EXHIBIT A12

BEFORE THE PUBLIC UTILITIES COMMISSION
OF THE STATE OF SOUTH DAKOTA

IN THE MATTER OF THE APPLICATION OF CROWNED RIDGE LLC, II FOR A FACILITIES PERMIT TO CONSTRUCTION 300.6 MEGAWATT WIND FACILITY

Docket No. EL19-027

SUPPLEMENT TESTIMONY AND EXHIBITS

OF CHRISTOPHER OLLSON

September 20, 2019

INTRODUCTION

Q. PLEASE STATE YOUR NAME AND BUSINESS ADDRESS.

A. My name is Chris Ollson. My business address is 37 Hepworth Crescent, Ancaster, Ontario, Canada.

Q. **BY WHOM ARE YOU EMPLOYED AND IN WHAT CAPACITY?**

A. I am the sole proprietor of Ollson Environmental Health Management (OEHM). This is a consultancy that provides expertise on environmental health challenges related to siting of energy projects (e.g., oil and gas, pipelines, gas plants, wind turbines, solar, transmission lines, and energy-from-waste). Clients include a mix of private sector companies and governments at all levels.

Q. **WHAT ARE YOUR RESPONSIBILITIES?**

A. I am a consultant to Crowned Ridge Wind II, LLC ("CRW II") on the scientific literature related to sound, shadow flicker, and the siting of wind turbines to ensure the protection of health of residents.

Q. **PLEASE DESCRIBE YOUR BACKGROUND AND QUALIFICATIONS.**

A. My area of expertise is in the field of environmental health science. I am trained, educated, and practiced in the evaluation of potential risks and health effects to people associated with environmental health issues. I have been consulting on environmental health issues for over 20 years. My full curriculum vitae is found in Exhibit CO-S-1.

My formal education includes:

- Doctorate of Philosophy, Environmental Science, Royal Military College of Canada, Kingston, Ontario, Canada, 2003.
- Master of Science, Environmental Science, Royal Military College of Canada, Kingston, Ontario, Canada, 2000.
- Bachelor of Science (Honours), Biology, Queen's University, Kingston, Ontario, Canada, 1995.

In addition to my consulting practice, I hold an appointment of Adjunct Professor in the School of the Environment at the University of Toronto. From 2013-2016, I was appointed to the Governing Council, and was Vice-Chair of the Academic Affairs Committee for the University of Toronto Scarborough. I teach a graduate course at the University of Toronto in Environmental Risk Analysis and have supervised a number of Doctoral students and Post Doctoral Fellows.

I have been qualified to provide expert opinion evidence on wind turbines and potential health effects at a number of North American hearings, tribunals, and legal cases.

Q. WAS THIS SUPPLEMENTAL TESTIMONY PREPARED BY YOU OR UNDER YOUR DIRECT SUPERVISION?

A. Yes.

Q. **HAVE YOU PREVIOUSLY TESTIFIED BEFORE THE SOUTH DAKOTA PUBLIC UTILITIES COMMISSION?**

A. Yes, in Docket No. EL19-003.

Q. PLEASE DESCRIBE THE PURPOSE OF YOUR SUPPLEMENTAL TESTIMONY.

A. The purpose of my testimony is to address the comments made at the August 26, 2019 Public Input Meeting on whether there are any health or welfare issues associated with the proposed CRW II wind project in the context of the scientific peer-reviewed studies on health and welfare.

HEALTH AND WELFARE

Q. AT THE AUGUST 26, 2019 PUBLIC INPUT MEETING COMMENTS WERE MADE ON THE SOUND THAT WILL BE PRODUCED BY THE PROJECT. ARE YOU FAMILIAR WITH THE CRW II WIND PROJECT AND THE APPLICABLE COUNTY ORDINANCES ON SOUND?

A. Yes, I understand that CRW II is proposing to build up to 300.6 megawatts of wind generation, with up to 132 wind turbines. The project is spread between Codington, Grant, and Deuel Counties. I have also reviewed the Direct and Supplement Testimony of CRW II witness Jay Haley. This includes the results of the Final and Updated Reports – Crowned Ridge II Wind Farm Sound Study Codington, Deuel and Grant Counties, SD. Based on a review of Mr. Haley's testimony, I understand that CRW II wind project will not exceed 45 dBA at a non-participant's residence and 50 dBA at a participant's residence, which applies the Deuel and Grant County sound requirements to the entire project.

Both Deuel and Grant Counties have sound ordinances restricting wind turbine sound to 45 dBA at non-participating occupied structures and 50 dBA at participating structures. Codington County restricts the wind turbine sound to 50 dBA at non-participating property lines and does not have a sound restriction at residences. However,

CRW II has designed its project in such a manner to ensure that all non-participating and participating structures in Codington County also meet the more stringent Deuel and Grant County requirements. Accordingly, CRW II meets all three county ordinance requirements.

Q. AT THE AUGUST 26, 2019 PUBLIC INPUT MEETING COMMENTS WERE MADE ON THE SHADOW FLICKER IMPACT FROM THE PROJECT. ARE YOU FAMILIAR WITH THE CRW II WIND PROJECT AND THE APPLICABLE COUNTY ORDINANCES ON SHADOW FLICKER?

A. Yes. All three counties restrict shadow flicker to no more than 30 hours a year without a waiver from the landowner. To comply with the counties shadow flicker requirements, it is my understanding that CRW II will either seek a waiver or curtail turbines to ensure the 30-hour threshold is not exceeded.

Q. AT THE AUGUST 26, 2019 PUBLIC INPUT MEETING, COMMENTS WERE MADE ABOUT THE SOUND LEVELS THAT WILL BE PRODUCED BY THE PROJECT. BASED ON YOUR UNDERSTANDING THAT NON-PARTICIPANTS WILL NOT EXPERIENCE SOUND ABOVE 45 DBA AT THEIR RESIDENCE, DO YOU HAVE ANY HEALTH AND WELFARE CONCERNS BASED ON THE SCIENTIFIC PEER-REVIEWED STUDIES?

A. No. The peer-reviewed scientific literature concludes that there are no health or welfare issues associated with non-participants experience sound at or below 45 dBA at the exterior of their residence. Indeed, the largest epidemiology study that evaluated health

issues associated with living in proximity to wind turbines noted no adverse health effects at noise levels up to 46 dB, attached as Exhibit CO-S-2. This study presents the peer-reviewed published findings of the Health Canada Wind Turbine Noise (WTN) and Health Study. This is most comprehensive study of its kind to date and its results will be referenced a number of times in my testimony. This study was initiated in 2012 and was a partnership between Health Canada and Statistics Canada to understand the potential impacts of wind turbine noise on health and well-being of communities in Southern Ontario and Prince Edward Island. A total of 1238 households participated in the study, with an almost 80% response rate of all households within 6 miles of projects investigated, making it the largest and most comprehensive study ever undertaken around the world. Households were located between 820 feet and 6 miles from operational wind turbines. The A-weighted dBA sound levels (audible sound/noise) were grouped into 5 dBA increments with the loudest level in the Health Canada study at the exterior of a home being 46 dBA Leq (highest nighttime level). The study found:

> Beyond annoyance, results do not support an association between exposure to WTN up to 46 dBA and the evaluated health-related endpoints.

I understand that at the August 26, 2019 Public Input Meeting that specific concerns were raised about vertigo, nausea, and depression, and that wind turbines could cause a worsening of pre-existing conditions. The Health Canada study, however, does not support these concerns because it did not find any relationship between these specific health concerns and living in proximity to wind turbines or the sound at their residences.

Another study on the impact of wind turbines on sleep evaluated 1,238 participants self-reporting sleep quality over 30 days using the Pittsburgh Sleep Quality

Index ("PSQI") and additional questions assessing the prevalence of diagnosed sleep disorders and the magnitude of sleep disturbance over the previous year (Exhibit CO-S-3). Also, for the first time in this study, objective measures for sleep latency, sleep efficiency, total sleep time, rate of awakening bouts, and wake duration after sleep were recorded using the wrist worn Actiwatch2® for 654 participants, over a total of 3,772 sleep nights. It is the largest and most comprehensive sleep study of its kind ever undertaken for wind turbine noise. The study presented the following conclusions:

> The potential association between WTN [wind turbine noise] levels and sleep quality was assessed over the previous 30 days using the PSQI, the previous year using percentage highly sleep disturbed, together with an assessment of diagnosed sleep disorders. These self-reported measures were considered in addition to several objective measures including total sleep time, sleep onset latency, awakenings, and sleep efficiency. In all cases, in the final analysis there was no consistent pattern observed between any of the self-reported or actigraphy-measured endpoints and WTN levels up to 46 dB(A) [820 ft]. Given the lack of an association between WTN levels and sleep, it should be considered that the study design may not have been sensitive enough to reveal effects on sleep. However, in the current study it was demonstrated that the factors that influence sleep quality (e.g. age, body mass index, caffeine, health conditions) were related to one or more self-reported and objective measures of sleep. This demonstrated sensitivity, together with the observation that there was consistency between multiple measures of self-reported sleep disturbance and among some of the self reported and actigraphy measures, lends strength to the robustness of the conclusion that WTN levels up to 46 dB(A) [820 ft] had no statistically significant effect on any measure of sleep quality.

Also, the first study to be published on before-after operation effect of wind turbine noise on objectively measured sleep was conducted with those living within 1.25 miles to a five-wind turbine project in Ontario, Canada. (Exhibit CO-S-4). A portable polysomnography was used in the study that is a complex system that objectively monitors people's sleep in their homes. The study concluded:

> The result of this study based on advanced sleep recording methodology together with extensive noise measurements in an ecologically valid setting cautiously suggests that there are no major changes in the sleep of participants who host new industrial WTs in their community.

The conclusion in these sleep studies, Exhibit CO-S-3 and Exhibit CO-S-4, supports the position that residents do not experience sleep disturbance from the wind turbine sound at or below the 45 dBA levels. As explained in the testimony of Haley, CRW II is designed so that no the wind turbines do not exceed 45 dBA at a non-participating resident.

Q. BASED ON YOUR UNDERSTANDING THAT PARTICIPANTS WILL NOT EXPERIENCE SOUND ABOVE 50 DBA AT THEIR RESIDENCE, WHAT IS YOUR VIEW ON WHETHER THE SCIENTIFIC LITERATURE HAS FOUND A HEALTH OR WELFARE CONCERN?

A. The scientific literature has not found a health or welfare concern from the operation of wind energy projects that result in sound at receptors less than 50 DBA. The study attached as Exhibit CO-S-5 reported the number or percentage of awakenings with those living in proximity to wind turbines in a rural setting. As shown in Table 7 of the study, which is reproduced below, more people in rural environments are awakened by people/animal sound and traffic/mechanical sounds, than by the proximate wind turbines. In this study, people living in close proximity to wind turbines reported wakening up more by people/animal noise (11.7%) and rural traffic/mechanical noise (12.5%), than by turbine noise (6.0%). The sound levels in this study were as high as 54 dBA from wind turbines at the exterior of neighboring homes.

Table 7
Sound sources of sleep disturbance in rural and urban area types, only respondents who did not benefit economically from wind turbines.

Sound source of sleep disturbance	Rural		Urban		Total	
	n	%	n	%	n	%
Not disturbed	196	69.8	288	64.9	484	66.8
Disturbed by people/ animals	33	11.7	64	14.4	97	13.4
Disturbed by traffic/ mechanical sounds	35	12.5	75	16.9	110	15.2
Disturbed by wind turbines	17	6.0	17	3.8	34	4.7
Total	281	100	444	100	725	100

Furthermore, the study attached as Exhibit CO-S-6 concluded that:

> Aggregate annoyance was effectively 0 (i.e., least squares mean − 0.11) among the 110 participants who reported to receive personal benefit from having wind turbines in the area, compared to an average of 1.93 among those who did not report such benefits.

Based on my review of the studies in Exhibit CO-S-5 and Exhibit CO-S-6, there are no health issues, sleep disturbance, or annoyance issues associated with participants experiencing sound levels of 50 dBA or lower at their residence.

Q. WHAT DOES SCIENTIFIC LITERATURE STATE WITH RESPECT TO HEALTH IMPACTS AND INFRASOUND OR LOW FREQUENCY SOUND?

A. Infrasound is a term used to describe sounds that are produced at frequencies too low to be heard by the human ear at frequencies of 0 to 20 Hz, at common everyday levels. It is typically measured and reported on the G-weighted scale (dBG). Low frequency noise (LFN), at frequencies between 20 to 200 Hz, can be audible. LFNis typically measured and reported on the C-weighted scale (dBC) to account for higher-level measurements and peak sound pressure levels. Universally, wind turbine sound standard are set using audible dBA levels, as they are in Deuel, Grant, and Codington Counties, and approved based on modeling.

A study was conducted to investigate whether typical audible noise-based guidelines for wind turbines account for the protection of human health given the levels of infrasound and LFN typically produced by wind turbines. (Exhibit CO-S7). In this study that I oversaw and co-authored, we conducted new field measurements of indoor infrasound and outdoor LFN at locations between 1,312 feet and 2,952 feet from the nearest turbine. The analysis showed that indoor infrasound levels were below auditory threshold levels, while LFN levels at generally accepted setback distances were similar to background LFN levels.

The study also discussed two guidelines for exposure to infrasound (dBG), although neither is specific to wind turbine noise. The first was The Queensland Department of Environment and Resource Management's Draft *ECOACCESS Guideline-Assessment of Low Frequency Noise* proposed an interior infrasound limit of 85 dBG. This value was derived based on a 10 dB protection level from the average 95 dBG hearing threshold and previous Danish recommendations for infrasound limits. The second was The Japanese Handbook on Low Frequency Noise, which provides an infrasound reference value of 92 dBG at 10 Hz and 1/3 octave bands up to 80 Hz. These values were derived from investigations that monitored complaints of mental and physical discomfort from healthy adults exposed to low frequency sounds in a room. The application of these guidelines for infrasound to CRW II shows that that infrasound would not reach homes. The homes are located too far from the turbines based on audible sound criteria to have the accompanying infrasound levels exceed these guidelines.

The Ministry for the Environment, Climate and Energy of the Federal State of Baden Wuerttemberg in Germany (Exhibit CO-S-8) also conducted extensive study of infrasound and LFN around wind turbines and concluded:

> Together with the health authorities, we in Baden-Württemberg have come to the conclusion that adverse effects relating to infrasound from wind turbines cannot be expected on the basis of the evidence at hand.

Therefore, these studies show that there no correlation between wind turbines sited as proposed by CRW II, the producing of LFN and infrasound, and impacts to sleep and health.

Q. GIVEN THE COMMENTS AT THE AUGUST 26, 2019 PUBLIC INPUT MEETING, WHAT DOES THE SCIENTIFIC PEER-REVIEWED STUDIES SHOW REGARDING WHETHER SOUND FROM THE WIND TURBINES WILL RESULT IN ANNOYANCE AND COMPLAINTS?

A. In the study attached as Exhibit CO-S-9, the World Health Organization Quality of Life – BREF questionnaire was administered to 1238 participants who lived between 820 feet to 7 miles from wind turbines. This questionnaire evaluated self-reported physical health, psychological, social relationships, and environment in relation to quality of life ("QOL"). The study showed that regardless of sound level produced by wind turbines at homes the QOL was not impacted:

> The present study findings do not support an association between exposure to WTN up to 46 dBA [820 ft] and any of the WHOQOL-BREF domains (Physical Health, Psychological, Social Relationships and Environment) or the two stand-alone questions pertaining to rated QOL and Satisfaction with Health. Participants who were exposed to higher WTN levels did not rate their QOL or Satisfaction with Health significantly worse than those who were exposed to lower WTN levels, nor did they report having significantly worse outcomes in terms of factors that comprise the 4 domains.

Further, annoyance from wind turbine noise does not directly translate to a number of complaints. The study attached as Exhibit CO-S-2 in Table IV, reproduced below, identifies the number of formal complaints (with % in brackets) by sound grouping. It also provides the annoyance levels at each sound level. Table IV shows that a greater percentage of people reported annoyance with visual aspect of the projects over that of the actual sound levels. Also, the percentage of complaints between 40-46 dBA (2.6%) was consistent with those living up to 7 miles from wind turbines where the sound level would be completely inaudible at the <25 dBA (2.4%). The highest level of formal complaints was at the 35-40 dBA (4.2%). This data suggests regardless of the sound level there will be a small percentage of complaints with those with visual complaints of the wind turbines.

TABLE IV. Perception of community noise and related variables.

	Wind Turbine Noise (dB)						
Variable	<25	[25–30)	[30–35)	[35–40)	[40–46]	Overall	CMH *p*-value[a]
Formal complaint[f]	2 (2.4)	2 (2.1)	3 (1.0)	22 (4.2)	6 (2.6)	35 (2.8)	0.2578
Reporting a high (very or extreme) level of annoyance to wind turbine features, *n* (%)							
Noise	0 (0.0)	2 (2.1)	3 (1.0)	52 (10.0)	32 (13.7)	89 (7.2)	<0.0001
Visual	2 (2.4)	15 (16.0)	17 (5.6)	81 (15.5)	44 (18.9)	159 (12.9)	

Further, a 2019 study (Exhibit CO-S-10) included participants from Europe and the United States. The U.S. sample included 1441 residents living near 231 wind farms, across 24 states. People living between 262 feet and up to 3 miles from a turbine were included in the research. Sound levels in the study ranged from <30 dBA to >50 dBA. The study concluded:

> Average annoyance due to local traffic noise was relatively low in both samples and, more importantly, comparable to WT noise annoyance. Annoyance caused by agricultural machinery noise was clearly stronger in the European sample compared to the U.S., but it was still only 'slightly' annoying in Europe.

* * *

> Average annoyance levels of residents near wind farms in Europe and the U.S. were low, with the levels for noise similar across both samples, with European levels slightly higher for shadow-flicker, lighting and landscape change. In all cases the annoyance levels were comparable to the levels associated with traffic noise.

In sum, the peer-reviewed studies, Exhibits CO-S-2, CO-S-9 and CO-S-10, do not support that sound levels of wind farms correlate to annoyance and complaints.

Q. AT THE AUGUST 26, 2019 PUBLIC INPUT MEETING THERE WERE COMMENTS ON SHADOW FLICKER. WHAT IS YOUR VIEW ON WHETHER THE SCIENTIFIC LITERATURE HAS FOUND A HEALTH OR WELFARE CONCERN WITH SHADOW FLICKER?

A. Shadow flicker occurs when the wind turbine blades interrupt sunlight that is experienced in the interior of homes. It manifests as a shadow "flickering" effect within the room of a house.

In the study I co-authored, Exhibit CO-S-11, we found no health effects associated with shadow flicker:

> Although shadow flicker from wind turbines is unlikely lead to a risk of photo-induced epilepsy there has been little if any study conducted on how it could heighten the annoyance factor of those living in proximity to turbines. It may however be included in the notion of visual cues. In Ontario it has been common practice to attempt to ensure no more than 30 hours of shadow flicker per annum at any one residence.

This study is further supported by the work conducted on shadow flicker and the potential risk of seizures in those people with photosensitive epilepsy. Photosensitive

epilepsy affects approximately 5% of people with epilepsy where their seizures can be triggered by flashing light. The Epilepsy Society first investigated this issue in the United Kingdom in the late 2000s. They polled their members and determined that no one had experienced an epileptic seizure living or being in proximity to a wind farm from shadow flicker (Exhibit CO-S-12).

Following on from this informal polling, two of the United Kingdom's academic experts in epilepsy published scientific research articles in the area (Exhibit CO-S-13) and (Exhibit CO-S-14). These are seminal studies that investigated the relationship between photo-induced seizures (i.e., photosensitive epilepsy) and wind turbine shadow flicker. Both studies indicate that flicker from turbines that interrupt or reflect sunlight at frequencies greater than 3 Hz pose a potential risk of inducing photosensitive seizures in 1.7 people per 100,000 of the photosensitive population. For turbines with three blades, this translates to a maximum speed of rotation of 60 revolutions per minute (rpm). Large, modern, utility scale wind turbines spin at rates well below this threshold and are typically below 20 rpm. For example, the General Electric turbines being proposed for the CRW II Farm have a maximum rotational speed of 15.6 rpm (0.78 Hz). Therefore, shadow flicker from these wind turbines is not at a flash frequency that could trigger seizures and not a concern supported in the peer-review scientific literature.

Further, in 2011, the Department of Energy and Climate Change (United Kingdom) issued a report, Exhibit CO-S-15, that concluded:

> On health effects and nuisance of the shadow flicker effect, it is considered that the frequency of the flickering caused by the wind turbine rotation is such that it should not cause a significant risk to health.

Therefore, there is nothing in the scientific literature that suggests that shadow flicker should be limited to protect health.

Q. ARE THE 30 HOURS OF SHADOW FLICKER STANDARD ADOPTED BY THE COUNTIES THAT WILL HOST THE CRW II PROJECT CONSISTENT WITH THE HOW OTHER JURISDICTIONS APPLY THE THRESHOLD FOR SHADOW FLICKER?

A. Yes. For context, the origins of the 30-hour shadow flicker threshold standard can be traced to Germany in 2002. (Exhibit CO-S-16 in German and English). The German standard was based on limiting the nuisance of local residents and was subsequently codified.

Also, the United States jurisdictions have successfully adopted shadow flicker restrictions based on the "Realistic/Expected" scenario of no more than 30 hours a year. The following are examples of state-wide legislation.

North Dakota

The North Dakota Public Service Commission ("ND PSC") requires effects from the impact upon light-sensitive land uses to be managed and maintained at an acceptable minimum (N.D. Admin. Code §69-06-08-01(5)(c)(3)). The ND PSC has recognized the 30-hour per year standard and evaluates shadow flicker impacts pursuant to this standard.

Connecticut

Similarly, the Regulations of Connecticut State Agencies Section 16-50j-95, part (c) requires:

Shadow flicker shall not occur more than 30 total annual hours cumulative at any off-site occupied structure location from each of the proposed wind turbine locations and any alternative wind turbine locations at the proposed site and any alternative sites.

Q. DOES THIS CONCLUDE YOUR SUPPLEMENTAL TESTIMONY?

A. Yes, it does.

State of New Mexico)
) ss
County of Bernalillo)

I, Chris Ollson, being duly sworn on oath, depose and state that I am the witness identified in the foregoing prepared testimony and I am familiar with its contents, and that the facts set forth are true to the best of my knowledge, information and belief.

Chris Ollson

Subscribed and sworn to before me this 18th day of 2019 2019.

OFFICIAL SEAL
ANTOINETTE BARRERAS
NOTARY PUBLIC
STATE OF NEW MEXICO
My Commission Expires 6/10/22

Notary Public

My Commission Expires 6/10/22