you not -- your testimony is that the complaints that have been lodged against wind turbines are in the annoyance category, right? That's your testimony?

A That is consistent with the peer-reviewed published literature.

Q All right. But would you agree with me that the -- I think you characterized as these nonspecific complaints, and they're all subjective, of headaches, earaches, vertigo, insomnia, those are all consistent complaints; are they not?

A Okay. First of all, you included insomnia, and we discussed the fact you can go into sleep lab and determine that.

Q That wasn't my question.

A But I'm saying you called them all subjective. And

I'm saying there is objective evidence to measure insomnia. So I'm just saying let's exclude that one.
Q Well, if I come to you as a doctor and say I can't sleep, that's a subjective complaint?
A That is correct.
Q All right. Now, all of these issues can well be characterized as health complaints if they affect the functioning of the individual; isn't that right?
A I think they can be health complaints whether they affect the function of the individual or not.
Q All right. And you heard the testimony of these individuals yesterday; did you not?
A I did.
Q And you said you had doubts about them?
A I didn't say that.
Q Okay. But did you believe them? Do you have any reason to doubt that they were --
A I don't have any reason to doubt. I take them for what they say, and that is what a physician is supposed to do. But you're not supposed to jump to the conclusion of what the cause is based on just what we saw today -- yesterday, excuse me.
Q Well, of course, no one is asking anyone to jump to any conclusions. But is it significant to you as an epidemiologist that when the individuals, number one,

had no predetermined disposition against wind farms, number two, when the wind turbines started spinning they started feeling these same complaints that we've listed, and number three, when they go away the symptoms disappear, is that significant from an epidemiological point of view?
A That is an observation. It's not tested. You know, this is not -- that was not a random sample of people that you brought in the room yesterday.
Q Well, that's true because they are a unique set of individuals who happen to live near wind turbines, right?
A But the point being is, is it, like we go back, we talked about annoyance, Pedersen, there is a number -- out of Sweden, there's a number of people talking about annoyance. And the process itself may be annoying to the individual. Many of the symptoms that they described, I would bet as a physician some people were feeling those very symptoms in this room yesterday during that process.
Q Yeah, well, that's true. But, so annoying, it was I'm sure annoying for you to get in a traffic jamb on the way here or whatever. But we're talking about people, Dr. Roberts, who left their homes, they no longer live in the homes that they've been in for

decades. Is that significant to you?
A That is very significant.
Q All right. That gets beyond annoyance, doesn't it?
A Again, I don't know their history and that sort of thing. That is significant to me. That's what I'm saying.
Q Worthy of further investigation?
A I'm not -- I think medical evaluation, yes.
Q Well, what about from an epidemiological point of view?
A Well, from an epidemiological point of view, a study of one person or a study of the -- I didn't count them, the number of people that were here yesterday, I don't think that we would have enough power to really determine the significance of it -- of those symptoms.

But, you know, you take headache, for example, we'll go back to that for a minute. In excess of 50 percent of the population, depending on the ethnic background, will report headaches at some time during the month. Headaches are frequent. To me it was significant that these people talked about headaches. But in the literature, there's about 93 different sets of symptoms that have been identified in internet searches about complaints about wind

turbines. We can't identify a condition from the literature that is associated specifically with wind turbines.
Q Well, let's back up a little bit. It is a challenge for science to prove much of anything conclusively, isn't it?
A Yes, and I'm glad it is.
Q So we still debate whether the theory of evolution is correct or the theory of relativity, don't we?
A I don't debate that.
Q Well, you don't, but there are folks who do?
A Probably so.
Q All right. And they're --
A That's part of the scientific process.
Q That's right. And so when -- let's take the folks that you heard yesterday. Is it true, as far as you know, that those complaints that you heard yesterday are not unique to individuals living near wind turbines?
A They're not unique to individuals period.
Q That wasn't my question.
A Well, that was my answer.
Q Yeah, well, try my question. Is it true that the individuals that -- you've read hundreds of articles now on wind turbines, right?

A I hadn't counted them.
Q Okay. You did a report for the Glacier Hills case?
A In 2009.
Q And that was at the request of WEPCo, I believe?
A I believe it was; and I've continued to look at the literature since then, so it's beyond that now.
Q All right. And fair to say that science is still trying to quantify the relationship between wind turbines and these subjective complaints that we heard yesterday?
A They're still in the scientific process, I would put it that way.
Q That's right. But there's no denying that individuals that -- experience these same symptoms near wind turbines, not just in Wisconsin, but all over the world?
A Give me that question again. I got lost in that.
EXAMINER NEWMARK: Let's just read it back.
(Question read by the reporter.)
A There is a -- the literature and -- there's two types now. One is the lay literature and one is the scientific literature. But when you look at it all, like I said, there are a lot of different symptoms, complaints, associated with wind turbine farms.

BY MR. REYNOLDS:
Q Major four: headaches, ear problems/earaches, vertigo, nausea/feeling of ill ease; those are the top four, aren't they?
A No, sir. I don't know that to be the fact.
Q Well, are those ones that are consistent symptoms that you've read or not?
A Oh, I've read about those symptoms, but I can't quantify -- I don't know of any study that has looked at all wind turbine or a sample of wind turbine projects to find out what the symptoms -- what the frequency are.
Q And you haven't done that study?
A I have not done that study.
Q You could, though, you could take -- you could probably help us out a little bit and pull all of those pieces together?
A Well, we can look at the literature. I would be glad to work at it with you. But the problem is that there is different instruments used, different timing, different ethnic aspects. So there is a bunch of epidemiological problems that go along with that. But you can go in the literature and you can look at that.
Q All right. Would you agree with me that it would be

a good idea to try to assess health conditions of individuals in the Town of Forest to potentially prevent problems?
A It's too late for that.
Q It's too late?
A That is correct.
Q So -- why is it too late?
A The process has already started. The people in the room that were from Forest that were here, they're already talking about their symptoms and that sort of thing. So there is this recall bias that's already going on in the individuals in the Forest area. The only real way you can do this would be to do a survey before there is any discussion about wind turbines, before there was any inkling.
Q So that means that the public can never have a survey because it's the wind industry that decides where they go and as soon as they're there it's too late?
A If that were the only design that we had, that would be correct.
Q All right. Is it fair to say that if the Highland project is built, the individuals there will have the kinds of health problems we've been talking about?
A The -- as far as what we know about annoyance in the literature, it would be reasonable that they would be

annoyed and they would report similar symptoms.
Q And so you're using again the word "annoyance."
A Um-hmm.
Q What about health problems?
A Well, what is a health problem?
Q Well, all right. How about the individuals who testified yesterday, were they experiencing health problems or was it just annoyance?
A I heard health complaints yesterday.
Q Right.
A Okay. And so --
Q Serious health complaints?
A Health complaints. I can't tell you the seriousness of it other than what they said. I would have to evaluate as a physician. I was not in this room as a physician yesterday, as a treating physician. I had no patient-physician relationship with those individuals. So the thing is that I heard complaints that are very similar to what I've heard and seen in the literature and that need to be addressed on a one-on-one basis with their personal physician.
Q Well, that's fine. But keep in mind as a scientist that the same turbines, same size turbines that are in the Glenmore Shirley project -- three individuals left their homes, and you heard them yesterday -- are

going to be the same turbines that are planned for Highland. Okay?

So with that question, is it a reasonable hypothesis to assume that some of the folks in Highland will suffer the same complaints as the folks in the Glenmore project unless there's mitigation?

A I'm not an engineer. But one of the things as an epidemiologist looking at the literature and looking at the evolution of wind turbines from downwind to upwind and vertical to horizontal and all that sort of thing, you can't compare -- you've got to watch that in the 40 years that we've had wind turbines in the U.S.

But the other thing is I don't know what has changed between the wind turbines that -- whatever they're going to use now versus whatever you're comparing it to, I don't know the ins and outs, I don't know the sound profile of those. No matter what they use, there is an underlying set of symptoms that we see in the literature, complaints that we will hear wherever you put wind turbines if there are people.

Q Well, what if the project is redesigned to minimize risk?

A As I testified earlier, I don't think -- if you would evaluate -- equate risk with the number of health complaints, I don't think you can do that.

Q Well, what if literature says that if you minimize sound levels at the residence, the number of complaints reported worldwide reduces to almost zero?

A It doesn't --

MR. WILSON: Objection, asked and answered.

EXAMINER NEWMARK: You can answer.

A I need to see that reference because I don't -- I don't -- one of the things that happens is, like if you look at WHO, for example, they say health complaints start at 30 decibels. But I'm not an acoustical expert.

BY MR. REYNOLDS:

Q All right. Well, then let me ask you this. Would you have a problem if another acoustical person said a target level to reduce risk of complaints should be 40 decibels and this Commission redesigned this wind turbine farm to minimize risk?

A That's entirely up to them.

Q Right. That would be consistent with preventive health, wouldn't it?

A Not necessarily. Because, like I said, first of all, there isn't any literature that there is a specific

health effect associated with wind turbines. Okay? Except annoyance. The second thing is if you evaluate the success of that change and acceptability based on complaints, you're not going to be successful. There's more to it than just the wind turbine itself.
Q What, you're talking about people just don't like looking at wind turbines?
A Well, that's one of the things in the literature that they say that there's -- in some of the studies there's actually more of an effect from being able to see the turbines than from hearing them.
Q That's your -- is that your assessment, that --
A That's what --
Q -- this is really a debate about visual stimuli and irritation?
A No. No, sir, it is not.
Q You recognize that there is something medically going on here, right? Otherwise we wouldn't have these kinds of complaints worldwide, would we?
A The thing is that I don't know that there's a medical condition. I know there's health concerns, I know there's medical concerns by those individuals. But do I know there's a health condition? No, I don't.
Q All right. So you -- all right. You're a spokesman

for the absence of knowledge rather than the profusion of knowledge, right? You say we don't know, science isn't there, so don't worry about it; is that it?

A No, sir, it's not. That's a mischaracterization of what I think.

Q Well, do you have any proof for the citizens of Forest that if this farm is built as designed, that they will -- they are assured from science that there will be no similar problems of people abandoning their homes?

A Science can never assure that.

Q Right. But by -- preventive health can minimize the risk by reducing sound levels?

A I'm not sure that that's the case. If you measure risk based on complaints, I don't think you can.

Q All right. Is it fair to say that the folks that have -- that distance from wind turbines is curative, that folks that are far enough away from wind turbines don't complain about them?

A I've got a problem, first of all, with curative.

Q Well, whatever.

A Throw that one out. And the next thing is --

Q Well, what --

A -- distance, because if they can see it, if they're concerned, if they're mad about the process, they're more likely to recall symptoms. If they love them and are a turbine hugger or whatever, I don't know, if they -- if they're for them, they're not as likely to report health complaints. That's called recall bias. And so part of it's hearing it, part of it's seeing it, part of it's the process.

Q Well, so since there is -- from your perspective there is no science relating health complaints and turbines, then why have any setbacks at all? What's the point of the setback?

A Well, you know, you -- the point being -- there are certain things. One is the fact of there is information that there is annoyance. Number one, though, is the fact that there are citizens that complain, there are -- this process, that signifies that society needs to make a decision about it.

Public health gets drawn into it. I got drawn into these sorts of things as a public health official in Oklahoma all the time. I could explain the health. I could explain the epidemiology. I can't -- I don't have -- I'm not in a position to make social decisions.

Q That's for the Commission to decide.

A That is correct.

Q But would you agree with me that if the choice is between maximizing profit for a wind farm and protecting public health, the Commission should err on the side of public health?

MR. WILSON: Objection, calls for speculation.

EXAMINER NEWMARK: Sustained.

A The Commission should use the science --

MR. WILSON: Dr. Roberts.

EXAMINER NEWMARK: No.

THE WITNESS: I don't have to answer?

EXAMINER NEWMARK: No. Sorry. I should have explained.

THE WITNESS: All right.

BY MR. REYNOLDS:

Q Well, I think you talked about in your testimony about biases, right, that science -- scientists have biases?

A Everyone has biases.

Q Right. And you as a scientist have your biases?

A Yes.

Q And it appears that you are critical of individuals like Dr. Pierpont for advocating for a closer look at wind turbines, you seem very critical of her?

A I'm critical of her work.

Q Right. But, Dr. Roberts, hasn't it been your basis that you need a hypothesis and then you need to do further study; isn't that --
A That is correct.
Q Isn't that what Ms. Pierpont is doing, she has a hypothesis and she's collecting data?
A I don't have a problem with her hypothesis. I have a problem with what she calls epidemiology. And it's not epidemiology, it's got biases and that sort of thing. And to propose something without science is not good science.
Q Well, the tobacco industry raged for decades about lack of science that connected smoking with heart disease. Right?
A That's the history.
Q And there isn't any literature that ties those things together, is there? Heart disease. Not lung cancer, heart disease.
A Absolutely there is literature that shows increased risk of heart disease in smokers.
Q That took how many decades?
A I don't know.
Q And you, I think, testified at some point that it might take ten years for the science to wrap its arms around this wind turbine issue.

A That's not exactly what I said.
Q All right. Well, let me ask you this. If there were one piece of peer-reviewed literature, such as Dr. Salt who you don't seem very impressed with, that said: I believe that I found the data that shows the cause and effect, you would doubt that, wouldn't you, unless there was another one?
A First of all, you mischaracterized my thoughts on Dr. Salt.
Q All right. Let's start with Dr. Salt.
A He is contributing to the science, he's contributing to the literature, and that's great. But he hasn't made the statement that there is a disease specifically associated with wind turbines that I'm aware of.
Q Well, he is basically trying to identify the realm of sound coming from wind turbines, which you agree is unusual, it's different than the sound --
MR. WILSON: Objection, he's not here as a sound expert.
EXAMINER NEWMARK: Yeah. Sustained.
BY MR. REYNOLDS:
Q Well, do you understand what Dr. Salt is trying to do?
A I understand what is in his published -- in his

peer-reviewed published literature. I have not talked to Dr. Salt.

Q It's good work, isn't it?

A It seems reasonable.

Q All right. And it then is one more piece of evidence that supports the hypothesis that there is a cause-and-effect relationship between large wind turbines and health problems, true?

A It is indication of the evolutionary process in science. It's like a brick in the wall. He's added one brick. We don't know what that wall is going to look like yet.

Q So the people in the Town of Forest have to wait until you're satisfied that the science has arrived at the correct conclusion?

MR. WILSON: Object, it's argumentative, Your Honor.

EXAMINER NEWMARK: Sustained.

BY MR. REYNOLDS:

Q Is it your view that -- you don't have any position on the design of this project, do you?

A No, I don't.

Q And so you wouldn't oppose a redesign if sound experts indicated that the lower -- a redesign of the project would minimize risk?

MR. WILSON: You know, I'm going to object to the line of questioning about redesigning. He's here as a health expert. He's not here with respect to design of the project or what a redesign might or might not do. It's not his area of expertise.

EXAMINER NEWMARK: Okay. I'll sustain the objection. I think he's also answered.

BY MR. REYNOLDS:

Q Would you agree, Dr. Roberts, that in post-construction scenarios, that the companies who run these projects ought to do sound studies to measure the amount of sound with respect to what is being produced for the benefit of science?

MR. WILSON: Objection.

EXAMINER NEWMARK: You'll have to read that back.

MR. REYNOLDS: I can restate it.

EXAMINER NEWMARK: No, no, let's read it back.

(Question read by the reporter.)

EXAMINER NEWMARK: What's the basis?

MR. WILSON: He's here as a health expert, not as a sound and -- it's basically asking him to speculate on a potential condition.

MR. REYNOLDS: That's not the basis of my question.

EXAMINER NEWMARK: Well, I'll let him answer that.

A I think that the public health officials should be involved so that it's a third party, and whatever investigative process is set up should be followed.

BY MR. REYNOLDS:

Q That wasn't my question. My question was, should data be collected on sound produced by turbines after construction for the -- for the benefit of science?

A I'm not sure that that would be that helpful.

Q Why not?

A Again, the -- would that be compared to -- if we're talking about human health issues, you can't really compare that because of what we've already said about the recall bias and that sort of thing. So it sounds like an operational issue, is it operating within the guidelines of the proposal. That's all I can say.

Q Well, what's wrong with more information; so that if people do have health problems and they're verifiable, that they're correlated with objective sound data?

A Well, again, unless there's objective outcomes that you can tie that to, all you can say is that the turbine is operating within or outside the guidelines

it was set up for.
Q Those guidelines are based on science, aren't they?
A I think so.
Q And there are different guidelines in different jurisdictions?
A I've seen different ones, that's correct.
Q New York, for instance, it's 38 or 40 dBA?
A I don't know about New York.
Q All right. Well, would you agree that we are in the experimental stage of wind turbines and we're going to learn and eventually hopefully develop a balance between residences and wind turbine farms based upon knowledge?
A I think there will be an evolution of that process.
Q And so, back to my question, you would oppose, then, if the Commission -- if the Commission put as a condition of this permit that post-construction sound studies be performed so that the residences know what sound is actually coming their way as opposed to predicted models?
EXAMINER NEWMARK: Rephrase that. What do you mean he would oppose?
BY MR. REYNOLDS:
Q All right. Dr. Roberts, you said that you didn't think post-construction sound studies would be

helpful, right?
A I said they would be hard to interpret because of the fact of recall bias among the citizens.
Q So in other words, don't do it, don't look at this evidence?
A You're putting words in my mouth.
Q All right. Well, I'm just trying to --
A I would consult with the Public Service Commission, public health department. I would do what I do as a public health official, and that would be consider what you're doing and what you're going to do and how is it going to be helpful to the citizens.
Q Well, wouldn't it be helpful for the citizens to know objectively what sound is present so that if they do have health problems, the Commission could have a better understanding about the correlation between particular sound levels and health conditions; wouldn't that be helpful information?
A I wouldn't turn that information down.
Q All right. Would you recommend that that be a condition of this permit?
A I would recommend there be a careful discussion of any studies that are done after the wind turbines are put in place.
Q As a condition of this permit?

A I don't know about the permitting process.

MR. REYNOLDS: That's all I have.

EXAMINER NEWMARK: Okay. Questions?

MR. McKEEVER: I have a couple just to follow up, if I may.

EXAMINER NEWMARK: All right.

RECROSS-EXAMINATION

BY MR. McKEEVER:

Q On this question of recall bias, correct me if I'm wrong, but you seem to imply in one of your answers to your questions that the people who spoke yesterday complaining of how -- were from the Town of Forest?

A No. I understand --

Q You understand that they're not from the Town of Forest?

A That is correct.

Q They're not complaining -- we don't have anybody who's complaining about wind turbine concerns or noise concerns in the record from the Town of Forest?

A That's what I understand, correct.

Q Okay. Thank you. I just wanted to make sure.

Now, let me ask you a question about risk. You were a public health official in Oklahoma?

A For 17 years.

Q Allergies, kids get allergies; and I suspect you had

some dealings with allergy issues in schools?
A Sick building syndrome.
Q Sick building syndrome. Well, let me posit a very short hypothetical. If two out of 100 children have a severe peanut allergy, we're not going to force those kids to eat peanuts?
A Definitely not.
Q Okay. And are you aware that the solution in most public schools, at least in Wisconsin, is to ban peanuts from all kids, not just those 200 (sic)?
A That is a social decision that they've made with counsel probably from their attorneys.
Q Okay. Is it a sound epidemiological, medical decision? You would support that decision? Let me put it that way.
A It would be hard to not support it.
Q Okay. Thank you. Now...
A Okay. But -- now, while you're looking. But the other thing is I would talk to the school about what that means in terms of what else -- what other allergies are you going to have to address, and make sure that if they go down that road, they are considering the risk to other allergies and that sort of thing.
Q Now, through Mr. Reynolds -- your response to

Mr. Reynolds' questions and to mine earlier, we came to the conclusion that there is a working hypothesis that there is a possible issue concerning noise produced by wind turbines and people complaining about health problems. It's a working hypothesis.
A That's one of them, yes.
Q Isn't that a hypothesis worthy of further investigation?
A I think it's being investigated now, but one of the things is epidemiologically it's difficult to do.
Q Tell me more about that. How would you go about investigating that hypothesis if you were so inclined to do so?
A And you gave me total funding and total carte blanche to violate the confidentiality --
Q Well, I'm not going to give you any money right now. What I'm going to do is to ask you to design the proposal.
A Well, the problem is that research is very difficult because one of the things is you've really gotta go back and look at the medical history of the individual, each of the individuals. And so this recall bias thing, it is totally normal, it's human. And so you've got to figure out some way to get objective information about that individual, both

those people who are complaining and those who aren't, in order to make that comparison.
Q How would you design this -- I mean, we agreed earlier that there is a problem. We don't agree about the cause, and I appreciate that. The cause is not proven. What I'm curious is how do we figure that out? What's the research we're going to do to get to that answer?
A Well, in science --
Q We all agree that we've got an energy problem and we need to address it.
A Yes.
Q We all agree that wind is part of that solution. How are we going to solve this problem?
A First of all is have patience.
Q I'm sorry?
A Have patience. Okay? It's not going to happen overnight. But each bit, as we talked about with Dr. Salt, Dr. Salt contributed something, a brick, to this wall, to the scientific wall of deciding what are the effects of -- if there are any of wind turbines.
A number of researchers around the country are doing work and they're publishing it; so we're seeing it, we're evaluating it, we're comparing that

to what we know now. To design a study, number one, a study won't do it. It's going to be a series of epidemiological studies that we can see that that association is clear-cut.

Q I just wrote you a bigger check. Tell me how these studies -- what they look like?

A Okay. One type -- well, I mean, we got the basic science studies which Dr. Salt and others are doing. Epidemiologically, it's going to take looking at a population where data is collected before the wind turbines are put in. So that can be going in and looking at the medical histories of those individuals, going in and looking at their medical records. That's the confidential issue.

Maybe there is a group -- a wind turbine goes in, a farm goes in, where there is a data system, an insurance system, that they're covering here. Indian Health Service might be one. So something where data was collected prior to -- data that's objective that we could get to that was collected prior to the wind turbines farm even being discussed.

Q So a moment ago you said prior to the wind turbines going in. Now your contention is that we have to have this information before it's even proposed?

A That's correct.

EXAMINER NEWMARK: He's explained that already.

A I've already explained. Excuse me.

BY MR. McKEEVER:

Q Okay. Now, one follow-up question. One of these hypothetical patients comes to you and they're complaining of headaches and nausea and all these things. It's -- would you agree that it's a -- I'm not sure what adjective to use here -- an unhelpful or an inappropriate response for the doctor to say to the patients have patience?

A No. I --

Q Just put up with this for a while and --

A No, no.

Q That's what you said, let's have patience.

A No, no. You were talking about science. I --

Q Yeah. I'm talking about the individual person that's affected.

A Okay. Please give me the question again as relates to a patient.

Q Patient comes to you complaining of headache and nausea and ear problems, things that literature, as you agree, reports may be connected with wind turbine. This patient comes to you, this individual.

It strikes me, would you agree, that it's an unhelpful or an inappropriate response to say to that patient just have patience?
A I wouldn't say that.
Q But you suggested that if we're going to solve this problem, we just need to have patience.
A Okay. And if you'll let me explain the two situations --
Q Well --
A Bear with me.
Q I understand very well. I'm just pointing out --
A You haven't let me answer the question.
Q Well, you've answered it to my satisfaction.
A Okay. If the judge is okay with it, I'm stuck.
Q You would agree that that approach is going to leave individuals complaining about these problems annoyed?
A The approach that you described is not what I would use and I don't recommend it.
Q I'm confused now. What approach -- what approach did I describe? I'm confused.
A Okay. If a patient came to me with the symptoms you described, I would not say, oh, just have patience, go away, it's in your head.
Q Okay. But if the population comes to you or a population comes to you with those things, your

testimony was have patience, we'll solve this?
A That is correct. It is a totally different question.
MR. McKEEVER: Thank you very much. I have no further questions.
EXAMINER NEWMARK: Okay. Redirect?
REDIRECT EXAMINATION
BY MR. WILSON:
Q Just one area, Dr. Roberts. You indicated that you hadn't updated your Exhibit 2 in this proceeding since 2009, but you have followed the literature since 2009?
A That is correct. Very much so.
Q And is there anything in the literature subsequent to 2009 that would change your conclusions in Exhibit 2?
A No. Up through publications in 2012, I have not found anything that substantially changes my position.
MR. WILSON: Thank you. That's all we have.
EXAMINER NEWMARK: All right. You're excused. Thanks very much.
MR. REYNOLDS: Hang on just a second. I've got one follow-up on that. I've got --
EXAMINER NEWMARK: Follow-up --
MR. REYNOLDS: -- two articles. I'm

wondering if he's looked at these.

EXAMINER NEWMARK: Follow-up on what?

MR. REYNOLDS: Follow-up on the question of recent science. He's reviewed the literature. I want to know if he's reviewed these two articles.

MR. WILSON: You already released him.

EXAMINER NEWMARK: He's answered the question. You've had your chance to cross him.

MR. REYNOLDS: Well, this is in response to the redirect. Just two articles.

EXAMINER NEWMARK: You had your chance to cross him. You're excused. Thanks.

(Witness excused.)

EXAMINER NEWMARK: Is that the balance of the applicant's witnesses?

MR. WILSON: They're all done.

EXAMINER NEWMARK: Okay. Believe it or not, hm? All right. I think we have time for Mr. Hessler.

MS. NEKOLA: Clean Wisconsin would like to call Mr. Hessler.

DAVID HESSLER, CLEAN WISCONSIN WITNESS, DULY SWORN

EXAMINER NEWMARK: Thanks for your patience.

DIRECT EXAMINATION

BY MS. NEKOLA:
Q Good morning, Mr. Hessler.
A Good morning.
Q Please state your name and business address for the record.
A My name is David Hessler. My business is located at 3862 Clifton Manor Place in Haymarket, Virginia.
Q Did you prepare 12 pages of direct testimony, nine pages of rebuttal testimony, five pages of surrebuttal testimony, and three exhibits in this proceeding?
A Yes, I did.
Q And is the information in your testimony and exhibits true and correct to the best of your knowledge?
A Yes, it is.
Q Mr. Hessler, have you had the opportunity to review Mr. Schomer's surrebuttal testimony?
A Yes, I have.
Q Mr. Schomer states that low frequency pulse will be audible to many residents of Forest. Do you agree with that?
A No, I don't think that's an inevitable or foregone conclusion. The --
MR. McKEEVER: Excuse me, Mr. Hessler. Could you speak up.

THE WITNESS: I'm as close as I can get to this thing without eating it.
MR. McKEEVER: Thank you.
A No, I don't think that conclusion is inevitable. That research that his testimony is based on is 30 years of experience evaluating health effects from low frequency noise associated with military sources like artillery and tanks. And he has just taken that result and just applied it wholesale to wind turbines without considering the dramatic difference in the magnitude of the two sources.
An artillery shot is, I think everyone realizes, much, much louder than any wind turbine could be. There are many studies that show that wind turbines -- the low frequency content of wind turbine noise is very, very low and is around the -- at or under the threshold of hearing. So tanks and artillery are not -- I wouldn't describe them as being near the threshold of (inaudible).
THE REPORTER: Near the threshold of what?
THE WITNESS: Hearing. (Laughter.) How about that?
BY MS. NEKOLA:
Q Mr. Hessler, is there a particular recent study that you can point to that assesses the magnitude of low

frequency wind turbine noise?

A Yeah. There's many, many studies that have been done, I've taken my own measurements. But there is one that I think kind of epitomizes the research on this topic, and it's a study that was undertaken specifically to try to address this issue of what is going on with low frequency noise in wind turbines. It's a study that was published in the Noise Control Engineering Journal April of last year by O'Neal. And just to very briefly summarize it, they kind of went through the literature and found all of the existing -- all the ones they could, all the existing thresholds for the perception of low frequency noise worldwide.

They did a literature review of all the papers that have -- that they could find that were ever written on the subject and they summarized the results of all of those. All of those results essentially say that it's so low in magnitude that it's pretty much inconsequential.

And then the last part of this study is that they went out and did their own field measurements on two different types of turbines; and then they compared those findings to all of the thresholds that they had found, and found that the levels were under the threshold of hearing in every instance, every ANSI standard, every threshold they could find.

(Hessler Exhibit No. 4 was marked.)

Q I'd like to hand you this. Is this a true and correct copy of the study that you were just talking about?

A Yes, it is.

MS. NEKOLA: Your Honor, we'd like to move this study into the record as Hessler Exhibit 4.

MS. BENSKY: We object, Your Honor.

EXAMINER NEWMARK: Okay. Go ahead.

MS. BENSKY: Well, I haven't seen it. I haven't had a chance to look through it. I'm paging through his testimony now to see if he did talk extensively about low frequency noise. I don't recall that he did. I don't believe this was cited in his testimony. So our witness can't see it and I don't have the ability to read it now and ask questions. So that's why I object.

EXAMINER NEWMARK: Response?

MS. NEKOLA: Your Honor, this is in response to surrebuttal testimony that referenced low frequency noise, and Mr. Hessler contemplated addressing low frequency noise all along in this case. I think it's highly appropriate to add this to the record. It's a more recent study than anything else that we have so far in the record. And if we -- we could give parties a chance to read it and perhaps decide later. We think it's --

EXAMINER NEWMARK: And just -- I didn't catch who he was responding to.

MS. NEKOLA: Mr. Schomer.

EXAMINER NEWMARK: Schomer's surrebuttal?

MS. NEKOLA: Surrebuttal, um-hmm.

MS. BENSKY: I guess there is no reason this couldn't have been part of Mr. Hessler's direct testimony. His work for Clean Wisconsin, as I understand it, is quite extensive on this case. And if this was going to be an issue that he wanted to address all along, then -- this is a 2011 study, there is no reason this couldn't have come in earlier. It'll take me more than ten minutes to read this and understand it.

We don't have any ability to put any information in the record to rebut it. So that's where the prejudice is.

MS. NEKOLA: Your Honor, this is a 2011 study that reviewed over 100 scientific papers worldwide on this topic, and also included a field study to measure wind turbine noise outside and within nearby residences. I think it would add to the record.

EXAMINER NEWMARK: Yeah, it looks like, from what I can see on direct, Schomer does reference studies about low frequency noise. And so I don't see why this couldn't have come in earlier. I'm going to have to leave it out as prejudicial. It's just too late to go through all of this and to have another witness come in.

MS. NEKOLA: One more thing that is relevant here, I think, is that we anticipated that Mr. Hessler would be able to do his own study of low frequency noise in another wind farm in Wisconsin. And he was -- he has so far been unable to do that because we haven't been able to get access to any wind farms. And so I think this is also his attempt to put in the best recent information on low frequency noise that he has available to him.

EXAMINER NEWMARK: I understand. Does staff have any opinion on this?

MR. LORENCE: I was just paging through his testimony. I see a reference to low frequency in his surrebuttal. But can you tell me where it is in his direct?

EXAMINER NEWMARK: Yeah, Schomer page 3, that first top of the page, there's been a multitude of literature published over the last 40 to 50 years that indicates that low frequency, and it continues on from there.

MR. LORENCE: Page 2 or 3?

EXAMINER NEWMARK: 3.

MR. LORENCE: I guess the only thought I have is if this is the only reference, I don't think he was really asserting anything other than the statement saying that there is publications. I thought his testimony was more direct in the sursurrebuttal with respect to low frequency. And I guess I thought -- and that was at least on page 16 of his sur-sur where he draws his last conclusion. Maybe it's the same thing. And so that's why I noticed that the -- the most as opposed to in his direct.

EXAMINER NEWMARK: And what pages on his surrebuttal? He just has surrebuttal, right? Does he have a third round?

MR. LORENCE: I saw it on surrebuttal page 16. And there may be other places. But I was looking at his last conclusion which is lines 12 through 22.

EXAMINER NEWMARK: I don't see that much difference in those two passages. But let's back up a little bit because I am aware that there is an attempt to do a study, is that the Glacier Hills farm? Is that the case?

MS. NEKOLA: Or the Shirley site.

EXAMINER NEWMARK: Or Shirley.

MS. BENSKY: He was denied access several months ago; isn't that correct?

MS. NEKOLA: No. They have not made a decision, final decision. But it has the same effect of being denied, actually.

MS. BENSKY: But in his direct testimony, doesn't he say he was denied?

MS. NEKOLA: Well, I'm not sure, but the -- the truth is that he has not been able to get access.

MR. REYNOLDS: Has there been any reason given for that?

MS. NEKOLA: No. Right, his direct testimony just says that we have not been granted access to the site. So thus far, we haven't been able to -- he hasn't been able to do the study.

EXAMINER NEWMARK: Okay. Well, the problem with this is I don't think this is enough of a substitute for a study at the other wind farms, and I know that the access question has not been fully determined.

MS. NEKOLA: That's right.

EXAMINER NEWMARK: And I would be prepared to reopen the hearing if we could have a study developed on that specific -- on those locations, one of those locations, if access is granted. But that would mean scheduling that and having a process for it.

But at this time in the game and at this hearing, I don't think we can admit this -- this study because the parties have not had a chance to review it and their witnesses aren't available. You know, if there is a point in time when we know access cannot be given, I can consider reopening the hearing to take a look at these late exhibits as a substitute. But I would like to, you know, try to -- I don't want to do that now and I don't want to thwart any attempts to get the studies done. I think that's much better evidence. So -- or it would be evidence rather than, you know, literature review.

So are there any other exhibits that relate to this? I saw you had a number of items there.

MS. NEKOLA: Not on low frequency noise. We have one other that we want to offer on another matter.

EXAMINER NEWMARK: Okay. All right. So are we okay with that?

MS. NEKOLA: We just want to point out that the study that we're -- tried to move in was not just a literature review, but that there were also actual sound measurements at wind farms.

EXAMINER NEWMARK: Okay. Thanks for clarifying that. So for now we will hold off on that.

MR. WILSON: Your Honor, for what it's worth, I had a discussion with Cindy Smith yesterday morning where this topic came up about the inability to do the low frequency testing --

EXAMINER NEWMARK: Let's go off the record.

(Discussion off the record.)

EXAMINER NEWMARK: Let's get back on.

BY MS. NEKOLA:

Q Okay. So do you think that low frequency noise problems can be ruled out?

A No. Despite the findings in that study, no, I don't think we can just assume that there won't be any problems. And I say that with respect to the testimony we heard yesterday from those three homeowners that had to leave their house -- houses at Shirley. That was very compelling and I think irrefutable evidence that there is a problem at that site. The question is why is that? And that's what we were hoping to explore with that field survey.

So I think what's happening is that there is a low frequency noise that is associated with very specific turbine models or types of blades or blade control mechanisms that results in, according to the studies that I've seen recently, results in inaudible low frequency sounds that can produce adverse symptoms and problems in certain people in rare cases. But it needs to be investigated. And that's really the state of knowledge on that.

Q You say that these instances are rare. Can you give an example of a more typical situation?

A Yeah. Yesterday we also heard from Jeff Bump who lives at the Glacier Hills site. And I'm familiar with Glacier Hills. And I know -- I met Jeff Bump. My brother and I set up instruments at his house last winter, and we measured day and night at his house for about 18 days I think at his house, and ten other houses around that site. All the ones with the closest possible exposure to turbines. We measured off of the site to get the background conditions on a -- kind of a running time history of background throughout the survey.

And, you know, he said he was bothered by this horn sound and that's -- I heard that, that's associated with the hydraulic system in the Vestas V90 turbine that's at that site. He said he was kept awake by a swishing noise. That's mid-frequency oscillation, around 500 hertz, due to the blades. But what he didn't complain about is low frequency issues and any of these adverse health effects. He said, well, he might have got a headache once, but really it was all about the fact that he was bothered at night.

But the point is that this project, Glacier Hills, has over -- I think it's over 120 turbines that are distributed over an area that's about, very roughly, 40 square miles. There are hundreds and hundreds of people that live in close proximity to turbines at that project. Yet the only people that are complaining are Mr. Bump and another fellow that lives next -- or nearby him. Those two people are the only ones that have any problem with noise out of many, many hundreds. And that is the typical situation based on all of the post-operational surveys that I've done. The number of people that are actually complaining or bothered by it is very, very low compared to the total population.

Q Thank you. Mr. Schomer also mentioned that the data contained in your Exhibit 1 is artificially elevated by pseudo-noise or instrument error. Do you have a response to that?

A Yeah. What we did in our analysis of the applicant's sound study was to look at the data, the sound data, as a function of wind speed. And that's been criticized as, well, the sound levels are elevated because the wind was blowing over the microphone. But the fact of the matter is that the winds were very light during that survey; and the peak wind, the highest wind, at the microphone during that entire two-week period was only seven miles per hour.

We have -- some years ago, I think it was about 2008, we did study, a wind tunnel study, to evaluate that phenomenon of wind blowing over the microphone to quantify what that error is. And in that study, what we found was for a seven-mile-per-hour wind, the self-generated noise or pseudo-noise would be only around 20 dB, whereas in the field survey at Highland, the levels being measured under those conditions was in the neighborhood of about 45 dBA. So there wouldn't be any effect at all from a pseudo-noise. I believe the data is perfectly valid.

(Hessler Exhibit No. 5 was marked.)

Q You've been handed a copy of a study that you just referred to and described. Is that a true and correct copy of that study?

A Yes, it is.

MS. NEKOLA: We'd like to enter this into the record as Exhibit 5.

EXAMINER NEWMARK: Any objections?

MS. BENSKY: No objection.

EXAMINER NEWMARK: All right.

(Hessler Exhibit No. 5 received.)

BY MS. NEKOLA:

Q Turning to the surrebuttal testimony of Mr. Horonjeff, have you had an opportunity to review that testimony?

A Yes, I have.

Q Mr. Horonjeff points out that your comparison of the Highland sound data with the met mast wind speed shows considerable scatter at any given wind speed,

and he suggests that the mean value should not be used. Do you have a response to that?
A Yeah. It's not really a matter of where you draw the line, the mean trend line, in that data. What it shows is that the vast majority of the sound levels that were measured during the survey were measured under very low wind conditions that -- below the point, generally speaking, where the turbines would begin to operate. And the principal point is that during the windier conditions when the project would be operating, there are very, very few measurements of low sound levels during those wind conditions, only about six to a dozen ten-minute samples out of roughly 2,000 measurements that were taken.
Mr. Horonjeff is saying that, well, sometimes it's quiet when it's windy, but that is a rarity and that's what that figure shows.
Q You were present yesterday when Mr. Reynolds questioned Ms. Blank about the sound modeling for the project, correct?
A Yes.
Q And do you recall that Mr. Reynolds quoted your direct testimony at page 11 as saying that sound models should have an ideal target level of 40 decibels? Do you recall him saying that?

A Well, I think what he said was that the project should be designed to 40. 40 is the recommended level. My view on that is -- and what we've asserted in papers and things that we've published based on our field studies of completed projects -- is that if possible, projects should use 40 dBA as an ideal design goal if at all feasible because what we find is that below 40 there's very few, if any, complaints. But as a regulatory limit, we've put forward a level of 45 because the regulatory limit is different from an ideal design goal. A regulatory limit has to balance everybody's best interest. So the 40 we weren't saying was a suggested regulatory limit but rather an ideal design goal.

Q So just to be clear, is it your position that the Highland wind project should meet the 40 decibel noise standard?

A Should it meet the 40?

Q Right, is that your position?

A No. I think it -- I would be satisfied or I would recommend that it meet the 45 limit as currently it's obligated to do.

MS. NEKOLA: Mr. Hessler is available for cross-examination.

EXAMINER NEWMARK: All right. Do you have questions?

CROSS-EXAMINATION

BY MS. BENSKY:

Q Good afternoon, Mr. Hessler.

A Good afternoon.

Q In your papers, you have a very distinct talent in taking complicated information and making it understandable for everyone, so I commend you on that and I ask that you do your best to keep it at that level here.

A We'll see how it goes.

Q Let's start with page 2, I'm just going to go through your testimony. So direct testimony page 2. At line 2, you say, "Typical projects involve field surveys to establish baseline background sound level conditions..." Is that the same way of saying ambient sound?

A Yeah. It's essentially the same thing.

Q And why is it important to establish that baseline?

A Well, the way most projects -- not just wind projects, but any fossil plant or any project -- would be evaluated is to see how its noise is going to compare to the sound level that already exists at that location. If the facility noise is going to greatly exceed the existing level, then there's

likely to be an adverse impact. If it's below the background, you might not even hear it. So it gives you a baseline to make a judgment on what the impact's going to be.
Q And in your view, is establishing that baseline an important thing to do?
A Yeah. We typically do do that for wind projects or any power plant.
Q Turning to page 3. You have your testimony up there with you?
A Yes, I do.
Q Now, page 3, and correct me if I'm wrong, it looks like you are first reviewing the initial predictions that were listed in the application using the zero coefficient assuming a total reflective ground?
A Where is it that you're at there?
Q On page 3, question number 7 -- or line 7. Your overall impression of the studies. I just want to clarify that what you're talking about right there is the modeling results where a zero coefficient was used; is that correct?
A Yeah, yeah. That's correct.
Q And looking at those results, if the average background noise was between 29 and 34 decibels and the project level was 45 decibels, your opinion is

that the project would be quite audible; is that correct?
A Yes, that's right.
Q If those were the actual numbers. And is the reason why the project would be quite audible is because you have that 11 to 16 above ambient level?
A That's right.
Q And do you have an opinion as to whether an ambient level of between 12 and 16 decibels -- or an actual level above -- let me start over.
Do you have an opinion as to whether that relative noise level would result in adverse community reaction?
A Yeah. If those were the actual levels, then we would conclude in any assessment that the project was likely to have a pretty significant adverse impact.
Q So it's not necessarily that 45-decibel level you're concerned about, you're more concerned about the relative difference, that 11 to 16 decibel difference; is that correct?
A Yeah. That's what I'm talking about in that particular paragraph.
Q Now, on page 4, going down to line number 12, you're talking about your review of the met tower data, and you had requested a site plan that you did not

receive?
A That's right.
Q And I understand later in your testimony that you kind of reverse engineered a site plan based on the available information?
A Yeah. It was possible to import into our modeling software the -- I guess the sound contour map from the application. It wasn't absolutely necessary to get the site plan in the first place. It was just -- it would have helped things. That's all.
Q So what information would you have expected the site plan to contain that would have been helpful to you?
A Just a particular kind of computer file that is easily imported into the modeling program. Just more to save time. What we had to do was just take the PDF and work with it.
Q So you feel that you obtained all of the information that you needed?
A Yeah. We made do.
Q The information that you used in your gathering of that data, do you know if that's the exact data that would have been contained in the site plan?
A We used the actual site plan from the application.
Q But you said you didn't receive the site plan.
A We used the site plan that was published in the

environmental assessment. It was just a matter of convenience to get the computer file. It wasn't germane to anything really.
Q So the actual data would have been the same? What I'm --
A That's right.
Q What I'm getting at is do you think that you input the right numbers based on the information that you had?
A Yes.
Q Now, let's talk about the met tower. The met tower was 49.5 meters, 162 feet. And is it your understanding that the hub height of the proposed turbines is between 299 to 328 feet?
A Right. Yeah. This met tower anemometer puts it within the rotor plane, not exactly at the hub height. It's very rare to have a met tower high enough that it goes all the way up to 80 or so meters.
Q So it's at the bottom of the rotor plane, 162 feet would be at the very bottom assuming the blade lengths are between 160 and 180 feet?
A Right.
Q Is there some sort of formula that you applied to that 49 meters to estimate the wind speed at the hub

height?
A The hub height wind speed wasn't needed for anything. What we did do was take the met tower wind speed at 49 and a half meters and then normalize that to 10 meters because you have to put the wind speed data on an even footing with the turbine sound power level data which is also -- which is always expressed as a function of the wind speed of 10 meters.
Q But that's something different than estimating what the wind speed would be at the hub height?
A Yes. The hub height, whether it's near the bottom of the rotor plane or at the hub height, it doesn't make any difference here, to what we were shooting for here.
Q But wouldn't it be -- if you want to know how fast the blades are going to turn, wouldn't you want to know the wind speed at the hub height? Wouldn't that be ideal?
A No. It's really -- it's all about the wind speed at this normalized height of 10 meters that's relevant to this whole thing. Even if we had a met tower that was -- met mast that was 80 meters, we would have just taken that value and normalized it to 10 meters. It would have been the same.
Q But if you had a met tower at 100 meters, you would

not have had to apply that formula?
A No. We would have had to apply it to any elevation anemometer. We want to bring it down to 10 meters from whatever height, the highest possible height.
Q So based on the met tower data, you don't know the actual speed of the wind at the hub height; is that correct?
A We could easily infer it from this 49 and a half meter data if we wanted to know it.
Q So you didn't -- is your answer you did not have the actual wind speed at the hub height?
A Met mast wasn't high enough.
Q And you did not have the actual speed at the rotor tip of 500 feet?
A We could have inferred that if we needed to know. The ideal thing would have been to have anemometers over the whole diameter of the blade, but you never have that.
Q So you have to make some approximations?
A Oh, yeah.
Q Is there generally a difference -- or can there be a difference in wind speed at 500 feet as opposed to 162 feet?
A Yeah. It is typically higher with elevation.
Q What happens when there's a very -- there's a higher

wind at the rotor tip than at the bottom of the rotor?

EXAMINER NEWMARK: In what sense? What do you mean what happens? In terms of what?

A Yeah, in terms of what?

BY MS. BENSKY:

Q When there is a higher -- when there's a higher wind at the top than there is at the bottom of the rotor, does that have any effect on the sound produced?

A Yeah. Yeah. The wind speed is typically always higher at the top than it is at the bottom. It's very rarely perfectly flat, although that does happen. The degree to which the wind speed varies from the top to the bottom or from -- between any two heights is the wind sheer, and the higher the sheer the more slanted that -- the greater the difference between the wind speeds at different heights, the greater the noise generation generally is.

Q Is there a particular season where the wind sheer is greater?

A Yeah, at most sites it's typically in the summertime.

Q The wind sheer is greater in the summertime?

A Yeah.

Q Are there any other weather conditions where the wind sheer would be greater?

A It's typically higher at night than it is during the day.
Q Now, looking at the bottom of page 4, is it your testimony that when the near ground level wind speed is very low, that does not necessarily mean that the hub height wind speed is the same; is that correct?
A Right. You -- it's hard to tell anything from the wind speed measured at a meter above the ground. That generally remains pretty low even when it gets really windy out. That's why we wanted to use the met mast that -- at the highest possible anemometer to get a sense of what's going on up at the elevation that the turbines would see that wind.
Q Just so we're all on the same page, what's an anemometer?
A A device for measuring wind speed.
Q And that's the thing that sits on top of that met tower?
A Yeah.
Q Let's turn to page 5. Looks like I already covered that. Let's go to page 10. Starting on line 6 and just follow along. Is it correct that you state, "A common design theory for new industrial projects of all kinds is to design the project so that its sound level does not exceed the background level by more

than 5 decibels..." Did I read that correctly?
A That's right.
Q Then you state, "...the logic being that such an increase is not particularly noticeable, at least when the character of the noise is rather bland and free of any prominent tones or other identifiable characteristics. Because wind turbine noise often has a variable, churning, sometimes periodic character to it, this approach is somewhat tenuous for wind projects, but nevertheless it is commonly used..."
Is it your testimony that wind turbines create a sound of such a characteristic that the 5 decibel above ambient is too much?
A Yeah. Yeah. The 5 increase would -- makes the most sense when you have a, for example, a very constant source that has a bland character to it like a conventional power plant. That sound 5 above the background is usually -- or usually results in a negligible impact, people don't really notice it. Now, wind turbines don't have a particularly steady sound so that they are more audible than other sources relative to the background. So even a 5 increase is generally pretty noticeable.
Q Thank you. Now, at the bottom of the page, you state

that assuming a background noise of 34 to 36 decibels, your recommendation in an ideal world is that the project noise be limited to between 39 to 41 decibels; is that correct?
A Yeah. That would be a 5 increase over this background level that I'm coming up with.
Q Okay. Now, on the next page, and I'm going to hand out an article that you reference and footnote on page 11.
EXAMINER NEWMARK: That's Hessler 5, right?
MS. NEKOLA: 6.
MS. BRANT: No, Your Honor. It's the same scientific journal, I believe, or a very similar format.
MS. BENSKY: No, it's a different article.
MS. NEKOLA: It's a different article, right.
BY MS. BENSKY:
Q And the first question is looking at the publication that I just gave you, is this indeed the publication that you reference in footnote 3 on page 11 of your direct testimony?
A Yeah, yeah. I'm glad you handed it out to everybody.
Q Now, let's turn to page 96, it's just this third page

in. And you're talking about the World Health Organization target noise level to protect the public. And that is listed at 40 decibels day or night; is that correct?
A I think they specifically call that the nighttime target.
Q Okay. Oh, you're right, nighttime sound levels.
And has that changed since this paper was published?
A Not to my knowledge, no.
Q And turning to page 98, first full paragraph beginning with Considering the EPA guidelines. And there's some discussion of day and night levels; and then you state -- first of all, did you author this paper?
A Yeah. I was a co-author on it.
Q Co-author with George Hessler?
A Yeah.
Q So you state, "A 45 decibel composite noise equivalent level with a 5 decibel evening weighing would be even more ideal at 45, 40 and 35 decibels for day, evening and nighttime levels, respectively."
EXAMINER NEWMARK: Can you point to that for the record.
MS. BENSKY: It is on -- it is a

publication which is footnote 3 of Hessler Direct 11. It's called, "Recommended noise level design goals and limits at residential receptors for wind turbine developments in the United States," and it's on page 98 of that publication.

EXAMINER NEWMARK: And where on page 98?

MS. BENSKY: It's in the middle of the page. There's a first -- full paragraph begins with Considering the EPA.

EXAMINER NEWMARK: Okay. Thanks.

MS. BENSKY: And I'm looking at the last sentence.

EXAMINER NEWMARK: Um-hmm. Okay.

BY MS. BENSKY:

Q So my question is, is it correct that in this paper, you recommend an ideal design target of 45, 40 and 30 decibels respectively during the day, evening and nighttime?

A No. What we're doing in that part of the paper is going through all of the regulations that pertain or could possibly pertain to wind projects and just summarizing each one. At the end of the section, then draw a conclusion on what we recommend based on all these various standards.

Q And your conclusion is that a composite noise

equivalent level would be even more ideal at 45, 40 and 35; is that your conclusion in this paper?
A It's not a conclusion. It's just a comment on this particular measure.
Q But it's correct that -- I'm reading it correctly, right, that, "A 45 dBA composite noise equivalent level with the 5 dBA evening weighing would be even more ideal at 45, 40 and 35 decibels for day, evening and nighttime levels, respectively." Am I reading that correctly?
A Yeah, yeah. The lower the level the better. But we end up concluding later that as a practical matter 40 is -- seems to make sense.
Q But taking out -- you're not a state regulator, correct?
A That's right.
Q So -- you're a noise engineer, correct?
A Right.
Q And based on your very extensive expertise as a noise engineer, your opinion is that it would be ideal to have a 45, 40 and 35 dBA level for day, evening and nighttime?
A I'll always say it's more ideal.
Q Let's move on. Tell me, did you make any differen -- what hours are we talking about? What's daytime?

What are daytime hours as you're talking about here?

A It's usually 7 in the morning to 10:00 (sic) at night.

Q And what's evening?

A Then that goes to -- I'd say it's 7 to 10 p.m. or something.

Q So daytime would be 7 to 7, evening would be 7 to 10?

A Yeah.

Q And then nighttime would be 10 to 7 in the morning?

A Right.

Q Now, please turn to the next page, page 99, first full paragraph on that page says -- starts The States of New York, Massachusetts and California. Are you there?

A Okay. Yeah.

Q The first -- or the second sentence reads, "An ambient-based method is based on the perception of the new sound in a specific residential community. A perception-based method is clearly a better approach than a single absolute limit, and, in fact, many years of experience have shown this approach is working well in all these three states."

Did I read that correctly?

A Yes, that's right.

Q And you're talking about three states that have an

ambient-based guideline; is that correct?
A Right.
Q And the words that I just read, are those your recommendations in this article? You're not quoting anyone else. I want to know if that is your work right there?
A Yeah, yeah. We're talking about how they do things in New York, Massachusetts and California. And how that is, how that works, is that you measure the background, you add some factor to it, in Massachusetts it's 10, and essentially what you come up with is an absolute limit that is derived from the background. But the final answer is an absolute number.
Q But your opinion, is it correct that your opinion here is a perception-based method, which is this ambient relative standard, is clearly a better approach than a single absolute limit; is that your opinion?
A It's what's -- that's what it's saying here. But the end result of the paper is that it's better to go with absolute numbers.
Q So you contradict yourself in this publication?
A I suppose so. I think my father wrote that part, but -- in fact, I'm sure he did.

Q I'm going to tell him you said that.
A I'm always -- I'm used to that.
Q Now, on page 11 of your testimony, you're still discussing this article and you're discussing the results of it looks like a survey that you conducted? Is that correct?
A Okay. We're back in the direct testimony again?
Q Yeah. The direct testimony on line 12 --
A Yeah, okay.
Q -- you're referring to a study, and the study that you're referring to is still in this article?
A Yeah. It's just later on in the same article, yeah.
Q And you state at least 95 percent of residents were apparently satisfied with or unfazed by the sound emissions of the new wind project, even when sound levels were around or above 45 decibels. Was that your conclusion based on this study?
A Yes, it was. And what that study is all about is we're --
Q I'm sorry. Let me ask you the questions, keep this moving along.
A Okay. Go ahead.
Q Please look at Table 4 of your paper, it's on page 101, and it looks like those are the results of this study that you're talking about in your direct

testimony?
A Yes, that's right.
Q So looking at site A, there are approximately 107 households that are within this kind of target area near wind turbines; is that correct?
A Um-hmm. Yes.
Q And you found that when noise decibel levels were below 40, there were no complaints --
A That's correct.
Q -- correct? No sound complaints or no complaints at all?
A No complaints related to noise.
Q Okay. So the survey didn't ask about did people have problems with nausea or sleeplessness, it just said are you bothered by the sound?
A Well, there was no official survey. These houses that are in the table or are counted in the table, what those are are all of the houses where the project operations ever received a call with any kind of concern about the noise from the project. Some were definite complaints, others were just kind of mild concern. But they're all included here. When we do these surveys, we'll ask, you know, who has ever called about a problem; and then we will put instrumentation at that house and include them in the

compliance study. So we know how many complain and we know what the level was there.

Q Okay. So you had 107 homes where there were noise complaints --

A No.

Q -- correct?

A No, that's incorrect. The 107 is the total number of households that are within 2,000 feet of a turbine at that project.

Q I'm sorry, I didn't hear you. My colleague was talking to me.

A Yeah, the -- all the numbers in that column, the 107 is how many houses there were within 2,000 feet of a turbine in that project. In other words, it's the total population essentially.

Q Okay. And this -- to obtain the complaint data, you went to the company to get their records, correct?

A Well, it was just a matter of talking with the operations people. No records per se.

Q So you didn't receive anything saying here's our stack of written complaints?

A We asked who has ever called with any kind of concern about noise. And they -- then they told us. There may be more. That's possible.

Q So it's -- you called up Bob who runs this project and said who's complained and he said, well, I think this guy, this guy and this guy; that's what it was?

A Well, it's whoever called up at any time. And I think this is -- it seemed to be pretty accurate.

Q But you didn't go to every -- you didn't send out a survey to 107 residences --

A No, no, not at all. This -- the purpose of these surveys was never to -- was not primarily to evaluate the impact. It was to carry out a compliance survey to see whether the project was meeting its requirements. And we just were able to draw out of that this information.

Q And that obviously is a very important distinction.

A Yeah. Yeah. None of these surveys were undertaken with the primary purpose of counting how many people complained.

EXAMINER NEWMARK: Let me just note, on your direct, you label this study, not a survey. So I don't know if that makes a difference as to what we're really getting at. You weren't intending to do a survey here, you were doing a study?

THE WITNESS: Well, all of the examples in this table, they're all field surveys of actual projects.

EXAMINER NEWMARK: Okay. So it did make a difference. All right.

BY MS. BENSKY:

Q So I just want to make a very important clarification. You did not go -- for site A, you did not go to 107 residences, personally ask somebody do you have a problem with the noise, yes or no, and then get a result, correct?

A Yeah, that's correct.

Q So if somebody didn't complain to the company -- even if they did complain to the company, they might not be included in this?

A Oh, yeah. There could be more. We're not claiming that it is the definitive number, but this was what we were able to find out.

Q Right. So you're not saying that 95 percent of 107 households are -- don't have any noise complaints related to this project? That's not what this is saying?

A Well, what it's saying is that we know how many definitely did complain and there may be some more, but in general it shows that the vast majority did not complain.

Q All right. Now, you were here and -- you had the great pleasure of sitting here all day yesterday, correct?

A Yes, I did.
Q And you heard some people come up and testify that they had various complaints about noise, correct?
A Um-hmm. Yes.
Q Did you hear anybody say that they didn't go off and complain to the company?
A It seemed like when asked, most of them said they did call the company and made various progress.
Q Did you -- do you remember hearing anybody say they did not complain to the company?
A I don't specifically remember any examples.
Q Okay. That's fine. Going back to the actual text of your testimony, at line 11, the text reads, "In fact, an interesting finding of the study was that at least 95 percent of residents were apparently satisfied with or unfazed by the sound emissions of the new wind project, even though sound levels around and above 45 dBA were observed..." That's what it says, correct?
A Yes, that's right.
Q But that's really not a conclusion that we can draw because you're assuming that at no -- that if a person did not complain to the company, that they are satisfied or unfazed by the noise, correct?
A That's why I used the word "apparently."

Q But that's an assumption that you're making in that statement?
A Yes. But this is -- as you can see from the table, this is repeatable over five sites in this study and several more after it.
Q I'm not concerned about the decibels right now. I'm just talking about the data, the number of complaints. So one big assumption of this study is that if a person was upset about the noise to any degree, that they complained to the company. Would you agree that that's an assumption that you're making in that statement?
A Yes.
Q Now, the second assumption that we're making is that the company gave you all of the complaints that they received?
A Yes.
Q And we don't know -- those are big assumptions. We just don't know if -- we don't know the answers, you never went back and double-checked that?
A They're assumptions, but I think they're fairly accurate.
Q But you really don't have a basis for thinking that they're accurate?
A I can't imagine that -- you know, in this first site

there was three complaints. I can't imagine there was 50 complaints there. I don't think that's the case.
Q But --
A And part of the reason for believing that is that we measure -- when we do these surveys, we measure in this example these three houses; but then at -- many, many others throughout the project area all have the houses that are closest to turbines. And not only do we measure, but I personally have talked to all these people, the ones that have complained and then the other ones elsewhere. And it's -- it's surprising to me, it was surprising to me how many people just don't -- it's not the noise, even though the levels are fairly high.
Q But that information that you just gave us is not reflected in this survey? You said you went out and you talked to people.
A Yeah.
Q But we don't know, based on this survey here, how many people you talked to, what they said, there's no written survey; is that correct?
A No. This is what I've gathered in the course of doing this work.
Q Okay. Just a couple follow-up questions, one having

to do with this. So let's turn to page 97. And there's two columns on the right-hand column, first full paragraph, that begins with, "In addition, the report clearly indicates."

A Yeah. Okay. I'm there.

Q Okay. About -- looking at the very last sentence of that paragraph beginning with Schomer. Do you see that?

A Yes, um-hmm.

Q And you state, "Schomer suggests that an adjustment of 10 decibels should be subtracted for quiet rural environments and perhaps another 5 decibels if the project is newly introduced into such a long-standing quiet setting." Is that what this says?

A Um-hmm.

Q And getting into this issue of day and night levels. Is there anywhere in this paper that you criticize Mr. Schomer's suggestion?

A No. This is just saying that we're taking onboard what he has to say about it and figured it into this overall analysis.

Q But you agree that you're not critical of that particular suggestion in this paper?

A No. That's why it's in there.

Q Now, you spent the day here yesterday and you heard

Mr. Hankard say that if you measure at very close to a wall, you're going to get a result that's three decibels higher and that's not a good thing to do to measure sound in a wall. Do you agree with that?

A Yes, yes. You don't want to put the microphone right on a vertical surface, no.

Q My question is, what's the decibel level on the other side of the wall? Does sound -- can sound waves go through the wall?

A Yes. To some extent. Depends on the wall construction and so on, frequency content of the noise.

Q I hear some laughing behind me from Mr. Schomer, so I don't know if that was a question showing a lot of naivety.

But what I'm getting at is when there's a 45-decibel level outside a home, what's going on inside the home? Does the sound travel through the wall such that the walls can create some sort of reverberation and make it even louder indoors than it is outdoors?

A No. What typically happens is the level inside is substantially lower than what you're measuring outside.

Q With any frequency of sound?

A Yeah, as a general rule.

Q Are there any frequencies that travel better through walls than other frequencies?

A Sure, sure. The lower frequencies pass through a given construction much more easily than high frequencies.

Q And when you say low frequency, what is the kind of baseline low frequency that's going to make it through the wall?

A Any frequency down to 1 hertz.

Q But up to what hertz level?

A Well, let's say from 20 hertz down.

Q Okay. I'm almost done. Can you please turn to your rebuttal testimony, and pull out Exhibit 3 from that testimony, please.

Now, Exhibit 3 looks like it's a comparison between the model predictions and the actual noise levels measured; is that correct?

A Is it this figure, you mean?

Q Yeah.

A Okay. Yeah. What that's showing is the black figures in the middle of the chart are the sound level at 1,000 feet from an isolated wind turbine in three different directions measured over 14 days.

Q So there are actually three black lines in here?

A Yeah. They all kind of are similar.
Q And the -- I guess it would be the Y axis at the bottom, that represents a total of 14 days?
A That's right.
Q So my first question is we see some peaks, correct?
A Yes.
Q What length of time is one of those peaks? Is it an hour, a minute, a second?
A This data was measured in ten-minute increments, and there's a couple of -- well, there is a very prominent spike right in the middle of the survey, that was probably 20 to 30 minutes in duration.
Q That spike?
A Yeah.
Q Is every spike -- is every little point a ten-minute average or 30-minute average?
A Well, the sound level data appears as a continuous line; but it's actually made up of many, many thousands of ten-minute samples all strung together.
Q What I'm trying to figure out is for how long was it that loud when we see a peak? Does this graph give us that information?
A Well, from having looked at graphs like this a lot, I can tell there's -- this peak in the middle is, like I said, probably 20 to 30 minutes long.

Q And where was this measurement taken? What state?
A This is at a site in Minnesota that was in an extremely rural area, not near any roads or towns or anything. And it was just in a wide open field.
Q And near what wind farm?
A Prairie Star, I believe it's called.
Q And do you know the make and model of the turbine?
A I think it was a Vestas V90.
Q And do you know what the power output was?
A The electrical power output? It was 2 megawatt, I think.
Q And do you know how tall the turbine was?
A I think it was on a typical 80 meter mast. This is just taken as an example just to compare modeling versus what you measure.
Q So with an 80 meter mast it would be probably around 400 -- 360, 370 feet?
A Right, right.
Q And this 14-day period was in August?
A That's correct.
Q Is there a certain month of the year where the winds are stronger?
A Well, it varies at every site. I don't know what the wind rose was at this particular site, I don't recall.

Q As a general matter in Minnesota, is it windier in the winter or in the summer?
A I think it's the wintertime there.
Q And you agree that in August there are generally more leaves on the trees, more grass on the ground, more birds?
A Yes.
Q Now, looking at this, we do see several points where there are exceedances over 40 decibels; is that correct?
A Yes. Remember, this is only a thousand feet away.
Q Right. But there are exceedances over 40 decibels?
A That's right.
Q Now, this bold red line looks like it is -- the first bold line at the top is using that 0.0 coefficient --
A Yes, that's right. Um-hmm.
Q -- modeling? And the second line down is using the .5 coefficient?
A Right.
Q And then there's a very, very faint red line down below and that's the 1.0 coefficient?
A Right.
Q Now, if the standard was you may not exceed 40 decibels at night, looking at this graph, would you think that there are exceedances?

A Yeah. It does go over 40 for this particular measurement setup, these distances and so on.
Q On average it doesn't, but it does go up there, it goes above it?
A Right. Well, that's typical.
Q So it is typ -- are you saying that it's typical that there are -- that the actual sound does exceed the modeling at certain times? Would that be a correct assumption?
A Oh, most definitely, yes.
MS. BENSKY: That's all I have.
MR. REYNOLDS: Could we take a break?
EXAMINER NEWMARK: It will be short if we do it now. It will be longer if we wait 'til after he's done.
MR. REYNOLDS: I'd rather take a short break. It's going to be at least a half hour.
EXAMINER NEWMARK: All right. Let's take 20 minutes.
(Recess taken from 12:15 to 12:43 p.m.)
(Change of reporters.)
EXAMINER NEWMARK: Okay. There's a motion to move Mr. Hessler's study that he footnoted in his testimony, and that would be --
MS. BENSKY: Footnote 3, page 11 of

direct.

EXAMINER NEWMARK: Okay. And his -- Exhibit 5 it would be, we would mark it as 5.

Any objections to that?

MS. BRANT: I'm sorry, Your Honor, would it be 5 or 6? We have a pending with 4 that was denied, but potentially to be admitted later.

MS. NEKOLA: And then we have 5.

MS. BRANT: Exhibit 5, which is his pseudo notice.

MS. BENSKY: So 6. 4 was marked.

EXAMINER NEWMARK: So 5 is still pending.

Let's go off the record.

(Discussion off the record.)

EXAMINER NEWMARK: So Hessler 6, any objections? No. Okay. It's in the record.

(Hessler Exhibit No. 6 marked and received.)

EXAMINER NEWMARK: All right. I think, Mr. Hessler, remember you're under oath, and you're available for cross.

CROSS-EXAMINATION

BY MR. REYNOLDS:

Q Mr. Hessler, I have a couple of questions for you. You testified that you were struck by the testimony of the Shirley Wind people.

A Yes. That's correct.
Q Why is that?
A Because of the -- because it's completely credible, and I don't doubt it at all.
Q And do you doubt -- is it significant to you that the residents testified that they had no problems before, and when they left the site, their symptoms disappeared?
A Yeah. That's very simple. It appears to be due to the project there.
Q And what -- was that one of the reasons you wanted to do some testing of Glacier Hills? Sorry, at Shirley.
A Yes. And I think what's needed is to get to the bottom of why that is.
Q And what -- is it fair to say that the symptoms that they complained of, such as headache, nausea, ear problems, are consistent with exposure to low frequency sound?
A Yeah, I think that's true. Of course it depends on the magnitude of the sound, whether you're affected or not, but because specifically one fellow said he lived one mile away, that means that it's the only possible sound that could travel that far would be low frequency noise.
Q And so what -- what has -- what's been the result of

your effort to test up there? What would you have to do and what request did you make, and what were the results?

A Well, we came up with a preliminary test plan where we had identified one or two units that were kind of isolated so we could kind of more or less scientifically measure them, and I think we submitted that to the project up there so they would know they were abound. But at first we didn't hear anything, and I think they finally said, well, they don't want to -- we're welcome to participate, but they don't want to do it.

Q And what were you planning to actually test for?

A Well, low frequency specifically. And what we had in mind was to test using a procedure that's outlined in IEC standard 61400, which is a procedure for measuring the sound power of wind turbines. It's what all manufacturers use. But the point is that that methodology uses a reflecting board that you put on the ground and then you lay the microphone right on the board, and the reason for that is that the wind speed is theoretically zero at the surface. So you're largely eliminating self-contamination from pseudo-noise that we talked about a bit earlier because it's very, very difficult to measure low frequency noise because it's covered up by cell noise of wind. It's a real technical challenge.

Q And let me ask you this. You've noted that there are significant differences. There's -- there's a significant difference between, say, Mr. Bump's testimony and the three individuals who abandoned their homes at Shirley?

A Right.

Q Now, there are different machines at the farms, right?

A That's right.

Q What's at Glacier Hills?

A Those are Vestas V90.

Q And what's the output?

A I think they're 2 megawatt.

Q All right. And what are the ones at Shirley?

A They're the Nordex N100, and that's two and a half -- I don't remember.

Q And the -- that's one of the machines that's proposed at this Highland project; is that right?

A One of the three that are being considered. It's prominent in these analyses I think just because it has a slightly higher sound power level, but that's the only reason it's really being looked at carefully.

Q All right. Are you aware of recent low frequency noise from large turbine literature that describes findings of higher low frequency noise from larger turbines, those in the 2.3 to 3.6 megawatt category?

A Yeah. I have heard that, but my sense is that -- well, what strikes me is how remarkably similar the sound power level is of all the turbines that are in current use all the way from one-and-a-half-megawatt units up to 3-megawatt units. They're all remarkably similar in my view.

Q Well, are you familiar with a 2010 low frequency noise from large turbines work by Henrik Moller and Christian Pedersen on the subject?

A Yeah. Yeah, I've read that, but some time ago. And I think they do some sort of analysis, and it appears that it maybe is a little bit louder in the lower frequencies for larger turbines, but that may be true slightly.

Q So you would point to the potential cause of the Shirley complaints to the machine itself?

A Yeah. I think -- I think this sort of problem is related to the specific turbine. Now, before yesterday when I heard that testimony, my view is that those kinds of problems were principally associated with the Vestas V82 in its early form that had stall-regulated blades instead of pitch-regulated blades. But this is the first I've heard of a problem with a N100 site. I've worked with project that put in N90s and N100s and there aren't any problems at that site, so it's puzzling.

Q Let me ask you this. You have -- you heard testimony about your recommended noise level design goals, right? That's a paper that you and your dad and -- you and your dad put together?

A Yeah.

Q All right. And would you -- your findings indicate that a 40-decibel level in the A range, that's the audible range, is ideal?

A Yeah. And the reason for that is that we found that there are few, if any, complaints at houses where the outside level was 40 or less.

Q And so in an ideal world, if it would be possible to have a project where the maximum level is 40 --

A Uh-huh.

Q -- is it fair to say that we probably wouldn't see the citizens come in here and talk about the need to abandon their homes?

A I think what you would see is a lack of complaints about audible noise and amplitude modulation, things like that, but that 40 dBA level really is not

connected in any way to this infrasonic situation.
Q The dBA level would be connected with sleep disturbance?
A Yeah. It's the audible noise, the swishing sound that you can hear, you know, as Mr. Bump said yesterday.
Q Well, let me ask you this. There have been some references to the sound of these turbines being at 40 dBA being like the sound of a refrigerator. Do you agree with that?
A No. There's no -- nothing that you can compare it to. It's not a constant sound. It's not particularly loud, but it does have a time variance to it that kind of calls attention to itself, and it depends on the specific wind conditions and how much turbulence there is and time of day. All kinds of factors go into it so, yeah, it's more noticeable than other things.
Q So that that you're referring to is the swishing sound or the noise amplitude?
A Yeah. And that -- that does occur, but that is not always the principal characteristic. In fact, I spent a lot of time at wind projects, and it's more or less a steady kind of -- I use the word churning sound. It's -- but there's not -- you don't always

or often see pronounced swishing or amplitude modulation.
Q Would you -- is it fair to say then that the sound from turbines combines three separate variables or parameters: one is audible sound in the dBA range; two is low frequency or infrasound in the very low to nonaudible range; and three would be the amplitude modulation from the -- from the pulsating action of the turbine blades?
A Yeah. I think the first and the third one are kind of related, but --
Q Well, is it fair to say that there's a difference in the ability of folks to sleep, for instance, if the sound is like white noise, just steady, as opposed to pulsating noise?
MR. SCRENOCK: I'm going to object, Your Honor. I'm not sure that Mr. Hessler's been qualified as an expert on sleep disorders.
EXAMINER NEWMARK: He has testified on people's reactions to sound, I think. Isn't that what he's been saying?
MS. NEKOLA: No, I don't think that's accurate.
EXAMINER NEWMARK: No? People complain, certain distances and --

MS. NEKOLA: Well, that's correct, but not specific health or sleep reactions, just complaints.

MR. REYNOLDS: Well, he's done investigation on complaints. He's analyzed ideal -- I mean, it's a pretty simple question. I mean, I'm not calling him to ask him an opinion to a reasonable certainty, but just a correlation between this aspect of wind turbine noise and sleep disturbance.

EXAMINER NEWMARK: Yeah.

MR. SCRENOCK: I understood his question to be asking the witness whether a particular parameter as he described it, wind turbine noise, what would cause someone to have difficulty sleeping, and I don't believe that is within the realm of what Mr. Hessler's been testifying on.

EXAMINER NEWMARK: Well, I'm going to let him answer. He can say he doesn't know.

THE WITNESS: You know what I would say to that is, I think it's the highly variable nature of wind turbine noise that appears to lead to sleep disturbance because you can be standing next to a turbine and it makes -- it will be making a certain sound, and then the next minute it will suddenly get louder and then get quieter again. And I think those changes, I think, may be associated with people waking up and having problems sleeping.

BY MR. REYNOLDS:

Q How about the whistling sound that Mr. Bump talked about?

A You know, that -- well, I think he said it was a foghorn sound. That's the way I would describe it. That's with a hydraulic pump that's in the nacelle of every one of those turbines, and it is a constant mechanical noise. He mentioned that it varied, but what he's really talking about is the yaw mechanism to move the nacelle back and forth, that's variable, that comes and goes, but the hydraulic noise is constant. That's just a feature of that particular model turbine.

Q All right. You have made a recommendation -- well, let me ask you this first. With respect to the modeling, you took a look at the Applicant's model, which predicted using the N100 predicted 45 residents would be potentially over 45 dBA, right? You saw that info?

A Yeah. That was with the -- I think the initial application where they were using a ground absorption coefficient of zero.

Q That's right. And when you used a ground absorption

coefficient of .5, you found that it would be 45 --
four houses above 45 dBA?

A Yes. That's correct.

Q And would you agree with me that if you're going to err on the side of public safety, that a more conservative model is probably a better way to plan a prospective wind farm?

A Well, when we first started analyzing wind projects 10 years ago or more, and we didn't know if the model was accurate or not, they would put on a safety factor and so on. Now since that time, we've had the opportunity to do a lot of testing and compared what's actually measured to what's predicted, and we found the best agreement, the most realistic agreement, is when you use .5 ground absorption. That gives the closest correlation to what's actually found out there.

Q All right. But you agree with me that models -- your data shows that the models are generally consistent but not perfectly on track with reality?

A Yeah. What the model gives you is the long-term average level from the project at a given point, and what we always made clear in our reports is that that is the average, and the actual level is going to vary commonly by plus or minus 5 dBA, sometimes by more.

It will get noise spikes like we were looking at a few minutes ago in that example. That's just the nature of a wind turbine.

Q So the 45 dBA which you're advocating for is not a maximum, it's an average?

A Yeah. That's a given. I'm glad you brought that up. Yeah. In this paper where we recommend that, we say what should be limited to 45 is the main long-term average level at each house. There's no practical way to maintain a level below a threshold like 45 or even 50 all of the time. That never happens. There's always spikes due to weather conditions and things. They're short-lived, but they're almost unavoidable.

Q All right. So then for a 45 dBA average, then you might have spikes up to, say, 45, but probably not over 50?

A I got mixed up in that. Can you --

Q All right. If you had the ideal target of 40 dBA, if that were -- if that were basically the target here measured by the model, and that would mean that there would be levels at the farm of up to 45 but probably not beyond 50 dBA?

A Yes. Yeah, it would go -- if you say designed to 40 at a particular point, the actual level would vary above and below that up to 45, within the 35-45 range, and there would be probably rare spikes to 50, even more than 50.

Q So with respect to your ideal level, that's based upon your evaluation of various venues and examining available complaints from residents?

A Right, right. And those levels -- well, you know, those -- that phenomenon where the level varies happens at every site. So what we did was we measured the main long-term level at all of these houses, and that's what's tabulated there is how many people were complaining between 40 and 44. That's the main long-term level between that range. You know, so at any given house they might be exposed to, let's say, a level 43, but the actual level might have gone up to 50 at times and down to 35. That happens everywhere. So I'm trying to keep everything on a level playing field.

Q All right. Now, assuming that the project could be redesigned for a 40 dBA, making that assumption, that would be your preferred dBA limit, would it not?

A Well, it would be better for everyone if that were the actual performance of the project, but typically it's not practical or feasible to achieve that level at most projects. I would say 90 percent.

Q So are we talking about economic development versus
the public interest to be free of noise complaints?
A I think it's just fundamental economics of the
project. To make 40 at a given site, you may --
oftentimes you have to remove so many turbines that
the project just becomes not viable.
Q All right. But assuming for the sake of this
question that this project could be redesigned for 40
dBA.
A Uh-huh.
Q You would recommend that based upon your work, right?
A That would be a good thing if that were possible,
yes.
Q And there are other jurisdictions such as New York
that have 38 to 40 dBA; isn't that right? I think
these are noticed in your paper. California, New
York. Page 98.
A Yeah. Now there that's what we talked about a little
while earlier. Those are relative limits that are,
like, converted to an absolute number. In New York
the methodology for years has been to measure the
background and then you could go over that by 5. So
I think the 38 is just based on a typical background
level of 33, plus 5. That's where that number comes
from.

Q All right. I think you testified to this earlier that there is a significant impact with respect to noise if the ambient level is very low and with wind turbines coming in with a higher noise threshold; is that right?

A Yeah. If you had a -- in the specific example there, if the project level were higher than 45 and the background level were 16 below that, that means that the project would be dominant, the only thing you could hear pretty much. That's that situation. But the absolute limits that we're putting forward of 40-45 are based on the -- the typical setting that all of these projects normally are in. In other words, rural farm country. Those levels appear to be to our mind satisfactory given that sort of an environment.

Q This is -- is it fair to say that the Town of Forest is unique because of its very quiet background levels?

A No, I wouldn't agree with that at all. That project site is very similar to dozens and dozens of other ones that I could think of.

Q Well, but we're talking about -- what areas where people live in are quieter than these at the 20 dBA level for ambient noise?

A Well, those are the kind of levels we find in every one of these sites that's in rural farm country. When the wind is calm, the level is always 20, 25 dBA, and that happens everywhere. It's really the wind. It's really the background level when the wind is blowing that has some relevance.

Q So with respect to -- back to the Shirley Wind Project. Given the fact that the applicant here is recommending the potential use of the same machines, of the same kind of configurations at the Highland Project as the Shirley Project, would you have concerns about potential impacts in the Town of Forest that have been reported in Shirley?

A Yeah. As I think I mentioned earlier, I think the issues there are related specifically to the -- to that model turbine, and I think until that's better understood, I don't see any reason why it wouldn't repeat itself if that same turbine were used somewhere else.

Q Do you -- now, with respect to the difficulty of you being able to test at Glenmore -- are you having the same problem at Glacier Hills?

A Yeah. We asked for permission, and same sort of no response thing. Went on for a long time, and then I think, oh, what was it, the other day they officially said, no, we don't want to do that.

Q All right. And do you think that it's -- that the Applicants would be -- that it's in the nature of good science to prevent scientists like you from gathering data?

A Yeah. You know, I think what needs doing is -- is some field testing to understand this thing.

Q And we agree that it's not completely understood?

A That's correct. Yeah.

Q And do you agree with the environmental assessment here that a certain percentage of -- of Town of Forest residents will suffer a decrease in quality of their life if this project is approved?

MR. SCRENOCK: I object to that, Your Honor. I'm not sure that Mr. Hessler's been qualified as a quality of life expert.

EXAMINER NEWMARK: Yeah. I think it's too ambiguous of a question.

BY MR. REYNOLDS:

Q All right. Have you read the environmental assessment?

A Yes. Uh-huh.

Q All right. And you -- do you remember a part in there where the environmental assessment assumes that if this project goes forward, there will be a small percentage of Town of Forest residents who will be adversely affected as designed?

A Yeah. I would say that's a very typical conclusion at least. I mean, there's hardly any site where you can sit back and comfortably say everybody's going to be fine. I don't -- there's hardly any situation that falls into that. I can only think of one project, and it was on an island and nobody lived there, but -- but for most projects, the norm is to conclude there will probably be some small impact.

Q And so especially if the same turbines are used at Shirley, you would expect the same result in the Town of Forest?

A Well, I don't have any reason to believe that it wouldn't -- that whatever is going on there would not repeat itself.

MR. REYNOLDS: That's all I have.

EXAMINER NEWMARK: Okay. Other cross?

MR. SCRENOCK: I do, Your Honor.

EXAMINER NEWMARK: Oh, go ahead.

MR. SCRENOCK: Just a few questions.

CROSS-EXAMINATION

BY MR. SCRENOCK:

Q Mr. Hessler, I note that in your testimony, I don't need to point to any specific points, but you refer

throughout, or at least at different points, about the incidence of complaints. And in response to one of Ms. Bensky's questions earlier, you used the phrase pretty significant adverse impact. By that were you referring to the same thing in terms of incidence of complaints?
A Yeah. I'm talking about complaints and that study we were talking about before.
Q Thank you. And you had a lengthy discussion about the wind speed monitor and the level from ground where those measurements were taken. You were talking about normalizing the wind speeds to 10 meters. Was the purpose of that to essentially equate a -- excuse me -- that I'm assuming, and I guess I want to know if my assumption is correct, that the way that the model works or the reason that you normalize the time of year is that there's assumed sort of graduation of wind speed throughout the elevations and that a wind speed at 50 meters normalized to 10 meters will equate to a specific wind speed up at the hub height. Is that the purpose of the normalization?
A Yes. The -- the primary reason that I normalized it to 10 meters is because that's what we always do in these assessments. So I wanted to look at it in the

way that we normally look at field data.

Q Okay.

A I wanted to keep it consistent so I can tell what it meant relative to other sites and other situations.

Q Okay. Now, you had talked with Mr. Reynolds a little bit about the 0.0 ground absorption coefficient versus the 0.5, and I think you indicated that you used that process frequently; is that right, that type of modeling with those coefficients?

A Well, what we always do is assume .5 ground because, as I mentioned, we get the best agreement between modeled and measured results in a particular point.

Q So you don't do that for the purpose of skewing the results?

A Oh, no. No. What I'm after is, I want to know what it's really going to be at a given house.

Q And you had indicated that when you ran your model with the 0.5 ground absorption coefficient for the Highland Project, that you found that there were four houses that you identified that would be within -- above the 45 decibels. Do you know whether those houses represent participating or nonparticipating landowners?

A I didn't at the time. I have heard recently that they are all participants.

Q Okay.
A Not sure about that, though.
Q And with -- Mr. Reynolds asked you about the use of the similar model turbines from the Shirley Project, I believe that's the N100 here, and you indicated that you don't have any reason to think that the problems -- the experiences of folks wouldn't reoccur. Do you have any reason to believe that they would?
A Well, I would say we don't fully understand why there's problems at Shirley, but my belief is that it's associated with a specific turbine model and possibly the blade regulation, whether it's pitch or stall regulated. I think I would be leery about using that turbine again before more is known about it.
Q If one of the other two turbine models that were discussed being used for this project were being used, what would be your perception?
A I would be more comfortable with that because I think the other ones are the Siemens. I don't know of any other model, Siemens and one other one, but I don't -- I've never noticed any problems with those.
Q So based on whatever is going on at Shirley that we're not sure what it is, you wouldn't have reason

to expect those issues to reoccur with either of the other two models?
A That's right.
MR. SCRENOCK: Thank you. I have nothing further.
EXAMINER NEWMARK: Okay. Other questions? I believe staff goes first.

CROSS-EXAMINATION

BY MR. LORENCE:
Q Mr. Hessler, are you familiar with the PSC noise measurement protocol?
A Yes.
Q Is any part of that protocol oriented towards infrasound?
A Well, I believe the intent of it was to try to quantify low frequency sounds by involving the C-weighted sound level and pre-construction measurements and post-construction measurements. That sounds good on paper, but the problem with C-weighted levels is that they're extremely sensitive to wind induced pseudo-noise that we talked about earlier. That wind blowing over the microphone affects only the lower -- the low end of the frequency spectrum, and the C-weighted level is directly dependent on what's going on in the low end

of the frequency spectrum. So any little breeze blowing over the microphone gives you a very high obstensible C-weighted sound level.

So to answer your question, the protocol has -- calls for C-weighted measurements, but -- and we've taken that data, and what we found is that the levels before the project and after the project are identical because they're purely a function of how fast the wind was blowing.

Q So the pre-construction measurements of the protocol are you saying are not capable of measuring infrasound?

A Yeah. That's right. That you get a result from taking those measurements, but it has no actual meaning. It's a false signal that's almost purely a function of the wind speed of the microphone.

MR. LORENCE: No further questions. Thank you.

EXAMINER NEWMARK: Go ahead.

MS. BENSKY: I have a follow-up.

RECROSS-EXAMINATION

BY MS. BENSKY:

Q How do you solve that problem? How should the protocol be different to account for that?

EXAMINER NEWMARK: I think he answered

that. You lay the microphone down on the ground with a board, is that --

THE WITNESS: Can I answer?

EXAMINER NEWMARK: Well, did you answer that already?

THE WITNESS: Not exactly.

EXAMINER NEWMARK: Okay.

THE WITNESS: No. You could use that technique that I referred to, but the problem with it is a practical nature. These surveys last -- or need to last for a period of weeks to get -- catch all kinds of wind speeds and times of day, and you can't leave a microphone sitting on the ground. You know, if it rains or snows, it destroys the equipment. So those kinds of measurements have to be attended. So to -- I suppose if you wanted to document the pre-existing conditions, you would take much shorter term measurements using -- perhaps using that technique and taking short band sample, but it's very -- it's a very challenging thing to measure.

BY MS. BENSKY:

Q And are you aware of any -- switching gears a little bit. Are you aware of any study that correlates wind turbine make and model with a particular number of

complaints? Is there anything that the Commission can look at that would be helpful in deciding the turbine model that would likely produce the least amount of complaints?
A No. Most turbine models have no known noise issues associated with them. The only ones -- there's only one or two that I'm aware of that have -- that are kind of special cases and have issues. I mentioned the Vestas V82, or at least in the format what used to be built five years ago. That -- I think that one's a problem. But -- but of the ones being considered here, only the Nordex appears to have possibly something going on with it.
Q So is the answer that you're not aware that that has been studied?
A No, it hasn't been specifically studied.
Q And one last question. To maintain absolute limit of 45 dBA that is never exceeded, what would -- what should the project be designed at?
A Yeah, that's a good question. It has to be substantially lower than that to allow for temporary noise spikes, up to 10 dBA below. Now, that issue has been around for a while of these temporary exceedances. What I suggested, and I wrote some siting guidelines for Minnesota Public Utilities

Commission, and what I say in there is that, well, if the measured level is in compliance 95 percent of the time or more, then I would consider it in compliance. So there has to be some allowance for these temporary excursions because they're essentially unavoidable.

Q But that -- but that 10 decibel drop is consistent with your recommendation in your paper that 35 dBA at night should be the limit ideally, correct?

A Well, that wasn't the conclusion of the paper, but --

Q Are those two consistent?

A Yeah.

MS. BENSKY: Thank you.

MR. REYNOLDS: Have one follow-up question.

EXAMINER NEWMARK: One. All right.

RECROSS-EXAMINATION

BY MR. REYNOLDS:

Q I wanted to show you, and I just want to identify this. I marked it as Hessler A. I don't have copies, but I just want to know if this is the paper that shows that -- that you referred to that shows that larger turbines above .2 -- .23 have higher low frequency levels than less than 2? Is that the paper you were referring to?

A Yes, I believe that's what this paper says. As I said, I haven't read it for years.

MR. REYNOLDS: Okay. And -- yeah, it's Hessler Exhibit No. 8. I just wrote on it.

MS. NEKOLA: Your Honor, we object. We haven't seen this.

MR. REYNOLDS: Yeah, I understand. I am just marking it so that he can identify it.

EXAMINER NEWMARK: What's his next exhibit?

MS. NEKOLA: It would be 7.

MR. REYNOLDS: Okay.

EXAMINER NEWMARK: It would be 7 anyway. Okay. Are you trying to move it in now at this point?

MR. REYNOLDS: I don't have to move it in now. I just wanted him to identify it and then I have one follow-up question.

EXAMINER NEWMARK: Well, based on this exhibit?

MR. REYNOLDS: Well, okay. Let me do a backup question.

BY MR. REYNOLDS:

Q What is the title of the exhibit that you're looking at?

A Low frequency noise from large wind turbines.

Q And is the premise of that article that large wind turbines above point -- 2.3 megawatts tend to have more low frequency sound than turbines less than 2 megawatts?

EXAMINER NEWMARK: He's already answered that. No. He's already answered.

MR. REYNOLDS: Okay.

BY MR. REYNOLDS:

Q Do you know, the other turbines that are proposed here are above 2.3 megawatts, are they not?

A There's been so much focus on the N100 that I don't even remember what the other two models were.

Q Well, if -- if I told you that they were above 2.3 megawatts, then they would -- those turbines would fall within the definition of larger turbines as outlined in that paper, right?

A Yeah, I suppose so, but I would point to a figure in that paper --

EXAMINER NEWMARK: Okay. Let's hold on, though. We're really running far afield if we're going to be digging into this exhibit since there's an objection already based on entering it in the record. Any response to that objection? You want to move it?

MR. REYNOLDS: Well, yeah. I think it's

relevant because the testimony about low frequency noise, I think this witness has talked about that it's not a big deal, and here we may have an answer with respect to why there's a difference between the wind turbines at Shirley, which are 2.5, and the lack of low frequency symptoms at Glacier Hills, which are less than 2, and the fact that this witness thinks there are low frequency problems at Shirley. So that the question is, well, we could use the other turbine, but there's still within the gamut of these larger turbines. So I think it's relevant to that, and I -- I'm certainly willing to give the -- my colleagues a chance to look at this. I only had one copy. It came up, you know.

EXAMINER NEWMARK: Timing has been an issue here. Do you guys have a response? Clean?

MS. NEKOLA: Just -- it's the same response. We haven't had a chance to look at this. Mr. Hessler hasn't seen it for a long time, and I don't see the relevance. I'm confused really what you're trying to do here.

MR. REYNOLDS: Difference between Glacier Hills and Shirley is --

EXAMINER NEWMARK: I'm going to leave it out.

MR. REYNOLDS: Okay.

EXAMINER NEWMARK: We're not going to put it in, and I think he's actually answered these questions anyway. It's already on the record, so it would be repetitive at this point. And let's move on.

MS. NEKOLA: Can we go off the record a minute?

(Discussion off the record.)

EXAMINER NEWMARK: All right. Back on the record. Do you have anything else?

MR. SCRENOCK: No.

EXAMINER NEWMARK: All right. I had some questions, but at the risk of opening up another whole round of cross, I'll forgo it.

Any redirect?

MS. BRANT: Yeah, we have some redirect.

REDIRECT EXAMINATION

BY MS. BRANT:

Q Mr. Hessler, you talked with Ms. Bensky about your Exhibit 3 in this proceeding?

A Yes. Uh-huh.

Q Can you just clarify for us the purpose of Exhibit 3?

A Yeah. It was just to give a generic example of actual measurements of wind turbine sound compared to modeling using three different ground absorption coefficients.

MS. NEKOLA: That's all we have.

MS. BRANT: That's all we have.

EXAMINER NEWMARK: All right. You're excused. Thanks very much.

(Witness excused.)

EXAMINER NEWMARK: Okay. So we can get into Forest Voice. Okay. We need to call Mr. Horonjeff?

MS. BENSKY: Uh-huh.

EXAMINER NEWMARK: Let's go off the record.

(Call placed to Mr. Horonjeff.)

RICHARD HORONJEFF, FOREST VOICE WITNESS, DULY SWORN

EXAMINER NEWMARK: Go ahead.

DIRECT EXAMINATION

BY MR. McKEEVER:

Q Good afternoon, Mr. Horonjeff. This is Peter McKeever.

A Hi, Peter. How are you?

Q Just fine. Thank you. Thank you for your patience in waiting a couple of days to have your moment in the sun here.

A Not a problem.

Q Would you please state your name for the record.
A First name is Richard. Last name is Horonjeff spelled H-O-R-O-N, as in Nancy, J-E-F-F, as in Frank.
Q And what is your business address, please?
A 81 Liberty Square Road, Number 20B, as in boy, in Foxborough, F-O-X-B-O-R-O-U-G-H, Massachusetts. And the zip is 01719.
Q Thank you. Have you prepared and filed some direct -- I'm sorry -- rebuttal and surrebuttal and sur-surrebuttal testimony in this matter?
A I have submitted direct and surrebuttal, but not sur-surr.
Q And have you also submitted a report as an exhibit to one of those -- one of that testimony?
A Yes, I have.
Q And if you were to be asked those same questions today, would your answers be the same?
A They would.
Q And was that testimony that you provided, it was truthful and accurate?
A To the best of my knowledge, yes.
Q And those opinions that you made, were those made to a degree of scientific certainty -- reasonable degree of scientific certainty?
A Yes, they were. Yes, they were.

MR. McKEEVER: Thank you. Dr. Horonjeff is available for cross-examination.

EXAMINER NEWMARK: Okay. I just wanted to check. He had three exhibits, right? You mentioned one study as an exhibit, but he filed three different exhibits?

MR. McKEEVER: He field three exhibits. One is his resume.

EXAMINER NEWMARK: Okay. Yeah. All right.

Any cross? Go ahead.

CROSS-EXAMINATION

BY MR. WILSON:

Q Good afternoon, Mr. Horonjeff. I'm John Wilson. I'm representing the Applicant in the proceeding.

A Good afternoon, Mr. Wilson.

Q Can you hear me okay?

A Yeah, I can hear you just fine. Thank you.

Q Okay. Can you turn to your Exhibit 3?

A Oh, let me just see. Exhibit 3 is which one? In my report?

Q No. That's your summary -- your table summarizing proposed and existing wind turbine installations in which you provided written comment or testimony.

A I'm looking for that right now. You have to pardon

me for a moment. I've got a notebook of double-sided material that's filling a one-and-a-half-inch binder. Okay. Tell me again which --
Q Your Exhibit 3.
A Exhibit 3?
EXAMINER NEWMARK: Let's go off the record.
(Discussion off the record.)
EXAMINER NEWMARK: Let's get back on the record.
Go ahead.
BY MR. WILSON:
Q It appears, Mr. Horonjeff, that -- that for these examples where you provided written comments or testified, that in most cases you produced a letter report?
A That is correct.
Q And do I take it from your testimony that some of these you testified for and some of them you did not?
A That is correct.
Q Which ones did you testify for?
A Just the Glacier Hills.
Q So the remainder of these were letter reports?
A That is correct.
Q Can I have you turn to page 16 of your direct

testimony.
A Let me pull that up.
EXAMINER NEWMARK: Okay. Did he file direct, or start with rebuttal?
MS. BENSKY: It's rebuttal.
MR. WILSON: I'm sorry. Your rebuttal testimony.
THE WITNESS: Okay. Hold on. Okay. So you said page --
MR. WILSON: 16.
THE WITNESS: 16.
BY MR. WILSON:
Q And I'd like to draw your attention to the answers -- the answer on lines 8 through 13.
A Lines 8 through 13, got it.
Q Take a moment and review that and let me know when you've had a chance to review it.
A I have reviewed it.
Q Okay. My question for you is, for the items listed on your Exhibit 3 where you provided letter reports or testified, was your ultimate recommendation in each of those cases consistent with your recommendation on page 16, lines 8 through 13?
A I believe it was. I would have to look at each of those individually, but I -- I have no reason to

believe that it would not have been.

Q And as a consultant, you would -- typically do not represent developers; is that true?

A That is correct.

Q Okay. I took a look at your resume in Exhibit 1, and I just -- I just wanted to confirm that you don't have any formal medical or health-type training or degree?

A That's correct.

Q Mr. Horonjeff, are you familiar with the PSC staff sound protocol?

A I have read through it, yes.

Q And do you have a view as to whether the Applicant sound studies are consistent with that protocol?

A In terms of the process that they followed, is that your question?

Q Yes.

A Yeah. It would appear to me that the process that they followed did indeed follow the PSC 128 protocol.

Q Okay. So I'm looking at page 6 of your testimony, lines 1 through 3.

A Same document?

Q Yes.

A Okay. Let me go to page 6 here. Okay. And you want me to look at line 3?

Q 1 through 3.
A Yes.
Q So is your criticism here, are you looking for additional data that would be outside of the PSC sound protocol?
A Essentially that is -- that is correct, yes.
Q On that same page at line 20.
A Yes.
Q It looks to me as if you're estimating here that there was self-noise at about approximately 20 dBA?
A I -- that is not correct. I had said that I have estimated the ambient sound level to be 20 dBA less.
Oh, oh. I'm sorry. I misread my own sentence here. You are correct that I have estimated from the information provided in the Applicant sound report that there were times when the sound -- the ambient sound level could drop to 20 dBA or less.
Q Okay. So that statement is not based upon any data that you collected?
A That is correct.
Q In fact, you haven't collected any data at all, have you?
A On this project, no.
Q Have you visited the site?
A No, I have not.

Q If I could draw your attention to page 12, lines 10 and 11.
A I have it.
Q I take it given your earlier testimony that you don't have any medical or health background, that your testimony here is from a layperson's perspective?
A That is correct.
Q I'm looking at the last page of your testimony now, Mr. Horonjeff, at --
A That -- that would be page 17, correct?
Q Yes. And I'm looking at your testimony that you believe a reasonable margin of safety could be achieved using a setback distance criterion equal to at least 1.5 to two miles; is that correct?
A That is correct.
Q Yet your recommendation on page 16 recommends one mile.
A That's true. The basic difference between those two pages is that on the last page I include a margin of safety, a specific margin of safety.
Q Is that 1.5 to two miles in addition to the one mile that you mention on page 16?
A No. No, it is not in addition. It is the total.
Q Okay. So in an ideal world, would you recommend that the setbacks be 1.5 to two miles?

A That is correct.

MR. WILSON: I believe that's all I have. Thank you.

EXAMINER NEWMARK: Okay. Other questions?

MR. REYNOLDS: Nope.

EXAMINER NEWMARK: No. Redirect?

MR. McKEEVER: No.

EXAMINER NEWMARK: All right, sir. You're excused. Thanks very much for your participation. I'm going to disconnect now.

THE WITNESS: Okay. My pleasure. Thank you very much.

(Witness excused.)

EXAMINER NEWMARK: Anyone else for Forest Voice?

MS. BENSKY: No.

EXAMINER NEWMARK: Town of Forest, you're next.

MR. REYNOLDS: Oh, okay. You want to cross Wes Slaymaker?

MR. WILSON: No.

MR. LORENCE: Do you want to stipulate to his testimony?

MR. REYNOLDS: He's here.

WES SLAYMAKER, TOWN OF FOREST WITNESS, DULY SWORN

EXAMINER NEWMARK: Okay.

DIRECT EXAMINATION

BY MR. REYNOLDS:

Q Could you state your name, please.

A Wes Slaymaker, S-L-A-Y-M-A-K-E-R.

Q And Mr. Slaymaker, you filed some direct testimony in this case?

A That's correct.

Q Is it true and correct to the best of your knowledge?

A It is.

MR. REYNOLDS: All right. That's it.

EXAMINER NEWMARK: Okay. You're excused.

(Witness excused.)

EXAMINER NEWMARK: All right. Who's next?

MR. REYNOLDS: Dr. SCHOMER.

PAUL SCHOMER, TOWN OF FOREST WITNESS, DULY SWORN

EXAMINER NEWMARK: Okay.

DIRECT EXAMINATION

BY MR. REYNOLDS:

Q Can you state your name, please.

A Paul Schomer.

Q All right. And have you filed testimony in this case?

A Yes.

Q All right. In the form of direct?

A Yes.
Q And rebuttal?
A Surrebuttal.
Q Yeah, whatever.
A Yes.
Q Did you bring that testimony with you?
A I did not.
Q All right. And since giving that testimony, have you received other information such as Roberts surrebuttal or listening to the testimony of Mr. Hessler? Do you have anything to add to that testimony that you've already given in written form?
A I would have comment on what Mr. Hessler said this morning.
Q All right.
A That would be all.
Q Go ahead.
A There's two points I would make very briefly and very simply. One has to do with the pseudo-noise, and he's talked about it. We've talked about it a lot. It's a very important issue in terms of being able to measure things around a wind farm, and Mr. Hessler's introduced it. He and his father did a study which was published in NCEJ, which he referred to this morning.

And when you're dealing with wind noise -- I'm going to try to make this very simple -- there's two kinds of turbulence. Turbulence is the air moving around for one reason or another. One kind of turbulence is just like the -- if you put a stick in water, a stream, and you see the line go out behind the stick, and that's called wake turbulence because it's just like a wake from a boat.

And there's another kind of turbulence called intrinsic turbulence. This is the air moving around on its own, heating the air against the ground or being turned over by buildings nearby or stones or shrubbery or whatever makes the air mixed up and not steady. So there's these two kinds of turbulence that is pseudo-noise, and this is what we're trying to get rid of so that we can make measurements that are accurate.

Q Okay. So what's your comment on Mr. Hessler's comment?

A The comment is that Mr. Hessler and his father measured only the wake turbulence in the wind tunnel because it was very smooth flow. It didn't have intrinsic turbulence, and the intrinsic turbulence is the much more dominating factor. And so the numbers he quotes for -- for what turbulence causes are quite

low compared to what you measure in reality.
Q All right. And how is that relevant to what we're considering here?
A That's relevant in the difference between the level of the turbine noise and the level of the background, that the level of the turbine compared to the level of the background exceeds 10 dBA. It's not less than 10 dBA.
Q And why is that important?
A That is -- 10 dBA is thought of when you start to have serious problems with a new noise source compared to what was existing. And so this exceedance is significant, and the numbers presented by Mr. Hessler are identical to what has been published for just the total pseudo-noise.
Q All right. Do you have any comments on the issue of low frequency sound emanated from large turbines defined as above 2.3 megawatts versus low turbines, smaller turbines, less than 2 megawatts?
A I would expect in just about any machine, as the machine gets bigger, the dimensions get bigger. It's how it couples energy out of it. As the sound radiated will get bigger, which means the wavelength is longer. The fundamental dimension to the sound gets bigger, which means it's lower frequency. This

would -- I would expect from any machine, and I'm not surprised to see the data for this machine go that way.
Q And would that explain the wide or rather consistent complaints of health effects from the residents at Shirley that have 2.5 megawatt machines as opposed to other wind farms?
MR. WILSON: I'm going to object to that question to the extent that it goes to health impact. I don't think he's qualified as a health expert.
EXAMINER NEWMARK: Okay. I'll sustain that.
BY MR. REYNOLDS:
Q You have given testimony on the -- do you have information about the relative impacts of low frequency sound on health?
A Yes.
MR. WILSON: Objection.
MR. REYNOLDS: This has been the part of it. He's testified to this. We've had Mr. Hankard who testified about annoyance versus health.
EXAMINER NEWMARK: The first question, did you say complaints or did you say health?
MS. BENSKY: That was just a foundational

question.

MR. REYNOLDS: Yes. Exactly.

EXAMINER NEWMARK: That's fine. Let him answer.

THE WITNESS: What question am I answering now?

EXAMINER NEWMARK: None. Let him think.

BY MR. REYNOLDS:

Q All right. There has been testimony about -- from the Shirley Wind residents who have machines that are 2.5 megawatts, and then we've had testimony about -- from complaints that -- that are more of the sleep category as opposed to the nausea, headache, earache category, okay? You've given testimony that the infrasound impacts to human health focus on those kinds of symptoms like headache, nausea, vertigo, feeling of ill at ease, right?

A Yes.

Q Would the size of the turbines at Shirley and its likely higher production of low frequency noise have a potential explanation for why the folks at Shirley are having such difficulty?

A I think it's a potential explanation, but I think I could come up with -- there's other explanations maybe. But that's certainly a potential explanation.

Q All right. Well, the whole -- the point of this hearing is to try to determine whether the project as designed for the Town of Forest is -- is appropriate.

A Yes.

Q And size of turbines is one factor?

A It is a factor.

Q What else?

A I think that -- that the -- to me, one of the important factors has been the nature of the community being somewhat unique. This is -- the basic things that have been talked about here are most important. The testimony you had yesterday, although I was not here, I've heard that kind of thing before, and I think that the issue before us is whether that's going to continue. The people are being taken out of their homes by the sound. This is not new. As I've pointed out in my testimony, this has been going on for 30 years, not with wind farms but with low frequency noise, and especially pulsating noise.

The notion that wind farms is somehow different is just not -- makes sense. And that we know and we've known for years that these same symptoms have occurred over time with different kinds of sources of low frequency sound, and the result is always the same. There's a fraction of the population, we don't think it's a large fraction, that has these symptoms to the point where some are driven out of their homes.

EXAMINER NEWMARK: Okay. Sir, I think wasn't the question what -- what was your question, what things can be done to prevent this, to reduce this?

MR. REYNOLDS: Yes.

BY MR. REYNOLDS:

Q Okay. So there are -- in your view, you've made a recommendation that if this project is -- is -- is approved, that the -- that the noise limits be reduced?

A I have made a recommendation that the noise limits be reduced and that the -- I have made a recommendation that the prediction based upon the average is not consistent with what's been put together as the procedures in Wisconsin.

Q All right. Explain that.

EXAMINER NEWMARK: Well, is this in his testimony already? He said he explained this.

MR. REYNOLDS: All right. Yeah.

EXAMINER NEWMARK: Okay.

BY MR. REYNOLDS:

Q Well, let me ask you this. We've been talking about average noise limits and maximum noise limits.
A Correct.
Q What are the limits that we should be shooting for here?
A Well, what I think about always is are things logical, is this what was meant. And as I understand it in Wisconsin and in this proceeding, people have said there's a 45 dB nighttime limit, and it has to be designed for 100 percent of the houses, the homes of nonparticipating residents meet 45 dB. It wouldn't be acceptable for 50 percent of the homes to meet 45 dB.
And then I ask the question, if 100 percent of the homes have to meet 45 dB, how can you have 100 percent of the homes meeting it half the time is somehow different than half the homes meeting it all the time. To me the two are the very same thing, just on a basis of logic that if you have a rule of 45 dB, it should be that way. You can't have it -- it's met half the time at all the houses but it -- the two are the same.
Q So is that the -- is your recommendation for a 39 dB limit designed then to make sure that the maximum doesn't exceed 45?

A No. I was saying that we should model using zero at a minimum, model using zero as the modeling rather than .5.

Q Okay.

A So that there is -- you get closer to this realization that you have a limit met all the time at all the houses and not -- well, all the time at some of the houses you wouldn't permit, but some of the time at all the houses is permitted. And the two are identical, so it's difficult to understand the distinction.

Q So when you first looked at this, the model that you looked at in the application was based upon a zero coefficient?

A The original material presented, I think it was called Appendix V as I recall, had zero for the modeling.

Q And you thought that was an appropriate number?

A I believe that is an appropriate number.

Q And why be conservative in modeling?

A Well, one of the reasons I came to this -- two reasons I come to this. One is the one I've just illuminated, that if you have a rule that all the houses meet it and then you say half the time, and then you say but you can't have -- it's met 100 percent of the time at half the houses, there's no logic there.

The other reason is that this is supposed to be done in terms of the ISO standard. People say we're applying ISO 9613, and ISO 9613 calls for -- if you follow it, it says we're making a conservative prediction and that the only permissible way and to say you're using 9613 is to make the prediction, and then if you want to have a time average according to ISO 9613, there's a specific procedure in the standard for doing that, and that's not being followed.

So I do it on the basis of logic, of what the rule is, and I've come to that conclusion on the basis of following the standards, which have not been followed.

Q So is it -- is it fair to say that a conservative model will err, if at all, on the side of public safety?

A I wouldn't call it erring, but it will certainly be on the side of public safety.

MR. REYNOLDS: Okay. That's all I have.

EXAMINER NEWMARK: Okay. Other questions?

CROSS-EXAMINATION

BY MR. WILSON:

Q Mr. Schomer, have you visited the site?
A No.
Q So that means you haven't taken any data at the site?
A No.
Q You testified in response to some questions from Mr. Reynolds that the nature of this community was very unique. If you haven't been to the site, how can you understand whether this community is unique or not?
A I find the unique factor in the activities this community has engaged in in terms of trying to maintain the quiet, rural nature of the community, and I find that to be similar to situations I've seen in other parts of the country where that kind of community existed, and I've seen very unique reactions when that exists.
Q So if I understood your testimony, what's unique about this community is that they're -- at least some people in the community are fighting the project?
A No. I said that in the testimony I've read that's been put in place in this, that this community has a land use plan of some kind. I don't profess to be a planner and get all the terms right, but that this community has gone out and said we want to maintain the quiet, rural nature of this community, we don't

want to plan for industry, we want a plan for five-acre homes and the maintenance of farms. That's where they're unique.

And the similarity I find that was I -- plans that the FAA tried to implement some probably 25 or 30 years ago, and probably the one example I can think of where the FAA was eventually stopped by Congress because of the uproar. And I find this -- the dynamics of this community to be along those lines.

Q So you've reviewed the comprehensive plan for the Town of Forest?

A I've reviewed the testimony.

Q But you haven't reviewed the plan?

A I've not reviewed the document, no.

Q Are you familiar with the fact that in Wisconsin, most local communities have to do some type of comprehensive plan by law?

A Yes.

Q Okay. So they're not unique from that perspective?

A No.

Q Okay. You don't have any medical training; is that right?

A That's correct.

Q You have an engineering degree?

A Correct.
Q So if you take a look at page 2 of your direct testimony. You have a copy of your testimony with you?
A I wasn't asked to bring them, so I am at the mercy of somebody to give me a copy.
MR. REYNOLDS: What do you want, direct?
MR. WILSON: For the time being, yes.
MR. REYNOLDS: All right.
MR. WILSON: He'll need sur, too.
MR. REYNOLDS: He is on direct.
THE WITNESS: All right. Page 2.
BY MR. WILSON:
Q Line 17 and 18, I find within a reasonable degree of engineering certainty that there will be significant health impacts. Can you explain to me the relationship between engineering and health impacts?
A I think that we've heard Mr. Hessler testify, and I think that on the same basis we have been observing and learning about these problems for many years. And, no, we're not going to give prescriptions out and -- but we understand better the acoustics and the physics, and I think that there's a shared burden to do these things properly, but we are part of the team.

Q Okay. Are you saying that -- you've already testified you're not a health expert; is that correct?

A I have testified, and I'm certainly not trained as a health expert.

Q Are you a health expert?

A I think I understand something about the health effects of noise from the literature that I follow. Does that say I'm a doctor, no.

MR. WILSON: Did you give him his sur?

MR. REYNOLDS: He's got it.

BY MR. WILSON:

Q So at page 11 of your sur, you're talking about your conclusion that the 0.00 contour is appropriate?

THE WITNESS: I have to ask for page 11 of the sur.

MR. REYNOLDS: I'm sorry?

THE WITNESS: The surrebuttal.

MR. REYNOLDS: It's right there.

THE WITNESS: It is?

MR. REYNOLDS: Yeah. It's all tabbed together.

THE WITNESS: Oh, right behind that?

MR. REYNOLDS: Yep.

THE WITNESS: Okay. That should be easy.

Page 11.

MR. WILSON: Yes.

BY MR. WILSON:

Q So at 11 there, you are testifying at line 15 about the appropriateness of the zero contour, correct?

A Correct.

Q And you would agree that that contour is the most conservative possible?

A It's the most conservative possible using 9613.

Q Okay. Now, if we could go back to your direct testimony on page 9. On page 9 in the middle of the page there you're describing your Exhibit 2, which is, you know, the results of you running a model, and in this case you used -- you used both zero and .5; is that correct --

A Yes.

Q -- to produce Exhibit 2?

A That is true.

Q Okay. And reviewing your testimony here on page 9, there's nowhere where you indicate in your direct testimony here that using the .5 is inappropriate?

A At that point in time, we had not received the operation of the source levels from proponent as perhaps you recall, and I was trying to make sense out of this with data that we had been able to collect off the internet, which were apparently precursor data to the real data. And my whole original testimony is somewhat screwed up because we didn't have the source data that should have been a part of the application.

Q Are you done?

A I'm saying I did the best I could given the data we did and didn't have.

Q Fair enough.

A And I did analysis of .5, but the analysis I did of .5 was equal to the zero case because the source data that I found were that much higher.

Q Okay. But you used a ground factor of .5 in your initial creation of Exhibit 2, correct?

A That was one of the numbers I looked at.

Q Okay. And why did you not at that time use zero for the entire run to create Exhibit 2?

A As I just told you, I was trying to figure out what was going on because I could not understand even what was being recommended by proponent, whether it was zero or .5, what the data were that were to be used. When I made my .5 predictions, they came out zero. The zero predictions of the report, I didn't know if the report was labeled wrong, whether there was 141 houses as Mr. Hessler criticized my report for. It was just -- would have been much better if we had the source data.

Q Okay. You have a fundamental belief that these models should be run using the zero contour, correct?

A I think that that's something that I thought about. I've not articulated it.

Q But you articulated it in your testimony?

A In this. Not up until here. I have -- I've come to that conclusion for Wisconsin for two reasons. One is because the standard that you say is being used calls for it. And the second is, when I read the rule, or as I understand the rule, and I have read the rule, there just doesn't seem to be a difference between the application two different ways. I have made predictions using the annual average for sources that call for that specifically. When you make predictions for an airport, it calls for the annual average. When you make predictions for a highway, these are called for. I didn't see that they were called for here. I saw a different kind of thing.

Q Okay. So you testified that you just recently came to the conclusion that zero is appropriate only here in Wisconsin; is that correct?

A No. I think it's probably a good idea all over, but it's something that we haven't done in this country

in transportation noise sources.
Q Okay. But this was a recent revelation that you've had; is that correct?
A This actually occurred serendipitously. I was asked to give a lecture this coming November on ISO 9613. And when I started to put the lecture together, I realized that it was calling for this conservative prediction and that indeed I had been misusing the standard, and I was on the committee that wrote it when it was written.
Q So does this revelation occur between the time that you submitted your direct testimony and the time you submitted your surrebuttal testimony?
A That part of it does, yes.
Q Yeah. So that explains why you were willing to use a .5 in your direct testimony but not in your surrebuttal testimony?
A No. The .5, as I've tried to say, is lots of reasons for it being there. Part of it is I tried to understand what was going on.
MR. WILSON: I think that's all we have.
EXAMINER NEWMARK: May or may not be. I want to let you know before you stop, I've decided to allow that Schomer page 6 on surrebuttal in. Basically we have so many standards at this point in

the record, and the studies we let in refer to WHO and all kinds of European standards, day and night standards. Let's just put it all in, and I'll give you a chance to cross him on that if you need to. None?

MR. WILSON: We're just fine with your ruling.

EXAMINER NEWMARK: All right. Any other questions?

MS. BENSKY: I have a few.

CROSS-EXAMINATION

BY MS. BENSKY:

Q We've talked a lot about this ISO 9613 standard. You said you were on the committee that wrote it?

A Correct.

Q Mr. McKeever is passing them out to everyone so I think it will be helpful to --

A I can't hear so well at my -- you have to speak up a little bit.

Q You spent too much time around wind turbines? Sorry. That was a joke. It was funny.

So you've just been handed a piece of paper. Is this the international standard 9613-2 that you helped create?

A Yes.

Q And this was designed in 1996, correct?
A This was first edition it says 1996, December 15th.
Q And has it been revised since then?
A No.
Q Was this standard designed specifically for wind turbine noise?
A No.
Q And if you turn to page -- I don't know what page it is -- the pages don't appear to be numbered. If you turn five pages in, it says acoustics.
A Okay. Maybe you have a clause number.
Q Part 2, acoustics attenuation of sound during propagation outdoors. It's the fifth page in.
A I'm not sure I know what -- there's Clause 2 is the following -- there's normative references. Are you in the --

EXAMINER NEWMARK: I think you have it right in front there.

THE WITNESS: Part 2, yes. That's all dealing with Part 2. Part 1 is air absorption, tables of air absorption.

EXAMINER NEWMARK: Can I have that back, please? I'm going to follow along.

THE WITNESS: Okay. Part 2.

BY MS. BENSKY:

Q And there are two columns on this page, and the right-hand column, the second paragraph beginning with the word, this method is applicable. Do you see where I am? That's on the right-hand column near the top.
A This method is applicable, yes.
Q Uh-huh. And it says, it is applicable directly or indirectly to most situations concerning road or rail traffic, industrial noise sources, construction activities, and many other ground-based noise sources. Is a wind turbine a ground-based noise source?
A Probably not. There's no other standard to use.
Q So this is the best standard, but it's not quite right?
A It's not going to be quite right.
Q But this standard specifically does not apply to sound from aircraft and flight or blast waves from mining, right?
A Okay. That was probably inserted by me.
Q Is one of the reasons why you are calling for using this very conservative absorption coefficient because of this limitation?
A That would be one of the reasons. We have -- we studied in my laboratory air to ground versus ground

to ground propagation by having one experiment where we had 100-foot-high tower that we did sound propagation measurements for, and then we had a source on the ground that we did the propagation measurements for, and the difference of 100-foot-high tower versus on the ground was -- oh, I've got published papers on it. I don't know that I remember the exact numbers. The levels -- the higher levels are about the same, but they're three times more often, then you're up 100 feet.
Q What happens if you're up 100 meters?
A It's going to possibly be even more frequent. Possibly be the same. I guess that didn't answer much, but that's the best I can do.
Q Well, the point is that we just don't know?
A Well, I know it won't be less, but I don't know that -- I haven't reached the saturation or that it's going to continue to grow.
Q Having this in your hand, and if you can do it very quickly, can you point to other paragraphs that encourage the model to be used in a conservative manner?
A Say that again, please.
Q Well, you talked about after looking through this, you realized that the intention was to obtain

conservative results; is that correct?
A Yes.
Q And I'm asking you where in the document we should look to get that information.
A Okay. That is one place. When it talks about the cement, and I just have to find where it talks about that. Well, in 3.2 in definitions it gives equivalent continuous downwind octave band sound pressure level, and downwind is a shorthand name for sound -- propagated sound where it travels in the louder manner. Because as everybody knows, you're downwind outdoors, it's louder than if you're upwind, and that's what the downwind means here, that you're getting a prediction that's hearing-enhanced propagation. So in 3.2, the definition of downwind indicates this. And then it talks about predicting the downwind. Let's see. I think on Equation 5 and 6 -- in 5 it talks about the downwind again.
EXAMINER NEWMARK: That's meteorological conditions, number five? Is that where you're at?
THE WITNESS: No. I'm on Equation 5 on the unknown page, but it's in the end of Clause 6.
EXAMINER NEWMARK: Oh.
THE WITNESS: And this is the basic equation for using ISO 9613, and it talks about

downwind. And as I said, if one wants to calculate the long-term -- the long-term averages, if you look at the bottom of just before you get to 7, there's -- you go up two paragraphs, it says the long-term average weighted sound pressure LAT, paren, LT for long-term, shall be calculated according to the equation there, and that's not been done.

BY MS. BENSKY:

Q In this project?

A In this project.

Q And what's the significance of that?

A Well, this is the procedure that was designed in the standard for going from downwind to long-term if long-term wanted to be used. What this does is it says that if you're up in the air, which is what I just -- we know we are, they recognized when this was written, they being -- this was really based upon a German standard initially -- that when you have an elevated source, you're going to get this high level more of the time, as I said, three times as often, which was a whole lot of the time from 100-foot high. When you look at this case, this standard says that you never have anything but the high levels from an elevated source and that the -- the average that's used for other sources shouldn't be used for this because it is elevated, and I think that's the difference that comes in here.

MS. BENSKY: Thank you.

EXAMINER NEWMARK: Anything else?

MS. BENSKY: Briefly.

BY MS. BENSKY:

Q Is it necessary for you to visit a site to be able to analyze data that was taken at that site?

A No.

Q Is this something that you do all the time in your professional work?

A Well, I like to judge the people that have made the measurements and have some feel for things, but I would say that things that are done by Mr. Hankard or Mr. Hessler, I believe the measurements in general. Now, I've said that I thought he was wrong on the empty pseudo-noise, but that's a separate thing.

Q And even though that you -- so, is your own experimentation necessary to be able to reach the opinions that you've reached in this case? Is it necessary for you personally to conduct experiments in order for you to reach the opinions that you have reached in this case?

A No. As I've said, even if I had done studies that

would be part of the team, that I think that nothing is done by one person alone.
Q And in fact, whoever uses this model is to some extent relying on your work, right?
A They're relying on my work. They're relying on the Deutsches In -- DIN, Deutsches Institut fur Normung.
Q So even though you've not been to the site, and even though you haven't done your own experimentation, can you still state the opinions that you stated in this case to a reasonable degree of scientific certainty?
A Yes, I do.
MS.
MS. BENSKY: Thank you.
EXAMINER NEWMARK: Okay. Other questions?

RECROSS-EXAMINATION

BY MR. WILSON:
Q Just a couple questions following up on ISO 9613-2. When you testified earlier that you were implementing a method incorrectly, was it this method that you were --
A I'm sorry? I don't quite follow the question.
Q Well, you told me -- you told me before when I was asking you questions that you had this recent epiphany which is the result now of using -- you're saying you use the zero ground contour, and you told

me that up until recently something had been -- had been implemented improperly by yourself as well.

A Yes. I had forgotten. I don't -- you know, I don't use 9613 that often. It's used for this, but it's not used -- I use 9613 for this, and I use it for small arms ranges occasionally.

Q Okay.

A But when you're doing airports or highways or other things, there's models put out by the DOT for those kinds of sources. So if you do general work, which I do in all kinds of noise areas, you use different things at different times. What I was saying is until I had looked over this to prepare this lecture for Brazil when I'll be there, I remembered that this was for the downwind situation, which is also called for in ISO 1996, which I do know because I'm chairman of that committee.

Q Okay. I just have one other question for you. Have you done any studies that implement this standard with your new recollection against actual sound measurements to be able to tell whether it's a good fit?

A Well, you're not looking for a good fit. When you're --

Q That's not my -- my question is this, have you

compared your calculations using this method against actual sound measurements with your recent recollection that you've got to do in a certain way?
A Well, of course I haven't.
MR. WILSON: Thank you. That's all.
EXAMINER NEWMARK: Okay. Redirect?
MR. REYNOLDS: Just a couple questions.
MR. LORENCE: Your Honor --
EXAMINER NEWMARK: Oh.
MR. LORENCE: -- I may have a question before we get to redirect.
MR. REYNOLDS: Sorry. Go ahead.
EXAMINER NEWMARK: While you're doing that, I was going to take a minute. Did we verify his testimony?
MR. REYNOLDS: If I didn't -- I thought I did.
EXAMINER NEWMARK: Did you? You know what, just do it again just in case because I don't remember.
FURTHER DIRECT EXAMINATION
BY MR. REYNOLDS:
Q Dr. Schomer, do you verify that the rebuttal or surrebuttal that you've given, or direct and surrebuttal, is true and correct?

A Yes.

MR. REYNOLDS: Okay.

EXAMINER NEWMARK: And these Exhibits 1 through 4 as well?

MR. WILSON: Your Honor, I think given the discussion of this document, it probably ought to go in as an exhibit.

MR. McKEEVER: Yes.

MR. LORENCE: I'm going to ask a couple questions on it, so you may want to hold off on that.

EXAMINER NEWMARK: Okay. Let me just have him answer. Are Exhibits 1 through 4 -- sir? Mr. Schomer, Exhibits 1 through 4, were they filed -- are they correct to the best of your knowledge?

THE WITNESS: I'm sorry?

EXAMINER NEWMARK: Your Exhibits 1 through 4, are they correct to the best of your knowledge?

THE WITNESS: Yes.

EXAMINER NEWMARK: Okay. Thanks.

All right. Commission staff.

CROSS-EXAMINATION

BY MR. LORENCE:

Q Dr. Schomer, on page 12 of your surrebuttal testimony, and I'm looking on lines 6 through 8.

A Uh-huh. I guess I'm not fast enough. All right. I got to page 12.

Q On lines 6 through 8 you say, ISO 1996 requires what is termed "downwind" or weather-enhanced propagation conditions so that model predictions are only infrequently exceeded. Do you see that sentence?

A Yes.

Q I have never seen ISO 9613-2 before today. Could you tell me where that's required in this -- in this ISO 9613?

A Those are the questions we just answered, but I can go through it again.

Q Well, you talked about the downwind stuff, but you say it says that it's only infrequently exceeded, and I'm wondering if it says that in here anywhere?

A That's what the downwind nomenclature means, and I believe it's in either 9613 -- I know it's in either 9613 or in 1996, which 9613 incorporates by reference.

Q I have one more question, and again this shows my complete ignorance on this standard. In Section 7.3, that's called ground effects, and again there's not a page number here, but if you could turn to that.

A Okay. 7.3. 7.3, ground effects, yes.

Q Is this section equivalent of the ground factor that we've been talking about the last two days?
A This section is -- makes use of the ground factor. It's not equivalent. This is where the ground factor comes in. What you have is on the next page there's graphs showing the -- what the sound propagation is in different octave bands. And then in the implementation there's a table on the next page, Table 3, and in Table 3 if you look in there, there's A sub S or A sub R in the middle column at the top, and that's for the source or receiver region. We've been talking about there's really three factors, the .5 or the zero whatever. You have a factor for the source region, a factor for the middle, and a factor for the receiver region. And if you look at the formulas under A sub R of the middle column, you'll see a G. That's the ground factor that goes between zero and 1.
Q And that's the ground factor we have been talking about for two days?
A There's three of them technically: one for the source, one for the receiver, and one for the middle.
Q So if we turn back one page where it begins with the letter A, then it says hard ground.
A Hard ground, yes.

Q That first paragraph ends -- it says, for hard ground G equals zero. So this is the ground factor zero that we've been talking about, correct?
A Correct.
Q And then for porous ground in B, it's G equals 1?
A Correct.
Q And then for mixed ground, it says it's someplace in between zero and 1. Do you see that?
A I see that.
Q So this is the ground factor we've been talking about here?
A Yes. But to understand that is a question that was earlier. You've got a source up in the air and not on the ground, so does this standard really apply. And my answer was, it's the best we have, but you can't apply it exactly the way you would if it was on the ground because the source is as high in the air, it changes what the propagation is. So that the definition of what is hard and what is soft, you have a source that's 100 meters in the air on average. That's not on the ground as one of the other counsel's pointed out.
Q But it has to get to the ground -- the sound has to get to the ground eventually, doesn't it?
A It has to get to the ground eventually.

Q And once it's on the ground, won't it travel along the ground?

A No. It's only -- the only thing you have is an effect of the microphone height at your receiver. The other -- it doesn't -- it doesn't come down to the ground and then travel across the ground like this. It doesn't do that. What you're interested in is the path that goes straight from this up in the air source to your receiver, which may be near the ground, but you don't have any other path. If you do, it's because you don't have good propagation. Then it's poor propagation conditions.

MR. LORENCE: Thank you. I have no further questions.

MS. BENSKY: Your Honor, can I follow up on that? This is really important, and I want to make sure I understand.

RECROSS-EXAMINATION

BY MS. BENSKY:

Q So are you saying that if we have a flat -- if we have a flat ground, if there's a source that's close to the ground emanating sound, that sound can just go and be absorbed in the ground, correct?

A Ground absorption -- what happens, and this is more related to people's experience. You know, if we went through all the details, it would be complicated, but I think people's experience is useful here. First of all, the first rule is that if you're downwind, it's louder than if you're upwind, and there's -- the reason is the downwind, and this is going to seem strange, we think of sound almost as rays, sound rays rather than waves.

And let's put it this way. Let's say you were behind the barrier. You expect it to be quieter. It's quieter because there's no direct path from the sound to you. It has to come around the corner just like if you had a -- something to stop the sun or a reflector of light. You go behind it, it's not as light as in front of it. Sound is the same thing. If you have a barrier or something that prevents the sound from getting to you, it's quieter than if you don't have that. Well, on a sunny day and you're upwind, you don't hear things. But if you're downwind, you do.

Another thing -- example, if you're out in a boat, do you hear things far away out in a boat? You've seen that? This is the hard surface of the water, and frequently above the water there's a temperature inversion because of the cooling and heating of the water. And those two can form two layers that the sound gets trapped in, and then you have very -- you hear the people whispering on the shore, and it's like they're 10 feet away from you. I'm sure many of you have experienced this. This has to do with the propagation downwind versus upwind, has to do with the propagation.

The physics is complicated, but the effects -- same thing. Ever hear sources very early in the morning? You wake up at 5:00 a.m. and you hear a distant train or horns or the wheels? Have you experienced that? That again has -- at that time of day, you've got a direct path from the source, which is -- you don't hear the rest of the day to you. It has to do with the physics of the situation.

I'm not going to attempt to go into the physics, but I'm trying to give you different examples out of your daily life that show you this is what goes on. We don't want to really go into the details of what's going on.

Q So if there's a source up in the air that's emitting sound, the sound's going to come down and it's going to hit the receptor before it hits the ground and absorbs; is that correct?

A It's going to hit the receptor directly. There will be -- it gets confusing.

Q That's for sure.
A The ground is important only that it gives a reflection that can enhance or interfere with the direct path. But it does hit the microphone, that's the first thing it hits in time. The sound will arrive at the microphone before -- it comes directly from the source, so it will arrive first.
Q So somebody standing outside near a wind turbine or any source up in the air, that sound wave is going to travel down, and it's going to hit that person's ear before it goes down to the ground and gets absorbed?
A Well, won't be totally absorbed but, yes, it does hit you before it's absorbed. And I think your point is good, that as you're traveling along the ground, from ground to ground it will be absorbing some of the sounds, and that alone is -- that's part of the reason that the air-to-ground path is louder.
Q And so do you think it's proper to assume no absorption and use that 0.0 coefficient for this reason?
A That's part of the reason. Part of the reason is the -- in order to have a prediction that is what is called for in the standard, which is a prediction that is -- if you like the term conservative, a prediction that predicts what's going to happen 90

percent of the time or 95 percent of the time or some percentage of the time, I actually think that from the data that I know of, the prediction is probably the -- about 85 percent of the time would be included, and 15 percent of the time you would be above what's being predicted with the 0.00 prediction. It's not the most conservative prediction in the world by any means.

Q But considering we have to use this model because we don't have anything better, the best way to use this model for a source that's 100 meters in the air is to use that 0.0 coefficient?

A 0.00 is the best you can do with this.

MS. BENSKY: Great. That's very helpful. Thank you.

MR. REYNOLDS: Couple questions on redirect.

REDIRECT EXAMINATION

BY MR. REYNOLDS:

Q Dr. Schomer, is it the heart of it that the challenge of creating a model to reflect what the citizens of Forest will actually experience, is that the heart of why it's better to have conservative estimates than not conservative estimates of sound? Because we're trying to figure out what's going to happen to the citizens in Forest.

A I think there's probably lots of reasons I can think of for doing this. Again, we're dealing with a low frequency sound primarily. The A-weighted sound is going to correlate with it as it does with nearly all noise sources.

I think it's important to understand how the ear hears because that's all a part of this, and the ear doesn't hear all frequencies equally. It doesn't process all frequencies equally, and it gets very different at low frequencies. The ear gets very different at low frequencies, and this is one of the reasons I would say this is important. We -- I think Mr. Hessler testified that the threshold of hearing changes, or maybe it was in that paper that was passed out, but the threshold of hearing is very different from one person to another.

But what's even more important is that at the middle frequencies, like 1,000 hertz, a change of 10 decibels is a doubling or a cutting in half of loudness. At these low frequencies, like let's say 10 hertz, at 10 hertz, about a 2 dB change is a doubling of loudness. So at low frequencies, anything that you're off gets magnified by the ear. If you're off by 5 dB at low frequencies, that's a

factor of four in loudness. Whereas if you're off by 5 dB at a middle frequency in a prediction, that's not even a factor of two in loudness. So errors get magnified at the low frequencies just because of how we hear.
Q That was one of the reasons for looking at the more conservative model. Are there any others?
A Well, let's see. I've talked about the standard calling for it. I've talked about it makes sense from the -- from the way the rule is written. Certainly it makes sense from being conservative from just the standpoint of how the ear hears. I think that just what we've talked about, the health effects and the fact that there's people that may be affected just like in one other community, somehow it seems like it calls for us to be cautious.
I think that if -- if it were some other area where government was involved directly, let's say, we're going to install -- we're going to license fire detectors that only work 90 percent of the time and 10 percent of the time people aren't warned about the fire protector, but that's good enough. People wouldn't say that's good enough, so the fire protection has to work all the time. And I think when we're talking about people literally being

driven out of their homes, we have to be a little bit cautious.

MR. REYNOLDS: Thank you. I don't have anything else.

EXAMINER NEWMARK: Highland?

MR. WILSON: No.

EXAMINER NEWMARK: All right. What are we doing with our ISO 9613-2?

MS. BENSKY: I'd like to move it into evidence.

EXAMINER NEWMARK: All right. Any objections?

MR. LORENCE: I guess I'd like to talk about that for a second.

EXAMINER NEWMARK: Okay.

MR. LORENCE: We've kept out all kinds of reports and exhibits today because they didn't come in at the proper time. Professor Schomer could have put it in at any time with his exhibits. I recognize that counsel here is not -- is not -- his witness is not asking this. But I guess I would ask the ALJ that under the theory that, you know, we've been keeping out late-filed things and this is awfully dense information, whether this should go in the record.

EXAMINER NEWMARK: Okay.

MR. LORENCE: And I just as a second aside for counsel, I'm not positive, but I think that these are usually under copyright, and is this something that we would be able to place on our website and make available to the world if -- I don't want to get you in any kind of copyright trouble if that's the case.

MR. McKEEVER: I'll just say I got it on the internet.

MR. LORENCE: Yeah.

MR. REYNOLDS: And this is the standard that has been used by all the measurers of sound, so this is -- this is kind of the bible of sound measurement.

MR. LORENCE: And I guess that reinforces my question then. Anybody could have put it in. Any of the experts could have put it in from direct testimony on it. So whether we get it here at this late hour or not, I'll defer to the decision, but I'm -- given what we've done today with other things, I just wanted to raise that point.

MS. BENSKY: I guess the nature of this exhibit is totally different. This exhibit doesn't give any opinions. It's just a standard that everybody -- all the sound people in this case have used and relied upon. So I think it would be helpful to have it in. And even if it wasn't in, I think it's the type of material that could be quoted and briefed anyway, so --

EXAMINER NEWMARK: Let's not get into that.

MR. WILSON: I think at the risk of making it look like Ms. Bensky and I are on the same team --

EXAMINER NEWMARK: We would like to see that.

MR. WILSON: I agree.

EXAMINER NEWMARK: Okay.

MR. WILSON: It should come in.

EXAMINER NEWMARK: I understand.

MR. WILSON: There's a lot of testimony on it.

EXAMINER NEWMARK: Let me say the overarching concern I have or rationale for letting it in is we've cited to equations and all kinds of portions of this document which I think can only be correctly or adequately explained or referenced by having the document. So for the abundance of caution for making the record even larger, I think it would enhance the Commissioner's review of the testimony we've just heard. So what's the number for this one? It's 9, Schomer 9, is that --

MR. REYNOLDS: I thought it was 5.

EXAMINER NEWMARK: Well, I don't know if we ever marked your other ones. I might have mentioned on the record because Mr. Schomer, I was not accepting his Exhibits 5 through 8, and I am pretty sure I referenced that at the beginning of the hearing. So we're just going to call this 9.

MS. BENSKY: Okay.

(Schomer Exhibit No. 9 marked and received.)

EXAMINER NEWMARK: All right. I think you're done.

THE WITNESS: Thanks.

EXAMINER NEWMARK: You're excused.

(Witness excused.)

EXAMINER NEWMARK: 3 o'clock. Let's take 15 minutes.

(Break taken from 3:05 p.m. to 3:20 p.m.)

EXAMINER NEWMARK: Well, got enough people back, I guess. You want to start off the record?

MR. McKEEVER: Yeah.

(Discussion held off the record.)

EXAMINER NEWMARK: All right. Next?

MR. REYNOLDS: Mr. Punch.

(Call placed to Mr. Punch.)

JERRY PUNCH, TOWN OF FOREST WITNESS, DULY SWORN

EXAMINER NEWMARK: All right. Go ahead.

DIRECT EXAMINATION

BY MR. REYNOLDS:

Q Good afternoon, Dr. Punch. Can you hear me okay?

A Good afternoon.

Q I want to just simply ask you if you have filed direct and rebuttal testimony in this case -- surrebuttal, I guess?

A I have. Direct and surrebuttal, yes.

Q Yes. And do you affirm that that testimony is true and correct to the best of your knowledge?

A Yes.

Q Okay. If you had to change anything, would you?

A No. No, I don't think so.

Q All right. You apparently spelled Ms. Pierpont's name wrong. Would you change that?

A I am so sorry about that typo.

MR. REYNOLDS: All right. Turning over to cross.

EXAMINER NEWMARK: Okay. Also submitted one exhibit; is that right?

THE WITNESS: I'm sorry?

EXAMINER NEWMARK: You submitted an exhibit, too, as well.

THE WITNESS: Well, the only exhibit I think was in the record -- is in the record is my curriculum vitae, my resume.

EXAMINER NEWMARK: But you can confirm that as well?

THE WITNESS: Yes.

EXAMINER NEWMARK: Okay. All right. Questions?

THE WITNESS: Sure.

CROSS-EXAMINATION

BY MS. BENSKY:

Q Good afternoon, Dr. Punch. My name is Anne Bensky, and I'm an attorney for Forest Voice, and they're the citizens' group that's involved in this docket.

A Yes. Good afternoon.

Q I just have a couple questions for you. You talk about your work related to hearing aids; is that correct?

A Yes, yes. Much of my research in the past has had to do with hearing aids and hearing aid failure.

Q There's some testimony in this case where one witness reported being unable to wear her hearing aid in her home while the wind turbines nearby are running. Do

you have any explanation for why that's the case?
A I think the explanation is probably -- probably has to do with the fact that some of the energy in wind turbine noise is audible, and the frequency range above 20 hertz. Hearing aids, basically they don't amplify beyond or below about 200 hertz that well. So she's probably hearing frequencies or pitches in the range of maybe 200 to 500, possibly as much as 1,000 hertz and she's probably hearing -- my guess is, and I haven't talked to this person of course, that she's hearing the thumping and the additional noise because hearing aids do fairly notoriously a poor job with handling background noise in general because you have a microphone at or behind the ear, and it's picking up all the sounds, including all the sounds you want to hear as well as all the background sounds you don't want to hear. So I think it's probably just a bothersome background noise that's amplified that she doesn't want to hear, and that's bothersome and requiring her to take out the hearing aid.
Q So do people who wear hearing aids generally in your experience have a problem if there is a loud noise in the background? Does that interfere with their --
A Yes, it can because of what I said before. The

microphone picks up all the sounds. Now, there are noise-reduction algorithms in the newer digital hearing aids that can suppress a little bit of the background noise.

There's one other thing that's helpful by a few decibels is directional microphones which tend to amplify the sounds from in front and de-amplify or attenuate sounds from the side and the back on the theory that you look at people you talk to and so you're facing the person you want to hear. They're not effective beyond about a reduction of 4 to 5 decibels, but that can be very critical in certain situations, like maybe a noisy restaurant where you and your spouse or your partner are talking, that sort of thing.

So there are algorithms to deal with it. Hearing aid companies are always coming up with new ways -- that's a perpetual problem in hearing aids, in the manufacturing of hearing aids. And it hasn't been resolved yet, so it still persists.

Q In your work have you heard of other people who wear hearing aids have complaints about wind turbine noise?

A Well, no. I must say no because I haven't -- I only got interested in this about three or so years ago, and I haven't really done clinical practice since then. And we don't have wind turbines in the immediate area. We have some maybe -- I'd say 50 miles away or a little bit farther in Michigan, so I don't think any one audiologist is going to see that many patients, or you wouldn't see a pattern probably at this point. Although I understand there are some audiologists beginning to see some in the Town of Alma north of us, about -- around 50 miles away. So we just don't have the experience yet, most of us as audiologists with wind turbines, enough experience to answer that kind of question.

Q Now, if you knew that there were a group of people in the Town of Forest in the footprint of this Highland Wind Project who did wear hearing aids, do you have any special advice for them in terms of dealing with the wind turbine noise?

A Well, as long as they wear the hearing aids, they're probably going to hear it. Particularly I would say outside where the high frequencies aren't attenuated very much, not as much as one is indoors. They're probably going to be bothered by wind in fact in that situation as well.

But if they're in critical situations, conversational situations where they really need to hear the person they're talking to, they can wear or obtain what's called assistive listening devices of various types, one or more types. For example, indoors with the T.V., there are infrared systems you can buy to help people pick up sounds just from the T.V. without wearing your hearing aid. And some of those can be coupled directly to -- that is electrically coupled to the hearing aid without getting -- picking up the interfering acoustic signals, you know, from background noise and so forth.

So, you know, in group situations there are ALDs like loop systems. If you go to a play or a concert, or a church or synagogue, for example, you can find those systems, and I don't -- I'm suggesting they could use something other than their hearing aid. But, no, if they use their hearing aid, they're probably going to pick up the noise most of the time.

Q Thank you. Now you -- you talk about in your testimony that, and I'll quote here, hearing alerts us to danger and provides us with a way to monitor our surroundings on a constant basis, even during sleep. My question is, do people hear during sleep?

A Yes. I mean, there's certain stages of sleep. I must say I'm not a sleep expert physiologist, but certainly during certain stages of sleep we're very aware of things that are changing in the environment sound-wise. If a car blows a horn, you know, nearby the house you're sleeping in, you know, it might wake you up even though you are -- you might describe yourself as soundly asleep. You know, we have alarm clocks that wake us up during sleep. Sounds that are loud enough or perhaps particularly sounds that aren't just low level and constant will probably wake you up because the ear is an open system. As I said there, it's in my testimony, it's -- hearing really is never off really as long as we're alive. Hearing is always on, except in stages of real exhaustion and fatigue, deep sleep, and that sort of thing.

Q Based on your experience, and if you can't answer this, if it's beyond your expertise, just say so, but my question is, what happens to a hearing-impaired person's well-being if they are unable to wear their hearing aids in their home?

A Well, I think I have enough expertise to make an educated guess. Basically they've gotten hearing aids because they've exhausted other possibilities. They probably denied having a hearing loss for some time, and they really need the hearing aid to function, and function includes not only the environmental awareness, alertness, and that sort of thing, but certainly communication, which is a very human condition or human trait that's unique to us, and that becomes very psychologically important.

There's even data now showing that people who either go a long time without -- who have hearing loss who don't get hearing aids or people who need more hearing than they have available to them, amplified or not amplified, suffer -- and this is after everything else is controlled for -- suffer more illness, they are in the hospital, more sick days. They are out of work more often and that sort of thing. So it has a wide range of psychological and social implications not to be able to hear well.

Q So not being able to hear well can affect you physically?

A Well, I meant physically in the sense that the ear is physically damaged or impaired, and so you're affected physically by virtue of having the hearing impairment. It can affect you physically aside from that only in the sense that if you miss some alerting signals, you might get run over by a car, for example. I mean, only in an indirect sense. I don't mean that you'll necessarily suffer physical ailments, crippling injuries or that sort of thing more often necessarily, but basically you will become psychologically depressed.

Depression is a big symptom in hearing impaired people. They become socially isolated, and that can lead to, you know, less activity, less going out in public, and generally sort of isolation into yourself. And a depression can lead to, I would think, and I'm not a medical doctor here, could lead to physical symptoms in that way.

Q Okay. The bottom of page 6 of your testimony you talk a little bit about infrasound. Is it generally accepted science that exposure to infrasound can cause health effects, or is that still being worked out?

A Well, as you heard in the testimony in the last couple of days, I'm sure that you know there's -- it's a controversy that it isn't settled. From my own -- my own opinion is, after several years of experience and interest in this and thinking about it and reading about it and trying to interpret what I'm reading, I've come -- if I can make a personal opinion here.

Q Please do.

A Opinion that -- that infrasound, even though it's inaudible, it can hurt people. It can lead to

adverse hearing -- I mean, excuse me, health effects. Not hearing loss of course but adverse health effects of other kinds. And you've heard all the descriptions I think already. Sleep disturbances is one of the main ones, and that almost everybody who lives close, if they have a complaint, they will complain about sleep disturbance first. And then after that, headaches and nausea and sometimes tinnitus, and it goes on and it can -- and it varies from person to person of course. The large variety of ailments, and no one personally is probably going to suffer all these ailments. They might suffer several or a couple. Sometimes they're crippling enough and debilitating enough that people can't tolerate it --
Q Sure.
A -- and leave their homes, for example.
Q Sure. At the bottom of page 7 of your testimony, you talk about being a chairperson of the Wind and Health Technical Work Group.
A Yes. I was up until about a year ago when the committee was disbanded.
Q Okay. At the bottom of the page you state that the noise issues proved by far to be the most contentious. Do you know why?

A We couldn't settle on a noise level, a limit, allowable noise limit. The previous guideline, the only one that Michigan -- the State of Michigan had ever adopted in the past was just a guideline. It wasn't a mandated regulation, but it was a guideline that local communities were using, and it allowed 55 dBA as the maximum average level of exposure day and night. And so I as chair and an epidemiologist who was co-chair, I appointed him as co-chair because he had the epidemiological background, were pushing pretty heavily along with one or so other -- at least one other member of the committee -- I think there's seven people on the committee -- for a level of about -- oh, of -- I think it was exactly 40 decibels. We weren't trying to make a distinction at that time in Michigan between day and nighttime because we were just trying to push that level below 55 because we knew that that level was potentially harmful to a lot of people, and so now -- well, let me stick with your question.

Do you have other questions about that?

Q Well, noise has been a big issue in this docket, and I'm just trying to figure out, can you give us any insight as to why this is such a contentious issue? I think you're the only audiologist who is testifying here. So if you can give us some insight, that would be helpful. And if not, that's okay.

A Well, for a couple of reasons. One is the A-weighted scale, which I think Dr. Schomer -- or Mr. Schomer testified to earlier. He made some points about A-weighting. I think it's a flawed metric if you use it alone because of the reason he stated. It basically adjusts for the difference in sensitivity of the ear at different frequencies, the middle frequencies being the most sensitive and the low frequencies being the least sensitive. It essentially puts in a filter or reverses the -- the sensitivity curve so that you don't really hear the low frequencies where the ear is least sensitive.

The problem is, the A-weighting is for moderate-level sounds, and by the time you get up to very high levels, there's no longer this big difference between low and high frequencies. And Dr. Schomer -- or Mr. Schomer related -- I think he made -- he made some comments about -- I forget now the details, but he said basically that there's a difference in the response of the ear in terms of loudness. Loudness grows for a large part of the levels, I'll call it the range of levels that we can hear, much faster as it changes in the low frequencies as opposed to loudness grows or diminution in the middle frequencies. So there's that difference.

And so at very high levels, though, my point is, it's not the same as it was at middle frequency, I mean middle levels or middle decibel levels, let's say. And so it's no longer very fitting to use A-weighting for -- for low frequencies and infrasound.

Basically one other thing is that the sensitivity is not the same for noise and pure tones, and the noise weighting scale is based on pure tones. So we've tried -- people in industrial noise measurements, for example, have tried to apply a scale that was better fitted -- was fitted to quantifying pure tones, and it's not very good when it comes to -- in my opinion, and I think opinion of a lot of other audiologists and related professionals. Some engineers I'm sure.

The worst problem is the A-weighting scale cuts out infrasound entirely, so you're not even picking up with your sound-level meters if you're measuring on the A scale, this critical region that's very low in frequency that's maybe inaudible but seems to have some real impact on resulting in adverse health conditions.

Q Okay.

A So that's a big problem. The other general problem I'd say is the big-picture problem in my view is that the ear is more sensitive. It's a more sensitive mechanism than any sound level instrument, and a lot of this -- I've been hearing some of the -- most of the testimony in the last two days online, and it seems like much of the problem is that people can't decide on what's the right standard, what's the right weighting scale perhaps, what's the right model to use in predicting noise using the sound level instrument we have available.

I think the ear is so much more sensitive than any instrument that it's going to be a while 'til the instrumentation catches up with the ear. And my point is that we need to listen to people because the ear is the most sensitive -- the ear and the brain are much more sensitive and detailed than our current instrumentation can corroborate.

Q Thank you. Speaking of infrasound, on page 8 and 9 you talk a little bit about infrasound. Can you tell me if there is -- if you know, if there's some biological or evolutionary reason why the ear filters out low frequency noise?

A Well, there's only a couple articles that I am aware of, or that I've read, talking about the evolution of the ear as animals have evolved from lower animals to higher animals. And if you, of course, believe in evolution, as most of us do. And the explanations, I'll tinker, aren't quite clear enough for me to describe what's really going on. I think that the -- you know, in lower animals, the vestibular system is probably more well-designed than it is in humans, and in a few animals, you know, dogs and maybe cats, but particularly dogs and a few other lower animals, the ear is better adapted to environments of humans. I'm sorry, better designed for hearing certain sounds that humans cannot hear, okay?

Generally when sound comes into the ear, it segregates. It could, given its physical pathways, the physiological -- or let's say given the anatomy and physiology together, it could be directed toward the vestibular system, but it primarily is picked up and used, transmitted to the brain via the inner ear or the cochlea.

So they're two very separate functions. Sometimes they can be found -- a lot of sounds I think can affect -- vibrations can certainly affect the vestibular parts of the ear, the inner ear, portions of the ear. There are -- I don't know if I'm answering your question. I'm trying to get to that.

Dr. Salt's research always comes up in this context. Basically he talks about there are ways for sound to get to the brain through the what's called the inner hair cells of the inner ear. If I had more time, I would go into all this, but I don't really think you want me to do that.

But the outer hair cells can pick up infrasound. It is transmitted to the brain, but my understanding is that is -- it's at lower levels. It's not picked up as sound per se, but it is -- it goes to certain centers of the brain, maybe the associated auditory cortex areas that sort of don't know what to do with it. And that's kind of my understanding of it, don't really know how to interpret the sounds and how to use it, and so I think the brain is sending out signals. And I'm not a, you know, a cortical or a brain expert either. But I'm trying to make as much sense of all this as I can, and this is what I've come to.

There are signals sent to the body to try to make certain adjustments, and I'm sort of getting pretty deep here, and I don't want to go too deeply

into this because I really don't understand fully all of it. But the point is generally that what you don't hear or can't hear can hurt you because the brain is just trying to make sense of everything that it -- that comes into it and because it is a sensory organ as well as a motor organ. It tells you to move your arms and legs, that sort of thing, but it's a major sense organ.
Q So is Dr. Salt's research, does that show that the brain can detect low frequency noise even if you can't hear it? Is that the essence of what he's doing?
A He's basically showing in the cochlea there are mechanisms by which the ear receives and transmits these signals -- infrasound signals to the brain, and I sort of took a leap further just a minute ago and said the brain interprets those sounds in the best way it can, not necessarily as sound, but as other kinds of stimulation to which the body tries to make adjustments.
Q And that could be nausea, vertigo?
A Yes. It could be nausea, vertigo, dizziness -- well vertigo and dizziness are pretty similar, although vertigo is more severe, fullness of the ear. And Salt has made those kind of comparisons himself.

I would make one further comment about the vestibular system. There are diseases in the ear like Meniere's Disease where medical researchers seem to think that there's an overproduction of inner ear fluid that affects both the vestibular system and cochlea, the inner ear, which has to do with hearing. And among other systems are these that I mentioned, vertigo, tinnitus, extreme nausea, fullness of the ear. And these are exactly the kinds of symptoms that have been widely reported, and Dr. Salt makes that very kind of comment. I've known that for some time.

And so things that -- says that things we know more about like Meniere's Disease, there are also a couple other disorders that we know more about now than we used to, we know that the -- these kind of symptoms can also result from those disorders.

Q Now, you state on page 9 near the top of your direct testimony that the ear is more sensitive to infrasound when there is no or very little high frequency sound. Is that a correct characterization of your testimony?

A Well, that's a good characterization of what I said, and that is not based on my own work but it's based on Salt's work. He has a study, I forget his co-author, but in the last year or two he's published a couple of papers, that is journal articles, and presented some papers at various society meetings or conferences where he's talked about -- he makes these direct measurements in the cochlea.

And people should understand, this is in the guinea pig. Guinea pig is a good model of the human ear. The cat and Rhesus monkey have been used as long as I've been in the field, as well as guinea pigs, to model what's going on in the human ear. You're not going do these kind of experiments in humans. I mean, nobody wants electrodes stuck into their inner ear. So you're going to have to do them in these kinds of animals, and he's found that the electrical activity in the inner ear, the cochlea, is greater in the low frequencies when you put simultaneous higher frequency into the ear.

Q Okay.

A So he has -- he has recording electrodes stuck in certain points in the hair cells, for example, in the cochlea, and he's just putting a sound through the normal ear, although the animal is anesthetized. So his work has created quite a big buzz in people who are interested in it for sound, and more recently he

and others have become interested in applying his work to wind turbine noise.
Q And in taking -- in taking that, would you say that people are more sensitive to infrasound at night because there are very few other sounds going on --
A Yes.
Q -- that they can hear?
A Yes. Absolutely. I think that's a direct inference of that finding.
Q Okay. Thank you. At the top of page 10 of your testimony, you talk about the importance of identifying vulnerable populations when you are introducing a noise source into a community?
A Yes.
Q What's the best way to identify vulnerable people, or what is a way to do it?
A Well, certainly case history questionnaires would be possible. I don't know that wind developers are in the position to do that. I think it would take medical or, you know, allied medical personnel to do that. Self reports, I and Dr. Phillips and others I think have pointed out is very critical. The whole basis of medicine is depending on giving weight and validity to a person's report that something a wrong, and even when the -- all the technical --

technological instrumentation doesn't corroborate it, you still don't decide that you no longer believe that person's complaint. So self-report.

I mean, if I may say so, the case of the autistic child in the one family, I think I read some of the -- I don't know if it was exhibits or some -- I think it was exhibits where they had the questionnaires -- showed the results of the questionnaires or there are open comments made, and I thought they described the problem very clearly. I mean, very well, and indicated they had spent years with I believe what's now a 20-year-old son evaluating his responses to different stimuli. And I would just consider that very valid information, and I say based -- I'd say based on the details of that description, this child probably would, although, again, I'm not a psychologist or expert in autism, that would seem to be a real critical indication that this child probably would suffer critically from exposure -- any significant exposure with wind turbine noise.

Q And you said you've been -- you have been watching these proceedings the last two days?

A Well, I read much of the testimony in the last couple of weeks, it was available, particularly where health was involved, and I listened to all the testimony yesterday online and most of it, not all of it, today. As much as I could today given my other things I was -- other things I was doing.

Q Okay. Limiting this question to anything that you have heard online in the last day and a half, do you have any other comments you'd like to add on to any piece of testimony that has been discussed today?

A Well, I guess one thing that struck me was questions came up, and again I'm -- I can tell you what I think I'm expert at and what I'm not, and I wouldn't say I'm an acoustic engineer kind of expert, but I did write an article with Rick James, who I think is, and one of our statements together, this is a corroborative effort, was that it's important to take note that there's little difference in noise generated across different makes and models of modern utility-scale wind turbines. Once you normalize their power output, so a 1.5 or a 2 -- and again, this is not -- obviously not as an audiologist but as one who understands sound and to some extent sound measurements and so forth, perhaps I'm qualified to make this statement, or to make it in this context.

The data from Camperman and others show that low frequency energy from what I'll call industrial wind turbines increases inversely with frequency. As you go down, in other words, there's a 3 dB per octave rise to level or frequencies around 10 hertz, and I don't think any -- any data are available below 10 hertz. So he keeps going -- the energy keeps rising, and Camperman, who's worked with James, and I've talked to Camperman but don't know him personally, he's concluded that the amount of noise generated at low frequencies increases by 3 to 5 decibels for every -- excuse me -- megawatt of power generated. So that's one point.

There was something else. I took a lot of notes. I don't know if I'm going to be able to find any more. Well, yeah. Here. The other thing was that, and this is more in the realm of acoustic engineering, but an article by van den Berg from, I believe, the Netherlands in 2003 in the Journal of Sound and Vibration looked at measurements of noise levels that were taken at daytime and nighttime, and science found that the turbine rotation and the wind speeds were greater, much greater, two and a half or so times greater at night than during the day and that they -- he concluded that predicting the noise at night from tall wind turbines underestimates the data you're going to get during the daytime.

So these measurements need to be taken at night when the wind speeds are higher, much higher, at higher altitudes near, you know, the blades than at the base of the tower. That's basically all I would have to say I think about the testimony that I've heard.

MS. BENSKY: Great. Thank you very much.

THE WITNESS: You're welcome.

MS. BENSKY: I don't have anything further.

EXAMINER NEWMARK: All right. More questions?

MR. WILSON: Yep.

EXAMINER NEWMARK: Yeah.

MR. WILSON: I wasn't going to ask any questions, but after all that, I can't resist.

THE WITNESS: You promised.

CROSS-EXAMINATION

BY MR. WILSON:

Q Dr. Punch, I'm John Wilson. I'm representing the Applicant in the proceeding.

A Yes.

Q I just wanted to clarify -- well, I wanted to ask you a few questions, but the first one I wanted to ask you about is clarifying Dr. Salt's work.

A Yes.
Q Did I hear you testify that Dr. Salt's work is solely on guinea pigs and has not been duplicated in humans yet?
A He makes that very clear I think, yes. It can't be duplicated in humans, that's my point. I think that's why I think everybody needs to understand that.
Q Okay. And that's all I needed. Thank you.
A Oh, okay.
Q And just a couple of questions about your expertise. You're not a physician, correct?
A Right.
Q And you're not an epidemiologist?
A Correct.
Q Okay. Is it -- would it be a fair characterization -- you had a lot of testimony about the health impacts of infrasound, correct?
A Yes. A great deal.
Q Okay. Is it a fair characterization of the -- of the general literature in this area that those infrasound studies are usually done at very high decibel levels?
A I'm not sure exactly how to interpret that question, at high decibel levels. I think the levels have been measured, and some of them have been found to be

high. I've seen some measurements that are quite high in the very low frequencies below 20 hertz in Michigan. The measurements were taken by Rick James and interpreted by Wade Bray, who's another acoustician in the Michigan area, near me in fact, and who works for Mercedes-Benz to study noise in cars and that sort of thing. So I think the answer is yes to your question.
Q I'm sorry? Could you repeat that?
A I said I think the answer is basically yes to the question of whether high level sounds had been, if that was your question, had been measured in terms of infrasound.
Q Taking just a quick look at your surrebuttal testimony.
A Okay.
Q On the very last page you have some references in footnotes, and I want to ask you about a couple of those.
A Okay.
Q On page 2, you're referencing a presentation by Carmen Krogh?
A Krogh.
Q Okay. And that's -- that was a presentation at an inner noise conference; is that right?

A I believe so, yes. That's the first reference, I believe.

Q Okay. So has that work been peer reviewed at all, to your knowledge?

A I can't say that I know for sure that it's been peer reviewed. I think for any -- I do know to this extent that it's been peer reviewed at a certain level. Peer review has a -- there's a continuum of peer review. I mean, when you present a paper -- I'm sure this is true in this case at this conference -- somebody had to read it, and usually at least two people read it. The same process happens when you submit a journal article, a manuscript for publication in a peer-reviewed journal. So almost everything is peer reviewed. These conferences are fairly well peer reviewed. There's some industry magazines and journals that aren't that well peer reviewed. An editor might, for example, decide I like this article and I'm going to publish it, but that's not what I'm talking about here.

Q Uh-huh.

A So I would have to classify it at least at a certain level of a peer-reviewed article or peer-reviewed presentation, and usually these are published as a result of the conference afterwards.

Q Okay. Were you in attendance at that conference?
A No, I was not.
Q Okay. Then on page 4, starting on line 5, using data from a home in Michigan, Swinbanks -- well, Bray and James and Swinbanks have shown that the wind turbines produce modulated infrasound. On it goes.
A Right.
Q And there's a reference for Swinbanks is Footnote 4 on the last page, and that reference is also to a conference and not a peer-reviewed paper?
A Well, I would have to say the same thing. I see an extra little dot in there, but it's the same conference that Krogh presented at. Let's see. It's the same date.
Q Okay.
A So it was this past August. So I would have to say the same thing about his as I said about Krogh's work.
Q Okay. So if you weren't there for Krogh's work, you weren't there to see Swinbanks' either?
A Right.
MR. WILSON: Okay. Thank you. That's all I have.
THE WITNESS: Okay.
EXAMINER NEWMARK: Questions?

(No response.)

EXAMINER NEWMARK: Sir, I had a question for you, and I'm not sure which witness had testified to this, but it was my understanding from the record that low frequency sound is not audible by humans, and it seemed like someone was saying one of the reasons, one of the benefits of that, I guess, is that you can't hear, like, your heart beating, things like that?

THE WITNESS: That's probably the statement I made maybe in my direct testimony.

EXAMINER NEWMARK: Okay. Because your answer seemed to sound like you didn't really know why there would be some sort of rationale that we couldn't hear those frequencies. I just wanted to make sure you weren't contradicting yourself.

THE WITNESS: Well, we certainly can hear low frequency sound. We can hear low frequency sound to about 20 hertz. That's the average. People differ. Some people can hear a little below that. Some people don't hear that far down. But infrasound, it generally is defined -- of course it's inaudible sound to all of us, essentially. We don't register it as sound per se.

EXAMINER NEWMARK: Okay.

THE WITNESS: I guess in some of the other comments I made earlier, just a while ago, you might have picked up on the fact that I said the brain doesn't always know what to do with every sensation it gets delivered to it.

EXAMINER NEWMARK: Right.

THE WITNESS: And I guess I base that partially on personal experience. I don't know if I can go do that here, but I was told that by a physician. I don't have any other reference. It's certainly not a peer-reviewed scientific conclusion.

EXAMINER NEWMARK: That you don't hear your heartbeat for that reason, or is that what you're saying?

THE WITNESS: Oh, I see. Yeah. That was sort of -- I guess I would have to say that was speculative on my part. I have -- I think I've read about it, but I've come to believe it. Your mind likes to fit the pieces of the puzzle together, and that was a more speculative aspect of my trying to see that the pieces all fit well.

I have heard that. I have read it. I think based on some early work that maybe Leventhall did, and I don't want to be that definitive because I'm not sure it was Leventhall, who did some early work in occupational plants on ventilation/heating systems and so on and infrasound. He did some very early work in England on infrasound, and I think he might have made that kind of statement. But he's a noise engineer, and I'm not sure it was he. So I can't be definite about that.

EXAMINER NEWMARK: That's fine.

THE WITNESS: I've seen references to it, though.

EXAMINER NEWMARK: All right. Redirect?

MR. REYNOLDS: No.

EXAMINER NEWMARK: Okay. I think that's all the questions we have, so thanks very much.

THE WITNESS: Thank you.

EXAMINER NEWMARK: We're going to disconnect.

(Witness excused.)

MR. REYNOLDS: Ready for another one?

EXAMINER NEWMARK: I'm ready for anything.

MR. WILSON: Your Honor, I am doing the next one, but I need to take four minutes with my client.

EXAMINER NEWMARK: Four minutes. You're doing the next cross you mean?

MR. WILSON: Yeah.

EXAMINER NEWMARK: Okay. Sure. We'll go off the record.

(Brief break taken.)

EXAMINER NEWMARK: You have another Town witness?

MR. REYNOLDS: Yes, I do. In terms of housekeeping, we can deal with this later. There's one lay witness where I'll need to submit an affidavit. We can do that.

EXAMINER NEWMARK: Carlson?

MR. REYNOLDS: Carlson and Wirtz.

EXAMINER NEWMARK: Okay. There's no questions for Wirtz?

MR. REYNOLDS: No.

EXAMINER NEWMARK: All right. Not a problem.

And since we're on the topic, there's also that Horonjeff surrebuttal that was filed in confidential form. You need to refile that.

MR. McKEEVER: You want a marking on that? We got that listed.

MS. BENSKY: We filed one confidential --

EXAMINER NEWMARK: Off the record.

(Discussion off the record.)

EXAMINER NEWMARK: Go ahead.

MR. REYNOLDS: Carl Phillips will be the next one by phone.

EXAMINER NEWMARK: Okay.

(Call placed to Mr. Phillips.)

(Unable to reach Mr. Phillips by telephone.)

MR. REYNOLDS: Let's do Mr. Stamberg.

JOHN STAMBERG, TOWN OF FOREST WITNESS, DULY SWORN.

EXAMINER NEWMARK: Have a seat.

DIRECT EXAMINATION

BY MR. REYNOLDS:

Q Your name, please.

A John Stamberg.

Q And you have filed direct and rebuttal testimony in this case?

A That is correct.

EXAMINER NEWMARK: Is it rebuttal or surrebuttal?

MR. REYNOLDS: It's probably surrebuttal.

EXAMINER NEWMARK: It matters.

MR. REYNOLDS: Okay. It's direct and surrebuttal. Sorry.

BY MR. REYNOLDS:

Q That's true and correct to the best of your knowledge?

A Yes.

Q You affirm the exhibits that were also attached?
A Yes.
Q Okay. And do you have anything to add based upon testimony, surrebuttal and otherwise, that you heard yesterday?
A I probably have comments on the sur-surrebuttal by Mr. Pobloskie.
Q All right. Let's take that one piece at a time. What is the first comment that you have?
A Probably the first thing I'd like to do is he made a chart that's Pobloskie 2 that showed average Michels and Stamberg comparison turbine removal costs.
Q Okay.
A I've got -- I reviewed those as best I could from the internet references that were made.
Q All right. Let me ask you this just to clarify. We're talking about the seven sites that the witness basically found on the internet?
EXAMINER NEWMARK: It's in the exhibit, right?
MR. REYNOLDS: Yeah.
EXAMINER NEWMARK: Pobloskie 2?
MR. REYNOLDS: Right.
EXAMINER NEWMARK: We know it's in there.
BY MR. REYNOLDS:

Q And so did you have a chance to review the information submitted yesterday?
A Yes, I did.
Q All right. And what did you find out?
A First of all, the wind turbines were small. They were sub -- two were smaller megawatt units, not the larger 2.5 megawatt units, which makes a big difference in height, foundation, and weight.
Q All right. And so were those sites then comparable in any respect to this project?
A No.
Q And were there any pieces missing in the -- in the decommissioning reports in this?
A Yes. They were incomplete in land reclamation, non-metal concrete, and that disposal cost, and the crane pad cost to remove either one that they installed or one that they left behind.
Q And how about concrete removal?
A Most of them were deficient in that or silent on that.
Q When you say deficient, that means it had something but not enough or --
A Right.
Q Or were they silent completely?
A There was a combination of silent and deficient.

Q What do you -- what do you consider deficient?
A One is they removed some small token amount of foundations or stuff like that that just disappeared, and they didn't have the trucking costs and disposal costs included in their estimate.
Q All right. How about the removal cost?
A The removal costs for these were much less by --- for example, I did the same thing with the internet. On a couple of wind turbines that were two and a half megawatts, not 2 and below. One was Record Hill in Maine. It was about five times the dismantling decommissioning costs as the average in Mr. Pobloskie's cull of material.
Q Let's -- all right. We'll get to that, but first let's talk about the seven and then we'll talk about the ones that are more comparable.
A Oh, okay.
Q All right. So were there any -- any of those seven that are comparable to Highland --
A No.
Q -- on Mr. Pobloskie's list?
A No.
Q All right. Were there any that were at least close?
A No.
Q Why not?

A The reason was, they used exceedingly high steel salvage values. They were using salvage values that weren't site specific, but they looked up what a recycler sells to the steel mill type of steel, or what we would get for shearable metal, such as an auto body, not two inch, one-and-a-half-inch thick steel tubes that are eight to ten foot in diameter. There is a limited number of people that can plasma cut and reduce that into sellable quantities to the steel mills.

In this area, rather than use a generic number what the steel sells for the steel mill, I contacted specific auto recyclers in Eau Claire and Minneapolis. And the Eau Claire group, there was an EMR, European Metal Recycle, sister company in Eau Claire that didn't have the capabilities. Alert Recycling and A&W Recycling did not have the capabilities to handle this large, thick metal.

The number that Mr. Pobloskie uses is for shearable stuff, such as auto bodies, waste, heating and ventilating ducts and that type of thing. And so you need to check with them. And so I, you know, contacted and visited American Iron, which is part of the national -- or Northern Metal Recycling Group owned by EMR, European Metal Recycling. There's, you know, consolidation. They have about a three- or four-block facility that has rail for delivering to the steel mill on one side and barge capability on the Mississippi on the other.

Q And would this be the kind of facility that would be able to recycle this kind of metal?

A Yes. And I've talked to them, and I've talked to them again last week, and of course the metal prices have gone down from when I contacted them.

Q All right. Well, let's just talk about the logistics of getting the metal to the recycler. How would a decommissioning effort accomplish that feat?

A First you'd have to what I call de-erect the maso-hub tower and lay it down. You can't lay it in just a cornfield or muck. You've got to have a crane pad or lay-down area, whatever the wording is, and it would be very similar to the lay-down and crane pad that you used to put it up.

You've got two choices. One is you leave this lay-down crane pad, or whatever you call it, area from construction or redo it, okay? I assumed it would stay, and it would be maintained and not let it get weeds, mud, and become forest, okay?

Q Are we talking about 30 years?

A Yes. So somebody would have to maintain that. If not, the cost of redoing that and removing it gets to be a higher cost, which I could do. But if you get too many things, you can make -- you know, exaggerate it or not.

Q All right. So you got the -- you've got the metal on the ground. How do you get the metal to the recycler?

A There's two steps that I use. One is to reduce it to 53 foot or thereabouts length and 20, 25 tons, which is road legal in Wisconsin, okay? If you do the blades, the extra-long tower sections and all that, then you have to add the cost of more expensive equipment such as when you bring it in and modify all the corners that they have to go through throughout the 41 turbines as far as moving electrical equipment, making radius turns that are temporary, and doing those kinds of operations.

So that's why I chose to have it at the site reduced to typical normal trucking size and weight because the cost of redoing all the radiuses and all that stuff is just way too expensive.

EXAMINER NEWMARK: Okay, sir. Mr. Reynolds, how does your question relate to this exhibit? Because I think he's repeating a lot of his direct right now.

MR. REYNOLDS: Okay. Thank you.

BY MR. REYNOLDS:

Q Are any of the things you're talking about accounted for in these other seven examples?

A Not that I could tell from the internet sites.

Q Would the prices that would be quoted be comparable to what it actually would take to remove the concrete pads and reduce the towers to the ground and cut them up for the recycling?

A Six of the seven had what I call Michels' level type of estimates that weren't itemized to the point where you could tell what they were based on.

Q And were they in the ballpark? Low? High? What? What do you mean by Michels-type estimates?

A I can't tell what they include or don't include, and seem artificially low and have exaggerated steel price salvage values to negate some of the cost.

Q And how did their salvage values compare with the salvage values that you checked out?

A What I've checked out is the average net back to the project is 44 and a half dollars a ton, and they were using -- like Pobloskie picked the sheering price at 220 versus the 44 and a half for what actually has happened with people I've contacted, you know, visited and understand that they're capable of doing that.

Q So were you able to find any recycling prices that matched the either Michels' estimates or the seven that were submitted yesterday?

A The answer is no.

Q All right. And with respect to the removal of the concrete, there was -- there was no removal of concrete provisions in any of those seven?

A Oh, it was so de minimis or token addressed that -- no explanation of why or what they were, based on what is possible seems, you know, almost artificially low, and I didn't have time to go into what the requirements of the various people were.

Q All right. Now, your estimate to remove four or five feet is something in the order of $7 million, half of your decommissioning estimate?

A For the 41?

Q For the 41.

A Yes.

Q And you also had an estimate for a potential removal of 35-foot depth?

A Yes. Because what -- when you look at the drawings S1 and S2, it is the minimum value or size of the structure based on the soil bearing strength of about 3,000 pounds per square foot, which in my opinion is only the 26, 27, 28, and alternate 20A at the east central area where it gets to be rocky and minimum amount of soil area that the minimum has even any possibility. You get into the areas where you have the wetlands or underneath the hay, beans, soybeans, and the corn areas, those soils are typically 1,000 PSI -- or PSF or less bearing strength.

Q All right.

A In which case you'd have to either make the spread footing maybe three times as large. You typically don't do that. You compromise and go deep like you do a fence post as opposed to a flange that lays on something strong.

Q That doesn't really matter for only removing the top four or five feet, does it?

A No.

Q Okay. Any other -- any other comments on Mr. Pobloskie's testimony from yesterday?

A No. Other than the comment that he won't just go to the internet and you get ones with comparable megawatt and size to what is proposed at Highland Wind. Those numbers are four and a half to five times his average, which means size matters I guess is what it boils down to.

Q And what are the names of those projects that you

found?
A It was Montage Wind in Oregon, and the other one was Record Hills in Maine.
Q And these are --
A And then I went to bed.
Q These are decommissioning plans that have been accepted?
A And on the internet.
Q Now, what is the -- does the Applicant have a motivation to have a low decommissioning cost?
A Yes.
Q Why is that?
A Well, it's out of sight, out of mind. Then they don't have to -- performance bond, bond an amount, or have a sinking fund factor that takes away from their income stream, that lowers their value in 20, 30 years or whatever the time is. Somebody else gets stuck with cleaning it up. Mr. Pobloskie was unaware that -- who would or whatever would have to take up and clean up the mess.
Q Well, who would if the company doesn't?
A It would most likely go to the community that authorized it. Less likely that the county or the state would take it up. It would be sort of like, you asked for it, Forest, you think you got some

benefits from it, you clean it up. And that's just speculation, but right now there is no decommissioning program at the federal or state level.

Q What -- what about projecting labor costs in 30 years? Give us a comparison of labor costs --

MR. LORENCE: Your Honor, can I just interject here? We're getting a bunch of questions that could have been asked as part of this witness's direct and prefiled a long time ago, it sounds to me at least.

EXAMINER NEWMARK: Right. I agree. I think it's also clear that this witness has calculated and investigated this topic, and that his estimate is way higher than the company's. So we're clear on that.

MR. REYNOLDS: All right. That's fine. I have nothing further.

EXAMINER NEWMARK: Okay.

MR. REYNOLDS: Oh, did I do the testimony? Yes, I did. I think I did. All right.

EXAMINER NEWMARK: Yep. We're all good with that.

MR. REYNOLDS: Okay.

EXAMINER NEWMARK: All right. Cross?

CROSS-EXAMINATION

BY MR. WILSON:

Q So I was little bit confused by some of your exchanges here. At the beginning of your questioning by Mr. Reynolds, you said something about two of the turbines were different, or two of the projects were different somehow?

A No. None of the seven in Pobloskie's case are of the size or completeness or realistic salvage value that had any meaning to my estimate, which is complete site specific in this case.

Q Were all of the sites that Mr. Pobloskie found dealing with utility-scale turbines?

A Say that again.

Q Were they all dealing with utility-scale turbines?

A They were dealing with 1.7 to 2 range. I don't care what you call them. They're smaller than the 2.5.

Q Do you happen to know --

A So you can put any label on them. They're about two-thirds the size of the turbines being proposed in this project.

Q Do you know what --

A In other words, that's the number. You can put whatever label you want on that.

Q Do you happen --

A They are smaller.
Q Do you happen to know how tall the towers were for each of these?
A No.
Q Did you look?
A But by compare --
Q Did you look?
A What? It wasn't part of the stuff that was downloaded that was used by Mr. Pobloskie, and he didn't go into any of those details either. He just took the numbers from the sites that he took, and I would have to spend a lot of time to go into those. And if you go to the smaller turbines independent of the height, you have less weight in the tower --
Q Mr. Stamberg, you've already testified to that.
A Okay.
Q Please answer my question. My question is, when you reviewed these sites, did you specifically look for the height of the towers?
A I did not and --
Q That's all I need. Thank you.
A And quite frankly, that's not important.
Q Thank you. Let's take a look at your testimony. Let's start with your direct. You would agree with me, Mr. Stamberg, that we have very little experience

with actually decommissioning wind farms in this country, correct?
A Nobody has that experience.
Q Okay.
A Yet. What I tried to do is itemize all the functions, some of which Mr. Pobloskie described, and then I went to a standard estimating manual.
Q I understand what you did. I've read your testimony. Thank you.
MR. REYNOLDS: Well, he's trying to answer your question.
EXAMINER NEWMARK: No. Let's move on. I think we got it.
MR. REYNOLDS: Okay.
BY MR. WILSON:
Q So on page 3 of your direct testimony, you're giving examples --
A Page what?
Q Page 3.
A Okay, 3.
Q You're giving examples of wind and wind projects that you've worked on. Were all of these examples that you're giving here regarding decommissioning costs?
A Some of them were. Others -- the Alaskan thing addressed the CO2 benefit because when you run a wind

turbine, you have to run an auxiliary other thing to make up the difference when you lose wind or gain wind, and the CO2 benefit isn't just the fuel that's displaced --
Q I'm really not interested in CO2. What I'm interested in --
A Oh, okay. I thought you asked me for it.
Q What I asked you is, your examples here, how many of them dealt with decommissioning costs?
A Most of them did.
Q Most of them. And in most of those cases, you were reviewing those projects on behalf of who?
A The town -- the State of Alaska. Let's see. Yeah. If you're going at it, I did not work directly for the developers.
Q You've never done any work for a developer?
A On wind, no.
Q Okay.
A On other subjects, yes.
Q Okay. At line 13 of your testimony, 13 and 14, you bring up the issue of decommissioning agreements. Can you describe for me generally what those agreements are?
A Where are you?
Q I'm at lines 13 and 14 on page 3.

A Yes. Because when I looked at some of the decommissioning costs that we have participated in and compared them to Michels Corporation or Michels Wind Energy, subdivision of them.
Q Okay. I guess I don't understand that. What is in a decommissioning agreement? Is that an agreement between the town and the developer?
A The developer, the bonding company, sinking fund factor. And the bonds can be either performance, which they say you do it no matter what, versus an estimated amount.
Q Okay.
A And those are two different structures of bonds. And the sinking fund factor is where you put it in an escrow account.
Q Sure. So these decommissioning agreements are essentially the surety agreements for the project?
A Yes.
Q Thank you. And on line 16 you begin referencing decommissioning plans that you reviewed, and like your previous work, none of that was done on behalf of the developer?
A Those items were not in there or in there properly.
Q I'm sorry? Say that again.
A Oh. The preparation, loading, and salvage, those

items were often not done properly. They used either internet quotes of what a recycle facility sells --

EXAMINER NEWMARK: Wait, wait, wait. Restate your question and let's focus.

BY MR. WILSON:

Q Do you see the reference to submit a decommissioning plan on line 16?

A Say that again.

Q Do you see the reference to decommissioning plans on line 16?

A Yes.

Q Okay. My question was, like your previous work, none of those decommissioning plans were reviewed on behalf of the developer?

A No.

Q And what was your charge when you were reviewing these plans? Was it for the adequacy of the plan? Was it for the cost?

A Accuracy of the plan, completeness of the elements in a decommissioning, and the salvage value that you would get in the site-specific area. Like I searched out a number of people here and found American Iron, Northern Recycling Group owned by EMR as the one that has the capability that you would --

EXAMINER NEWMARK: Okay.

MR. WILSON: You've already testified to that.

THE WITNESS: Okay.

MR. WILSON: You already testified to that.

BY MR. WILSON:

Q Let me just ask you. This is your -- on page 3, this is your body of work as it were with respect to decommissioning, and I just wanted to ask you if in any of your professional work regarding decommissioning whether you have ever concluded that a cost estimate was too high?

A No.

Q Have you ever concluded that a cost estimate was reasonable?

A Not in total, but certain elements I agreed with.

Q Okay. So not in total means you've never found one reasonable?

A If it's underneath the cost and they excluded things or overvalued the actual site-specific salvage value, the answer is I have not done that.

Q I also was curious about your dialogue with Mr. Reynolds with regard to foundations. As you're aware, there's been a difference of opinion about the depth of the foundations. Is it -- is it still your testimony that foundations in this project will need to be 32-feet deep?

A They -- several things. First of all, the not subject to construction for permit review only --

MR. REYNOLDS: Let me object.

THE WITNESS: -- quantities and all that is not --

MR. REYNOLDS: Excuse me. I'm objecting. This isn't -- his design criteria of the foundation is irrelevant. We're talking about decommissioning, and he's perfectly happy to design these pads if you'd like, but I think we're going to waste a lot of time.

EXAMINER NEWMARK: All right. Well, the company wanted some clarification on what he said, and I agree, I was lost. So, I mean, if you want that clarification, you can keep going. That's fine with me.

BY MR. WILSON:

Q And if you can answer this yes or no, I would really appreciate it. Is it your position that there will still be a need for foundations for this project that are two or -- 32-feet deep? Yes or no.

A That is one of the options with the foundations that don't meet the specific requirement by Renewable

Recycle Consultants --
Q Okay.
A -- that LLC. It is one of the options, you go deep rather than spread it out in the poorer soils as defined by them.
Q Okay. Is it your testimony that the foundation designs in this project by RRC are faulty?
MR. REYNOLDS: Objection. Relevance. This isn't what his testimony is about.
EXAMINER NEWMARK: Overruled. Overruled.
THE WITNESS: They're premature. There has not been soil borings specific to the area to decide whether you go spread footings that are larger or deeper, okay? The submitted S1, S2 is minimal. It's stated on the drawing, these are minimum sizes and assume a soil strength that probably doesn't exist in the surface other than probably in the area of 27, 28, and 29, and 20A may be able to use foundations that would be the minimum. The others will likely have to be wider or deeper.
BY MR. WILSON:
Q And if no soil borings have been done, how can you possibly tell us whether we've got the right turbine foundation or not?

A Yeah. There's two things that are needed. One is you need to select the turbine because the turbine's weight and momentum for falling over are different and specific, difference between Siemens and the Nordex ones. So to do this properly, you need to select the turbines, do the soil boring, and then do the foundation design, be it spread, deeper, or you cut the hole deep enough that you get to some soil that is strong enough to meet the criteria in the design.
Q And what's the basis of your assumption that there are no soil borings that have been done?
A I found no soil borings specific to the different turbines. One size does not fit all. You've got the rocky stuff to the center and east, and then you go to the wetlands and the agricultural soils with the hay, soybeans, and corn.
Q So did you request from the developer or the Applicant in this proceeding whether they had any soil data?
A They may have soil data. There's only a few data, but none of them is specific to the turbines that you would need for design.
Q Okay. Did you ask for any data that they may have with regard to soil?

A No.
Q Okay. And when you say you looked, where did you look? Just in the application?
A The application and the revised applications, yes.
Q Okay. Your Exhibit 6, this was taken directly from the application?
A Correct.
Q Okay. Mr. Stamberg, I've just handed you an enlarged drawing of sheet S3 which was contained in the original application in this proceeding right behind the two that are contained in your Exhibit 6. Have you seen this document before?
A No, I have not. I looked for it in the stuff that we downloaded, but I did not have that.
Q Okay. So at the top on the left, do you see that, an indication of what the height of the foundation is going to be?
A Yes.
Q And what would that be?
A This is the way -- it's a preliminary drawing is, 8 foot 2 plus 2 foot, which makes it 10 foot 2 inches.
Q Okay. And taken together with these other drawings, this would be spreader foot foundations?
A Is this what?
Q Are these -- is this a spreader foot foundation?

A This is a preliminary, not for construction, minimum design.
Q Right. Did you base your testimony on the two drawings, S1 and S2?
A Yes.
Q Okay.
A And I assumed that the base of the foundation was about two foot under the surface below the frost line so you wouldn't get heave without this drawing. That was a basis of my calculation.
Q And did it surprise you at all when you found sheets S1 and S2 that there was no profile drawing of the foundation?
A I could not find it in the stuff that we had.
Q I understand you couldn't find it. I asked you if you were surprised that it was there.
A I wasn't surprised. I looked for it, and I couldn't find it, and I made assumptions that the foundation at least had to be two-feet deep or thereabouts to be below the frost line of design so you wouldn't get frost heave where you get frozen water, it expands, and deteriorates that. So you probably have to be about two feet, at least, deep.
Q Okay.
A And that's the basis of my calculations.

Q So all of your testimony was done without knowledge that sheet S3 existed?
A Correct.
Q You would agree with me, Mr. Stamberg, that foundation removal is one of the most expensive tasks in decommissioning?
A Yes.
Q In fact, in your estimate, it's approximately 50 percent of the cost?
A 48 percent, yes.
Q Okay. I'm looking at -- take a quick look at Exhibit 8.
A Yes.
Q So in the first line on your Exhibit 8 is the foundation removal. Only five feet of the 30-foot-deep foundation, correct?
A Yes. And that's 680 cubic feet, thereabouts. Your minimum drawing is 690 something. So we pretty much agree on how much minimum cement is there. The difference between S3 that you just showed me and my assumption was that the foundation was only deep enough to meet the frost requirement for frost heave as opposed to being variable.
Q Okay. Let's start, are you familiar with PSC 128 decommissioning provisions?

A Say that again.
Q Are you familiar with the PSC 128 rules decommissioning provision?
A Not in detail, no.
Q Are you aware that those rules only require removal to four feet instead of five feet?
A Yeah. And by varying the foundation, you can gain and leave this 95 percent still in place.
Q Okay. My question was, are you aware that the requirements are that you only remove four feet below the surface?
A If you say so, that's fine.
Q Okay. So to the extent that you're removing five feet here, your estimate's going to be a little bit high because there's a foot that we aren't going to have to remove, correct?
A Yeah. I had the whole foundation was at least two feet which is sitting above the four-foot level.
Q Okay. All right. And so I think you referenced this already, but if you -- if you go to S1 in your Exhibit 6, and under the design criteria there on the right-hand side of the page.
A Yes.
Q Under two, that's the estimated structural material quantities. Do you see that?

A Uh-huh.
Q And between the base concrete and the pedestal concrete, the pedestal concrete is what would be essentially above ground. You've got approximately 707 cubic yards, correct?
A Where is that on there?
Q Well, the base --
A There's A, B, C, D, E.
Q Under A, base concrete, there's 694 cubic yards, correct?
A Yes. And I've used 680 in my calculation assuming that was two foot below.
Q And then B is the pedestal concrete?
A All right.
Q Which is 13-and-a-half cubic yards?
A Yeah.
Q Okay. So together those are approximately 707 cubic yards?
A That's correct.
Q Correct. Okay. So for the foundations that are represented by this set of drawings, your cost estimate is removing 90-some percent of that foundation, correct?
A Yeah. Basically the whole foundation because I assumed it was all --

Q And that's not required, is it?
A What?
Q And that's not required, is it?
A What is not required?
Q To remove 90-some percent of the concrete.
A No. If you go by 128, it's four feet.
Q Correct.
A And so the way to avoid getting rid of the foundation is just make it deeper below the four feet, and the ground level thing needs to be sophisticatedly defined, original contour, slope, and different things like that that can make several feet difference.
Q All right. So if we have a foundation which is 10 feet 2 inches deep, and we only remove down to four feet below the surface, that's approximately 40 percent of the -- of the foundation, correct?
A I haven't done the arithmetic, yes. But by putting the spread foundation deep, under four foot, you can meet the minimum requirements of 128, but not the spirit of removing it.
Q Okay. My question was, if we have an approximately 10-foot-deep foundation and we're only required to remove four feet of it.
A Correct.

Q Does that not mean that approximately 60 percent is going to be left in the ground?
A I'd have to sit here and calculate it, but it would be less.
Q How much less?
A Well, you want me to sit here and calculate it?
Q Yeah, I do.
A Okay. I don't know what the percentages are.
Q Mr. Stamberg, I'm showing you a set of calculations that Mr. Pobloskie did. He -- those numbers indicate that if you remove four feet, that you're only removing 26 percent of the base and pedestal. Do you see that?
A I see that, but I can't verify it unless I sit down -- you give me an hour, I can make my own chart, okay?
Q Okay.
A Then the other thing is --
Q I didn't ask you a question.
A Oh, okay.
Q You can't give me an answer as to whether that 26 percent looks reasonable for a spreader foundation?
A I calculate stuff. I can't do that right now.
Q Fair enough.
A You give me a half hour, I will.

Q Fair enough. Subject to check, if only 26 percent of the foundation is being removed -- let's just use 25 percent for round figures.
A That's your assumption.
MR. REYNOLDS: Is this a hypothetical question?
MR. WILSON: It's a subject to check question.
MR. REYNOLDS: Okay. Is that --
BY MR. WILSON:
Q 26 percent of the foundation would be removed to get down to four feet below grade, and if that were true, then your removal of 680 tons is -- the proper amount that would have to be removed is one quarter of 680 tons, correct?
MR. REYNOLDS: Object to the form of the question. There's no foundation for these numbers in the record. These are just assumptions.
EXAMINER NEWMARK: Well --
MR. REYNOLDS: I'm mean, we're back to kind of the late exhibit, that Mr. Pobloskie could have testified to these facts if that's true, but I think it's too late now.
EXAMINER NEWMARK: Fine.
MR. WILSON: Let me ask the hypothetical

then.

EXAMINER NEWMARK: Yeah. If that's how you want to do it, yeah.

BY MR. WILSON:

Q Hypothetically, Mr. Stamberg, if we only had to remove 26 percent of the foundation to get down to the required four feet, would we have to remove all 680 tons in your estimate, or would we have to remove approximately 25 percent of that?

A I can't stipulate to the 25. When you say four feet --

Q No. I'm asking you to make that assumption. This is a hypothetical question. Your answer has to assume that we only are removing 26 percent of the foundation. If that's true --

A If it's proportionately less, the estimate will be proportionately lower. Then your assumption about the four feet is at odds with Pobloskie's thing which shows four feet dipping down into the cone and back up. If you look at Pobloskie --

Q We can get out Mr. Pobloskie's picture and look at it in a few minutes, but I think you just said that your -- the amount of concrete that we would have to take out would be proportionately reduced?

A Under your assumptions, that's correct.

Q Right. So at 25 percent, we would need to take out only 25 percent of 680?
A That is purely based on your assumptions, and I have not made independent calculations of that.
Q And so if that's true, then the cost of removing the foundation would be significantly less than is in your estimate; isn't that right?
A It would be less and proportional under those series of assumptions, the four feet and the 26 percent.
Q Okay. Mr. Stamberg, when you estimated 680 tons for only the first five feet --
A I said what I did. I assumed that the foundation was surface mounted and two-feet deep under the frost line, so the entire model lid or foundation was above the four feet. And these preliminary designs, without knowing the turbine or the soil conditions, may be different.
Q How does that relate to the 32-foot assumption?
A The --
Q Was that 32 feet underground?
A Yes. And what you do is when you look at this, this is predicated on a 3,000 pounds per square foot soil bearing strength. The cornfields, the hayfields, the soybean fields, the agricultural area does not have that. So you have to either make a much bigger

spread foundation, or you go deep like a fence post, or find an economic optimum between the two. And my judgment is that only about three of the foundations have a possibility of using the minimum design here. The rest of the designs would either have to be spread out, much larger, calculated last night maybe about 120-feet diameter, which would be probably about three times the concrete. That's probably not what you would do to optimize this design. You would compromise the spread footing and try and get rid of the load and bearing strength down to areas that have the strength and will take the momentum of tipping over that. You've got 2.5 megawatts, which is like a 3,000 horsepower engine up there working in reverse generating. It's about 90 tons up there. You don't want this thing to tip. Two things that you need to be aware of site specific because one is the --

Q You're not being responsive to my question. Let's try it a different way.

Tell me how you calculated 680 cubic yards was being removed. How did you come up with 680 yards?

MR. REYNOLDS: Your Honor, I object. We've been around this now for almost a half an hour, and I think he's beat it to death.

MR. WILSON: I don't even think I've started, Glenn.

MR. REYNOLDS: Okay.

MR. WILSON: It's pretty clear that he's overestimated the amount of concrete, and that's pretty critical to the record.

MR. REYNOLDS: I think we've been through that.

EXAMINER NEWMARK: It would be much quicker if you could direct your witness to answer the questions. When the company asks a question, give a specific answer. We could move on.

BY MR. WILSON:

Q How did you calculate 680 cubic yards had you removed only down to five feet?

A I took the 67-feet diameter and calculated the volume of the cone and pedestal and came up with 680, versus your 690 minimum, okay? It's essentially the same, okay?

Q So you essentially --

A But you got to let me answer now. Is I assumed that this would be a surface-mounted spread footing and not buried to minimize or move the foundation out of the four feet and comply with a four-foot compliance.

Q I thought you just told me the 32-foot assumption,

that 32 feet was all underground?
A No. That's not what I have in my estimate.
Q Yeah, but you -- did you testify that the 32 feet of the foundation that you assumed was underground?
A No.
Q Do we need to go back and read your testimony?
A I made the judgment, okay, knowing the typical soil strength that you would probably preserve the foundation and work with caissons, piling, or some deeper foundation to gain the strength where you lacked it in the soil bearing strength that's on the high side in the assumption of the 680- or 690-cubic-yard feet.
Q So was your assumption that -- you testified earlier, I believe, that you went two feet into the ground?
A With the minimum design, I assumed it had to be at least two feet under the ground or surface to prevent frost heave.
Q And how much would be above ground?
A The rest of the 10 feet -- the 10 feet minus the two.
Q Oh, okay. So your assumption is about the same as the Applicants, it's just that you've got it all above ground except for two feet?
A Correct.
Q Have you ever seen a foundation designed like that?

A Yeah.
Q Where?
A That was in Connecticut and some of these places. That's a foundation. A lot of people don't traditionally bury spread foundations.
Q But would you have understood that had you looked at drawing S3?
A No. The design of S3 buries the concrete so that the four or five foot or the dip that was shown in Pobloskie's thing, the amount of removal required under 128 is avoided by burying the foundation.
Q So I think we've discovered the source of our misunderstanding. You believe we have to move 680 tons because in your design it's mostly above ground?
A Correct.
Q Okay. Can you please turn to page 9 of your direct. Now let me -- let me ask you, based upon the design -- foundation design that you assumed went into the ground two feet?
A Yes.
Q So under the PSC requirement to go to at least four feet, we would have to remove 100 percent of your design, correct?
A Not my design, of the amount --
Q Of what you assumed?

A Of a spread footer if it's on the surface and not over four-feet deep.
Q Right. Which is what you assume in coming up with your estimate?
A Correct.
Q Okay. So why then at line 7 on page 9 do you say that 85 percent of the tower foundation will remain?
A Where is this?
Q Line 7.
A Page 9 where?
Q Line 7.
EXAMINER NEWMARK: Direct 9.
MR. REYNOLDS: Your direct.
BY MR. WILSON:
Q Are you looking at your direct testimony?
A Yes.
Q Page 9, line 7.
EXAMINER NEWMARK: It's in print.
THE WITNESS: I got the erection of 41 turbines placing them on the ground at the site.
EXAMINER NEWMARK: This is not what was filed.
MR. REYNOLDS: Here you go.
EXAMINER NEWMARK: Maybe we'll find S3 in there somewhere.

THE WITNESS: The 85 percent is incorrect.
BY MR. WILSON:
Q Your testimony is incorrect?
A This note is, and this is for the minimum design foundation. If you have to increase it because of poor soils, then the deeper, wider foundation -- well, you decrease that, but that's in error.
Q So if -- if this is incorrect that 85 percent of the tower foundation will remain, does that also mean that your calculation of how much concrete had to be removed is incorrect?
A No. The amount on my assumption that it's two feet into the ground is correct. The 85 percent is incorrect.
Q Okay. Then let's go back to your Exhibit 8. Are you there?
A Yes.
Q Okay. Item 1, foundation removal, paren, only five feet of 30-foot-deep foundation. So that parenthetical is incorrect, too?
A Yeah. It should be a possible 30-foot depth if you don't have the soil conditions to justify the minimum amount of things. So it should be in a possible 30-foot depth.
Q And your assumption on foundation here is the

foundation that you described, two feet under and --
A Yeah, below the frost line.
Q Okay. So if you look at -- there's an -- after foundation removal, there's a footnote, Footnote 1. And Footnote 1 says, design submitted by the Highland Wind Farm per Exhibit JBS 6?
A Right.
Q So the design of the Highland Wind Farm is not what you assumed in your testimony, is it?
A No. It was based on S1, S2, and I did not have S3.
EXAMINER NEWMARK: Do we need any more? Do we need any more? I mean --
MR. WILSON: Just give me one second.
EXAMINER NEWMARK: Okay.
MR. WILSON: I think that's all we have for Mr. Stamberg, but I think we're going to end up having to put Mr. Pobloskie back up to substantiate the calculation of the amounts removed.
EXAMINER NEWMARK: Okay. Any other cross for Mr. Stamberg?
MR. LORENCE: No.
EXAMINER NEWMARK: Redirect?
MR. REYNOLDS: Yes.

REDIRECT EXAMINATION

BY MR. REYNOLDS:

Q Bottom line is that regardless of the design of the foundation or how much, you know, is compliant with 128, you have concrete that needs to get taken out of the ground and removed, right?
A Yes.
Q And you've given a per cubic yard expense for that, haven't you?
A Yes.
Q All right. And so even with a reduced amount, how does your foundation removal estimate compare with Michels Pipeline's removal estimate?
A They are -- I'm around --
MR. WILSON: I'm going to object to that. That's improper redirect. I never asked anything about the Michels' plan.
MR. REYNOLDS: Well, I'm just trying to get to the heart of this issue that we've spent at least a half an hour on.
MR. WILSON: Right. And there's proper direct and redirect.
MR. REYNOLDS: Well, I'm redirecting on this subject matter.
EXAMINER NEWMARK: Well, these figures are in the record. I think the calculations can be made based on that, so let's go on.

THE WITNESS: It's about --
EXAMINER NEWMARK: That's okay. Do you have another question?
BY MR. REYNOLDS:
Q I'm sorry. So is there -- if your estimate of $7 million to remove 41 turbines is less -- is reduced by a certain percentage, then we would get to your figure by whatever percentage less of concrete that needs to be removed --
A Yes.
Q -- is that right?
All right. Now, with respect to the recycling of the metal, how do we get the metal --
MR. WILSON: Objection. I never asked a thing about recycling.
EXAMINER NEWMARK: Yeah. Sustained.
MR. REYNOLDS: All right. That's all I've got.
EXAMINER NEWMARK: Okay. You're excused. Thanks very much.
(Witness excused.)
MR. LORENCE: Off the record.
(Discussion off the record.)
EXAMINER NEWMARK: I just want to be sure, you don't need to put it in as a separate item, S3,

but it is part of the application. It is in a document titled RCC Turbine Foundation Design Drawings, which is part of Appendix E in the application, PSC reference number 160362, and that's been on ERF.

Okay. So what do we have left? Do we want to re-call --

MR. REYNOLDS: Yep. I've got a new number.

EXAMINER NEWMARK: Oh, right. The call and re-call, okay.

MR. WILSON: I think we'll forgo any cross of Mr. Phillips.

EXAMINER NEWMARK: Generous of you. Anyone else need cross of Mr. Phillips?

MR. McKEEVER: Give me just a moment to look at my notes.

EXAMINER NEWMARK: Off the record.

(Discussion off the record.)

(Call placed to Mr. Phillips.)

CARL PHILLIPS, TOWN OF FOREST WITNESS, DULY SWORN

EXAMINER NEWMARK: All right. Go ahead.

DIRECT EXAMINATION

BY MR. REYNOLDS:

Q Mr. Phillips, can you hear me okay?

A Yes.
Q All right. You have submitted some surrebuttal testimony in this case?
A Yes.
Q All right. Is it true and correct to the best of your knowledge?
A Yes, it is.
Q And if you were -- if you -- is there anything you'd want to change in it as of today?
A No.
MR. REYNOLDS: All right. That's all I've got.
EXAMINER NEWMARK: And you'll affirm your exhibit as well? Your exhibit is true and correct to the best of your knowledge?
THE WITNESS: I'm sorry? What was it?
EXAMINER NEWMARK: Your exhibit, is that true and correct to the best of your knowledge?
THE WITNESS: My submitted testimony and CV, yes, they are.
EXAMINER NEWMARK: Okay. Cross?
CROSS-EXAMINATION
BY MR. McKEEVER:
Q Good evening, Mr. Phillips. This is Peter McKeever. I'm one of the lawyers for the Forest Voice group,

the group of citizens.
A Hello.
Q I've got a couple of questions for you. Do you have a copy of your surrebuttal testimony there in front of you?
A I do.
Q Okay. On page 3 at line 19, you state that there's overwhelming scientific evidence that wind turbines cause serious health problems for some people living near those residences; is that correct?
A Yes.
Q Okay. We can argue a lot about what constitutes scientific evidence, and there's plenty in this record that does that. Isn't it true that there's also overwhelming anecdotal evidence of the same thing?
A Well, yes. In fact, most of the scientific evidence as I state elsewhere in this document actually takes the form of what's sometimes called anecdote, though in this case they're better considered to be individual experiments. So that's the bulk of the scientific evidence that I'm referring to. Not all of it, but the bulk of it.
Q Okay. And these reports, they constitute what you refer to in your testimony as AERs; is that right?

A That's right. Adverse event report.
Q Okay. And you're an epidemiologist, correct?
A That's right.
MR. McKEEVER: Okay.
EXAMINER NEWMARK: I don't think anything here is something we haven't seen in direct --
MR. McKEEVER: I understand.
EXAMINER NEWMARK: -- or surrebuttal.
BY MR. McKEEVER:
Q I lost my train of thought. Those AERs play an important role in -- let's call it the epidemiological process; is that right?
A That's right. In addition to cases like this where they actually contain individual experimental data, they also play a very crucial role in the drug monitoring and approval process. They're called AVEs in that context, adverse drug events. But the idea is that when we don't have a formalized study going on to look for a particular outcome, it's this type of report that's our best source of information to discover it.
Q Okay. You state in your testimony, and I'm not going to be able to put my finger on the page and the line right at the moment, but you state that there is, quote, a clear pattern of disease. What does that

mean?
A By that I'm referring to the particular type of health outcomes that we've seen. While any given individual report might have a few odd claims where someone suffered some other disease just by coincidence probably, we have this clear pattern of these stress-related diseases that identify insomnia, inability to concentrate, headaches, stress disorders, mood disorders, and that is -- that's a pattern of outcome that are quite reasonably related to each other. It's not like we saw something strange like, you know, bladder cancer and spinal injuries showing up. And it's that pattern that's part of what helps us conclude that, yes, there really is a phenomenon we're observing here.
Q Right. So these elements that are what you include and what you call a clear pattern of disease, those conditions, would you consider those health problems?
A Oh, absolutely.
Q Okay. From an epidemiological point of view, are they still health problems even if scientifically we don't fully understand how the human body is stimulated by the sounds and infrasounds of wind turbines?
A I'm sorry. I missed the phrase. It's the yes-or-no

nature of that. But to answer, absolutely they are health problems even to the extent that we don't understand why they're happening. In fact, that is one of the most important aspects of epidemiology is it lets us detect a health problem, a cause-and-effect relationship, without knowing every intervening step that's the causal mechanism in between. And so there's -- you know, there's nothing that changes the fact that these are serious health problems to be found in our lack of understanding about exactly why they occur.

Q And you would agree that more data, more research, is needed on that causal question?

A Yes. That would be very useful. If we had that research, we'd have a much better idea about what -- what intervention, what technological changes, and so forth could eliminate these problems. Without that, all we have is the broad sweep of the cause and effect, and it's very difficult for us to figure out how to improve the situation.

Q Now, epidemiology is -- it's defined -- it's defined in your testimony and it has consequences, excuse me, for let's call it social policy, does it not?

A Yes.

Q Okay. Do you have an opinion based on this pattern that you -- that you perceive in the literature, do you have an opinion what would be a prudent social policy to pursue at this stage when we're talking about this issue?

A Yes. Well, it's been the case for quite some time that the reasonable policy to pursue would be to find out more before continuing to expose more people to these risks. For almost everything in society where we have a situation where a lot of people are going to be exposed to something that might be harming their health, we require analysis about what's going to happen and -- you know, and a reason for why we should allow that to happen or how we can stop it from happening before we go on and create the exposure. This case is a situation -- you know, not this case particular in Wisconsin, but this entire -- this entire technology is a situation where we've done it completely backwards from what's considered the normal acceptable practice.

MR. McKEEVER: Thank you. I have no other questions. I appreciate your time and your patience with us.

THE WITNESS: You're welcome.

EXAMINER NEWMARK: Okay. Do you want to reconsider?

MR. WILSON: I suppose I have to.
EXAMINER NEWMARK: Okay.
MR. McKEEVER: No, you don't.
CROSS-EXAMINATION
BY MR. WILSON:
Q Dr. Phillips, I'm John Wilson. I'm representing the Applicant in this proceeding.
A Hello.
Q Do you have any formal academic training as an epidemiologist?
A I -- I have a Ph.D. in public policy in which I studied econometrics ostensibly. That's basically the same science, the same statistical method, the date collection and analysis. It just happens to be the economist's word for it rather than the public health people's word for it. Then I did a postdoc in public health specifically.
Q Okay. And do you hold yourself out as an expert in epidemiology?
A Yes.
Q Do you have any medical training?
A Actual clinical practice training, no. I've taught in medical school, but -- certainly been involved in medical education, but I haven't attempted to -- clinical education myself.

MR. WILSON: That's all I've got.

EXAMINER NEWMARK: Okay. Other questions?

(No response.)

EXAMINER NEWMARK: Redirect?

MR. REYNOLDS: No.

EXAMINER NEWMARK: All right. Well, I'm glad we found you, but now we'll have to let you go. Thanks very much.

THE WITNESS: I apologize for the difficulty. Thanks.

(Witness excused.)

MR. REYNOLDS: Jaime Junker would be my next witness.

EXAMINER NEWMARK: Okay. Let's go off the record.

(Discussion off the record.)

(Brief break taken.)

JAIME JUNKER, TOWN OF FOREST WITNESS, DULY SWORN

DIRECT EXAMINATION

BY MR. REYNOLDS:

Q Could you state your name, please.

A Jaime Junker.

Q And Mr. Junker, have you submitted testimony in this proceeding?

A Yes.

Q In the form of direct and surrebuttal?
A Correct.
Q Yes. And is that testimony true and correct to the best of your knowledge?
A Yes.
Q Yes. And the exhibits that you've submitted, are they true and correct?
A Yes.
Q Okay. Now, there has been responses to your testimony in these proceedings, Mr. Mundinger among others, sur-surrebuttal or whatever. Is there anything that you would like to add to in response?
A Yes.
Q What is that?
A So Mr. Mundinger on his sur-surrebuttal, page 1, line 9, the question is, on page 2 of Mr. Junker's surrebuttal, he suggests the company showed up unannounced to a January 10, 2008 meeting of the town board, how do you respond? Essentially he says that is correct, they weren't on the agenda, and then he points out through Exhibit Mundinger 8 --

MR. WILSON: Now, Your Honor, I'm going to object. All he's doing is repeating what's in his sur-surr.

EXAMINER NEWMARK: Well, let's have him

answer as it relates to -- his sur-surr, right. As it relates to Exhibit 8 anyway. So what were you going to say?

THE WITNESS: Yeah. So actually this is responding to what was handed to me yesterday morning.

EXAMINER NEWMARK: I understand.

THE WITNESS: Okay. So basically in a nutshell they spoke at the public input section of the Forest town meeting. My point was, they used in Appendix Z attendance at that meeting, what people would think -- it says they gave a presentation. So that confused people that they gave a presentation at a town board meeting when they apparently did that during public input.

The point being, if anyone wanted to be invited to public output, you usually wouldn't do that through the public input section of a meeting because nobody knew they were coming.

BY MR. REYNOLDS:

Q Anything else?

A Yeah. It shows up saying he says they never came unannounced again, but the fact is they, on the very next month, showed up to the plan commission meeting. And again the plan commission made a vote to put him on the agenda right there at the meeting, which in government is not appropriate to do. The issue is they're using that as their public outreach again in Appendix Z, and so the broad public did not have an ability to know that they were communicating about this information.

Q Anything else? Any other responses to Mundinger's latest?

A Yeah. There's a clear issue. So on page 3, the first question, basically it says, how do you respond to Mr. Junker's assertion that the plan commission was unaware of any project details when -- when it was developing the Town of Forest comprehensive plan. So essentially the Town is asserting and has asserted that, you know, the plan commission was not aware of all the details.

And again, the way I would respond to that is, if you look at the Appendix 3 in the Town's testimony, it basically shows the plan commission chairman on January 10, 2010 through basically getting a question -- we're reading the plan commission minutes, okay. And the plan commission -- commissioners are asking this figure, Carl Cress, who was the chair of that plan commission, they're asking him, do you have any details about this project. And he basically responds, there's no details available at this time. This is January 10, 2010.

MR. WILSON: Your Honor, this is all in the record. All of it.

THE WITNESS: But it's to his surrebuttal that I got yesterday morning.

EXAMINER NEWMARK: But you haven't changed your answer in terms of what's already prefiled.

THE WITNESS: But he's given new information.

EXAMINER NEWMARK: Okay. So you're using the information currently on the record to respond to the new information. Okay. So it does -- so your information on the record applies to what he's saying here, that's what you're saying?

THE WITNESS: Yes.

EXAMINER NEWMARK: Okay.

Anything else?

THE WITNESS: The last comment would be, then in August 2010, the attorneys of the Town and Highland are going back and forth, and they're trying to sort out --

MR. WILSON: Again, it's already in the record, Your Honor.

EXAMINER NEWMARK: Okay. Is there just

someplace you can point to your prefiled that you can say responds to this section?

THE WITNESS: Sure. It's -- I'll give you that reference.

EXAMINER NEWMARK: Okay.

THE WITNESS: It looks like Appendix 10.

EXAMINER NEWMARK: Okay. And just in terms of how we're labeling things, is there --

MR. REYNOLDS: You mean Exhibit 10?

THE WITNESS: Exhibit 10.

EXAMINER NEWMARK: Okay. Your Exhibit 10 responds to that portion of Mundinger's sur-surr?

THE WITNESS: Well, it was Exhibit 10 of my direct -- of the Town's direct.

EXAMINER NEWMARK: Okay. Right. Okay.

THE WITNESS: Okay.

BY MR. REYNOLDS:

Q I have a question about Mr. Mundinger's testimony about his interpretation of your comprehensive plan and the basis for his belief that he knows more about that subject than you do. Can you respond to that?

EXAMINER NEWMARK: Was he here for that discussion?

MR. REYNOLDS: I believe he was.

EXAMINER NEWMARK: You're talking about

what was dealt with at the hearing yesterday?

MR. REYNOLDS: Yes.

EXAMINER NEWMARK: Okay.

MR. WILSON: I'm going to object to the -- object to the question because it mischaracterizes Mr. Mundinger's testimony. He never said he was more qualified than Mr. Junker.

EXAMINER NEWMARK: More qualified, okay. Can you rephrase?

BY MR. REYNOLDS:

Q Well, okay. Is it your understanding that mister -- that there's dispute between you and Mr. Mundinger about how your plan should be interpreted?

A Yes.

Q All right. And you heard Mr. Mundinger's response to my question answering basically why do you think your -- your view of the comprehensive plan carries more weight?

A Yes.

Q All right. And what's your response to that?

A Okay. So the comprehensive plan is a document that's 60 pages long. Basically you can read the document, and it says very clearly that -- probably the number one thing in our township is this visual aspect of being in the country. Everything else falls in after that, okay? So that's number one.

Now, part of the question is, Highland keeps coming back to the fact that the plan mentions renewable energies, and it does, but everything in the comprehensive plan is small scale. Also --

MR. WILSON: That's already in the record, Your Honor.

EXAMINER NEWMARK: Yeah. I guess if you can answer how -- how your interpretation is more -- why the Commission should be giving greater weight to your view of the comprehensive plan as opposed to Mr. Mundinger's. What's your background, your personal experience with it that gives you that edge.

THE WITNESS: Well, I represent the Town, and it's the Town's opinion that should matter the most. And we're just going to the facts where the Town created the document, and if we listed the things pro and con, it's the reasons in the plan document that don't favor large wind turbines.

EXAMINER NEWMARK: Okay.

BY MR. REYNOLDS:

Q Are you considering the -- this project to be an industrial project with respect to how that's defined in the land use plan?

A Absolutely.
Q And why is that?
A Everything in the land use plan reads -- refers to scope and scale, an appropriate small scale, and these 500-foot turbines no one envisioned when they drew up the comprehensive plan.
Q All right. And you were -- before being on the town board, were you on the plan commission?
A I was.
Q For how long?
A Approximately six and a half years.
Q All right. And you've lived in the town how long?
A Dozen years.
MR. REYNOLDS: That's it.
EXAMINER NEWMARK: All right.
MR. REYNOLDS: Your witness.
EXAMINER NEWMARK: Do you have questions?
MR. WILSON: Yes.
EXAMINER NEWMARK: Okay. Let's go in order.

CROSS-EXAMINATION

BY MR. WILSON:
Q Do you have a copy of the comprehensive plan up there?
A I do.

Q Have you reviewed what's been marked as Mr. Mundinger's Exhibit 3? Would you agree that that is the comprehensive plan that we're talking about?
A I believe so. We've referenced it, yes.
Q Okay. It hasn't -- hasn't been amended since Mr. Mundinger submitted it into evidence here?
A No.
Q Okay. You said you were on the plan commission for six and a half years. Can you give me the dates?
A Sure. It's in my testimony, but it's approximately December of 2001 to December of 2007.
Q And when did you become town chairperson?
A It's in the spring of 2011.
Q So between December of '07 when you came off of the plan commission until the spring of 2011 when you went onto the town board, did you have any official capacity with the town government?
A No.
Q Okay. The comprehensive plan was prepared between 2008 and 2009; isn't that correct?
A I believe so, ending in 2009.
Q Right?
A That's the date on it.
Q And so you weren't on the plan commission at the time that they developed the plan?

A That's correct.
Q And you weren't on the plan commission when -- at any of the plan commission meetings where Emerging Energies was making presentations about the project?
A No.
Q So the exhibit that Mr. Mundinger put in with the -- the May 7, 2008 PowerPoint presentation -- February 7th -- had you seen that presentation before?
A No.
Q Okay. So you never saw that presentation until it came into this record?
A Correct.
Q Okay. And would you agree with me that there are a number of things in that presentation that have already been talked about that indicate that these gentlemen were talking about a utility-scale project to the plan commission in early 2008?
A No. You can't tell that by what somebody sees as a picture, and I don't know how those people are looking at that, and I know that --
Q You can't tell that by references to 100-meter towers and 100 meter --
A You know they didn't know that because they didn't understand and they kept asking him for questions

about details of the plan, which they weren't given by Highland. At no time did Highland ever give the number of turbines, size of the turbines, or where they're going to be located to the plan commission. Never. That created a huge confusion, and they were in the fog.

Q You would agree with me that in that presentation that was made in both February and March of 2008, that there are indications in that presentation of turbines that would be utility scale?

A That's Highland's perception, but at no place did they ever spell it out for people.

Q Are you aware of any utility-scale turbines that are on 100-meter towers?

A I don't think it's a relevant question. You're asking me to -- certainly the PowerPoint presentation, I have looked through it. I saw it come in. One of the questions was why wasn't it put in Appendix Z. It's coming in seven months later.

Q That's not responsive to my question.

A Okay.

Q If you were on the plan commission at the time that that presentation was made and you saw references in that presentation to wind turbines that were going to sit on 100-meter towers, are you telling me you won't understand that we're talking about utility-scale turbines?

A Well, if I was on the plan commission, I would have been asking questions just like they asked the chairman, and the questions were do we have any more details about it, and they weren't given any information.

Q This was -- this was at the 2008 -- February 2008 meeting?

A That was all the way to 2010 with the same members. So you can assume that same group wasn't given any details all the way back to 2008.

Q You were not present at that meeting, correct?

A In 2008 or '10, no.

Q Okay.

A But the minutes clearly show they didn't have those details.

Q Is it possible they didn't have the details about the number and the locations of the turbines because they didn't exist yet?

A No. Because that information wasn't given by Highland until August of 2010.

Q Is it your testimony that they withheld that, that that -- that that data existed and they withheld it?

A I don't know if it existed, but it is that they withheld it from even the town board right up until the afternoon of August 10th and 11th, and it's in my testimony. They weren't --

Q Another way to say that, isn't it, that in August of 2010, they presented the town board with the information about the number of the turbines and the size of the turbines?

A For the first time.

Q Yes. Okay. We can agree on that. So I believe you told Mr. Reynolds that you believe that this project is incompatible with the comprehensive plan primarily because you view it as an industrial activity, correct?

A No. Primarily because the comprehensive plan spells out that all -- anything larger than a small-scale activity needs to go down into the hamlet, which would essentially be the downtown of Forest, which is about one square block. And it says that in the comprehensive plan several times, three or four times. So that would be the first reason it's not compatible.

The second is the biggest thing in the comprehensive plan with a clear reading for anyone is that the town wants to preserve its visual impact, its visual view, and the 500 turbines or -- sorry --

the 500-foot turbines just don't sync up with that in any way, shape, or form.

Q Okay. Mr. Junker, do you believe that the -- putting in this project constitutes industrial activity?

A We watched and was debated yesterday, so it comes down to semantics. It -- many people would say that the pictures that we see in the application of the size of the trucks necessary to bring in a single blade would absolutely qualify that as industrial no matter what you want to call it, and --

Q So it is industrial?

A That might not be the industry's terminology, but in terms of how the comprehensive plan defines it, it's industrial. Absolutely. No question about it.

MR. WILSON: Okay.

EXAMINER NEWMARK: He's asking you, is it industrial?

THE WITNESS: Oh.

MR. WILSON: Yeah.

THE WITNESS: Yes. Absolutely.

BY MR. WILSON:

Q Okay. And you just mentioned by definition in the plan it's industrial, and one of my questions was, as I wasn't able to locate a definition of industrial in the comprehensive plan, can you point me to a

definition of industrial?
A I don't think that definition would be in the plan, but I think we're messing with the intention of the plan because I can point to four or five places where the plan says it promotes small-scale things. And I could go to those, and that's in my testimony, but did the comprehensive plan make a definition of industrial, I don't think so, but --
Q Would you like to take the time to check?
A Well --
Q Or are you sure that there's no definition?
A What if I can point to the three or four places that says small-scale?
Q You get to answer my questions, unfortunately.
A Okay.
Q Do you want to take the time to look and see if there's a definition of industrial, or do you just agree that there is no definition of industrial in the plan?
A Let's take some time and see what it does say.
Q All right.
A Yes.
Q That's fine. Let's take the time to look for a definition of industrial.
A The plan shows on page 39 that it intended zero

growth --
Q Hold on. Let me get there. 39 you say?
A Yep. The plan has zero industrial and zero commercial use. That's one thing you would use to interpret the meaning of the plan.
Q Where on page 39?
A There's a table. Do you see that?
Q Uh-huh.
A Okay. If you look at commercial and industrial, between 2007 and 2030, there is zero growth in either commercial or industrial categories for the Town.
Q Okay. That's your forecasted growth. I'm looking for the definition of industrial.
A That's pretty good right there.
Q That's not a definition. Find me a definition of industrial.
MS. BENSKY: I'm going to object to this.
MR. REYNOLDS: Can we consult Black's Law Dictionary?
MS. BENSKY: We can move on.
MR. REYNOLDS: These are standard definitions of agricultural, residential, commercial, and industrial. They have standard definitions in the land use.
MR. WILSON: There are no definitions in

this document that I have been able to find.

THE WITNESS: I found it.

BY MR. WILSON:

Q Where we at? What page?

A Page 36.

Q Okay.

A Large-scale commercial and industrial uses.

Q Where?

A Okay. To the right side of the picture. Large-scale commercial and industrial uses are seen as potential conflicts with the existing uses in the Town.

Q Okay. Where's the definition of industrial?

A I think people would agree in reasonable terms that that's --

MR. McKEEVER: Judge, I'm going to object. He's asked the question several times. It's a question of interpretation. If a court had to interpret it, they would have looked to the rest of the document for context and meaning. They use typical rules of statutory interpretation. I think he's beating a dead horse and a dog that doesn't hunt.

EXAMINER NEWMARK: All right. Well, look at page 27, which by the way is the last page I have on exhibit -- is it multiple pages? You're right.

27 in the green box, it says in some dashes down --

THE WITNESS: You know what, Judge, you might be referencing, like, Mundinger's testimony where I happen to be looking at the actual plan.

EXAMINER NEWMARK: Hang on. Hang on. There's a green box on page 27, it says industrial building, State Highway 64 and County Highway D.

THE WITNESS: Okay.

EXAMINER NEWMARK: Does that help you in determining what is meant by an industrial building in this document -- industrial use, I guess, in this document?

THE WITNESS: You're looking at the green box?

EXAMINER NEWMARK: Uh-huh.

THE WITNESS: The green box says structures on the Wisconsin Architecture and History Inventory.

EXAMINER NEWMARK: Uh-huh. It's pointing out a particular building like that exists.

THE WITNESS: Industrial building.

EXAMINER NEWMARK: Okay.

THE WITNESS: Okay. So it's design the industrial building on South 64 and County Road D.

EXAMINER NEWMARK: Okay.

THE WITNESS: Which would be -- yeah, it's the stuff down in the hamlet. Thank you.

EXAMINER NEWMARK: Well, that doesn't get us as far as we want to get I don't think, but let's see.

THE WITNESS: It's pretty good, though. Well, you found a use of industrial in the plan.

BY MR. WILSON:

Q Is there a section in this comprehensive plan that has definitions in the traditional sense?

A I don't believe so.

Q Okay. So it's fair to say that you believe that this is an industrial activity, but the plan doesn't necessarily define large-scale utilities as industrial, does it?

A I believe it's -- if I can back up. I believe it's either commercial or industrial, okay?

Q That's your belief?

A Yeah. But you pin me into the corner of industrial -- commercial or industrial, yes. That's a fair response to your question.

Q Okay.

A And I -- yes.

Q But there's no definition in the document?

A Right.

MR. REYNOLDS: We've covered that ground.

MR. WILSON: I've never gotten an answer.

MR. REYNOLDS: Look, these are land use categories. You don't need to define residential.

EXAMINER NEWMARK: But he answered, right? Didn't he just answer?

MR. WILSON: He just answered.

EXAMINER NEWMARK: All right. Let's move on.

BY MR. WILSON:

Q I'm looking at your surrebuttal testimony, Mr. Junker, at page 5. I'm looking at lines 15 through 18 where you testified that although the comprehensive plan references renewable energy, this can be attributed to the small-scale types of projects such as solar panels on the roof of a local chicken coop recently erected in Forest. Can you point me to a place in the plan that substantiates that?

A I believe I can. The comprehensive plan in Section 7.2.

Q Can you give me a page number? Okay. Hold on a minute, Mr. Junker.

MR. WILSON: Your Honor, the next section of it is under 168663.

EXAMINER NEWMARK: There's three parts, right?

MR. WILSON: Yeah.

EXAMINER NEWMARK: Okay.

BY MR. WILSON:

Q Go ahead, Mr. Junker.

A I'm referencing a reference in my testimony right above where you are at, and it says, overall other than agricultural, forestry, recreation, and cottage industry consistent with the community's rural nature, no new large-scale business or industry is desired in the Town of Forest unless it is located in the designed -- I'm sorry -- located in the designated area in the hamlet of Forest along State Highway 64.

Q Okay. Let me ask the question a different way. Can you show me a place in the comprehensive plan where it's referring to renewable energy that makes a distinction between small and large? Specifically where renewable energy is mentioned, a distinction between the large and small?

A So if I go into the plan, and one of the 12 uses of renewable energy and I have to link that to small scale, I don't think I can do that. But we can link small business, and this is a business. So if the

comprehensive plan says a small business, I think it's more than reasonable to connect those two.
Q Okay.
A The plan says small business.
Q Okay. So I think what I heard you say at the beginning of that was that you cannot point me to anyplace in the plan that mentions renewable energy where there is a distinction made between large and small renewable projects?
A If A equals B, and B equals C, A equals C. So if this says small business and what we're talking about here is a business, then by definition small -- large scale or small scale, it doesn't matter.
Q Mr. Junker, you didn't respond to my question.
A I really did.
Q No. My question is, in any of the 12 places where renewable energy is mentioned in the comprehensive plan, does the plan distinguish between large and small scale for the renewable energy?
MR. REYNOLDS: Asked and answered. Objection.
MR. WILSON: He did not answer.
EXAMINER NEWMARK: Overruled.
THE WITNESS: I would have to read the whole plan document and find each one -- each time

that it uses renewable energy and -- to see if small scale is linked.

EXAMINER NEWMARK: Okay. Well, the document speaks for itself. If you want to go with a hypothetical that it doesn't say that and continue, we can, but --

BY MR. WILSON:

Q So, Mr. Junker, in your testimony you testified to the fact that 77 percent of the Town in the survey now that was done for the comprehensive plan, 77 percent of those people agreed, visual impacts are important; is that correct?

A What page are you on, please?

Q I think it's in the direct on page 7, I believe. Yeah, page 7, line 13.

A Yes. What you said is referenced, 77 percent believe the visual impact of development is an important consideration when evaluating proposed development.

Q Okay. You would agree with me also that the survey -- in the survey, 75 percent of the people responding to the survey agreed or strongly agreed that wind should be in any economic development strategy; is that correct?

A I believe seeing that reference, I have no reason to doubt it. I probably didn't tie it into the last two

weeks.
Q Okay.
A You could probably tell me where it is in the plan. I have no reason to doubt that.
Q So is it fair to say that given that those numbers are both so high, right? That at least some of the people who said that visual impacts are important also agreed that wind should be used in economic development?
A That's true. But it all comes down to scope and scale, which the plan says over and over. It's about scope and scale, and nobody was thinking of 500-foot wind turbines. Nobody.
MR. WILSON: I think that's all we have. Thank you very much.
THE WITNESS: You're welcome.
EXAMINER NEWMARK: All right. Any questions?
MR. McKEEVER: I have a couple questions. Thank you, Judge.
CROSS-EXAMINATION
BY MR. McKEEVER:
Q Mr. Junker, give us a layperson's -- give us your definition of industrial.
A It has to do with factories, large equipment, things

that need to be put on very large trucks, things that make a lot of noise, things of a commercial nature.
Q Prior to -- you've been here for two days. You've heard all the testimony; is that correct?
A Yes.
Q Okay. Prior to today or yesterday, had you ever heard the expression utility-scale wind turbine project?
A No. No, I've just become aware the last two days how it's being contrapted to kind of pin this thing down.
Q And what was the expression -- or was there an expression that you used or you had heard to describe what is proposed for Highland?
A It's commercial. It's industrial. It's very large that requires large trucks to move around.
Q Was the expression, an industrial wind project or a wind farm a term that you had heard previously, IWT?
MR. WILSON: Objection. Leading the witness.
THE WITNESS: Yeah, that's how -- that's how these projects are being referenced. The health aspects are IWTs.
EXAMINER NEWMARK: It's in his testimony, IWT. That's in someone's testimony.
MR. WILSON: That's right.

BY MR. McKEEVER:
Q Now, as a resident of the Town of Forest, did you participate in the planning process for the comprehensive plan?
A No. No, I was off the planning commission at that time. You know, I did my six and a half years, and I was raising my family.
Q Well, did the -- do you know, maybe you don't know, did the plan commission have a public participation process?
A Not about the wind that I'm aware of.
Q No, no. About the comprehensive plan.
A Oh, yes. Yes.
Q Often townships when they're developing a comprehensive plan, or cities and villages in Wisconsin for that matter, collect information from residents via a survey. Do you recall if there was a survey like that that was circulated?
A Yes. Mr. Wilson's referencing it with the 77 and 75.
Q Okay.
A So they did a survey. That's at the tail end of the plan.
Q Okay. Did you participate in that survey, do you recall?
A You know, when I was on the plan commission, we did

one six years earlier. I can't recall if I participated in that particular one or not.
Q Okay. Now, you have a plan commission now.
A The -- I'm a town board member, town chairman now.
Q I understand that, but there is plan commission?
A Oh. We have one, yes.
Q And if a proposal comes before that plan commission for a building or some other structure, do your ordinances provide that the plan commission will review it for its visual appearance, the facade, the design, those kinds of issues?
A Yes. And we've got an ordinance that says the plan commission would review anything relating to wind as well and make a recommendation.
Q Okay. As the -- as the town chairman and a former plan commissioner, do you have an opinion regarding the extent to which a locally developed comprehensive plan ought to be respected and followed?
A Yes. It's sacrosanct. It needs to be followed to absolutely the letter. That was Wisconsin's complete intention when it came out with smart growth in 2009, that the comprehensive plans would be adopted for this exact purpose, to protect the town that did a plan from this type of industrial wind and commercial wind plan.

Q Has the Town of Forest comprehensive plan changed since it was adopted? I believe you said no earlier; is that correct?
A That's correct.
Q Just one last question. I believe you said in response to a question that Mr. Wilson asked that it was your belief that commercial and industrial were similar?
A The plan specifies both and predicted that between 2007 and 2030 both -- both commercial and industrial in our comprehensive plan would grow by zero.
Q Okay. Do you have an opinion as the town chair and former plan commissioner, even though you weren't involved in the development of this particular plan, do you have an opinion what the residents -- what the intent of the residents of your community was on these issues, industrial commercial development in the scale and scope of a wind farm at the time they adopted the comprehensive plan?
MR. WILSON: Objection. Calls for speculation.
MR. McKEEVER: It calls for an opinion. He's the town chair.
EXAMINER NEWMARK: Well, then I think he's answered this already, but go ahead.

THE WITNESS: Yes.

BY MR. McKEEVER:

Q And what's that opinion? What was their intent?

A Their intent was that anything in the Town -- the visual aspect of things is so important, anything coming into the Town needs to go down into the hamlet, and it needs to be small scale. The intent was to keep things out just like this, something that would -- we have the subdivision ordinance as an example. That was a document that when I was on the plan commission we put together. Five-acre minimum. We had farmers on our group, and the whole idea was that people's land was their 401k is the quote, and that you couldn't do anything in Forest to mess up anyone's individual homeland acreage. You just couldn't do anything to hurt that. So we developed the subdivision ordinance in light of that because that would -- that is what was considered the biggest thing that could foul up any one person's land, a big development coming in. And so this subdivision ordinance was made. And, you know, just the comprehensive plan did not envision any kind of big projects. No industrial, no commercial, and nothing that would mess up or foul up the visual landscape of the Town.

EXAMINER NEWMARK: Okay.

BY MR. McKEEVER:

Q And is it your view that the proposed project would be in violation of that tenent that you just articulated?

A Yes. Absolutely.

MR. McKEEVER: I have nothing further.

MR. WILSON: And I have just one question.

EXAMINER NEWMARK: Okay.

RECROSS-EXAMINATION

BY MR. WILSON:

Q Mr. Junker, are you aware that in most places where zoning ordinances contemplate wind farms, that it's typically a conditional use in an ag district?

A No, I'm not aware of that.

MR. WILSON: Thank you.

EXAMINER NEWMARK: Redirect?

MR. REYNOLDS: No.

MR. LORENCE: Your Honor.

EXAMINER NEWMARK: Sorry.

CROSS-EXAMINATION

BY MR. LORENCE:

Q Mr. Junker, a quick question. The plan was adopted in 2009, correct?

A Yes.

Q And Section 5 has to do with utilities and community facilities, correct?
A Page, please.
Q 21 of your plan.
A Okay.
Q Why is there no mention of a wind farm in the plan?
A They didn't know about it. They did not know about the wind farm. I've given that -- I started that off. Why is there no mention of the wind farm in the comp plan? They didn't know about it.
Q There's a picture of the weather tower in the plan, but they didn't know there's a wind farm planned here?
A They didn't know any of the details.
Q I didn't ask if they knew about the details. I just asked why there's no reference to the wind farm in the plan.
A Well, I wasn't on that plan commission.
Q If you know.
A What I do know is there's minutes in January of 2010 where the plan commission is asking Carl Cress, the chairman of the plan commission, where's the beef. It's in the minutes, where's the beef.
Q I recognize that. But it just seems to me that if someone is planning a wind farm in your area, it

would be mentioned in the 30-year plan, wouldn't it?
A That's a huge cover-up. Yes. I mean, very much so. Highland didn't give any of the details to the plan commission or the Town throughout the whole process. Nobody knew, and it's spelled out in the e-mails. It's in the record. Nobody knew in the Town.
Q But Highland had been talking to the Town?
A Okay. So the practicality of it is they were talking to the town chairman who signed the 2008 wind development agreement. Now he's getting a turbine.
Q But they represent the -- the town chair represents the Town at that time just like you represent the Town today, correct?
A Right. But because of the conflict, he wasn't communicating to the town people.
Q No, I understand that. I was -- I think your answer is, you don't know why it's not mentioned in the plan?
A I do know.
Q And how do you know that?
A Because I've talked to the plan commission members, and I've read the minutes, and I see that that group was asking for details and they weren't getting them. I'm just trying to -- that's the facts. That's the knowledge that the Town has, and it's spelled out in

the e-mails and the minutes.

MR. LORENCE: No, I understand. Thank you.

THE WITNESS: Okay.

EXAMINER NEWMARK: Okay. Redirect?

MR. REYNOLDS: Nothing.

EXAMINER NEWMARK: All right. Thank you, sir. You've excused.

(Witness excused.)

MS. BENSKY: Can we go off the record a minute?

(Discussion off the record.)

JAMES LEPINSKI, COMMISSION STAFF WITNESS, DULY SWORN

EXAMINER NEWMARK: Have a seat.

DIRECT EXAMINATION

BY MR. LORENCE:

Q State your name, please.

A James Lepinski.

Q And you work for the Public Service Commission?

A Yes.

Q In preparation of this hearing, did you prepare direct testimony and two exhibits marked No. 1 and 2?

A Yes.

Q And if I asked you the questions in your direct testimony today, would your answers be the same?

A Yes.
Q And are Exhibits 1 and 2 accurate to the best of your knowledge?
A Yes.
Q And are you also preparing to submit a delayed exhibit, Exhibit 3, which will be the public comments --
A Yes.
Q -- filed in this case?
A Yes.
MR. LORENCE: I have no further questions. Mr. Lepinski's available.
EXAMINER NEWMARK: Okay. Is there any questions of Mr. Lepinski?
MR. REYNOLDS: Yes.
EXAMINER NEWMARK: Go ahead.

CROSS-EXAMINATION

BY MR. REYNOLDS:
Q Mr. Lepinski, you're an engineer?
A Yes.
Q Are you kind of the central engineer for this project?
A Yes.
Q All right. And you heard a lot of debate about decommissioning?

A Yes.
Q Are you going to -- what are you going to do with this information? Are you going to do something, or are you going to -- are you going to try to figure it out?
A I will prepare a section in all likelihood for the briefing memo that goes to the Commission that addresses the arguments of the parties on the decommissioning costs.
Q Okay. Forgetting about the arguments, how about the facts? Are you going to do an independent analysis of trying to project out in 30 years what it's going to cost the Town of Forest --
EXAMINER NEWMARK: What?
BY MR. REYNOLDS:
Q -- to take these things down?
EXAMINER NEWMARK: No. Don't answer that. Move on. What are you talking about? The record will be closed. How can he do an independent analysis without -- after the hearing? Just move on. Move on.
BY MR. REYNOLDS:
Q Do you feel like you're a prisoner of the record, or can you do -- can you independently verify as an engineer for the PSC?

MR. LORENCE: Objection, Your Honor. The attorney is just, you know, putting his own testimony into the record here.

EXAMINER NEWMARK: Do you have anything else?

MR. REYNOLDS: No.

EXAMINER NEWMARK: Okay.

MR. McKEEVER: I have a very quick question.

EXAMINER NEWMARK: Go ahead.

CROSS-EXAMINATION

BY MR. McKEEVER:

Q You're an engineer?
A Yes.
Q Do you have formal training in acoustics?
A No formal training.
Q Do you have formal training in the measurement of noise?
A No formal training. Let me answer that again. In college I had a class, which is very odd, it's called metrology.
Q Metrology?
A Yes.
Q Sounds like weather.
A No. It's the studying of measuring anything and

everything.
Q Okay.
A A very brief, probably one-session class -- not even a full session was devoted to the measurement of sound.
Q Okay. Now, at the risk of exposing our mutual age, how long ago was that class?
A 1982. Maybe '81 or '82.
Q Okay. One last question. To your knowledge, has the Public Service Commission retained the services of an outside consultant to either develop the sound measurement protocol that's been discussed here today or to help the staff evaluate the kind of evidence that we've heard and is in this record regarding sound?
A No.
MR. McKEEVER: Thank you. I have no other questions.
EXAMINER NEWMARK: Okay. Anyone else? Redirect?
MR. LORENCE: No.
EXAMINER NEWMARK: Okay. You're excused.
(Witness excused.)
MR. LORENCE: Any chance we can get Mr. Jaeger on as well?

EXAMINER NEWMARK: He's right there.
MICHAEL JOHN JAEGER, COMMISSION STAFF WITNESS, DULY SWORN
EXAMINER NEWMARK: Have a seat.
DIRECT EXAMINATION
BY MR. LORENCE:
Q Can you state your name and where you work.
A My name is Michael John Jaeger, and I work for the Public Service Commission.
Q In preparation for this hearing, did you prepare direct testimony and three exhibits?
A Yes, I did.
Q And if you were asked the questions in your direct testimony today, would your answers be the same?
A Yes, they would.
Q And are the three exhibits correct to the best of your knowledge?
A Yes, they are.
MR. LORENCE: Mr. Jaeger's available for questions.
EXAMINER NEWMARK: Any questions?
MR. McKEEVER: I have some questions for Mr. Jaeger.
CROSS-EXAMINATION
BY MR. McKEEVER:
Q First, let me make sure. Is it Jaeger, Jaeger, or

something different?
A My family pronounces it Jaeger. I respond to any of those.
Q Okay. Thank you. You're an analyst in the gas and energy division at the Public Service Commission?
A That's correct.
Q And your formal training is in zoology?
A That's correct.
Q Do you have formal training in acoustics, noise measurement, or noise prediction?
A No, sir, I do not.
Q You participated in the preparation of the environmental assessment?
A Yes, I did.
Q And a couple of your colleagues joined you in that work, Andrea Rankin and Marilyn Weiss; is that correct?
A That's correct.
Q Do you know whether either of them has formal training in acoustics or noise measurement?
A I do not believe so.
Q Did you personally visit the Town of Forest?
A Yes, I have.
Q Okay. And in the context of this project?
A Yes, I have.

Q Okay. Thank you. Now, you would agree that there are studies out there that support the fact that some people have had bad reactions or complaints about wind turbine noise primarily through sleep disturbance and nausea and the things that we've talked about?

MR. LORENCE: And I object. And ask for more clarification when he says some studies.

EXAMINER NEWMARK: Okay.

BY MR. McKEEVER:

Q Well, I'm just asking him whether or not he's aware that there are studies out there and whether he agrees that there are studies that report that?

A Well, my direct testimony says essentially that.

Q Thank you. Now -- and you've been handed a document there. Let me find my copy, which I -- just disappeared someplace. Here it is. PSC reference number 117032. This purports to be the excerpt from the EIS for the Glacier Hills Wind Project. Does that look like what that is?

A It appears to be an excerpt from the draft environmental impact statement for Glacier Hills, yes.

Q Okay. And would you agree that this is a copy of the noise section of that document?

A Yes, that's what it appears to be.

Q And you agree that the environmental -- your opinion and your colleagues in preparing the environmental assessment was that you did not need an EIS in this matter because you were relying, to a very large extent, on this EIS, that is the Glacier Hills EIS?

MR. LORENCE: Hang on. Object, Your Honor. I don't believe that's in his testimony. That's assuming facts. Further, this is not the EIS in this matter, this is the draft, and I would not have this be placed in the record. And I don't think there should be any questions given to this because the draft is the draft, and it wasn't what the Commission reviewed or accepted in that case.

EXAMINER NEWMARK: Okay. Well, let's just back up a little bit. Ask your -- this current question you'll just need to, you know, just point to his testimony. But I guess my question is, do we -- why -- is there a reason why you're using the draft? Is there something special or different than the final? Are you going to bring the final out or compare them? Or why are we dealing with the draft document?

MR. McKEEVER: Because I made a mistake, okay? Mr. Reynolds has just handed me the final, and because I frankly made a mistake and copied the wrong one.

EXAMINER NEWMARK: Okay. So you have the final?

MR. McKEEVER: I have the final here, yes.

EXAMINER NEWMARK: All right.

MR. McKEEVER: And my intention would have been to do the same thing, make it the excerpt of the noise section. What I'm trying to get to here, Judge, and I can do it in a variety of ways, is the same question that Mr. Wilson had the other day. I've been assuming that we could refer in briefing to other documents that were ERFed previously in other dockets. I'm trying to get to the point where this EIS upon which great reliance was given in this matter is part of the docket in this case and can be used in briefing.

EXAMINER NEWMARK: Okay. And that's in Jaeger's testimony?

MR. McKEEVER: That's in his testimony, and it's to a great extent his exhibit, the environmental assessment, which is incorporated in his testimony.

EXAMINER NEWMARK: And do you dispute that, they're relying on the -- I'll ask you. Do you dispute that you're relying on the FEIS for Glacier Hills in this case?

MR. LORENCE: I'd like to respond first.

EXAMINER NEWMARK: Yeah.

MR. LORENCE: And what he's shown us here is just the excerpt with respect to noise. There's nothing in his testimony or in the EA that says we relied on the Glacier Hills with respect to noise. The Glacier Hills exhibit or the Glacier Hills EIS, if they wish to have that in this record, would need to be introduced in its totality because otherwise he's taking it out of context.

EXAMINER NEWMARK: Uh-huh. Okay. Okay. But -- but the -- okay. So we don't know whether -- all right. Well, does anyone object to just putting the whole final EIS in?

MR. SCRENOCK: I have a question, Your Honor.

EXAMINER NEWMARK: Okay.

MR. SCRENOCK: I guess it would go to respond or ask a further question about what Mr. McKeever means when he says cite to it. I don't know if what he's referring to is citing to it for purposes of making arguments in briefing on the merits on the CPCN, or making arguments that would be challenging the Commission's decision to conduct only an environmental assessment and not proceed to prepare an EIS in this particular case. I think -- I think the answer would be different depending on which use he's talking about.

MR. McKEEVER: I'm talking about the first use. The question of whether or not they should have prepared an EIS has been resolved. They didn't. So I'm talking about using it in support of an argument having to do with the CPCN in this matter. In fact, the EA almost quotes exactly word for word. If one was to compare the text, I suspect that there was some cutting and pasting going on because comparison language that's in the EA for this docket is essentially identical to the language, some of the language from the EIS for Glacier Hills.

MR. SCRENOCK: We would object, Your Honor. I'm sorry.

MR. LORENCE: Go ahead. I was going to say, that begs the question why you need that in the final then.

MR. SCRENOCK: Well, it does. And to the extent that there's questions about the statements that are in the EA, we can question the staff if we want to as to those that were responsible for those statements. We have no way of knowing which staff members may have been involved in preparing the EIS for Glacier Hills or whether they're even still on the staff, whether they're even available for questioning. And I guess that I don't know that it's relevant to the issues that are in this docket.

MR. McKEEVER: I've never seen another situation in which an environmental assessment in one project relies as heavily as this one does on an EIS done three years previously. And I think the fact that it states that in the EA, it states that in Mr. Jaeger's testimony, is worthy of bringing this document into this record for reference purposes.

If they want to bring the whole thing in, that's fine with me. I won't object to that. But I think we only need the chapter on noise, the section on noise, for my purposes. If somebody else wants to use it for some other purpose, but I think this is essentially an exceptional circumstance that there was great reliance on this EIS. We won't learn anything more from it. This docket ought to be -- that's what the language of the EA says, essentially, not going to inform them. We ought to have the opportunity to refer back to that document and see with whether in fact it does inform this discussion, because I think it does.

MR. LORENCE: That sounds like an argument that could have been put in rebuttal testimony, Your Honor.

MR. REYNOLDS: This is an issue for appeal, by the way, because the -- there is no Environmental Impact Statement, and that is a potential appealable issue. And I think for purposes of preserving that issue, it should be part of the record. It's not a big deal.

MR. McKEEVER: In response to Mr. Lorence's comment, it could have been part of rebuttal, but I was operating, frankly, on the same assumption that Mr. Wilson was, that it was in the record. With all due respect, I found the scheduling order on that point a little vague and a little difficult to understand, and I interpreted it the same way that Mr. Wilson did, that if it was previously ERFed in another docket, it was fair game for purposes for reference in this case.

MR. WILSON: I wonder why we didn't hear that earlier.

MR. McKEEVER: I didn't argue with you

when you said it.

MS. BENSKY: There's no prejudice here.

EXAMINER NEWMARK: Anything else?

MR. SCRENOCK: Your Honor, we just don't see it.

MR. McKEEVER: There's no prejudice at all.

MR. SCRENOCK: We don't see it as relevant to the issues to this docket.

MS. BENSKY: Except that EA says that it is.

EXAMINER NEWMARK: Hang on. You said it for me. It's in his testimony. To the extent that it's mentioned earlier in his testimony, we can let it in. We'll just put the whole thing in, the final -- the final version of this document. You'll have to ERF that.

MR. SCRENOCK: Where is it in his testimony?

EXAMINER NEWMARK: I'm relying on their representation that it is.

MS. BENSKY: It's in the EA, which is an exhibit to his testimony.

MR. McKEEVER: It's in the exhibit, several references to it.

Just a procedural question, will the -- will the staff here ERF it, or do we need to do it?

EXAMINER NEWMARK: You need to do it.

MR. McKEEVER: Okay.

EXAMINER NEWMARK: And that will be Jaeger 4.

MR. McKEEVER: Yes.

(Jaeger Exhibit No. 4 marked and received.)

MR. McKEEVER: A couple more questions if we've resolved that issue.

EXAMINER NEWMARK: Okay.

BY MR. McKEEVER:

Q Mr. Jaeger, you refer in the EA, and I believe in your testimony, but at least in the EA, to recent literature reviews from Minnesota and Massachusetts; is that correct?

A Yes, I do.

Q Did you read those?

A Yes, I have.

Q Okay. And you would agree that what those studies say is that there's no evidence that industrial wind turbines cause health problems and -- but that they don't say the opposite of that. They simply say there's no evidence in the scientific way in the literature to say that, but they don't exclude industrial wind turbines as a potential cause of the problems that are out there?

A I don't think that's an accurate characterization. I believe that the studies say, and the way I've tried to discuss it in the EA and in my testimony, is that those two particular reviews conclude that there is limited evidence. But there is evidence that there is, and I believe the Massachusetts study combined annoyance and sleep disturbance. So they did recognize that there was evidence for annoyance and sleep disturbance. They also concluded that there was no evidence to support any other direct health effects other than the annoyance and sleep disturbance. And then they went on to conclude a few other things, and part of it was that there was no basis that they were able to find to support the -- the -- a pure point wind turbine syndrome, and there was some discussion also about low frequency noise.

Q Yes. Thank you. So essentially they say the same thing that we heard Dr. Roberts say earlier, that we can agree that there's a problem, and we can disagree about whether there's evidence that wind turbines are the cause?

MR. LORENCE: I object. He's asking for an opinion that's beyond Mr. Jaeger's testimony.

EXAMINER NEWMARK: Okay. Sustained.
BY MR. McKEEVER:
Q You heard Dr. Roberts testify, did you not?
A I did.
MR. McKEEVER: That's all I'm asking is whether or not he agrees with what Dr. Roberts testified to.
MR. LORENCE: He's asking for him to testify to medical opinions, and Mr. Jaeger isn't a witness to that.
EXAMINER NEWMARK: I agree. Sustained.
BY MR. McKEEVER:
Q The -- as far as you know, the actual turbine model to be used in this project has not yet been selected?
A That's my understanding.
Q So we really don't know how much noise will be produced by this project, do we?
A At this point, there are three possible turbine models that had been proposed. There has been some information and modeling done on those. I do not know whether any of those three would be the actual model they would choose and install if they get approval. So the question is, no, we don't know exactly what the turbine model is and what --
Q What the consequences of that choice will be? We

don't know what the consequences in terms of noise will be?
A We don't know exactly because we don't know the turbine model, that's correct.
MR. McKEEVER: Thank you. I have no other questions.
EXAMINER NEWMARK: All right. Other cross?
MR. REYNOLDS: Yes.
CROSS-EXAMINATION
BY MR. REYNOLDS:
Q Mr. Jaeger, you've been at this hearing for both days, haven't you?
A Yes, I have.
Q And you heard the testimony of the citizens at Shirley and Horicon?
A Yes, I did.
Q All right. And you heard Mr. Hessler's assessment that the -- that the folks in the Town of Forest may be in danger if the same turbines are put in the Town of Forest?
A I heard Mr. Hessler's testimony, yes.
Q All right. And is that evidence significant to you in terms of determining whether there's a basis to do an Environmental Impact Statement?

A I don't think what Mr. Hessler said in his testimony changes my -- what we have said in either the environmental assessment or in my testimony.
Q Did you agree with Mr. Hessler that the -- that the statements of the Shirley residents was irrefutable, that they're having health impacts as a result of the wind turbines?
A I don't have an opinion on his statement about that.
Q All right. If you accepted Mr. Hessler's opinion that it was irrefutable, would this potentially be a significant impact in Forest?
MR. SCRENOCK: Your Honor, I'm going to object. I don't recall that Mr. Hessler referred to it as irrefutable. And I object to the form of the question.
EXAMINER NEWMARK: Yeah. Well, I can't verify that right now, so you'll have to rephrase it.
BY MR. REYNOLDS:
Q All right. Assuming that Mr. Hessler -- you know that Mr. Hessler wanted to do some testing at Shirley?
A Yes, I do.
Q All right. And you heard him testify that he saw the symptoms complained of by the Shirley residents as

consistent with low frequency noise: nausea, vertigo, headaches, et cetera?

MR. SCRENOCK: Your Honor, object. I don't believe Mr. Hessler connected those.

MR. REYNOLDS: Well, I'm asking him a question. I'm not asking you.

MR. SCRENOCK: And I'm objecting to the question.

MS. NEKOLA: So am I.

EXAMINER NEWMARK: Can we just ask him if Hessler said it was irrefutable, what would he do in terms of the EIS?

MR. REYNOLDS: Yeah.

EXAMINER NEWMARK: Just leave it at that.

BY MR. REYNOLDS:

Q Did you hear Mr. Hessler talk about any concern about replicating what's happening in Shirley in the Town of Forest, Mr. Jaeger?

A I actually do not remember if he said something specifically about that.

Q If -- if his testimony was offering an opinion that if the same turbine that's used in Shirley is used in Forest, that they will have similar experiences, would that be significant to you in terms of determining whether an environmental impact statement is going to --

MR. LORENCE: Object, Your Honor. This has been asked and answered. He said he's listened to Mr. Hessler's testimony and it made no difference with respect to his opinion with the EA or EIS questions.

MR. REYNOLDS: Well, he may not have been listening when Mr. Hessler was testifying.

MR. LORENCE: That was a very specific answer that he gave, Your Honor.

MR. REYNOLDS: He hasn't had a chance to answer the question.

MR. LORENCE: He did five minutes ago.

EXAMINER NEWMARK: Let him answer it.

THE WITNESS: Could you read me the question, please.

(RECORD READ.)

THE WITNESS: I think what I have said in both my testimony and in the environmental assessment is that our -- my interpretation is that there's -- there could be people who are going to be bothered by wind turbines in the Town of Forest. There's -- but I don't have any way of saying how many or who those people are, but I -- what I tried to do in the testimony is recognize that there's a chance of that. What I heard Mr. Hessler say I thought was consistent with what I've said in my testimony. I don't see that there's anything different in what he said except maybe in the extent or maybe in the -- how emphatic he was about certain aspects of it, but --

BY MR. REYNOLDS:

Q Well, your environmental assessment relied on Glacier Hills primarily, did it not?

A We used a lot of the analysis we did in Glacier Hills because it was still relevant, yes.

Q It didn't rely on the experiences of the Town of Shirley, did it?

A No. The Town of Shirley Project was not in place at that point.

Q Was that information important to you as the EA coordinator, the Shirley resident testimony and Mr. Hessler's evaluation of it?

A The Shirley testimony in my opinion is similar to some of the reactions we were seeing or the reactions we were seeing to some individuals in the Forward Project, some individuals in the Glacier Hills Project, some individuals -- I mean, essentially in any wind project in the state, there have been a few people who have had significant complaints. I didn't see necessarily that the Shirley complaints were fundamentally different. But then again, I'm not -- I don't have a medical background to be able to draw that finding or distinction.

Q Well, you distinguish between annoyance and the level of complaint that causes individuals to leave their homes?

A I don't know if I've distinguished that yet. I recognize that some people through annoyance, through sleep disturbance in particular -- sleep disturbance I think can significantly affect a person's well-being, and I could see how that could lead to someone leaving their home. I don't know if there are other reasons why people leave their homes. I can't specifically say for any of those individuals what the situation was.

Q Well, is it -- is it fair to say -- well, let me ask you this. The Town of Forest's response to your conclusion that some -- that folks may suffer or will suffer in the Town of Forest was to request the Public Service Commission to do an evaluation, do you recall that?

MR. LORENCE: Object, Your Honor. He's mischaracterizing what the Town of Forest replied in their comments.

EXAMINER NEWMARK: Okay. Well, if you can -- you want to point to something, you can.

BY MR. REYNOLDS:

Q Do you recall receiving the Town of Forest comments on the EA?

A Yes, I do.

Q All right. And did it remind -- was it consistent with the basic statement that if the -- if this CPCN is granted, it has to be in the public interest?

A It may have said that. I do not --

Q All right. And is it in the public interest to try to assess who in the Town of Forest may be leaving their homes if this project is built?

MR. LORENCE: I object, Your Honor. Again, he's asking for a legal conclusion that's outside the scope of his testimony.

EXAMINER NEWMARK: Okay. Sustained.

MR. REYNOLDS: I'm not asking for a legal conclusion. I'm asking for what would trigger an Environmental Impact Statement. Does that clare -- do I have to ask the question again? I'm trying to understand at what point evidence would be sufficient -- significant enough where we dig a little deeper and find out with respect to the turbines in Shirley and their application to the

Town of Forest, when we're going to try to make a better prediction about what's going to happen if this project goes through.

MR. LORENCE: Your Honor, I'll object again. He's asking for speculation. The Commission has put in the environmental assessment and the testimony. Asking when we might do something in the future or what would change our situation is pure speculation.

EXAMINER NEWMARK: You're asking him why he didn't do an EIS, is that your question?

MR. LORENCE: I believe he asked when we would do an EIS.

EXAMINER NEWMARK: Right, right.

MR. LORENCE: What would change to make us change an EIS, and nothing's going to need to change at this point, and that's why it's speculation.

MR. REYNOLDS: Only this witness knows if it's speculation.

MR. LORENCE: That doesn't change my objection.

EXAMINER NEWMARK: Well, let's see what he says. You can answer.

THE WITNESS: I guess I do not want to speculate about that.

BY MR. REYNOLDS:
Q All right. Did you -- you're aware that the -- last week one day after Jaime Junker's testimony was filed, the Town submitted a series of questionnaires showing health problems at at least 16 residences in the Town of Forest.
MR. LORENCE: Object, Your Honor. Objection. I don't believe that's in evidence.
EXAMINER NEWMARK: That's correct.
MR. REYNOLDS: Well, I'm going to make an offer of proof if I can, and I'd like to ask him questions about it. I think it's legitimate. If he's seen it.
EXAMINER NEWMARK: So you want to object to the ruling keeping those documents out, and you're making an offer of proof for that purpose?
MR. REYNOLDS: Absolutely, yes. And I meant to bring that up with you. I definitely want it in the record. You can say it's out, but -- and I'll ask you perhaps to revisit that after tomorrow, but I certainly want to ask this witness if he's aware of what was filed.
EXAMINER NEWMARK: Okay. So let's --
MR. LORENCE: Your Honor, if he was going to make an offer of proof, wouldn't he have had to

do that through his witness that he was trying to offer the exhibit. He can't do that through Mr. Jaeger.

EXAMINER NEWMARK: Okay.

MR. REYNOLDS: I just want to know if Mr. Jaeger's aware of the evidence that the Town of Forest submitted in the ERF.

EXAMINER NEWMARK: For what purpose?

MR. REYNOLDS: Well, because if we're going to take the Town of Shirley incident seriously, and we're going to believe what Mr. Hessler's concern is, and we know that if this project goes in without knowing who the vulnerable people are, that people will be leaving their homes unless the Public Service Commission changes something. This is a major action affecting the human environment from the Town of Forest perspective, and if the Public Service Commission is refusing to acknowledge the information, refusing to do an EIS, that's certainly an appealable issue. If the Public Service Commission ignores it all and just, you know, approves the permit. So we're entitled to make a record on this.

EXAMINER NEWMARK: Well, if you want to make an offer of proof, we'll be back here next week so we can recall your witness for that purpose.

MR. REYNOLDS: Well, the offer of proof would pretty much be the -- it's really a simple offer of proof. I can make it now. It's the --

EXAMINER NEWMARK: Well, no. I think what we'll do is we'll -- it's better to have your witness who conducted the study make the offer. So we can do that next week, but it's not appropriate to do that right now.

MR. REYNOLDS: All right. Well, let me just ask this witness if he knows anything about it, and then I can be done.

EXAMINER NEWMARK: Well --

MR. LORENCE: Back to my first objection, Your Honor, is saying that he's asking a question about things not in evidence.

EXAMINER NEWMARK: Yeah. Okay. I'm sustaining the objection, so let's move on.

MR. REYNOLDS: Well, this is -- I know it's late. I understand your ruling. This is extremely important information. Are we going to basically say that we're going to --

EXAMINER NEWMARK: No, sir. I said next week -- first of all, I said tomorrow those people can come to the hearing, and they can put their evidence in. It's their right to do so.

MR. REYNOLDS: Okay.

THE COURT: And I said next week you can make your offer of proof through your own witness. So what else do you need to know?

MR. REYNOLDS: Well, I want to get the offer of proof before this technical expert on the EIS issue. That's it. So we'll have all 16 folks come tomorrow and we'll verify --

EXAMINER NEWMARK: You can recall this witness if this -- if this -- during your offer of proof.

MR. REYNOLDS: Save a lot of time if I could just ask him if he's aware of it. Maybe he's not and then I don't have to recall him.

EXAMINER NEWMARK: It's not on the record right now.

MR. REYNOLDS: That's all I have.

EXAMINER NEWMARK: All right. Redirect?

MR. SCRENOCK: I have one question, Your Honor.

EXAMINER NEWMARK: Sorry.

CROSS-EXAMINATION

BY MR. SCRENOCK:

Q Mr. Jaeger, in your testimony on your direct, pages 4

and 5, you reference the noise modeling that was submitted with the application and the reference to the potentially 45 homes that may experience sound above 45 decibels. I think we all understand that it was based on the models submitted with the application which was based on the 0.0 ground absorption coefficient. Is that your understanding?
A That's my understanding, yes.
Q My question is this, Mr. Jaeger. If the application would have included the modeling results from both the 0.0 ground absorption coefficient and the 0.5 ground absorption coefficient model that was submitted later with Ms. Blank's rebuttal testimony, would your testimony on the environmental assessment reflect both models?
A I would have reflected both, yes.
Q And in that reflection would you have made some qualitative statement as to which was better or more appropriate?
A I would not have made a statement as to which were better or more appropriate, no.
MR. SCRENOCK: Thank you.
EXAMINER NEWMARK: Redirect?
MR. LORENCE: No, Your Honor.
EXAMINER NEWMARK: All right. You're

excused.

(Witness excused.)

MR. McKEEVER: Judge, may I ask on the record a procedural question? The prescheduling order provides on page 4 at Section 6(A)(1) that 15 collated paper copies of all exhibits shall be filed with the Commission's record management unit. I'd like to ask that that condition be waived for purposes of this EIS which you admitted into evidence this time. It seems to me to be more than redundant and an environmental unsound use of paper to make 15 more copies of this document. Can we -- would you be willing to waive that requirement?

EXAMINER NEWMARK: I can get back to you.

MR. McKEEVER: Thank you.

EXAMINER NEWMARK: Because, to be honest with you, it's not my request. So I can get back to you.

MR. McKEEVER: Oh, you mean it's a request from the -- gotcha. Thank you.

EXAMINER NEWMARK: Anything else?

MR. REYNOLDS: Yeah, I have a question about -- I didn't perhaps understand. Are we continuing this hearing until next week?

EXAMINER NEWMARK: Well, let's go off the record.

(Discussion held off the record.)

EXAMINER NEWMARK: On the record.

MR. WILSON: It's fairly clear based upon the questioning from Mr. Reynolds that there is going to be an argument that the Commission ought to require that this project be redesigned to a 40 dB standard, and if that argument is made, there's nothing in this record that would indicate to the Commission what the impact of that would be, and we think that that's important information that the Commission would have to have or should have in making a decision on that question. And Mr. Hankard is -- is able to address that issue with regard to the scheduling of it. I think it actually would be beneficial to continue the hearing until next week, because I think it would give him an opportunity to more thoroughly look at the question and make sure that the responses are well thought out as opposed to just bringing them up today.

EXAMINER NEWMARK: Okay. And there's an objection, so let me hear that.

MR. REYNOLDS: My objection would be that all the direct testimony from Mr. Schomer and surrebuttal and Mr. Hessler's testimony had an ideal dBA limit of 40. Ms. Blank testified that the project could be redesigned with a dBA limit of 40, and so there was plenty of opportunity in rebuttal, surrebuttal, which we got at the last minute, or Mr. Hankard to address this issue. It was -- it was right up front last -- yesterday in all the direct and everything that's preceded this.

I got hammered by missing a day of putting in health surveys, and now we're in a position where new information is coming up that we don't have the ability to even know what it is. That's just unfair. Now we have to get responses to Mr. Hankard's new testimony. That's number one.

Number two, I think Mr. Pobloskie wants to come in and testify about a decommissioning study.

EXAMINER NEWMARK: Well, let's work on one thing at a time.

MR. REYNOLDS: Fine.

EXAMINER NEWMARK: Do we have any other response?

MS. BENSKY: I guess my position on Hankard is I think that would be fair to allow that ultimately, but I would ask that Mr. Hankard submit that testimony in writing to us as soon as possible, and because of the nature of the material, we would need the opportunity to go over it with our own noise engineers and give them the opportunity if they choose to rebut it, and then come back for a hearing. Because just having him come in for cross-examination is not going to be meaningful.

EXAMINER NEWMARK: Okay. Clean, anything?

MS. NEKOLA: I would agree with that, actually. I would like an opportunity to look at that and involve Mr. Hessler in it.

EXAMINER NEWMARK: Okay. Do you agree, it's -- I forgot how you characterized it.

MS. BENSKY: It's a technical issue that's beyond what I can meaningfully do in cross-examination.

EXAMINER NEWMARK: But you don't -- you don't object to the concept of having that evidence on the record?

MS. BENSKY: I don't object to the concept.

EXAMINER NEWMARK: Okay. And you as well do not object?

MS. NEKOLA: I think it's likely that an argument is going to be made that the project should be redesigned, that the Commission would absolutely need to know what that meant.

EXAMINER NEWMARK: Uh-huh. Staff, any comments?

MR. LORENCE: Nope.

EXAMINER NEWMARK: Okay. All right. And what was the other -- Pobloskie as well was going to be recalled for additional evidence. So anything you want to say on that front?

MR. WILSON: I think it's one of the -- one of the critical disagreements in this hearing is, you know, that the estimates on decommissioning, and Mr. Stamberg wasn't able to sit up there and do those calculations for what it meant to his -- how much of the foundation would actually be removed. Mr. Pobloskie has already done that, that calculation. And I think to inform the record and again inform the Commission about the difference between these two estimates, that they need to understand that particular calculation and how much of the foundations would actually be removed to understand the impact on the cost.

EXAMINER NEWMARK: Okay. Response?

MR. REYNOLDS: Well, Mr. Pobloskie testified yesterday that he wasn't doing a decommissioning study. Now he's doing a decommissioning study. I'd say it's too late. The record's closed pretty much, and we're out of time for Mr. Pobloskie's study.

EXAMINER NEWMARK: Anyone else?

MR. WILSON: I would just note that it's fairly common to do these types of things at the end of the hearing where there's a hole in the record, and we know there's a hole in the record.

EXAMINER NEWMARK: Staff?

MR. LORENCE: Once again, I don't have a strong opinion on this. You know, it appears we're in a never-ending hearing here, and so that's one argument. But I can see Mr. Reynolds' side on this as well. So I don't have an opinion.

EXAMINER NEWMARK: Okay.

MR. WILSON: We're happy to also provide this in advance to the parties, allow them to look at it before they have to cross Mr. Pobloskie on it.

EXAMINER NEWMARK: Okay. So what's our timing like for the process? We might need Mr. Lepinski's advice on this.

MR. LEPINSKI: I think some of these dates were already set, but I have initial briefs due on December 17th.

EXAMINER NEWMARK: No. We can go off.

(Discussion off the record.)

EXAMINER NEWMARK: So the Applicant has offered to submit information related to development of the project using a 40-decibel variable in this, or limit I guess in this case, and suggestions were made for how that would be presented in testimony and how we would proceed from that point. I think at this point from what we know now and what the Applicants propose, you know, my initial response would be to have the Applicant file its presentation, its case on this point, and they've committed to Monday on the 15th, and I'll review what's been filed and determine the process from that point as to how much time to give response and in what form that will take and what point we'll hold a hearing on that issue.

And if we treated this like an offer for late evidence to come into the record, that does provide parties an opportunity to respond. And what I would do is give parties a chance. We could do that by Thursday. Parties can take a look and then give me their suggestion on the process that would be required for fair evaluation on the new filings.

MS. BENSKY: So by Thursday we're going to tell you what we think -- what we would like the schedule to be going forward?

EXAMINER NEWMARK: Yeah. If you can get me the schedule, that would be good. At least give me what you think you need to do to respond.

MS. BENSKY: Okay.

MR. REYNOLDS: Judge, I have one point.

EXAMINER NEWMARK: Yeah.

MR. REYNOLDS: For the record, I object for the reasons I've stated. But if now the record is going to be extended, I would ask you to reverse your ruling on the health surveys. I don't see any reason to keep that out now.

EXAMINER NEWMARK: Okay. Note your objection.

Okay. Anybody else?

(No response.)

EXAMINER NEWMARK: Okay. So at this point we have some new stuff to deal with, and we do have a hearing tomorrow. And I don't know if there's anything else outstanding at this point. Anyone think of anything?

MR. WILSON: Pobloskie.

EXAMINER NEWMARK: Well, why don't you -- can you file his calculations on Monday as well? We'll deal with it all the same way.

MR. WILSON: Okay.

EXAMINER NEWMARK: That will work.

All right. Thank you very much. We're adjourned. We'll see some of you tomorrow.

(The hearing adjourned at 7:41 p.m.)

* * *

STATE OF WISCONSIN)
MILWAUKEE COUNTY)

We, JENNIFER M. STEIDTMANN, RPR, CRR, Registered Professional Reporter, Certified Realtime Reporter, Notary Public, and LYNN PEPPEY BAYER, CM, Certificate of Merit, Notary Public, with the firm of Gramann Reporting Ltd., 710 North Plankinton Avenue, Suite 710, Milwaukee, Wisconsin, do hereby certify that we reported the foregoing proceedings had on October 10, 2012, and that the same is true and correct in accordance with our original machine shorthand notes taken at said time and place.

____
Jennifer M. Steidtmann
Registered Professional Reporter
Certified Realtime Reporter

____
Lynn Peppy Bayer
Certificate of Merit

Dated this 18th day of October, 2012.
Madison, Wisconsin.

I N D E X

*****

E X H I B I T S

7030.0050 NOISE AREA CLASSIFICATION.

Subpart 1. **Applicability.**The noise area classification is based on the land use activity at the location of the receiver and determines the noise standards applicable to that land use activity unless an exception is applied under subpart 3.

Subp. 2. **Noise area classifications.** The noise area classifications and the activities included in each classification are listed below:

Noise Area Classification	Land Use Activities
1	Household Units (includes farm houses)
	Hotels, motels, or other overnight lodging
	Mobile home parks or courts
	Other residential units
	Motion picture production
	Medical and other health services
	Correctional institutions
	Educational services
	Religious activities
	Cultural activities and nature exhibitions
	Entertainment assembly
	Camping and picnicking areas (designated)
	Resorts and group camps
	Other cultural, entertainment, and recreational activities.
2	Railroad terminals (passenger and freight)
	Rapid rail transit and street railway passenger terminals
	Bus passenger terminals (intercity and local)
	Other motor vehicle transportation
	Airport and flying field terminals (passenger and freight)
	Marine terminals (passenger and freight)
	Automobile parking
	Transportation services and arrangements
	Wholesale trade

	Retail trade, including restaurants and bars
	Finance, insurance, and real estate services
	Personal services
	Business, legal, or other professional services
	Repair services
	Contract construction services
	Governmental services (except correctional institutions)
	Miscellaneous services (except religious activities)
	Public assembly (except entertainment assembly and race tracks)
	Amusements (except fairgrounds and amusement parks)
	Recreational activities (except designated camping and picnicking areas)
	Parks
3	Manufacturing
	Transportation (except passenger terminals)
	Highway and street right-of-way
	Communication
	Utilities
	Race tracks
	Fairgrounds and amusement parks
	Agricultural and related activities
	Forestry activities and related services (including commercial forest land, timber production, and other related activities)
	Fishing activities and related services
	Mining activities and related services
	Other resource production and extraction
	All other activities not otherwise listed.
4	Undeveloped and unused land area
	Noncommercial forest development
	Water areas
	Vacant floor area
	Under construction

Subp. 3. **Exceptions.** The noise area classification for a land use may be changed in the following ways if the applicable conditions are met.

A. The daytime standards for noise area classification 1 shall be applied to noise area classification 1 during the nighttime if the land use activity does not include overnight lodging.

B. The standards for a building in a noise area classification 2 shall be applied to a building in a noise area classification 1 if the following conditions are met:

(1) the building is constructed in such a way that the exterior to interior sound level attenuation is at least 30 dB(A);

(2) the building has year-round climate control; and

(3) the building has no areas or accommodations that are intended for outdoor activities.

C. The standards for a building in a noise area classification 3 shall be applied to a building in a noise area classification 1 if the following conditions are met:

(1) the building is constructed in such a way that the exterior to interior sound level attenuation is at least 40 dB(A);

(2) the building has year-round climate control; and

(3) the building has no areas or accommodations that are intended for outdoor activities.

D. The standards for a building in a noise area classification 3 shall be applied to a building in a noise area classification 2 if the following conditions are met:

(1) the building is constructed in such a way that the exterior to interior sound level attenuation is at least 30 dB(A);

(2) the building has year-round climate control; and

(3) the building has no areas or accommodations that are intended for outdoor activities.

Statutory Authority: *MS s 115.03; 116.07*

History: *11 SR 43; 18 SR 614; 41 SR 763*

Published Electronically: *January 27, 2017*

7030.0040 NOISE STANDARDS.

Subpart 1. **Scope.** 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 part 7030.0050. However, these standards do not, by themselves, identify the limiting levels of impulsive noise needed for the preservation of public health and welfare. Noise standards in subpart 2 apply to all sources.

Subp. 2. **Noise standards.**

Noise Area Classification	Daytime		Nighttime	
	L_{50}	L_{10}	L_{50}	L_{10}
1	60	65	50	55
2	65	70	65	70
3	75	80	75	80

Statutory Authority: *MS s 116.07*

History: *11 SR 43; 18 SR 614*

Published Electronically: *December 12, 2003*

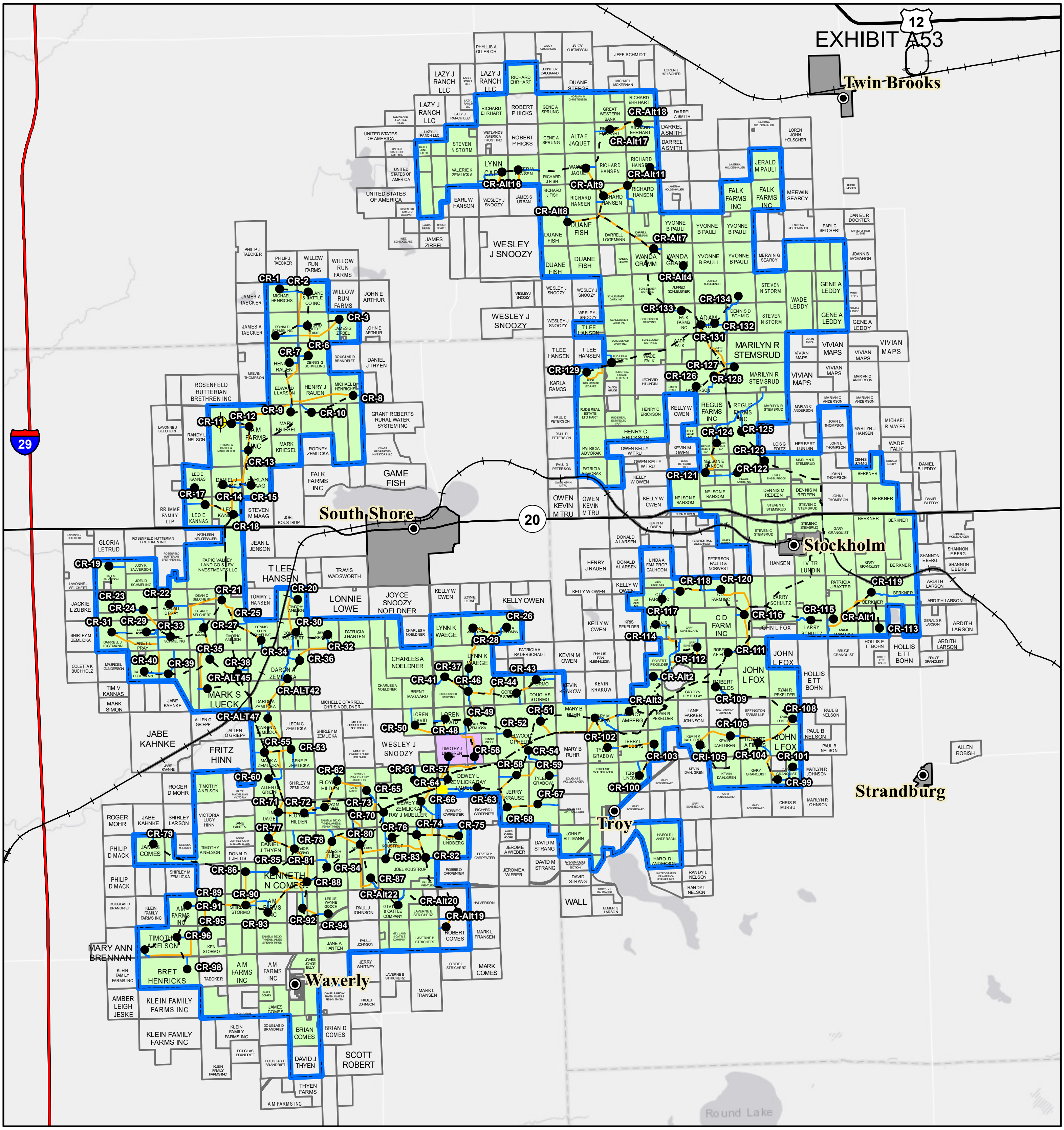


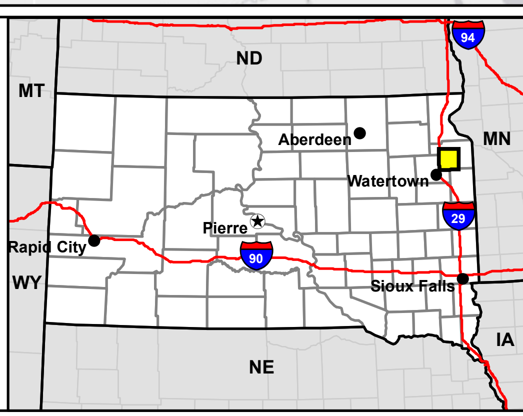
Figure 3a. Project Map

Crowned Ridge Wind Farm

- MET Tower
- Turbine
- City
- Access Road
- Collector Line
- Crane Path
- Railroad
- Interstate Highway
- U.S. Highway
- State Highway
- O&M Facility/ Substation
- Town Boundary
- Project Boundary
- Parcel Boundary

Lease Status

- Leased, Signed
- Under Option but Likely to Expire/Not Resign



Kilometers

0 2.5 5

Miles

0 2.5 5

Base Map: World Light Gray Canvas Base
Sources: Esri, HERE, Garmin, © OpenStreetMap contributors, and the GIS user community
Codington and Grant Counties, South Dakota

Projection: NAD 1983 UTM Zone 14N

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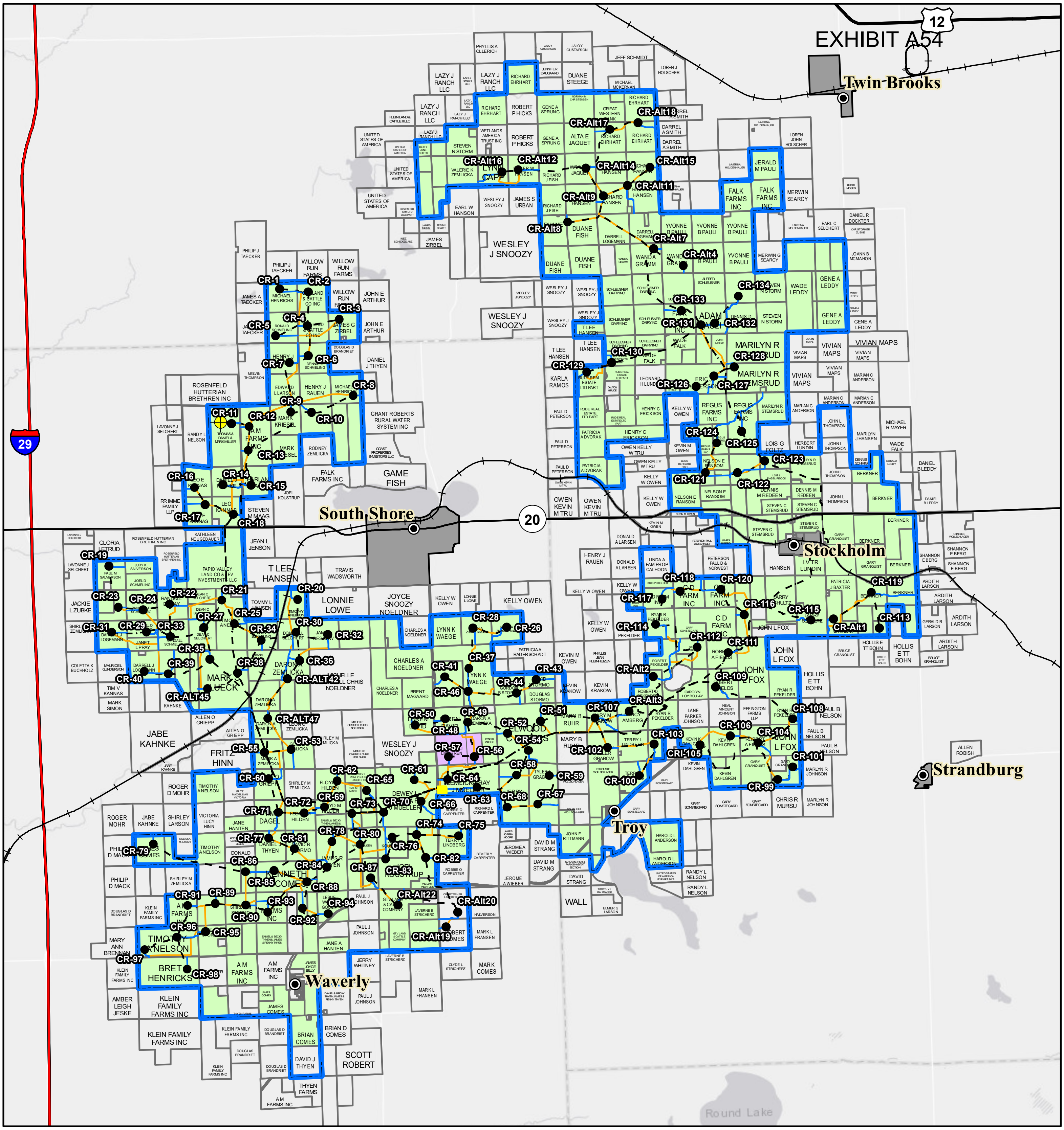

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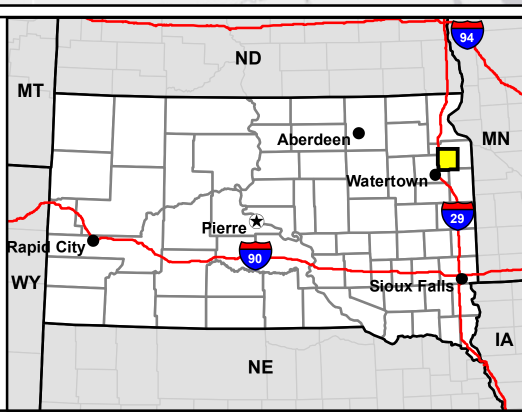

Kilometers

0 2.5 5

Miles

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SWCA ENVIRONMENTAL CONSULTANTS

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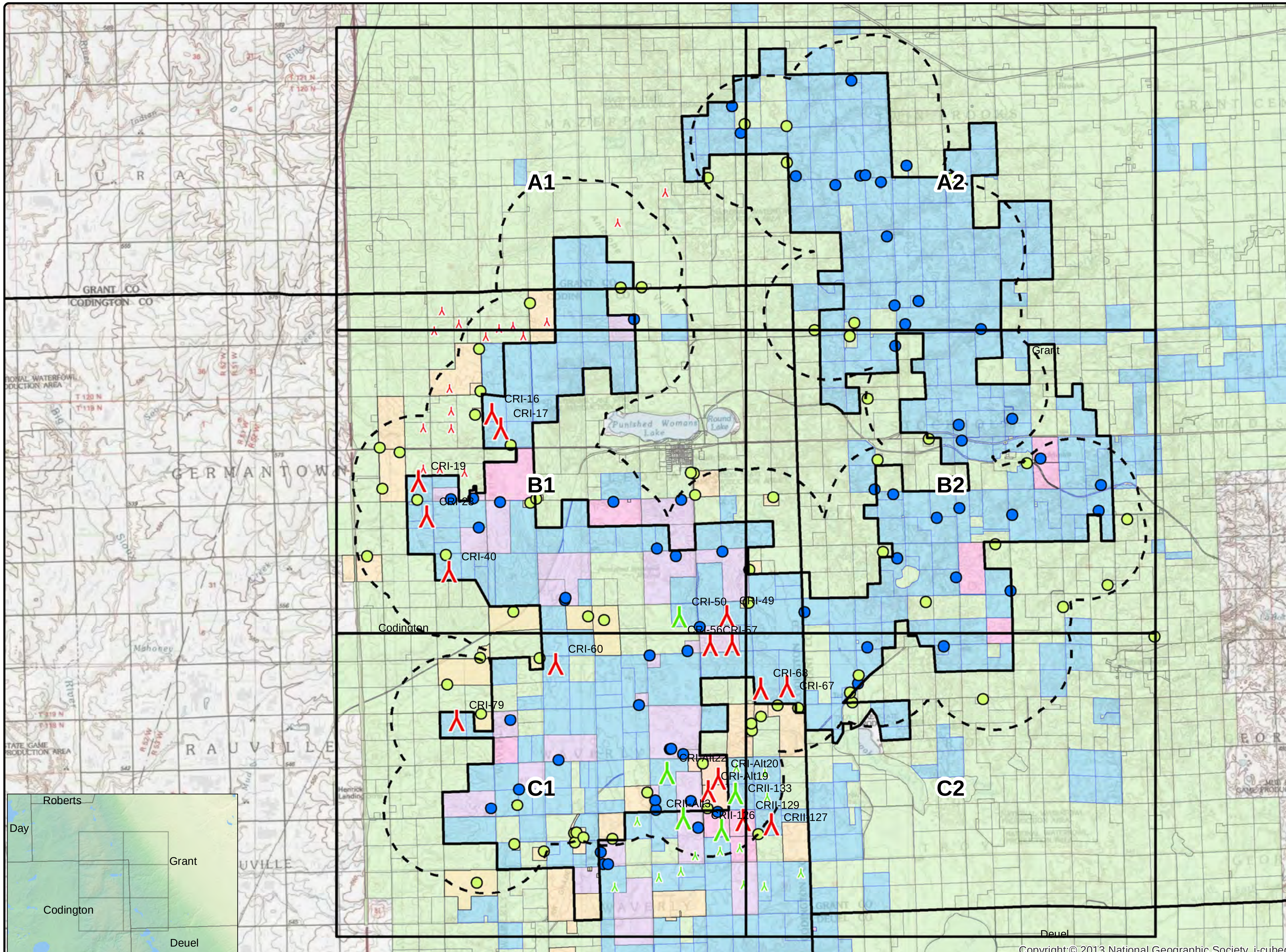


EAPC WIND ENERGY

www.eapc.net | 701.775.3000

Crowned Ridge Wind Farm Current Array with Proposed Turbine Drops and Moves

Client

SWCA Environmental Consultants

Project Description

Wind turbine layout with occupied structures within 2 km.

Proposed turbine drops and moves.

Location: Watertown, SD

Project #: 20174431

Issue Dates

#	Description	Date
1	Original	2019.06.08

Drawn By: AS *Checked By:* JH

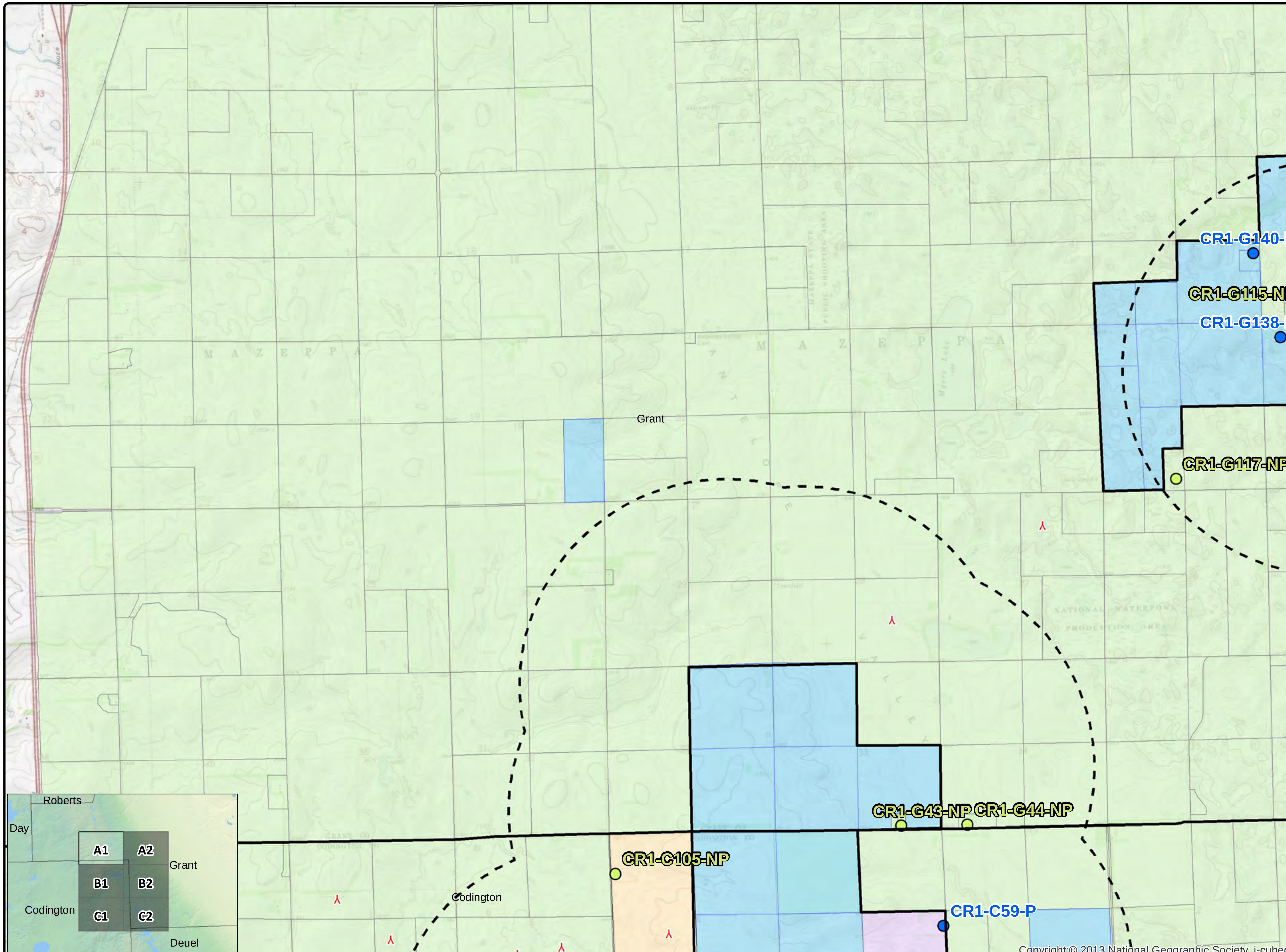
Legend

- Dropped Turbines
- Moved Turbines
- Crowned Ridge II Wind Turbines
- Dakota Range Wind Turbines
- 2 km Turbine Buffer
- County Lines
- CR1 Project Boundary
- Non Participants
- Participants
- Non-Participating Codington Parcels
- Participating Codington Parcels
- Participating Parcels
- Pending Parcels
- Non-Participating Parcels

N W E S

0 0.75 1.5 3 Mile

EXHIBIT A55



0 0.25 0.5 1 Mile

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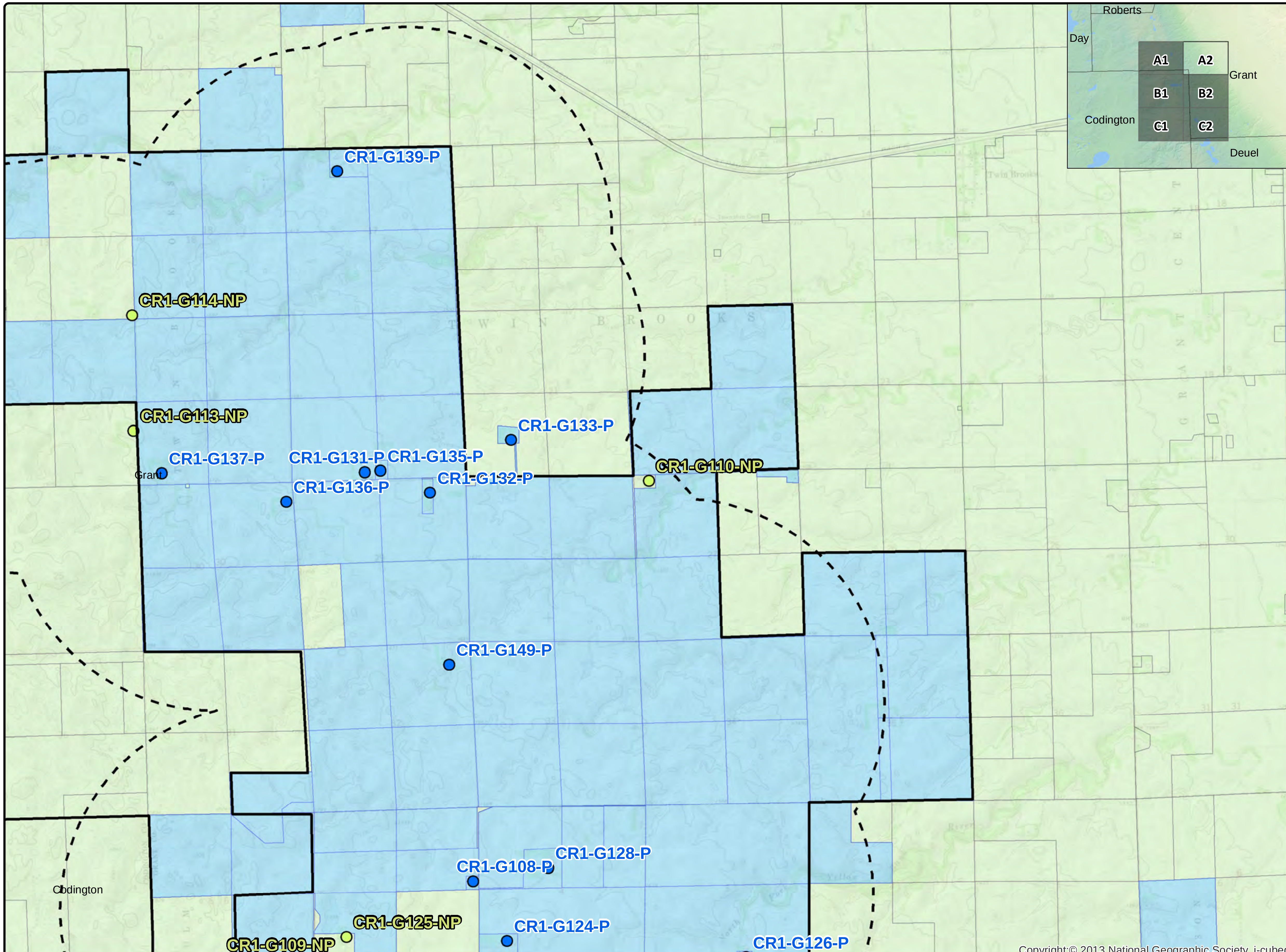
N W E S

EXHIBIT A55



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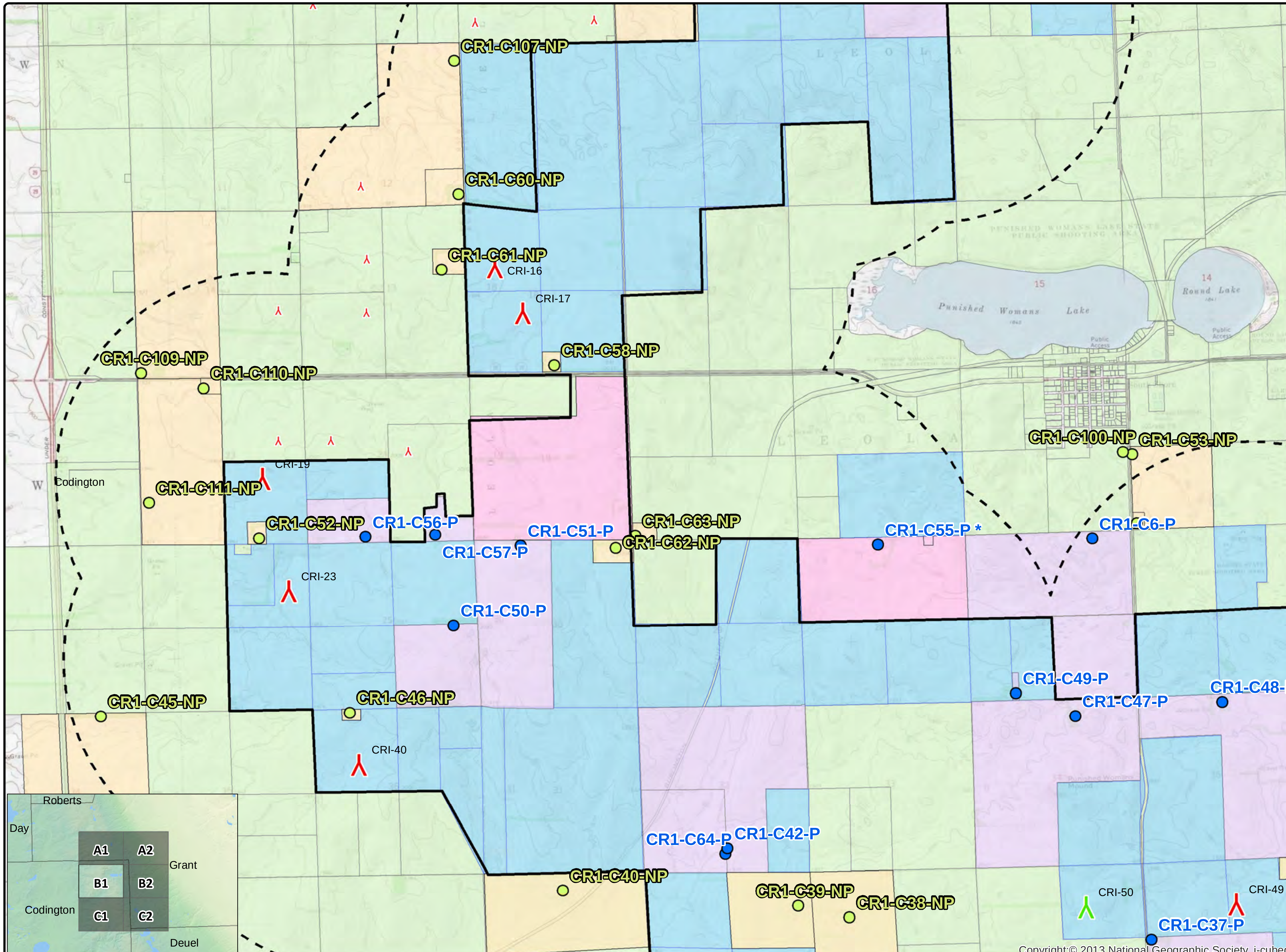
N W E S

0 0.25 0.5 1 Mile

EXHIBIT A55



0 0.25 0.5 1 Mile

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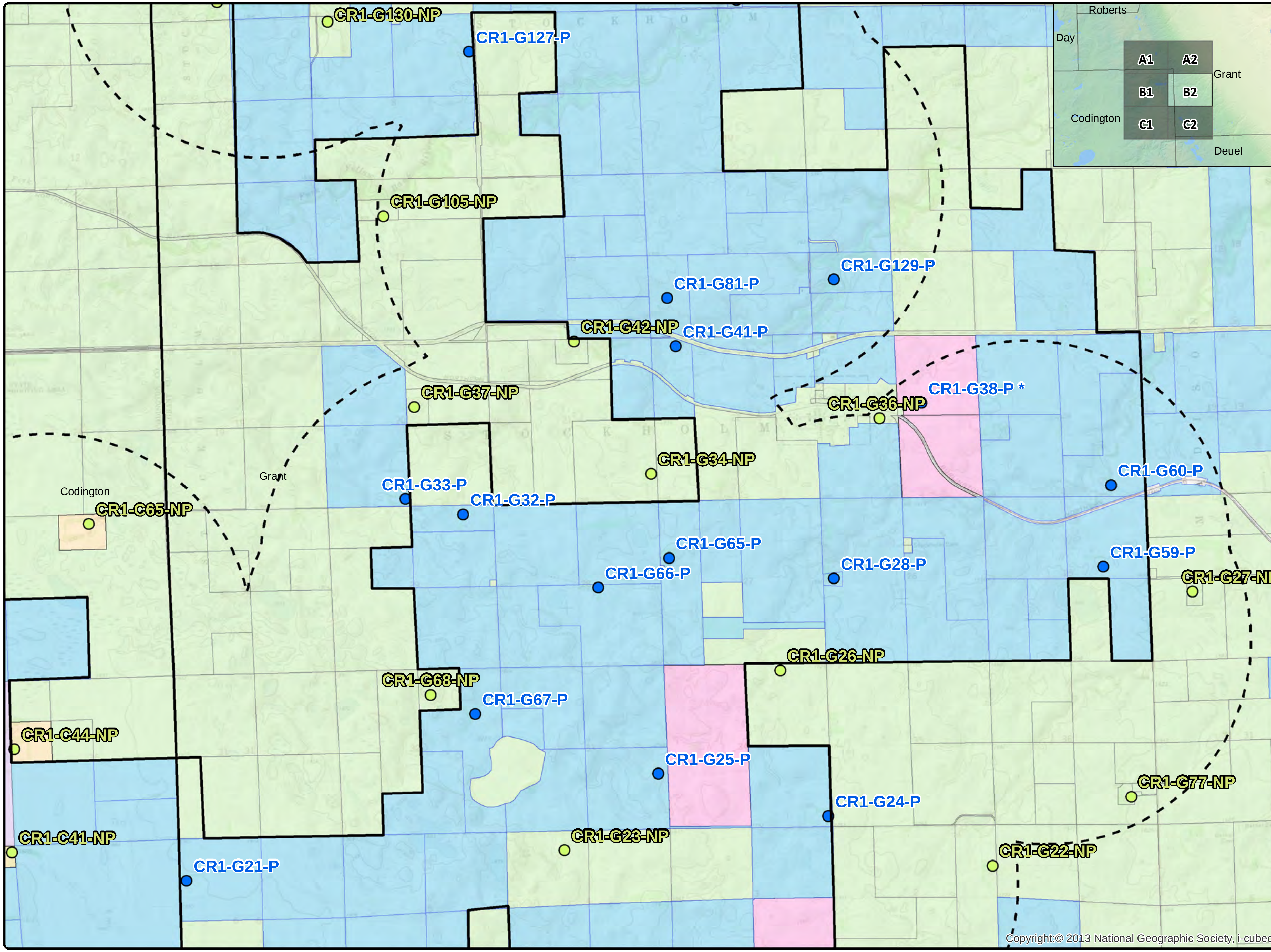
N W E S

EXHIBIT A55



0 0.25 0.5 1 Mile

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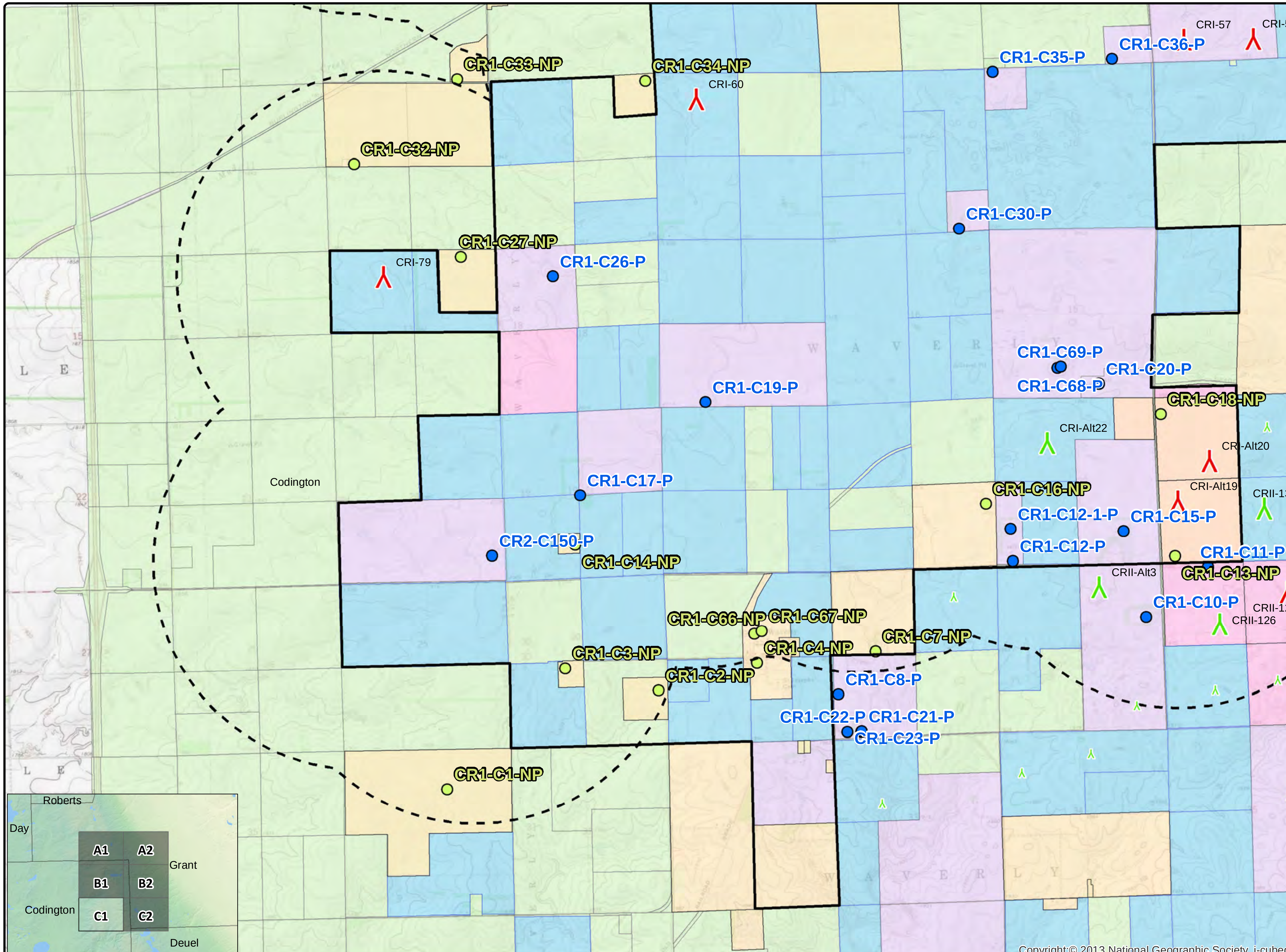
N W E S

EXHIBIT A55



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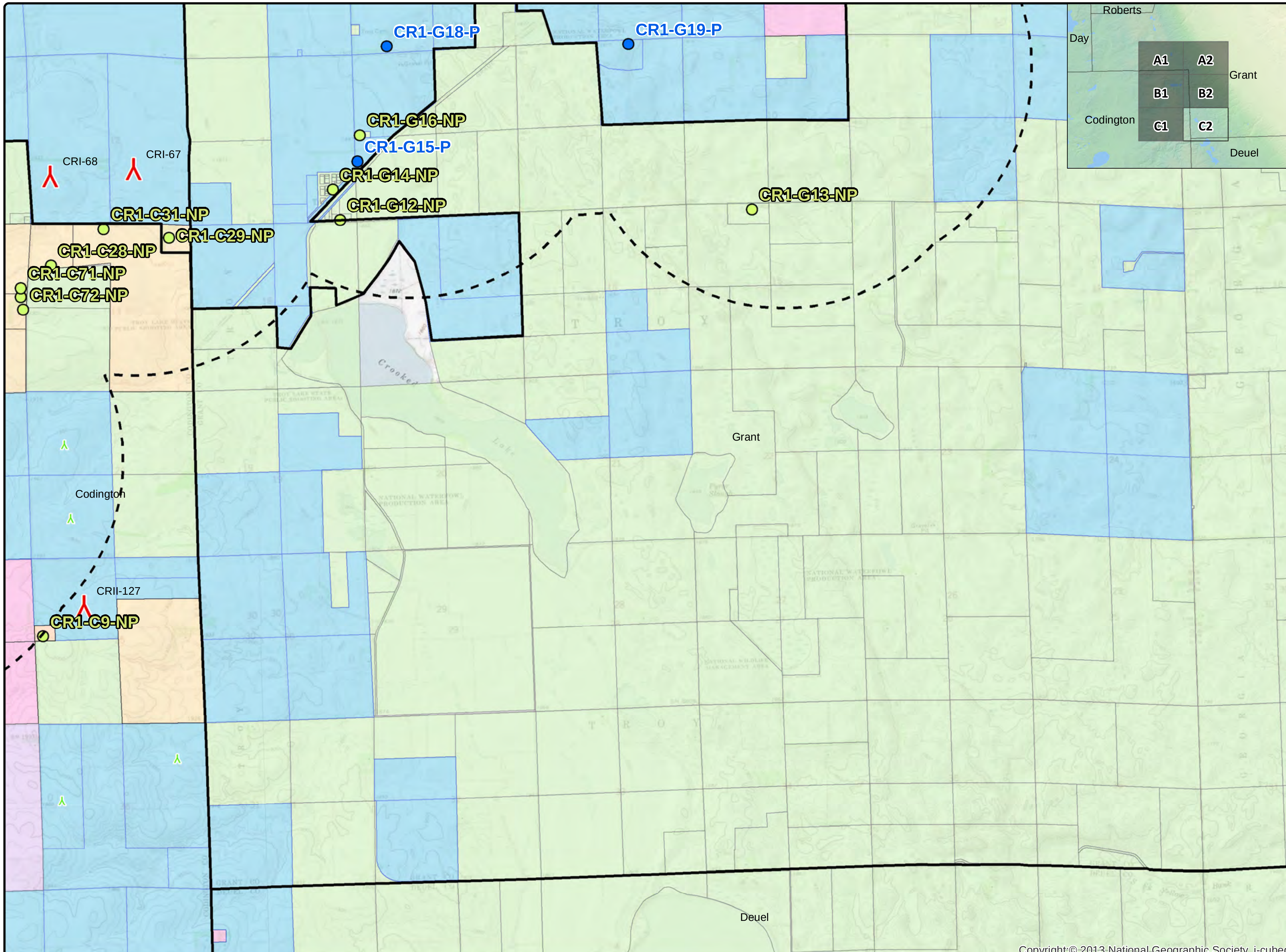
N W E S

0 0.25 0.5 1 Mile

EXHIBIT A55



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Location: Watertown, SD

Project #: 20174431

Issue Dates

#	Description	Date
1	Original	2019.06.08

Drawn By: AS *Checked By: JH*

Legend

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- Moved Turbines
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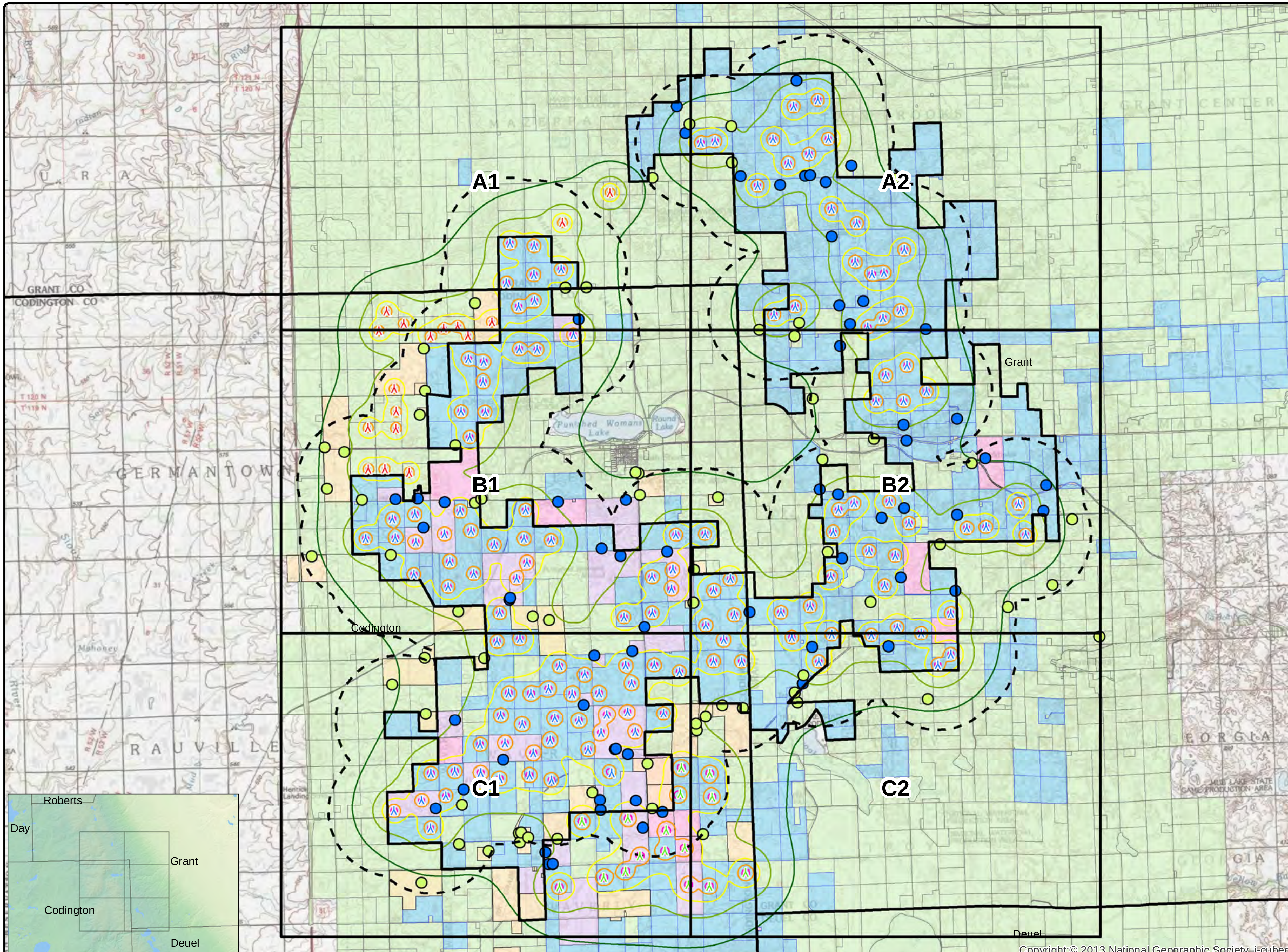
- Participating Codington Parcels
- Participating Parcels
- Pending Parcels
- Non-Participating Parcels

N E S W

0 0.25 0.5 1 Mile

EXHIBIT A56



0 0.75 1.5 3 Mile

EAPC WIND ENERGY

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Crowned Ridge Wind Farm Sound Pressure Iso-Lines Overview Map

Client

SWCA Environmental Consultants

Project Description

Wind turbine layout with occupied structures and parcel boundaries within 2 km.

Predicted sound pressure levels at existing residences and land parcel boundaries.

Additional 2 dBA added.

Includes all proposed turbine changes.

Location: Watertown, SD

Project #: 20174431

Issue Dates

#	Description	Date
1	Original	2019.06.10

Drawn By: AS *Checked By:* JH

Legend

- Crowned Ridge Wind Turbines
- Crowned Ridge II Wind Turbines
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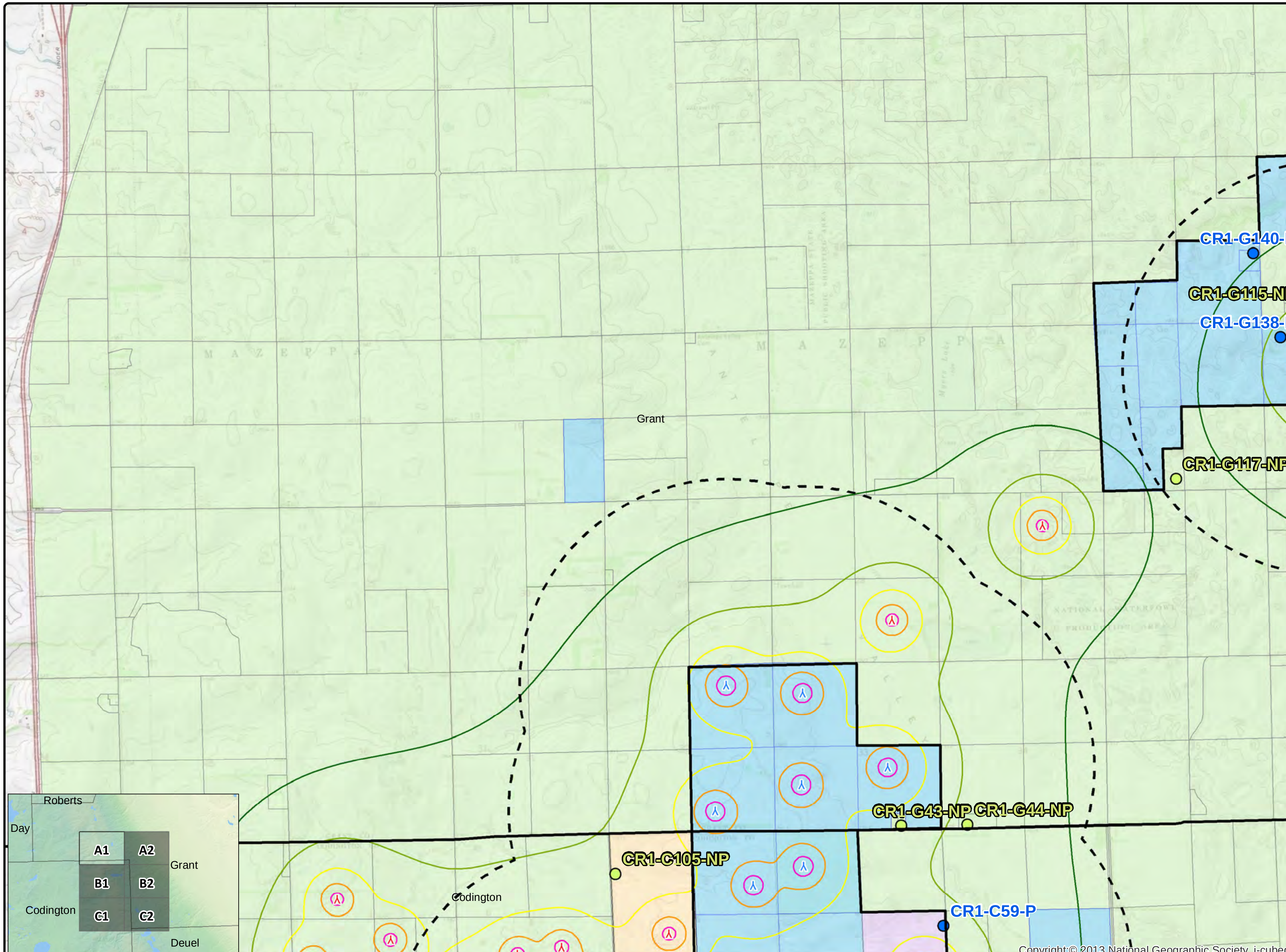
- County Lines
- CR1 Project Boundary
- Non Participants
- Participants

Sound Pressure (dBA)

- 35
- 40
- 45
- 50
- 55
- Non-Participating Codington Parcels
- Participating Codington Parcels
- Participating Parcels
- Pending Parcels
- Non-Participating Parcels

N E S W

EXHIBIT A56



0 0.25 0.5 1 Mile

EAPC WIND ENERGY

www.eapc.net | 701.775.3000

Crowned Ridge Wind Farm
Sound Pressure Iso-Lines

Client

SWCA Environmental Consultants

Project Description

Wind turbine layout with occupied structures and parcel boundaries within 2 km.

Predicted sound pressure levels at existing residences and land parcel boundaries.

Additional 2 dBA added.

Includes all proposed turbine changes.

Location: Watertown, SD

Project #: 20174431

Issue Dates

#	Description	Date
1	Original	2019.06.10

Drawn By: AS *Checked By:* JH

Legend

- Crowned Ridge Wind Turbines
- Crowned Ridge II Wind Turbines
- Dakota Range Wind Turbines
- 2 km Turbine Buffer
- County Lines
- CR1 Project Boundary
- Non Participants
- Participants

Sound Pressure (dBA)

- 35
- 40
- 45
- 50
- 55
- Non-Participating Codington Parcels
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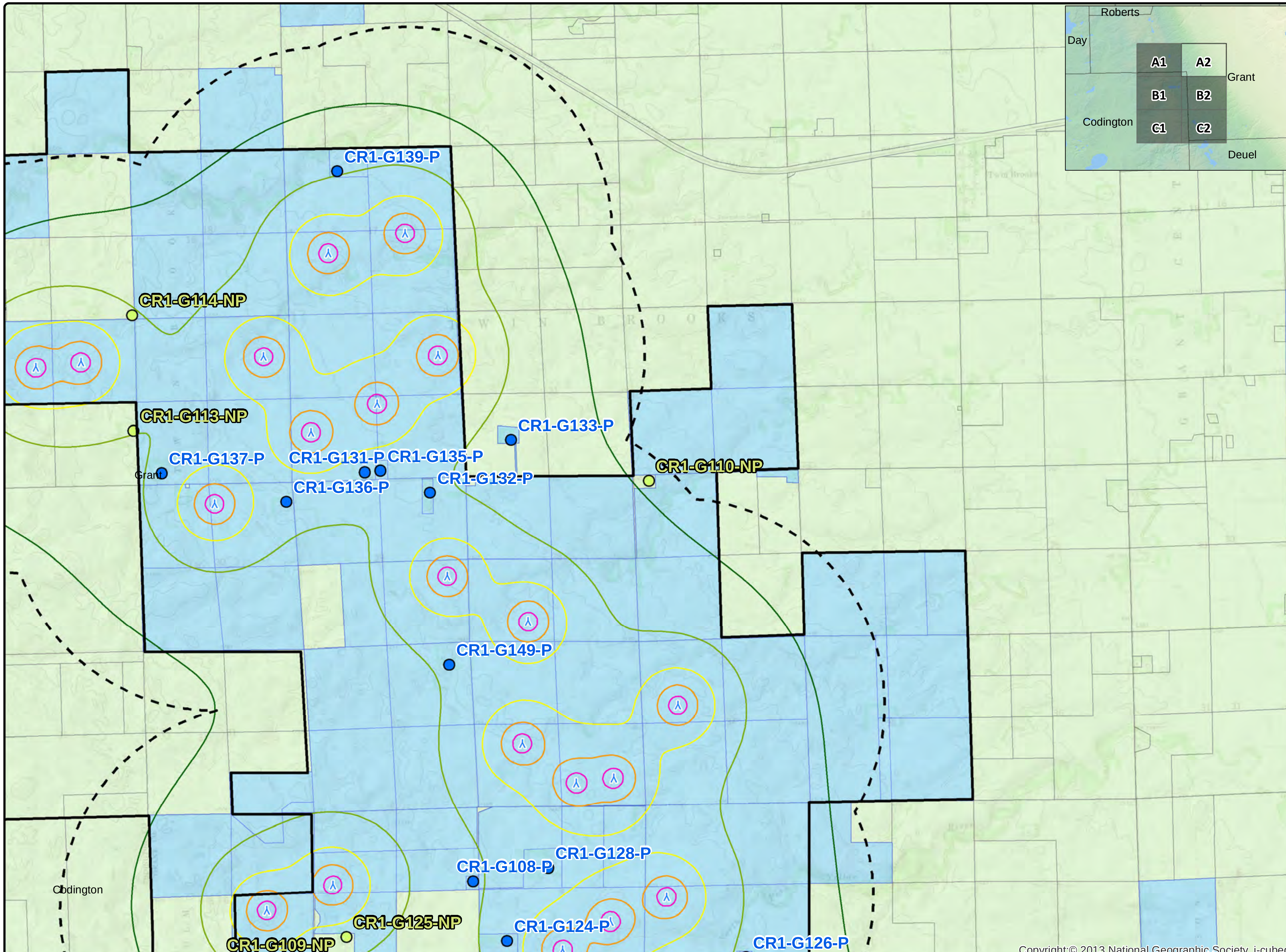
EXHIBIT A56



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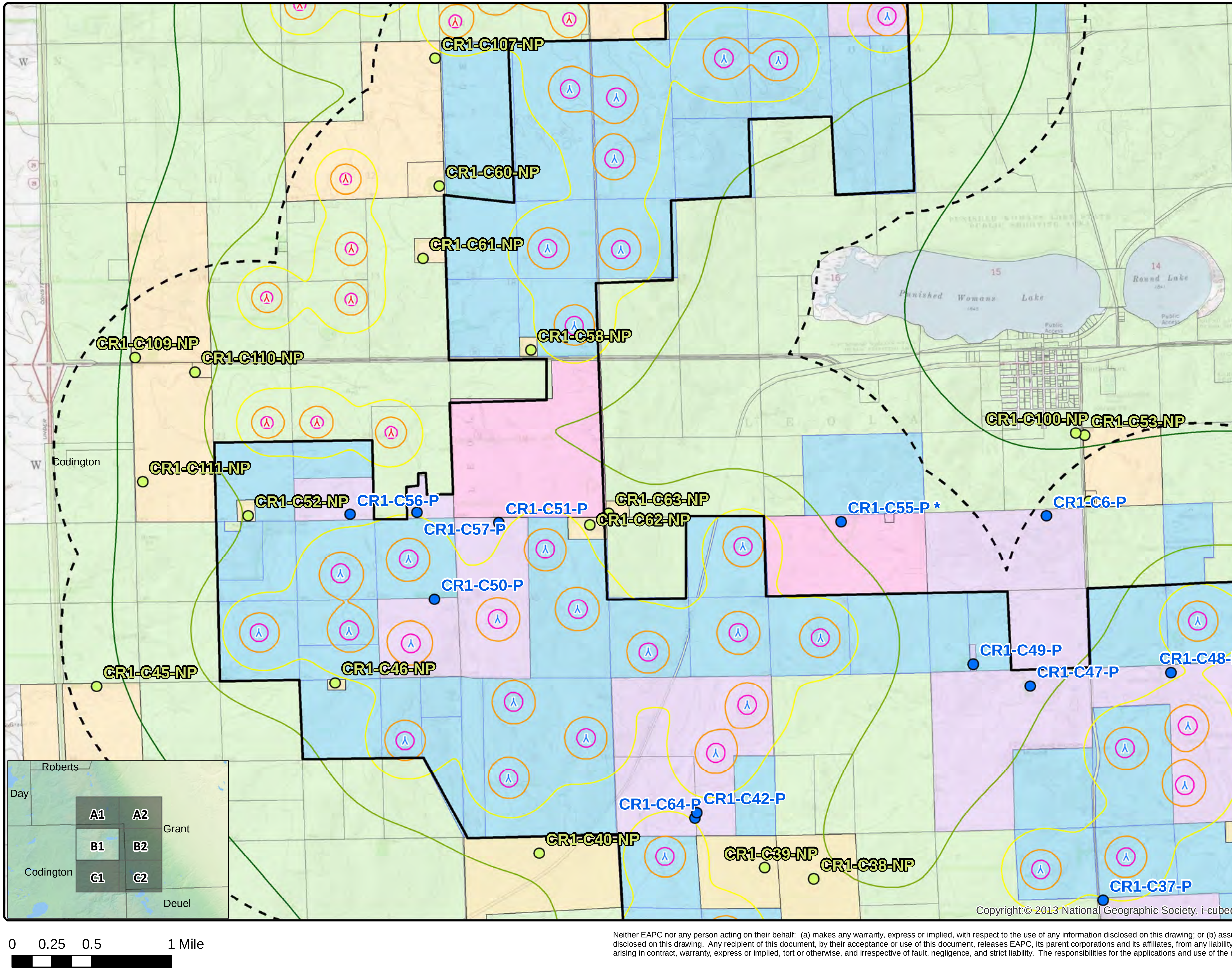

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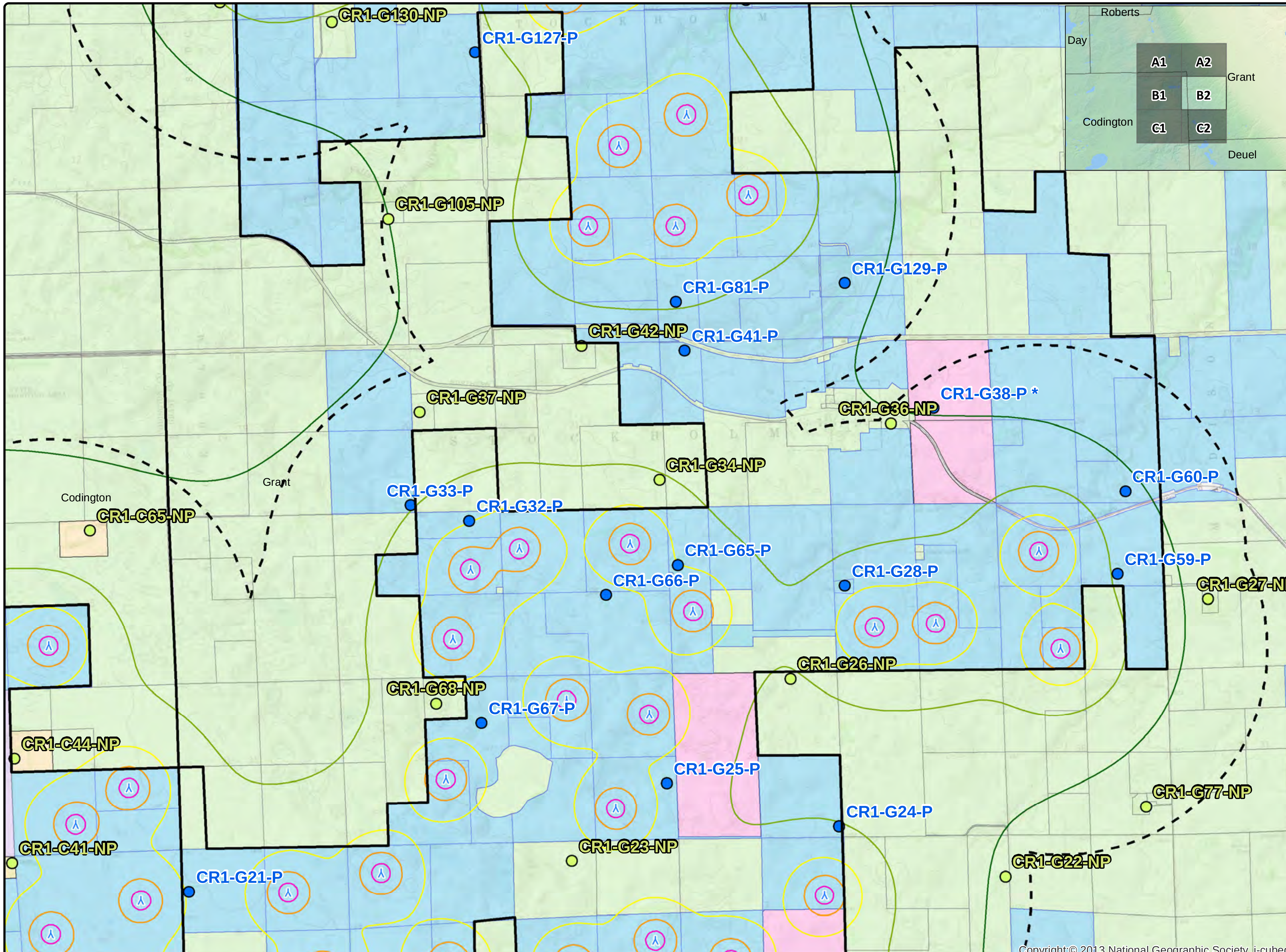

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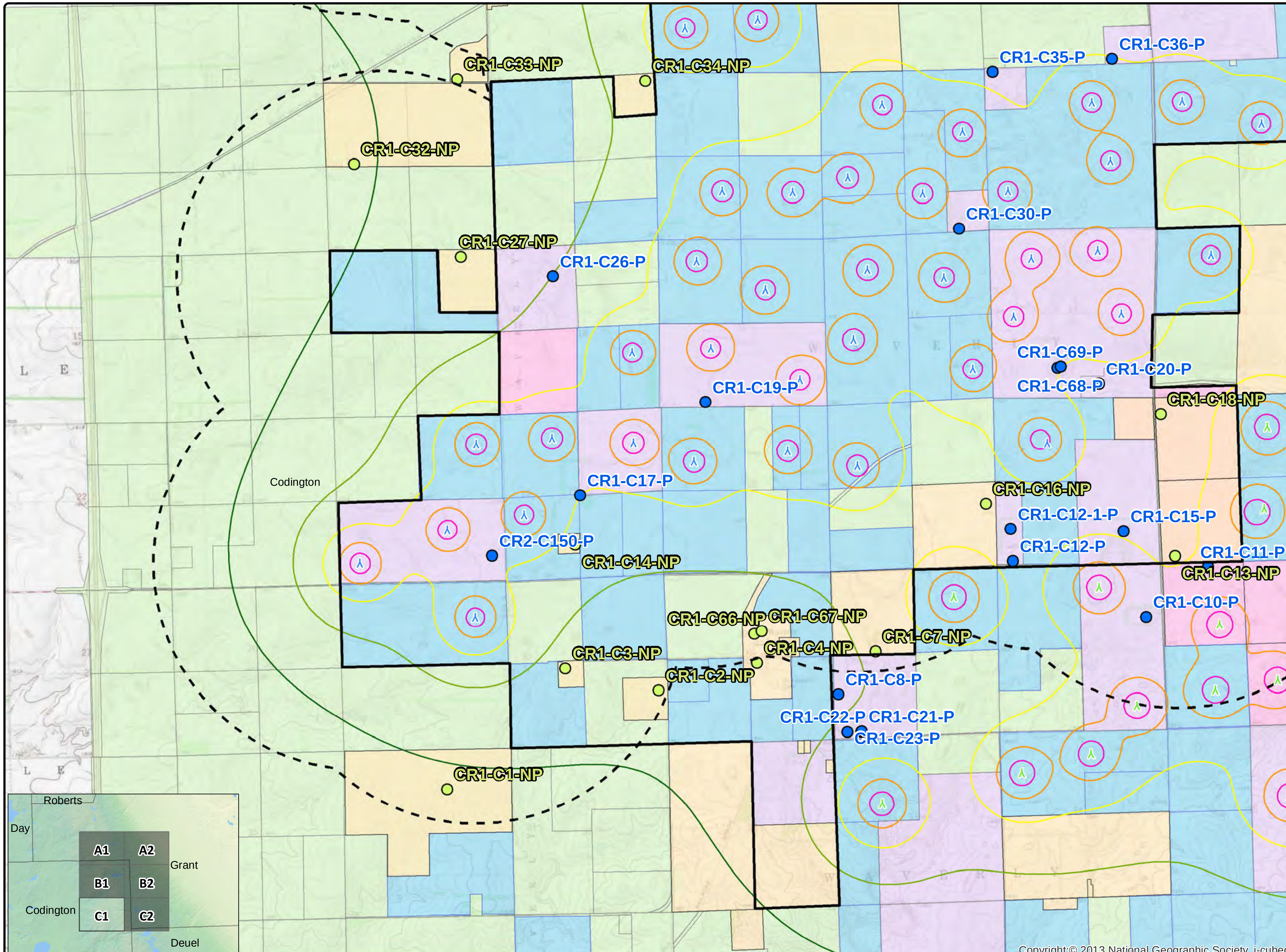

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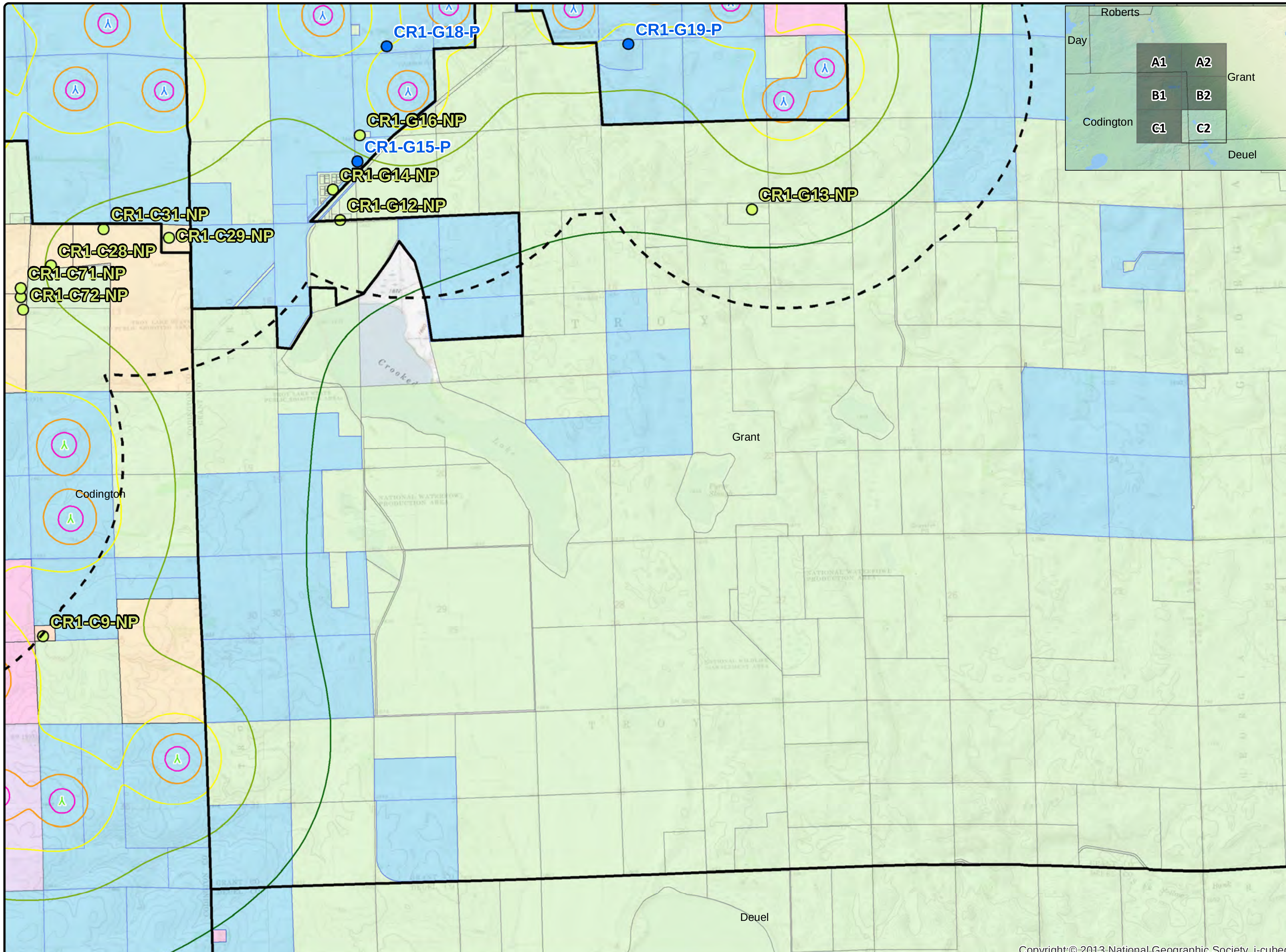

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Table C-3: Crowned Ridge Sound Level Tabular Results Sorted by Sound Level - Updated 6/9/19
16 turbines removes as suggested by Mr. Hessler
Realistic case sound results at occupied structures
Results using GE 2.3-116-90 m HH, GE 2.3-116-80 m HH WTG's
UTM NAD83 Zone 14
Codington County

Receptor ID	Participation Status	Easting (m)	Northing (m)	Elevation AMSL (m)	Hessler Case Sound (dB(A))	Real Case Sound (dB(A))	Reduction (DB(A))	Distance to Nearest Turbine (ft)
CR1-C46-NP	Non-P	655,802	4,993,540	609.1	44.2	44.4	-0.2	1,795
CR1-C41-NP	Non-P	665,053	4,992,084	576.1	44.1	45.0	-0.9	2,359
CR1-C9-NP	Non-P	665,352	4,985,004	609.0	44.1	44.1	0.0	2,034
CR1-C62-NP	Non-P	658,375	4,995,138	615.0	43.9	43.9	0.0	1,676
CR1-C107-NP	Non-P	656,811	4,999,855	598.8	43.8	43.9	-0.1	1,401
CR1-C13-NP	Non-P	663,792	4,985,785	612.0	43.7	44.2	-0.5	2,589
CR1-C44-NP	Non-P	665,076	4,993,095	578.2	43.7	44.0	-0.3	2,155
CR1-C14-NP	Non-P	657,982	4,985,894	609.0	43.3	43.4	-0.1	1,880
CR1-C58-NP	Non-P	657,781	4,996,906	615.0	43.3	43.7	-0.4	1,647
CR1-C16-NP	Non-P	661,960	4,986,288	606.0	42.9	43.0	-0.1	2,736
CR1-C18-NP	Non-P	663,651	4,987,157	610.4	42.5	42.7	-0.2	3,409
CR1-C34-NP	Non-P	658,661	4,990,389	588.2	42.3	44.5	-2.2	1,726
CR1-C105-NP	Non-P	658,372	5,001,257	600.3	42.1	42.2	-0.1	2,549
CR1-C39-NP	Non-P	660,144	4,991,670	588.0	42.0	42.2	-0.2	2,605
CR1-C63-NP	Non-P	658,566	4,995,254	612.4	42.0	42.1	-0.1	2,408
CR1-C61-NP	Non-P	656,690	4,997,831	612.0	41.5	44.2	-2.7	1,686
CR1-C40-NP	Non-P	657,865	4,991,818	583.7	41.3	41.4	-0.1	2,690
CR1-C7-NP	Non-P	660,893	4,984,861	593.2	41.1	41.1	0.0	3,022
CR1-C72-NP	Non-P	665,158	4,988,170	594.6	41.0	41.7	-0.7	3,776
CR1-C70-NP	Non-P	665,135	4,988,293	595.9	40.9	41.7	-0.8	3,540
CR1-C71-NP	Non-P	665,137	4,988,378	595.6	40.8	41.8	-1.0	3,448
CR1-C38-NP	Non-P	660,639	4,991,557	597.0	40.7	40.9	-0.2	3,474
CR1-C60-NP	Non-P	656,855	4,998,565	613.5	40.7	42.1	-1.4	2,592
CR1-C52-NP	Non-P	654,924	4,995,231	603.0	40.4	44.6	-4.2	1,883
CR1-C28-NP	Non-P	665,429	4,988,598	590.9	40.1	41.9	-1.8	2,831
CR1-C31-NP	Non-P	665,939	4,988,950	585.4	39.5	43.3	-3.8	2,126
CR1-C110-NP	Non-P	654,385	4,996,686	593.9	38.9	40.1	-1.2	2,910
CR1-C112-NP	Non-P	660,002	4,984,908	604.6	38.8	38.9	-0.1	5,627
CR1-C67-NP	Non-P	659,789	4,985,057	606.0	38.8	38.9	-0.1	5,791
CR1-C3-NP	Non-P	657,888	4,984,697	604.2	38.7	38.7	0.0	3,294
CR1-C5-NP	Non-P	659,958	4,984,794	604.8	38.7	38.7	0.0	5,659
CR1-C66-NP	Non-P	659,718	4,985,032	606.0	38.7	38.8	-0.1	5,800
CR1-C29-NP	Non-P	666,572	4,988,867	575.9	38.6	41.3	-2.7	2,457
CR1-C4-NP	Non-P	659,744	4,984,749	606.0	38.3	38.4	-0.1	5,981
CR1-C27-NP	Non-P	656,876	4,988,683	583.0	37.3	37.5	-0.2	5,974
CR1-C2-NP	Non-P	658,791	4,984,483	602.0	37.2	37.2	0.0	6,273
CR1-C65-NP	Non-P	665,805	4,995,305	579.0	37.1	37.3	-0.2	3,884
CR1-C33-NP	Non-P	656,839	4,990,404	569.8	36.6	36.9	-0.3	7,418
CR1-C109-NP	Non-P	653,780	4,996,828	588.0	36.2	37.1	-0.9	4,797

*** Pending** **** Under Option but Likely to Expire / Not Re-sign**

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UTM NAD83 Zone 14
Codington County
continued

Receptor ID	Participation Status	Easting (m)	Northing (m)	Elevation AMSL (m)	Hessler Case Sound (dB(A))	Real Case Sound (dB(A))	Reduction (DB(A))	Distance to Nearest Turbine (ft)
CR1-C111-NP	Non-P	653,857	4,995,573	591.0	36.2	38.3	-2.1	3,678
CR1-C54-NP	Non-P	663,421	4,995,376	583.4	36.2	36.4	-0.2	5,351
CR1-C53-NP	Non-P	663,376	4,996,043	578.8	35.1	35.3	-0.2	7,201
CR1-C32-NP	Non-P	655,843	4,989,581	568.8	34.9	35.2	-0.3	9,708
CR1-C1-NP	Non-P	656,743	4,983,525	596.0	34.7	34.8	-0.1	5,541
CR1-C45-NP	Non-P	653,390	4,993,503	573.2	34.3	35.1	-0.8	5,673
CR1-C30-P	Participant	661,699	4,988,957	615.0	47.8	47.8	0.0	1,614
CR1-C50-P	Participant	656,806	4,994,388	621.0	46.7	46.8	-0.1	1,591
CR1-C19-P	Participant	659,243	4,987,276	611.6	46.3	46.4	-0.1	1,722
CR2-C150-P	Participant	657,178	4,985,788	612.0	46.1	46.1	0.0	1,640
CR1-C10-P	Participant	663,510	4,985,195	609.0	45.9	46.3	-0.4	1,762
CR1-C36-P	Participant	663,181	4,990,600	615.0	45.3	46.2	-0.9	1,532
CR1-C68-P	Participant	662,652	4,987,606	609.0	45.2	45.2	0.0	2,146
CR1-C17-P	Participant	658,031	4,986,373	609.1	45.1	45.1	0.0	1,886
CR1-C69-P	Participant	662,685	4,987,619	609.0	45.1	45.1	0.0	2,185
CR1-C11-P *	Participant	664,111	4,985,679	609.0	44.8	45.0	-0.2	1,860
CR1-C37-P **	Participant	663,563	4,991,342	605.1	44.8	46.5	-1.7	1,631
CR1-C64-P	Participant	659,436	4,992,174	581.0	44.8	44.9	-0.1	1,614
CR1-C48-P	Participant	664,247	4,993,646	588.0	44.6	44.7	-0.1	1,847
CR1-C57-P	Participant	656,628	4,995,266	615.0	44.6	44.8	-0.2	1,568
CR1-C42-P	Participant	659,458	4,992,229	580.0	44.5	44.6	-0.1	1,801
CR1-C20-P	Participant	663,054	4,987,455	606.0	43.9	44.1	-0.2	2,336
CR1-C51-P	Participant	657,455	4,995,160	621.0	43.9	44.0	-0.1	1,768
CR1-C56-P	Participant	655,953	4,995,244	606.5	43.9	44.7	-0.8	1,972
CR1-C12-P	Participant	662,222	4,985,736	603.0	43.7	44.1	-0.4	2,201
CR1-C35-P	Participant	662,025	4,990,475	609.0	43.7	43.9	-0.2	2,123
CR1-C15-P	Participant	663,291	4,986,026	615.0	43.2	44.4	-1.2	1,952
CR1-C12-1-P	Participant	662,199	4,986,047	606.0	42.9	43.3	-0.4	2,818
CR1-C59-P	Participant	661,548	5,000,754	584.2	42.7	42.7	0.0	1,644
CR1-C21-P	Participant	660,756	4,984,086	594.0	41.9	41.9	0.0	2,388
CR1-C22-P	Participant	660,755	4,984,082	594.0	41.9	41.9	0.0	2,375
CR1-C23-P	Participant	660,619	4,984,078	595.8	41.4	41.4	0.0	2,523
CR1-C26-P	Participant	657,767	4,988,493	597.0	40.1	40.3	-0.2	3,484
CR1-C8-P	Participant	660,532	4,984,445	599.4	39.9	40.0	-0.1	3,740
CR1-C55-P *	Participant	660,914	4,995,169	607.5	39.3	39.4	-0.1	3,360
CR1-C47-P	Participant	662,825	4,993,508	613.9	39.1	39.4	-0.3	3,750
CR1-C49-P	Participant	662,250	4,993,731	609.0	38.1	38.4	-0.3	5,148
CR1-C6-P	Participant	662,989	4,995,228	599.8	36.2	36.4	-0.2	6,102

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UTM NAD83 Zone 14
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CR1-G68-NP	Non-P	669,159	4,993,632	565.6	42.9	43.0	-0.1	2,113
CR1-G43-NP	Non-P	661,141	5,001,721	583.6	42.8	42.9	-0.1	1,909
CR1-G125-NP	Non-P	668,289	5,000,643	543.0	42.6	42.8	-0.2	1,716
CR1-G23-NP	Non-P	670,471	4,992,104	560.0	42.4	42.5	-0.1	2,185
CR1-G16-NP	Non-P	668,419	4,989,861	576.0	41.4	41.8	-0.4	2,070
CR1-G114-NP	Non-P	666,214	5,006,667	521.1	40.7	40.8	-0.1	2,205
CR1-G34-NP	Non-P	671,320	4,995,798	531.0	40.6	40.8	-0.2	2,238
CR1-G115-NP	Non-P	664,933	5,006,731	544.6	40.3	40.5	-0.2	2,188
CR1-G113-NP	Non-P	666,228	5,005,549	537.0	40.2	40.3	-0.1	2,746
CR1-G109-NP	Non-P	667,064	5,000,425	566.2	39.9	40.1	-0.2	2,152
CR1-G26-NP	Non-P	672,589	4,993,869	531.0	39.8	39.9	-0.1	3,140
CR1-G130-NP	Non-P	668,147	5,000,233	549.0	39.2	39.3	-0.1	3,005
CR1-G44-NP	Non-P	661,781	5,001,732	583.7	39.1	39.2	-0.1	3,123
CR1-G14-NP	Non-P	668,156	4,989,332	574.1	38.1	38.7	-0.6	3,940
CR1-G42-NP	Non-P	670,566	4,997,097	518.9	38.0	38.0	0.0	3,819
CR1-G12-NP	Non-P	668,229	4,989,039	575.0	37.3	37.9	-0.6	4,623
CR1-G13-NP	Non-P	672,216	4,989,142	558.0	37.1	37.2	-0.1	3,576
CR1-G37-NP	Non-P	668,998	4,996,452	549.0	36.5	36.6	-0.1	5,246
CR1-G36-NP	Non-P	673,559	4,996,344	498.0	35.4	35.4	0.0	6,211
CR1-G105-NP	Non-P	668,696	4,998,325	549.0	35.2	35.2	0.0	6,345
CR1-G117-NP	Non-P	663,801	5,005,084	581.3	35.2	35.3	-0.1	4,501
CR1-G110-NP	Non-P	671,218	5,005,064	456.2	34.7	34.8	-0.1	5,889
CR1-G22-NP	Non-P	674,670	4,991,955	527.6	34.7	34.8	-0.1	5,781
CR1-G27-NP	Non-P	676,630	4,994,642	480.8	33.9	34.0	-0.1	4,944
CR1-G77-NP	Non-P	676,031	4,992,629	502.7	33.1	33.2	-0.1	5,728
CR1-G65-P	Participant	671,496	4,994,973	537.0	45.2	45.3	-0.1	1,539
CR1-G18-P	Participant	668,678	4,990,722	585.0	45.0	45.1	-0.1	1,585
CR1-G32-P	Participant	669,477	4,995,401	546.0	44.8	45.1	-0.3	1,545
CR1-G21-P	Participant	666,766	4,991,807	577.1	44.6	44.9	-0.3	1,555
CR1-G66-P	Participant	670,802	4,994,681	539.7	43.8	44.0	-0.2	1,801
CR1-G25-P	Participant	671,391	4,992,858	549.0	43.6	43.8	-0.2	1,804
CR1-G19-P	Participant	671,018	4,990,744	570.0	43.2	43.4	-0.2	2,077
CR1-G67-P	Participant	669,597	4,993,440	556.1	43.1	43.2	-0.1	2,106
CR1-G28-P	Participant	673,113	4,994,772	513.9	43.0	43.2	-0.2	1,614
CR1-G128-P	Participant	670,242	5,001,314	513.0	42.8	42.9	-0.1	2,612
CR1-G131-P	Participant	668,466	5,005,145	505.2	42.8	42.9	-0.1	2,133
CR1-G124-P	Participant	669,843	5,000,605	525.0	42.5	42.7	-0.2	1,791
CR1-G135-P	Participant	668,616	5,005,161	504.0	42.4	42.6	-0.2	2,142

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16 turbines removes as suggested by Mr. Hessler
Realistic case sound results at occupied structures
Results using GE 2.3-116-90 m HH, GE 2.3-116-80 m HH WTG's
UTM NAD83 Zone 14
Grant County
continued

Receptor ID	Participation Status	Easting (m)	Northing (m)	Elevation AMSL (m)	Hessler Case Sound (dB(A))	Real Case Sound (dB(A))	Reduction (DB(A))	Distance to Nearest Turbine (ft)
CR1-G136-P	Participant	667,706	5,004,861	522.0	42.1	42.2	-0.1	2,277
CR1-G138-P	Participant	664,809	5,006,456	549.0	41.6	41.8	-0.2	1,824
CR1-G137-P	Participant	666,501	5,005,136	529.3	41.4	41.6	-0.2	1,939
CR1-G149-P	Participant	669,284	5,003,283	503.2	40.9	41.0	-0.1	2,815
CR1-G132-P	Participant	669,098	5,004,948	501.0	40.6	40.6	0.0	2,703
CR1-G81-P	Participant	671,478	4,997,523	508.8	40.6	40.7	-0.1	2,421
CR1-G24-P	Participant	673,058	4,992,440	539.4	40.4	40.5	-0.1	2,231
CR1-G33-P	Participant	668,911	4,995,550	548.7	39.8	39.9	-0.1	2,779
CR1-G108-P	Participant	669,516	5,001,186	522.2	39.7	39.7	0.0	3,586
CR1-G139-P	Participant	668,199	5,008,062	476.2	39.7	39.8	-0.1	2,612
CR1-G15-P	Participant	668,396	4,989,607	576.0	39.6	40.0	-0.4	2,746
CR1-G59-P	Participant	675,755	4,994,888	487.7	39.4	39.6	-0.2	2,605
CR1-G126-P	Participant	672,157	5,000,446	484.3	39.3	39.4	-0.1	3,176
CR1-G127-P	Participant	669,534	4,999,939	533.8	38.7	38.7	0.0	3,369
CR1-G133-P	Participant	669,881	5,005,460	478.8	38.3	38.3	0.0	3,556
CR1-G41-P	Participant	671,563	4,997,050	497.6	37.9	37.9	0.0	3,983
CR1-G129-P	Participant	673,111	4,997,703	478.1	36.2	36.3	-0.1	4,153
CR1-G60-P	Participant	675,830	4,995,687	477.0	36.2	36.4	-0.2	3,343
CR1-G140-P	Participant	664,546	5,007,269	551.4	35.1	35.2	-0.1	4,360
CR1-G38-P *	Participant	673,972	4,996,493	494.5	35.0	34.9	0.1	5,646

*** Pending** **** Under Option but Likely to Expire / Not Re-sign**

		Sound and S/F on Interveners from Hessler 7 turbine moves and final land status					
		As Filed			Latest Moves		
Receptor	**Name**	**Sound Pressure (dBA)**	**Shadow Flicker (Hr/yr)**	**Dist. To Nearest Turbine (feet)**	**Sound Pressure (dBA)**	**Shadow Flicker (Hr/yr)**	**Dist. To Nearest Turbine (feet)**
CR1-G70-NP	Mr. Allen Robish	28.8	0:00	12,651	29.3	0:00	12,651
CR1-C29-NP	Ms. Amber Christenson	41.4	6:54	1,952	38.6	6:56	4,675
No Recpt.	Ms. Kristi Mogen	28.6	0:00	13,166	28.8	0:00	13,166
CR1-C27-NP	Mr. Patrick Lynch	40	6:58	1,752	37.3	0:00	6,218
CR1-C112-NP	Waverly School	39.4	0:46	5,892	38.8	0:44	5,745

Final land status turbine shifts and the Hessler 7 turbine moves						
Receptor	**Landowner**	**Turbines dropped**	**Replacement Turbines**	**Turbines moved**	**LNTE's**	**Notes**
CR1-C46-NP	OSTHUS GRANT	CR1-40	CR1-Alt42			Noise compliance below 45 at CR1-C46-NP
CR1-C58-NP	HAMANN GARY F & HAMANN DAWN E	CR1-17	CR1-Alt45			Noise compliance below 45 at CR1-C58-NP
CR1-C9-NP	DAGEL KENNETH & DAGEL KATHLEEN M	CRII-127, CRII-129	None			Noise compliance below 45 at CR1-C9-NP
CR1-C37-NP	LINDGREN TIMOTHY J	CR1-56, CR1-57	None	CR1-50		Noise compliance below 45 at CR1-C37-NP
CR1-C13-NP	COMES ROBERT	CR1-Alt19	None			Noise compliance below 45 at CR1-C13-NP
CR1-C18-NP	STRICHERZ CHRISTOPHER L & STRICHERZ TAMARA	CR1-Alt20	None			Noise compliance below 45 at CR1-C18-NP
CR1-C11-NP	STRICHERZ CLYDE L	None	None	CRII-126, CRII-133	CRII-126, CRII-133	Noise compliance below 45 at CR1-C11-NP
CR1-C27-NP	JOHNSON MELISSA M & LYNCH PATRICK M	CR1-79	None			Orphaned turbine CR1-C27-NP
CR1-C15-NP	STRICHERZ LAVERNE B & STRICHERZ BARBARA J	None	None	CR1-Alt22, CRII-Alt3	CRII-Alt3	Noise compliance below 45 at CR1-C15-NP
Multiple	Multiple	CR-16, CR19, CR-23, CR-49, CR-60, CR-67, and CR-68	None			Hessler 7 turbines

Impacts on non-participants Adopting of 7 Hessler turbine moves

Turbines Dropped CR-16, CR19, CR-23, CR-49, CR-60, CR-67, and CR-68

	Noise	
Receptor	**Before**	**After**
CR1-C52-NP	44.6	40.4
CR1-C31-NP	43.3	39.5
CR1-C61-NP	44.2	41.5
CR1-C34-NP	44.5	42.3
CR1-C28-NP	41.9	40.1
CR1-C60-NP	42.1	40.7

PROPOSED PERMIT CONDITIONS

1. Applicant will obtain all governmental permits which reasonably may be required by any township, county, state agency, or federal agency, or any other governmental unit for construction and operation activity of the Project prior to engaging in the particular activity covered by that permit. Copies of any permits obtained by Applicant shall be filed with the Commission.

2. Applicant shall construct, operate, and maintain the Project in a manner consistent with (1) descriptions in the Application, (2) Application supplements and corrections, (3) commitments made by the Applicant in responses to data requests, (4) the Final Decision and Order Granting Permit to Construct Facilities, and attached Permit Conditions, (5) applicable industry standards, (6) applicable permits issued by a federal, state, or local agency with jurisdiction over the Project, and (7) evidence presented by Applicant at the evidentiary hearing.

3. Applicant agrees that the Commission's complaint process as set forth in ARSD Chapter 20:10:01 shall be available to landowners and other persons sustaining or threatened with damage as the result of Applicant's failure to abide by the conditions of the Permit or otherwise having standing to seek enforcement of the conditions of the Permit. Participating landowners are free to use the complaint process free from retribution or consequence regardless of any private easement term to the contrary.

4. At least 14 days prior to commencement of construction, Applicant shall provide each participating and non-participating landowner in the Project Area, using the addresses designated to receive the property tax bill sent by the county treasurer, with the following information:

   a) A copy of the Final Decision and Order Granting Permit to Construct Facilities with attached Permit Conditions;

   b) Detailed safety information describing:

      1) Reasonable safety precautions for existing activities on or near the Project;

      2) Known activities or uses that are presently prohibited near the Project; and

      3) Other known potential dangers or limitations near the Project;

   c) Construction/maintenance damage compensation plans and procedures (only to participating landowners);

   d) The Commission's address, website, and phone number;

   e) Contact person for Applicant, including name, e-mail address, and phone number.

5. In order to ensure compliance with the terms and conditions of this Permit pursuant to SDCL 49-41B-33, it is necessary for the enforcement of this Order that all employees,

contractors, and agents of Applicant involved in this Project be made aware of the terms and conditions of this Permit.

6. Except as otherwise provided in the Permit Conditions, Applicant shall comply with all mitigation measures set forth in the Application and Applicant's commitments in its responses to data requests, and Applicant exhibits and testimony at the evidentiary hearing. Material modifications to the mitigation measures shall be subject to prior approval of the Commission.

7. Applicant will negotiate road use agreements with Codington and Grant Counties and all affected townships, if required. Applicant will comply with such road use agreements. When using haul roads specified in applicable road use agreements, Applicant shall take appropriate action to mitigate wind-blown particles created throughout the construction process, including implementation of dust control measures such as road watering, covering of open haul trucks when transporting material subject to being windblown, and the removal of any soils or mud deposits by construction equipment when necessary.

8. In accordance with applicable road use agreements or applicable law, Applicant shall comply with the following conditions regarding road protection:

   a) Applicant shall acquire all necessary permits authorizing the crossing of federal, state, county, and township roads.

   b) Applicant shall coordinate road closures with federal, state, and local governments and emergency responders.

   c) Applicant shall implement a regular program of road maintenance and repair through the active construction period to keep paved and gravel roads in an acceptable condition for residents and the public.

   d) After construction, Applicant shall repair and restore deteriorated roads resulting from construction traffic or compensate governmental entities for their repair and restoration of deteriorated roads, such that the roads are returned to their preconstruction condition.

   e) Within 180 days of completing construction and reclamation of the Project, Applicant shall submit documentation to the Commission identifying that the roads were repaired in accordance with this Condition 8 and to the satisfaction of affected townships and county. If the townships or county will not provide such documentation, then Applicant shall provide a report to the Commission on the outstanding road repair issues and how those issues have been or will be resolved.

   f) Privately owned areas used as temporary roads or crane paths during construction will be restored to their preconstruction condition, except as otherwise requested or agreed to by the landowner.

   g) Should Applicant need to widen any existing roadways during construction of the Project, Applicant shall return the roadways back to original width after completion of the Project, unless otherwise agreed upon with the federal, state, county, or township entities, or the landowner.

9. Applicant shall provide signage that identifies road closures and disturbances resulting from the Project in accordance with the most recent editions of the Manual on Uniform Traffic Control Devices as published by the Federal Highway Administration.

10. Applicant shall promptly report to the Commission the presence of any critical habitat of threatened or endangered species in the Project Area that Applicant becomes aware of and that was not previously reported to the Commission.

11. Applicant agrees to avoid direct impacts to cultural resources that are unevaluated, eligible for, or listed in the National Register of Historic Places (NRHP). When a NRHP unevaluated, eligible, or listed resource cannot be avoided, Applicant shall notify the South Dakota State Historic Preservation Office (SHPO) and the Commission of the reasons that complete avoidance cannot be achieved in order to coordinate minimization and/or treatment measures.

12. Applicant agrees to develop an unanticipated discovery plan for cultural resources and comply with SDCL 34-27-25, 34-27-26, and 34-27-28 for the discovery of human remains.

13. Applicant shall file a Level III Archaeological survey of the remaining facilities (i.e. access roads, crane paths, collection lines, O&M facilities, concrete batch plant, and laydown areas) with the Commission and provide a copy of the survey to SHPO prior to commercial operation. The survey report may contain confidential information and all confidential portions of the survey report shall be filed as confidential and not for not for public disclosure. If any potential adverse impacts to NRHP unevaluated, listed, or eligible cultural resources are identified in the survey, Applicant shall file with the Commission a report describing the SHPO-approved planned measures to ameliorate those impacts.

14. Applicant shall provide the Stormwater Pollution Prevention Plan (SWPPP) to the Commission when Applicant has a final design for the Project. The SWPPP will outline the water and soil conservation practices that will be used during construction to prevent or minimize erosion and sedimentation and be in a form consistent with the South Dakota Department of Environment and Natural Resources guidelines. The SWPPP will be completed before submittal of an application for a National Pollutant Discharge Elimination System (NPDES) general permit for construction activities. All contractors to be engaged in ground disturbing activities will be given a copy of the SWPPP and the requirements will be reviewed with them prior to the start of construction.

15. Applicant shall repair and restore areas disturbed by the construction or maintenance of the Project. Except as otherwise agreed to by the landowner, restoration shall include the replacement of the original pre-construction topsoil or equivalent quality topsoil to its original elevation, contour, and compaction and re-establishment of original vegetation as close thereto as reasonably practical. In order to facilitate compliance with this Permit Condition, Applicant shall:

    a) Strip the topsoil to the actual depth of the topsoil, or as otherwise agreed to by the landowner in writing (e-mail is sufficient), in all areas disturbed by the Project; however, with respect to access roads, Applicant may remove less than the actual depth of the topsoil to ensure roads remain low-profile and the contours align with the surrounding area;

b) Store the topsoil separate from the subsoil in order to prevent mixing of the soil types;

c) All excess soils generated during the excavation of the turbine foundations shall remain on the same landowner's land, unless the landowner requests, and the landowner agrees otherwise; and

d) When revegetating non-cultivated grasslands, Applicant shall use a seed mix that is recommended by the Natural Resource Conservation Service (NRCS), or other land management agency, unless otherwise agreed upon with the landowner in writing.

16. Applicant shall work closely with landowners or land management agencies, such as the NRCS, to determine a plan to control noxious weeds and the Applicant shall implement the plan.

17. Applicant shall stage construction materials in a manner that minimizes the adverse impact to landowners and land users as agreed upon between Applicant and landowner or Applicant and the appropriate federal, state, and/or local government agency. All excess (non-permanent) construction materials and debris shall be removed upon completion of the Project, unless the landowner agrees otherwise.

18. In order to mitigate interference with agricultural operations during and after construction, Applicant shall locate all structures, to the extent feasible and prudent, to minimize adverse impacts and interferences with agricultural operations, shelterbelts, and other land uses or activities. Applicant shall take appropriate precautions to protect livestock and crops during construction. Applicant shall repair all fences and gates removed or damaged during construction or maintenance unless otherwise agreed upon with the landowner or designee. Applicant shall be responsible for the repair of private roads damaged when moving equipment or when obtaining access to the right-of-way.

19. Applicant shall bury the underground collector system at a minimum depth of 48 inches, or deeper if necessary, to ensure the current land use is not impacted.

20. Applicant shall repair or replace all property removed or damaged during all phases of construction, including but not limited to, all fences, gates, and utility, water supply, irrigation, or drainage systems. Applicant shall compensate the owners for damages or losses that cannot be fully remedied by repair or replacement, such as lost productivity and crop and livestock losses. All repair, replacement and/or compensation described above shall be in accordance with the terms and conditions of written agreements between Applicant and affected landowners where such agreements exist.

21. Applicant shall, in the manner described in its written agreement with a landowner, indemnify and hold the landowner harmless for loss, damage, claim, or actions resulting from Applicant's use of the easement, including any damage resulting from any release, except to the extent such loss, damage claim, or action results from the negligence or willful misconduct of the landowner or his employees, agents, contractors, invitees, or other representatives.

22. Applicant may make turbine adjustments of 250 feet or less from the turbine locations identified at the time a Facility Permit is issued without prior Commission approval, so

long as the specified noise and shadow flicker thresholds are not exceeded, cultural resource impacts and documented habitats for listed species are avoided, and wetland impacts are avoided or are in compliance with applicable U.S. Army Corps of Engineers (USACE) regulations. Prior to implementing the turbine adjustment, Applicant will file in the docket an affidavit demonstrating compliance with the limitations set forth above. Any turbine adjustment that does not comply with the aforesaid limitations, or turbine model change, would be considered a “material change,” and Applicant shall file a request for approval of the “material change” prior to making the adjustment pursuant to the following approval process:

Applicant will file with the Commission and serve on the official Service List a request for approval of the adjustment that includes:

- An affidavit describing the proposed turbine adjustment, the reason for the adjustment, the reason the adjustment does not comply with one or more turbine flexibility limitations set forth above, and information regarding compliance with all other applicable requirements; and
- A map showing both the approved location and the proposed adjustment (in different colors).
- Once received, the information would be reviewed by Commission staff, and Commission staff will have 10 calendar days within which to request further Commission review.
- If no further review is requested, Applicant may proceed with the adjustment.
- If further review is requested, the Commission will issue a decision regarding Applicant’s request at its next available regularly scheduled Commission meeting, subject to notice requirements, after the request for further review is made by Commission staff.

23. Applicant may adjust access roads, the collector and communications systems, meteorological towers, Aircraft Detection Lighting System (ADLS) facilities, the operations and maintenance facility, the Project Substation, and temporary facilities, so long as they are located on land leased for the Project, cultural resources are avoided or mitigated in consultation with the SHPO; documented habitats for listed species are avoided; wetland impacts are avoided or are in compliance with applicable USACE regulations; and all other applicable regulations and requirements are met.

24. If the Project causes interference with radio, television, or any other licensed communication transmitting or receiving equipment, Applicant shall take all appropriate action to minimize any such interference and shall make a good faith effort to restore or provide reception levels equivalent to reception levels in the immediate areas just prior to construction of the Project. This mitigation requirement shall not apply to any dwellings or other structures built after completion of the Project.

25. Applicant will provide Global Positioning System (GPS) coordinates of structure locations to affected landowners at any time during the life of the Project. Coordinates will be provided in writing to landowners within 30 days of a request.

26. The Project, exclusive of all unrelated background noise, shall not generate a sound pressure level (10-minute equivalent continuous sound level, Leq) of more than 45 dBA as measured within 25 feet of any non-participating residence unless the owner of the residence has signed a waiver, or more than 50 dBA (10-minute equivalent continuous

sound level, Leq) within 25 feet of any participating residence unless the owner of the residence has signed a waiver. The Project Owner shall, upon Commission formal request, conduct field surveys and provide monitoring data verifying compliance with specified noise level limits. If the measured wind turbine noise level exceeds a limit set forth above, then the Project Owner shall take whatever steps are necessary in accordance with prudent operating standards to rectify the situation.

27. Not less than 30 days prior to commencement of construction work in the field for the Project, Applicant will provide to Commission staff the following information:

    a) the most current preconstruction design, layout, and plans, including the turbine model selected;

    b) a sound level analysis showing compliance with the applicable sound level requirements;

    c) a shadow flicker analysis showing the anticipated shadow flicker levels will not exceed applicable requirements per year at any residence, absent a waiver agreement executed by the residence owner(s);

    d) should Applicant decide at a later point to use a different turbine model, it shall provide the information required in parts a-c above. Applicant shall also demonstrate that in selecting locations for the other turbines, it considered how to reduce impacts on non-participating landowners; and

    e) additional Project preconstruction information as Commission staff requests.

28. The Applicant agrees to use alternative turbine locations instead of the following primary turbine locations CR-16, CR19, CR-23, CR-60, CR-49, CR-67, and CR-68. If during construction at an alternative turbine, Applicant determines that the location is not suitable for a turbine due to geotechnical, cultural, environmental issues or other constructability issues, the Applicant shall file an affidavit with the Commission setting forth why the alternative turbine cannot be used and identifying which primary turbine will be used. If there is a dispute over the use of a primary turbine, the Applicant and PUC Staff shall meet and attempt to resolve the dispute within 10 business days of the filing of the affidavit. If the dispute cannot be resolved within 10 business days, the Applicant shall file a request for a material deviation with the Commission.

29. Within 90 days after the Project's commercial operation date, Applicant shall submit a report to the Commission that provides the following information:

    a) as-built location of structures and facilities, including drawings clearly showing compliance with the setbacks required by state and local governments set forth in Table 9-1 of the Application;

    b) ArcGIS shapefiles of the final turbine and facility layout;

    c) the status of remedial activities for road damage, landowner property damage, crop damage, environmental damage, or any other damage resulting from Project construction activities; and

d) a summary of known landowner complaints and Applicant's plan for resolving those complaints.

30. Applicant shall seek input from local emergency response personnel to properly and effectively coordinate an emergency response plan consistent with local resources and response abilities. Upon completion of construction, a Project operation emergency response plan shall be provided to Commission staff to make available to the general public on the Commission's website.

31. Prior to the construction of the Project, Applicant will notify public safety agencies by providing a schedule and the location of work to be performed within their jurisdiction. The agencies contacted will include the South Dakota Department of Public Safety, the sheriffs of Codington County and Grant County, and the Codington County and Grant County Offices of Emergency Management.

32. Applicant agrees to undertake a minimum of two years of independently-conducted post-construction avian and bat mortality monitoring for the Project, and to provide a copy of the report and all further reports to the USFWS, SDGFP, and the Commission.

33. Applicant shall file a Bird and Bat Conservation Strategy (BBCS) prior to beginning construction of the Project. The BBCS shall be implemented during construction and operation of the Project.

34. At least 30 days prior to commencement of construction, Applicant shall submit the identity and qualifications of a public liaison officer to the Commission for approval to facilitate the exchange of information between Applicant, including its contractors, landowners, local communities, and residents, and to facilitate prompt resolution of complaints and problems that may develop for landowners, local communities, and residents as a result of the Project. Applicant shall file with the Commission its proposed public liaison officer's credentials for approval by the Commission prior to the commencement of construction. After the public liaison officer has been approved by the Commission, the public liaison officer may not be removed by Applicant without the approval of the Commission. The public liaison officer shall be afforded immediate access to Applicant's on-site project manager, its executive project manager, and to the contractors' on-site managers and shall be available at all times to Commission staff via mobile phone to respond to complaints and concerns communicated to the Commission staff by concerned landowners and others. Within 10 working days of when Applicant's public liaison officer has been appointed and approved, Applicant shall provide contact information for him/her to all landowners in the Project Area and to law enforcement agencies and local governments in the vicinity of the Project. The public liaison officer's contact information shall be provided to landowners in each subsequent written communication with them. If the Commission determines that the public liaison officer has not been adequately performing the duties set forth for the position in this Order, the Commission may, upon notice to Applicant and the public liaison officer, take action to remove the public liaison officer. The public liaison's services shall terminate 90 days after the Project commences commercial operations, unless the appointment is extended by order of the Commission.

35. If the Project is decommissioned, Applicant will follow Section 21 of the Application and the decommissioning plan laid out in Appendix L of the Application. The Commission shall be notified prior to any decommissioning action.

36. Applicant shall utilize an Aircraft Detection Lighting System if approved by the Federal Aviation Administration.

37. The terms and conditions of the Permit shall be made a uniform condition of construction and operation, subject only to an affirmative written request for an exemption addressed to the Commission. A request for an exemption shall clearly state which particular condition should not be applied to the property in question and the reason for the requested exemption. The Commission shall evaluate such requests on a case-by-case basis, which evaluation shall be completed within 60 days unless exigent circumstances require action sooner.

38. Applicant shall provide a copy of the Commission's Final Decision and Order Granting Permit to Construct Facilities; Notice of Entry and attached Permit Conditions in this docket to the affected county, townships, and municipalities in the Project Area.

39. Shadow flicker at residences shall not exceed 30 hours per year unless the owner of the residence has signed a waiver.

40. Applicant will use two methods to detect icing conditions on turbine blades: (1) sensors that will detect when blades become imbalanced or create vibration due to ice accumulation; and (2) meteorological data from on-site permanent meteorological towers, on-site anemometers, and other relevant meteorological sources that will be used to determine if ice accumulation is occurring. These control systems will either automatically shut down the turbine(s) in icing conditions (per the sensors) or Applicant will manually shut down turbine(s) if icing conditions are identified (using meteorological data). Turbines will not return to normal operation until the control systems no longer detect an imbalance or when weather conditions either remove icing on the blades or indicate icing is no longer a concern. Applicant will pay for any documented damage caused by ice thrown from a turbine.

41. For purposes of this Project and the commitments herein, "residences," "business(es)," "structures," "schools," "churches," "cemeteries," and "public buildings" shall include only those that are in existence and in use as of the date of the Commission's order issuing a permit.

42. Turbines shall be set back at least 1.1 times the tip height, with a minimum set back distance of 500 feet, from any surrounding property line. However, if the owner of the wind turbine tower has a written agreement with an adjacent land owner allowing the placement of the tower closer to the property line, the tower may be placed closer to the property line shared with that adjacent land owner.

43. The Applicant shall implement the avoidance, minimization and mitigation measures identified as follows for Traditional Cultural Properties (TCPs):

    i) Implement standard avoidance or resource protection practices (e.g., barrier fencing, contractor training) for TCPs, where feasible, in collaboration with the Sisseton-Wahpeton Oyate, Yankton Sioux, Rosebud Sioux and Spirit Lake Tribal Historic Preservation Officers (THPOs) and the Applicant;

ii) Make reasonable efforts to identify participating landowners who may be willing to work with the tribes on site preservation, accessibility and protection of TCPs on their property;

iii) Conduct site revisits prior to construction;

iv) Help facilitate post-construction site revisits for tribes with the landowners; and

v) Identify and implement education/interpretation opportunities regarding tribal resource preservation and/or Native American perspectives which may include sensitivity training when needed.

A Federal Aviation Administration determination of no hazard is pending for the following turbine locations:

CRI-37

CRI-44

CRI-46

CRI-49

CRI-52

The Project, exclusive of all unrelated background noise, shall not generate a sound pressure level (10-minute equivalent continuous sound level, Leq) of more than 45 dBA as measured within 25 feet of any non-participating residence unless the owner of the residence has signed a waiver, or more than 50 dBA (10-minute equivalent continuous sound level, Leq) within 25 feet of any participating residence unless the owner of the residence has signed a waiver. The Project Owner shall, upon Commission formal request, conduct field surveys and provide monitoring data verifying compliance with specified noise level limits. If the measured wind turbine noise level exceeds a limit set forth above, then the Project Owner shall take whatever steps are necessary in accordance with prudent operating standards to rectify the situation.

If a field survey and monitoring data is requested by the Commission, the Project Owner shall submit the test protocol to the Commission prior to conducting the survey and sound monitoring for approval. The test protocol shall include and be implemented as follows:

a) The post-construction monitoring survey shall be conducted following applicable American National Standard Institute (ANSI) methods.

b) Sound levels shall be measured continuously for 14 days in an effort to capture a sufficient quantity of valid readings meeting the wind conditions delineated below in subpart (e). A sufficient quantity shall be defined as 0.5% of the total number of samples, or a minimum of 10 for a 14 day measurement period. As a precaution against the possibility that a sufficient number of valid readings are not automatically recorded during the chosen 14 day sampling period, 10 on/off tests shall be carried out during the survey period when the project is operating at full power production irrespective of the ground level wind speed. For the on/off tests, all units in the project shall be shut down for a 10 minute period synchronized with the monitors clocks (starting, for example, at the top of the hour or 10 minutes after, 20 minutes after, etc.). The background level measured during the shut down interval can then be subtracted from the average of the levels measured immediately before and after it to determine the project-only sound level. The results from these tests may be used to make up for any shortfall in collecting 10 samples measured when the ground level wind speed is low.

c) Measurements shall be conducted at a select number of non-participating and participating residences with the highest expected noise levels and/or at specific residences identified in the Commission's formal request. Typically, 4 to 6 measurement locations total should be selected.

d) Measurements shall be conducted using sound level meters meeting ANSI Type 1 specifications. An anemometer shall be placed within 20 feet of each microphone, and at a height of approximately 2 meters above the ground.

e) The measurement data shall be analyzed as follows:

   i. At a minimum, the closest five wind turbines will be operating for evaluation periods and when at least the closest wind turbine is operating at a condition at full (within one decibel of maximum sound power levels) acoustic emissions.

- ii. Discard those samples measured when the 10-minute average ground wind speed is greater than 5 m/s.
- iv. Discard those samples measured during periods with precipitation.
- v. If measured (total) sound levels exceed the sound level limits, determine project only sound levels by removing transient background noise (i.e. occasional traffic, activities of residents, farming activities, and wind gusts) based upon audio recordings, excessive wind gusts, personal observations, and/or comparison of sound level metrics.
- vi. If measured (total) sound levels exceed the sound level limits, determine project only sound levels by removing, continuous background noise. This approach requires wind turbine shut-downs, where the background noise is measured directly. Background noise levels will be subtracted from total noise levels measured during these wind conditions to calculate turbine-only noise levels.
- vii. As necessary, review of the frequency spectra of potential turbine-only samples to identify and remove outliers (spectral shape clearly differing from those samples measured under very low (less than 2 m/s) ground wind conditions, which are the samples most representative of turbine-only noise).

f) Compare the resulting turbine-only noise levels to the 45 and 50 dBA limits. Compliance shall be demonstrated if all samples are less than the limits.