**BEFORE**
**THE OHIO POWER SITING BOARD**

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| In the Matter of the Application of **REPUBLIC WIND, LLC** for a Certificate of Environmental Compatibility and Public Need for a Wind-Powered Electric Generating Facility in Republic and Sandusky Counties, Ohio. | )<br>)<br>)<br>)<br>) | Case No. 17-2295-EL-BGN |

# DIRECT TESTIMONY OF

**Isaac Old**
**Resource Systems Group, Inc.**

**on the behalf of**

**Republic Wind, LLC**

**October 21, 2019**

**Q-1. Please state your name, current title, and business address.**

**A-1** My name is Isaac Old. I am a Consultant at Resource Systems Group, Inc. ("RSG"). My business address is 55 Railroad Row, White River Junction, Vermont 05001.

**Q-2. What is your educational background?**

**A-2** I have a Bachelor of Science degree in Physics from Centre College and a Master of Science degree in Architectural Acoustics from Rensselaer Polytechnic Institute (RPI). I received the Robert Bradford Newman Award for Merit in Architectural Acoustics for my thesis work at RPI.

**Q-3. What is your professional background?**

**A-3** I am an acoustician, specializing in noise assessments for environmental sound sources, and consultation on building acoustics, with more than nine years of experience. For environmental noise, I am involved in pre- and post-construction sound level measurement, sound propagation modeling, design of noise mitigation, and project management. For architectural acoustics, I am involved with design of acoustical treatments, room-acoustics modeling, and sound insulation modeling. I have worked on projects in many different industries including renewable energy, electrical transmission, institutions, parks and tourism, and residential developments. I am a member of the Acoustical Society of America, and the Institute of Noise Control Engineering. I am FHWA Transportation Noise Model 2.5 certified. I have undertaken training courses in both the Cadna/A sound propagation modeling program and the sound level monitoring methods of the National Park Service.

I have extensive experience particular to wind power projects with involvement in more than twenty wind power project noise assessments for projects located in thirteen different states. I have presented three papers at national and international conferences on subjects relating to wind turbine noise. Two of these papers were presented at and published by the INCE Europe International Conference on Wind Turbine Noise. I have been involved in preconstruction ambient sound level monitoring for at least ten wind turbine projects and postconstruction compliance monitoring for another ten wind turbine projects. I have also peer-reviewed the postconstruction monitoring efforts of other acoustical consultants. A copy of my resume is attached to my testimony as Attachment IO-1.

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

**A-4** I am testifying on behalf of the Applicant in the case, Republic Wind, LLC (“Applicant” or “Republic Wind”).

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

**A-5** The purpose of my testimony is to sponsor the Noise Impact Assessment Report (“Noise Report”), which is Appendix H to the Amended Application for Certificate of Environmental Compatibility and Public Need (“Application”), and updated on June 28, 2019 with the filing of Republic Wind’s modifications to the Application.

**Q-6. Please discuss the Board’s construction and operational noise requirements that apply to the project.**

**A-6** The Board requires applicants to submit certain information regarding potential noise impacts. This information includes:

- OAC 4906-4-08(A)(3)(a)- An analysis of construction noise levels expected at the nearest property boundary;
- OAC 4906-4-08(A)(3)(b)- An analysis of operational noise levels expected at the nearest property boundary;
- OAC 4906-4-08(A)(3)(c)- The location of any noise-sensitive areas within one mile of the facility;
- OAC 4906-4-08(A)(3)(d)- A description of the equipment and procedures that will be used to mitigate the effects of noise emissions during construction and operation; and
- OAC 4906-4-08(A)(3)(e)- Preparation of a preconstruction background noise study of the project area that includes measurements taken under both day and nighttime conditions.

At the time of the initial Application, there were no Ohio state statutes or regulations establishing quantitative noise standards. However, in cases decided prior to the Application, the Ohio Power Siting Board (OPSB) conditioned similar permits using a sound level standard of 5 dBA above nighttime ambient sound levels measured in the area, using the equivalent continuous sound level ($L_{eq}$) as the metric.[1] While not a required standard at the time of the Application, given the precedent, this is the noise design goal applied to this Project in the Application.

**Q-7. Please generally describe the process of preparing the Noise Report.**

**A-7** The first step was to establish the existing nighttime ambient sound level. Sound monitoring locations were selected to represent the unique soundscapes in the project area. In selecting locations, RSG considered land use, roads and railways, ground cover, elevation, and population density. Monitors were then deployed to collect ambient sound levels. The results were analyzed and used to describe the existing acoustical environment within the Project area. In addition, the data was processed and summarized to derive the nighttime ambient equivalent continuous sound levels ($L_{eq}$). This is used to establish the noise limit for the Project.

Once the sound monitoring was complete, the Project sound propagation model was developed with current project and turbine information. The model was used to calculate operational project sound levels at each receptor location, as well as providing sound level contours. At each receptor location, compliance was evaluated relative to the project noise limit of 5 dBA above the nighttime ambient equivalent continuous sound level. For the receptors that did not meet the noise limit without mitigation, low-noise modes were implemented in the model for select wind turbines until the noise limit was met at each nonparticipating receptor. Once all receptors were modeled to be in compliance, the noise assessment report was prepared, which presents project information, methodology, and results of the ambient sound monitoring and sound propagation modeling.

**Q-8. Why is it important to determine the pre-existing ambient sound levels of the project area?**

**A-8** The project noise impact must be evaluated based on the change to the existing ambient sound levels. To comply with OPSB precedent project sound level limits, the pre-existing ambient sound levels must be measured for comparison in the acoustical analysis.

[1] The Board has since incorporated the 5 dBA above nighttime ambient levels standard in OAC 4906-4-09(F)(2).

**Q-9. Please describe the standards and methodology you followed when analyzing the pre-existing ambient sound levels in the project area?**

**A-9** To document the pre-existing ambient sound level, seven sound level monitoring systems were deployed at locations representative of soundscapes present within the project area. The monitors were deployed for a 15-day period to collect sound level data over a range of meteorological conditions. Each monitoring location was equipped with one of three sound level meter models: the Cesva SC-310, Svantek SV979, or Rion NL-22. The Cesva and Svantek models are ANSI/IEC Class 1 sound level meters, which provides an accuracy of approximately ± 0.7 dB. A Class 1 sound level meter provides the highest accuracy for environmental sound monitoring. The Rion model is an ANSI/IEC Class 2 sound level meter and was stationed at one monitoring location. This type of meter has an accuracy of ± 1 dB. All of these sound level meters logged A-weighted equivalent continuous sound levels once each second. A-weighting is the most commonly used sound level weighting metric used for environmental noise assessment. A-weighting is applied to instrument-measured sound levels in an effort to account for the relative sensitivity of human hearing to different frequencies of sound, at relatively low magnitudes. The A-weighting curve approximates the relative sensitivity of the human ear relative to a 40 dB tone at 1 kHz. The human ear is most sensitive to frequencies around 3,500 Hz, but becomes rapidly less sensitive to sound at frequencies below 500 Hz and higher than 4 kHz. The Cesva and Svantek sound level meters were also set to log 1/3 octave sound levels once each second. Each sound level meter was equipped with audio recording capability through either internal capability or an external audio recorder. All audio recordings were collected through the same microphone that collected sound level measurements. Audio recordings were continuous at all locations and were used for sound source identification and soundscape characterization. Each sound level meter's microphone was mounted on a wooden stake at a height of approximately 1.2 meters (4 feet) and covered with a seven-inch diameter weather-resistant windscreen. Data was collected at one-second intervals, which was then compiled into 10-minute periods during post-processing. During this process, data collected during periods with high wind or rain were removed from the data set. Also removed were sounds that were due to interaction of people or animals with the equipment or were seasonal. Data post-processing focused on two sound level metrics: equivalent continuous sound levels ($L_{eq}$) and 10th percentile sound levels ($L_{90}$). The $L_{90}$ is the sound level exceeded 90-percent of the time and gives information about the residual level of sound during quieter periods. It typically removes all transient sound sources, which may include sources that are intrinsic to the monitored locations. The $L_{eq}$ is one of the most common ways of describing environmental sound levels. It measures the average sound energy present over a given period of time. The OPSB's precedents have typically specified the $L_{eq}$ sound metric in its noise requirements. Even though OPSB precedents have typically only specified the $L_{eq}$, the $L_{90}$ is also presented in the noise assessment to allow for better characterization of the soundscapes and range of sound levels at each monitoring location.

**Q-10. How did you select your monitoring locations?**

**A-10** Each location was selected as representative of a given landscape or soundscape that would be in and around the project area. Factors such as land use, road traffic, distance to roadways, population density, and distance to geographic features (rivers, relative elevation, ground cover, etc.) were considered in selecting the sound monitoring locations. Consideration was also given to accessibility in winter weather and to the security of the monitoring equipment. For instance, the "North Boundary," as shown in Figure 3 of the report was selected because this location is near the northern extremity of the proposed project and represents a lower vehicle traffic agricultural area in the northern part of the project. The "Mixed Residential" location, illustrated by Figure 5, was selected to represent one of few higher-density residential areas within the proposed project boundary. Next, the "Agricultural Operations" areas, as shown in Figure 7, represents the majority of the area within the proposed project boundary; it consists of larger-scale agricultural operations and related low-density housing. The "Wooded Area," as demonstrated by Figure 11, represents areas with sporadic tree cover and surrounding agricultural fields. The "Remote Rural" area in Figure 13 was selected to represent a quiet area that is still subject to agricultural activity. Lastly, the "Southern Boundary," illustrated by Figure 15, is located near the southern extremity of the proposed project and represented a lower traffic agricultural area in the southern part of the project. By selecting locations with geographic, residential proximity, and varied activity levels, an accurate characterization of existing sound levels throughout the project area could be obtained.

**Q-11. Did you follow any particular industry standards when you selected your monitoring locations?**

**A-11** The selection of the monitoring locations was based on best practices in the industry, professional judgment, and my experience evaluating sound levels within similar areas for this type of project. In addition, I followed relevant guidance in ANSI S12.9-2005/Part 2 (Quantities and Procedures for Description and Measurement of Environmental Sound – Part 2: Measurement of long-term, wide area sound) and ANSI S12.9-2013/Part 3 (Quantities and Procedures for Description and Measurement of Environmental Sound – Part 3: Short-term Measurements with an Observer Present) as applicable. The purpose of the monitoring was to summarize long-term wide area sound, similar to the intent of ANSI S12.9 Part 2, but also to characterize sound sources, similar to the intent of ANSI S12.9 Part 3. The wide-area survey method used is similar to the "deterministic spatial sampling method" described in Section 5.1.1 in ANSI S12.9 Part 2. The methods used by RSG in this case are the same as those previously employed for other Ohio-based projects (13-0197-EL-BGN (Northwest Ohio Wind), 13-1177-EL-BGN (Scioto Ridge Wind), and 10-2865-EL-BGN (Black Fork Wind)).

**Q-12. What did you determine to be the average nighttime ambient sound level for the project area?**

**A-12** Among all seven sites in the project area, the average nighttime sound level is 41 dBA. Applying the OPSB's precedent regarding operational sound level limit of 5 dBA above the average nighttime ambient sound level, the operational sound limit for this Project is 46 dBA $L_{eq\ (1\ hr)}$ measured at any non-participating sensitive receptor.

**Q-13. In your opinion, is 41 dBA an accurate reflection of the ambient nighttime average sound level in the project area?**

**A-13** Yes, it is. It is based on sound monitoring under a variety of meteorological conditions at representative soundscapes in the project area.

**Q-14. Did you perform an acoustical analysis regarding the potential noise impacts of the project during operation?**

**A-14** Yes. To determine the potential noise impacts from the proposed wind turbines, RSG performed sound propagation modeling.

**Q-15. Please describe the standards and methodology you used in your sound propagation modeling for this project?**

**A-15** RSG's sound propagation modeling was performed in accordance with the standard ISO 9613-2, "Acoustics – attenuation of sound during propagation outdoors, Part 2: General method of calculation." This portion of ISO 9613-2 specifies an engineering methodology for calculating the attenuation of sound during propagation outdoors to predict the levels of environmental noise at a distance from a variety of sources. The modeling takes into account sound source power levels, surface reflection and absorption, atmospheric absorption, geometric divergence, meteorological conditions, barriers, and terrain. The acoustic modeling software we used was CadnaA, from Datakustik, GmbH. CadnaA is a widely accepted acoustical modeling propagation tool, used by many noise control professionals in the United States and internationally. CadnaA implements the ISO 9613-2 standard. Parameters used in RSG's sound propagation modeling are considered to provide accurate but conservative results for conditions where receptors are downwind of turbines, or equivalently, with a moderate nighttime inversion.[2] The model assumes all wind turbines are producing their maximum sound emissions. Sound emissions information used for each turbine was the most recently available from the manufacturer. RSG's modeling approach has been accepted by the OPSB in prior cases and are commonly used in professional practice in the United States and abroad.

**Q-16. Please describe the different scenarios you considered when analyzing the proposed wind turbine models.**

**A-16** Sound propagation modeling for this Project was performed for the following wind turbine models:

- Vestas V136 (3.6 MW)

[2] (Evans & Cooper, 2012)

- Vestas V150 (4.2 MW)
- Vestas V 150 (5.6 MW)
- Siemens SG145 (4.5 MW)
- Nordex N149 (4.5 MW)
- Nordex N149 (4.8 MW)
- Nordex N149 (5.5 MW)
- Nordex N149 (5.7 MW)

Sound propagation modeling was performed for each of the proposed models at all fifty of the proposed turbine locations. In those instances where the modeled turbine exceeded the 46 dBA noise limit at non-participating receptors, selected turbines were placed into noise reduced operations (NRO). Each turbine model has its own set of NRO modes, which result in different sound level reductions.

**Q-17. Based on your initial modeling results, would any of the scenarios result in operational noise that exceeds 5 dBA over ambient for any non-participating landowners?**

**A-17** After incorporating NRO modes for certain turbines, our modeling results showed that for the eight scenarios evaluated, no non-participating receptors have modeled sound levels in excess of 46 dBA.

**Q-18. Have you reviewed the petition to intervene of Republic County Residents ("Residents") that was filed in this case?**

**A-18** Yes.

**Q-19. In their petition to intervene, the Residents claim that Republic "manipulated its measurement of the existing average ambient noise to inflate that calculation." What is your response to this statement?**

**A-19** This assertion seems to be based on the Residents' preference of the $L_{90}$ sound level metric for derivation of the project sound level limit. This was not used for several reasons. The first reason is the OPSB specifies use of the $L_{eq}$ for calculation of the nighttime ambient sound level in previous wind project cases. Additionally, under ANSI S1.1-2013, the "ambient" sound is, "All-encompassing sound at a given place, usually a composite of sounds from many sources near and far." Since the soundscape at the monitored locations includes transient sound sources (both near and far), those will need to be included in any representative sound level measurement of the area. The $L_{90}$ sound level advocated for by the Residents would not include 90% of the sound present at these locations, and thus would not be representative of actual soundscapes or the ambient sound. Use of the period-long $L_{90}$ would remove any and all distinct sound sources, which would not adequately describe sound sources that are present in this area. Further, the $L_{eq}$ has also previously been used to describe the ambient sound level for OPSB cases Northwest Ohio Wind LLC (13-0197-EL-BGN), Scioto Ridge Wind Farm (13-1177-EL-BGN), and Black Fork Wind Farm (10-2865-EL-BGN). In these cases, OPSB accepted the methodology RSG used in those case to determine ambient sound levels.

**Q-20. In their petition to intervene, the Residents' sound expert states, "The Seneca and Sandusky County nighttime is not a constant, raucous clamor of 41 dBA." Is this an accurate description?**

**A-20** This description is an incorrect characterization of the soundscape. First, not all sound sources, even if they have the same overall level, will sound the same. Second, as far as sound levels go, 41 dBA is a relatively low level. For example, normal (non-raised) speech volume is approximately 60 dBA at 1 to 2 meters distance. The maximum recommended interior sound levels for a variety of rooms is above 41 dBA, including living rooms, hotels/motels, offices, conference rooms, health care facilities, worship spaces, libraries, and courtrooms.[3] The same level of sound, 41 dBA, is also the average level (nighttime $L_{eq}$) of over 100 monitoring locations in rural agricultural land.[4] Other Ohio wind power projects that have had ambient sound measured in a similar manner have also had similar average ambient sound levels (Scioto Ridge – 42 dBA, Northwest Ohio Wind – 42 dBA, and Black Fork – 43 dBA). As an additional comparison, below is a table with car passby levels (excluding trucks) at all Project monitoring locations with the distance to the closest road included. In some cases, cars are not the loudest sound sources in the area. For example, at the Mixed Residential monitor, train passbys can have maximum one second equivalent continuous average sound levels of 81 dBA.

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[3] (Cowan, 2016)

[4] (Kaliski, Bastasch, & O'Neal, Regulating and Predicting Wind Turbine Sound in the U.S., 2018)

| Monitor | Distance to Closest Road | Car Passby Sound Pressure Level Range (Maximum 1-second $L_{eq}$ - dBA) |
|---|---|---|
| Agricultural Operations | 96 meters<br>315 feet | 46-59 dBA |
| Busy Roadway | 80 meters<br>262 feet | 52-63 dBA |
| Mixed Residential | 150 meters<br>492 feet | 36-48 dBA |
| North Boundary | 378 meters<br>1,240 feet | 40-45 dBA |
| Rural | 350 meters<br>1,148 feet | 43-49 dBA |
| Southern Boundary | 93 meters<br>305 feet | 52-60 dBA |
| Wooded Area | 615 meters<br>2,018 feet | 33-42 dBA |

**Q-21. In their petition to intervene, the Residents state that the project will produce noise at non-participating residences in excess of the World Health Organization's ("WHO") 2009 recommendation of 40 dBA threshold for adverse health effects. What is your response to this statement?**

**A-21** The WHO Europe's Night Noise Guidelines for Europe ("WHO Europe 2009 Guidelines") provide recommendations for governing jurisdictions and regulatory agencies to consider when attempting to address potential environmental noise impacts. These are simply guidelines, particularly for communities considering establishing noise standards, and they do not automatically apply in any circumstance and were not developed specifically for wind turbines. These guidelines do not override noise regulations that have been established by a regulatory entity. In our case, the OPSB has established a precedent sound level limit of 5 dBA over the project area ambient nighttime $L_{eq}$ specifically for evaluating wind power facilities.

**Q-22. Has the WHO issued environmental noise guidance for wind turbines regarding sound levels at residences?**

**A-22** The 2018 WHO Europe Environmental Noise Guidelines for the European Region (WHO 2018) contain a "conditional" recommendation of 45 dB $L_{den}$ (annual average day-evening-night level) limit for wind turbines. The term "conditional" means that a recommendation would require a rigorous policy-making process involving substantial debate and involvement of various stakeholders; moreover, there is less certainty of its efficacy owing to lower quality of evidence. Thus, there may be circumstances where WHO 2018 does not apply.

WHO 2018 outlines the shortcomings of their work in Section 3.4.2.3, "Consideration of additional contextual factors." Among several shortcomings, Section 3.4.2.3 states that 1) there is minimal evidence about the adverse health effect of long-term exposure to wind turbine noise; 2) other than annoyance, evidence of health effects from wind turbine noise is either absent or rated low or very low quality; 3) the recommendation for wind turbines remains conditional due to insufficient evidence to provide a strong, certain, and definitive recommendation; and 4) there are serious issues with noise exposure assessments relating to wind turbines found in the literature.

Furthermore, the applicability of the guideline is questionable due to the use of the $L_{den}$. The WHO 2018 report does not state any prediction methodologies for wind farms. In addition, it does not state how to measure an annual average $L_{den}$ for wind turbines, and there are currently no standardized methods to do this. Assessing compliance with the $L_{den}$ would require measurement of turbine-only sound levels during all times of day and during all meteorological and operational conditions. Due to the number of other sound sources at most wind turbine sites, this would be difficult, if not impossible. Compliance assessment for a project with the $L_{den}$ as a regulatory limit would require a months-long, if not years-long, compliance measurement period. This would be quite costly, if it could be done at all. It is entirely possible that a considerable number of the operational conditions exhibited by wind power projects would be un-measurable due to presence of other sound sources. For residents in and around the project, it would also increase the amount of time that would transpire before compliance test results, stemming from noise complaints, would be known.

If the $L_{den}$ metric had been demonstrated to be the best assessment of wind turbine noise impacts, then its use as a metric would be more justifiable. As is mentioned by the WHO, this has not been demonstrated. The primary reason for its use as the guideline metric is due to its inclusion in the European Noise Directive, and is not applicable in the U.S.

In any event, WHO guidelines have not been adopted as noise standards by the OPSB in Ohio.

**Q-23. In their petition to intervene, the Residents claim that Republic Wind's "calculation of a 41 dBA average ambient noise level is inflated by its failure to screen out wind noise picked up by the noise monitors." How do you respond to this statement?**

**A-23** The Residents' claim is incorrect. As is stated on p. 17 (Section 4.2) of Appendix H of the Application, we eliminated sound level data if microphone-height wind speeds exceeded 5 m/s (11 mph). This is consistent with ANSI S12.9 Part 3. We also used seven-inch wind screens, which will filter out wind-caused pseudo sound to a greater extent than the standard three-inch versions. The Residents' assertion partially relies on a quote from ANSI/ASA S12.100-2014. I should also mention that the quote provided from ANSI/ASA S12.100 is in the introduction to the standard and not the body. No specific requirements regarding measurements collected during windy periods are found elsewhere in ANSI/ASA S12.100-2014. ANSI/ASA S12.100 is also explicitly intended to measure the $L_{90}$, so in cases where that is not the intent, it is not applicable.

**Q-24. In their petition to intervene, the Residents claim that Republic Wind inflated ambient sound levels by locating the "Mixed Residential" noise monitor near the Flat Rock Care Center parking lot. How do you respond to this?**

**A-24** The Mixed Residential monitor was carefully positioned to prevent any single sound source from dominating the ambient sound level. First, the monitor was positioned approximately 60 meters (197 feet) from the parking lot of the Flat Rock Care Center (FRCC) parking lot. This is not as close as it could have been. If we had chosen to position the monitor closer to the parking lot, we could have moved it south along the tree line. Second, any movement to the north or west of the current location would have moved the monitor closer to the rail line, County Road 29/Main Street or County Road 34. Both of those roadways are well traveled. The rail line would also have been a major noise source, particularly with the horn blasts that are required at the crossings of both county roads. Further movement to the south would have moved the monitor closer to Flat Rock Quarry and eventually out of the village of Flat Rock, and out of the soundscape that the Mixed Residential monitor was chosen to represent. Quarry sound was also audible at this location, so movement to the south or west of the current location probably would have made this more dominant. In short, the location of the Mixed Residential monitor was not chosen to inflate sound levels, it was actually chosen to reduce sound levels, while still representing the soundscape of Flat Rock. Finally, activity at Flat Rock Care Center was focused on the daytime, and data used for derivation of the OPSB sound level limit was exclusively obtained from the nighttime.

Monitoring was also performed during the winter months, when sound due to vegetation is at a minimum and sound due to agricultural activities was greatly reduced relative to the growing season. This results in lower overall sound levels relative to monitoring performed during other seasons.

**Q-25. In their petition to intervene, the Residents claim that Republic Wind artificially lowered its noise emissions calculation in its Noise Report. How do you respond to this statement?**

**A-25** Although it is not entirely clear what the Residents are referring to, it appears that the Residents are addressing the fact that the Noise Report accounts for when the turbines operate in reduced noise mode as mitigation for selected turbines. Use of such mitigation is consistent with accepted practice and is typically included as part of the manufacturer specifications of turbines.[5] Because a greater number of turbines are evaluated than will actually be constructed, it may not be necessary to apply mitigation to all turbines for which it is currently specified.

**Q-26. Does this conclude your testimony?**

**A-26** Yes, it does, except that I reserve the right to update this testimony to respond to any further testimony in this case.

[5] (Petitjean, Ambekar, Drobietz, & Kinzie, 2015)

## CERTIFICATE OF SERVICE

I hereby certify that the foregoing Direct Testimony of Isaac Old was served upon the following parties of record via regular or electronic mail this 21st day of October 2019.

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# ISAAC OLD

Consultant

Isaac Old is an acoustician, specializing noise assessments for environmental sound sources, and consultation on architectural spaces. For environmental noise, he is involved in pre- and post-construction sound level measurement, sound propagation, design, and project management. For architectural acoustics, he is involved with design, room-acoustics modeling, and sound insulation modeling. Isaac has worked in many different industries including renewable energy, electrical transmission, academia, parks and tourism, and residential developments.

## EXPERIENCE

9 years

## EDUCATION

MS, Architectural Acoustics, Rensselaer Polytechnic Institute (2010)

BS, Physics, Centre College (2009)

## PROJECT EXPERIENCE

**Golden West Wind Farm** – Conducted sound propagation modeling for a proposed 250 MW wind farm in Colorado. Studied compliance of the project with the area's property line noise standard, as well as impact on the surrounding structures. (2011)

**Maine Wind Farm** – Conducted sound propagation modeling for a proposed 33 MW wind farm in Maine. This model took into account the effect of the area's unique meteorology on noise levels that would be produced by the wind farm. Assessed compliance of the project with the Maine DEP noise standard. Aided in preparing a report comparing the modeled impacts of construction of the wind farm as well as the finished wind farm to existing sound levels of the area. Performed post-construction monitoring to assess compliance with the Maine DEP noise standard. (2015)

**Black Fork Wind** – Conducted sound propagation modeling for a proposed wind farm in Ohio. Helped to develop a turbine arrangement that complies with the Ohio Power Siting Board's (OPSB) noise standard. (2011)

**Massachusetts Wind Farm** – Prepared noise impact assessment for a proposed wind farm in Massachusetts. Performed analysis on monitored sound pressure level and wind speed data. Used measured data to compare modeled noise impacts with existing background sound levels and wind speed. Demonstrated in the report the probability of the proposed project exceeding Massachusetts' noise standard. Worked with developer to determine the financial impact of possible sound mitigation strategies. (2011)

**Minden, Michigan Wind Farm** – Modeled noise impacts of a proposed 35 MW wind farm in the "thumb" of Michigan. Worked with the client to develop an array that would meet state and local ordinances, taking into account the additional impacts of a

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neighboring wind farm owned by a different developer. (2011)

**Existing Maine Wind Farm** – Worked with a developer to model mitigation measures for complainants of an existing wind farm in Maine. Measured existing sound insulation of a home and modeled mitigation measures that included strategically-placed exterior building additions and sound insulation reinforcement of the resident's houses. Worked with developer to select and obtain suitable building materials for the improvements. Later performed monitoring to assess compliance of the wind farm with Maine DEP standards Chapter 375(10). (2011 and 2013)

**Canton Wind Farm, Canton, Maine** – Prepared noise modeling report for a proposed wind farm in Maine. Performed ISO 9613-2 sound propagation modeling in compliance with Maine Department of Environmental Protection (DEP) regulations and prepared the report to directly address concerns of the Maine DEP. After the project was constructed, performed compliance monitoring in conformance with Maine DEP requirements and wrote a report summarizing findings of the measurements. (2013 and 2018)

**Spruce Mountain Compliance Monitoring** – Wrote a spreadsheet macro to analyze compliance sound level data from Spruce Mountain Wind to determine valid monitoring compliance periods in accordance with Maine DEP regulations. Wrote five annual reports outlining monitoring results, to fulfill Maine DEP permit conditions. (2016)

**Scioto Ridge Wind** – Performed noise impact assessment for proposed wind farm in Hardin County, Ohio. Conducted long term monitoring to determine background sound levels across the project area. This data was used to determine the project sound level limit according to OPSB precedent. Conducted sound propagation modeling to determine project compliance with that sound level limit. (2012)

**GMP Vergennes Net Metering Turbine** – Conducted compliance monitoring of net metered wind turbine near Vergennes, Vermont. Measured sound levels over several days, coinciding with periodic turbine curtailments. Analyzed data to determine compliance with Vermont Public Service Board permit conditions.  (2012)

**Kingdom Community Wind Compliance Monitoring** – Conducted preliminary compliance monitoring of proposed wind project to determine the feasibility of a proposed compliance monitoring method. Collected data at four primary monitoring sites and four background monitoring sites and conducted correlations to determine degree of agreement between sites. Performed compliance monitoring once each season for two years to assess compliance of the project with permit conditions. (2014)

**Michigan Wind 2 Compliance Monitoring** – Performed sound level compliance monitoring for the Michigan Wind 2 wind project in the "thumb" of Michigan. Monitored at nine locations over a period of 10 days to measure operational and background sound levels. Analyzed the measured data to asses compliance with permit-specified limits. Wrote a report summarizing applicable sound level limits, monitoring methodology, and monitoring results. (2012)

**Massachusetts Research Study on Wind Turbine Acoustics** – Conducted background sound level monitoring and analysis for a research study on wind turbine sound. Study included data collection from five wind projects in New England and quantitative analysis of factors such as infrasound, amplitude modulation, sound pressure levels, and sound propagation modeling. (2016)

**Walnut Ridge Wind Farm** – Performed a noise modeling study of the proposed Walnut Ridge Wind Farm in Bureau County, Illinois. Modeled the proposed wind turbine array at nearby receivers and evaluated compliance of the project with the Illinois Pollution Control Board (IPCB) octave band standard and Bureau County, Illinois ordinance. Summarized findings in a report that was submitted as part of the project's conditional use permit application. (2014)

**Blazing Star I Wind Farm** – Helped perform a noise impact assessment of a wind power project proposed for Minnesota. Performed pre-construction sound level monitoring and monitoring data analysis in accordance with Minnesota's guidance for performing noise assessments (2016)

**Cassadaga Wind Farm** – Performed a noise impact assessment for the Cassadaga wind power project, in accordance with New York Article X guidelines and stipulations made between the project developer and the State of New York Department of Public Service. Project work included two seasons of background sound level monitoring, annualized sound propagation modeling, analyses of monitoring accuracy, and extensive literature reviews of literature concerning wind turbine noise. After permit submittal, provided support for written testimony and briefs. (2018)

**Baron Wind Farm** – Performed a noise impact assessment for the Baron Wind Farm, located in Steuben County, New York. Noise impact assessment was performed in accordance with New York Article X guidelines. The impact assessment included two seasons of monitoring, a literature review on wind turbine noise, percent highly annoyed estimates, short- and long-term term operational modeling, and extensive construction noise modeling. Participated in negotiating stipulations with the New York Department of Public Service. Provided assistance written testimony and briefs. (2019)

**Jordan Creek Wind** – Performed sound propagation modeling for a proposed 400 megawatt wind farm proposed for Warren and Benton County, Indiana. Services included sound propagation modeling, documentation, and hearing support. Hearing support included reviews of literature submitted by intervenors and local authorities. (2016)

## PUBLICATIONS

Old, Isaac. "Human Health Hazard – The Shirley Wind Story." *8th international Conference on Wind Turbine Noise.* Lisbon, Portugal: 12-14 June 2019.

Old, I. and Kaliski, K. "Wind Turbine Noise Dose Response – Comparison of Recent Papers." *7th International Conference on Wind Turbine Noise*. Rotterdam, Netherlands: 2-5 May 2017.

Old, I. and Duncan, E., High Transmission Loss Glass Wall Design. *Noisecon 2013*. Denver, Colorado: 26-28 August 2013.

Kaliski, K., Old, I. and Blomberg, L., Sound Emissions from a Plug-in Electric Vehicle. *Internoise 2012.* New York, New York: 19-22 August 2012.

Old, I.  Sound Transmission Loss Measurement:  A Scale Model Approach.  Rensselaer Polytechnic Institute, 2010.

## PRESENTATIONS

Old, I., Eros, E., and Duncan, E., Wind Turbine Noise Ordinances: A Review of Selected State and Local Regulations, 161st Meeting of the Acoustical Society of America, May 2011.

## LICENSES, CERTIFICATIONS, MEMBERSHIPS, AND AFFILIATIONS

- Associate, Acoustical Society of America
- Member, Institute of Noise Control Engineering
- FHWA Transportation Noise Model 2.5 Certified