BEFORE THE STATE OF WASHINGTON

ENERGY FACILITY SITE EVALUATION COUNCIL

In the Matter of Application No. 2009-01: WHISTLING RIDGE ENERGY LLC; WHISTLING RIDGE ENERGY PROJECT	EXHIBIT NO. 7.00

APPLICANT'S PREFILED DIRECT TESTIMONY

WITNESS #7: MARK STORM

Q Please state your name and business address.

A My name is Mark Storm, and my business address is 1615 Murray Canyon Road, Suite 1000, San Diego, California 92108-4319.

Q What is your present occupation and profession, and what are your duties and responsibilities?

A I am a Senior Project Engineer with URS Corporation, an international environmental and engineering consulting firm providing services to organizations such as Whistling Ridge Energy LLC. URS Corporation assists organizations in analyzing

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environmental impacts and land use compatibility of projects such as the Whistling Ridge Energy Project. I am Institute of Noise Control Engineering (INCE) Board Certified and have over 18 years of acoustics and noise control experience that includes managing tasks for environmental noise regulation review, field surveys, acoustical impact assessment, and mitigation planning and compliance evaluation for various types of energy projects—including wind energy projects. My duties on this Project were to conduct or direct existing ambient sound measurement, predictive construction and operation noise analysis, and noise impact assessment and mitigation recommendations. I assisted in the preparation of the Application for Site Certification for this Project.

Q Please identify what has been marked for identification as Exhibit No. 7.01.

A Exhibit No. 7.01 is a résumé of my education background and employment experience.

Q Are you sponsoring any portions of the Application for Site Certification for the Whistling Ridge Energy Project?

A Yes. I am sponsoring the following sections for which I was primarily responsible for the analysis and development:

Section 4.1.1 Noise

Q Are you sponsoring any appendices or other documents that are part of the Application for Site Certification?

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A No.

Q Are you familiar with the identified section of the Application for Site Certification?

A Yes.

Q Did you prepare this section, or, if not, did you direct and/or supervise its preparation?

A Yes.

Q Is the information in this section within your area of authority and/or expertise?

A Yes.

Q Are the contents of this section of the Application for Site Certification either based upon your own knowledge, or upon evidence, such as studies and reports that reasonably prudent persons in your field are accustomed to rely on in the conduct of their affairs?

A Yes.

Q To the best of your knowledge, are the contents of this section of the Application for Site Certification true?

A Yes.

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Q Do you incorporate the facts and contents of this section as part of your testimony?

A Yes.

Q Are you able to answer questions under cross examination regarding this section?

A Yes.

Q Do you sponsor the admission into evidence of this section of the Application for Site Certification?

A Yes.

Q Are there any modifications or clarifications to be made to that portion of the Application for Site Certification that you are sponsoring?

A Yes. On the bottom of page 4.1-13 of the Application, following Tables 4.1-8 through 4.1-11, it is mentioned that operation of the Project's wind turbines is also capable of meeting guideline criteria with respect to increase over ambient. To clarify, neither the State of Washington nor Skamania County utilize an "increase over ambient" criterion, which is subject to some uncertainty or variability because it depends upon the ambient sound level at a given receiver location. Jurisdictions that utilize such an "increase over ambient" criterion often express it as some quantity of decibels (*e.g.*, +10 dBA) over ambient. Here, with the predicted range of increase over ambient being less than 10 dBA at all three nearest representative receivers (see the values in the "Increase" column of the aforesaid Tables), compliance with a hypothetical +10

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dBA over ambient guideline criterion is implied. However, both the State of Washington and Skamania County utilize absolute "Sound Level Limit" thresholds that are not subject to the uncertainty or variability that is inherent in an "increase over ambient" criterion.

Q Would you briefly summarize and describe the state of Washington and Skamania County's noise regulations?

A Energy facilities in Washington must meet the noise standards established under the state's Noise Control Act of 1974, codified at Ch. 70.107 RCW and implemented by WAC 173-60. These rules set maximum permissible environmental noise limits (and exclusions therefrom) based on Environmental Designations for Noise Abatement (EDNA's), which designates areas (types of environments or zones) within which maximum permissible noise limits must be observed. Residential areas (where people reside and sleep) are Class A EDNA's. *See* WAC 173-60-040. Lands characterized by economic activities of such a nature that higher noise levels are anticipated (such as industrial/agricultural) are Class C EDNA's.

Maximum permissible sound levels in Washington are regulated on an A-weighted scale. Most sounds in our environment do not consist of or occur at a single frequency. Environmental noise consists of a broad band of frequencies differing in sound levels. The method commonly used to quantify environmental sounds includes evaluating all frequencies of a sound according to a weighting system which reflects that human hearing is less sensitive at low frequencies and extremely high frequencies than at the mid-range frequencies. This weighting system takes into account humans' audibility of the various frequencies and the decibel level is referred to as the A-weighted sound level (dBA).

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The maximum permissible noise limit for a Class A EDNA receiver is 60 dBA during the day, reduced by 10 dBA during nighttime hours of 10 p.m. to 7 a.m. These identical limits were adopted by Skamania County Code, at Title 8, Ch. 22: Noise Regulations, which identifies county noise limits and exclusions. Skamania County's definitions of EDNA's, and the maximum permissible noise limits and exemptions applicable therein, are consistent with WAC 173-60.

Q Would you please summarize and briefly describe the evaluation of potential noise emissions from the construction of the Whistling Ridge Energy Project?

A The noise that will be generated by construction of the Project will vary depending on the stage of construction, number of construction personnel and type of construction equipment. Construction noise impacts were assessed using calculations that included inputs for (a) distance from source; (b) duty cycle; (c) quantity; and (d) hours (see Section 4.1.1.4 of the Application). Values for source sound power level and distance were reproduced from available manufacturers' data or calculated using industry-accepted formulas linking sound generation to the rated engine horsepower of the equipment. Table 4.1-6 of the Application shows the predicted construction noise levels at the two existing residences closest to the Project. Because all noise-generating construction activities will occur during the hours of 7 a.m. and 10 p.m., construction activities for the Project are exempt from the receiver noise limit guidelines of 60 dBA for daytime and 50 dBA nighttime at residential properties (see WAC 173-60-050). Blasting would occur to the extent necessary for turbine foundation construction. This activity, limited by the number of foundations that require it, would occur during daylight hours only on an intermittent basis within a

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short, one-to two-month period of time. WAC 173-60-050 exempts blasting noise from the state noise limits when conducted during the hours of 7 a.m. and 10 p.m.

Q Would you please summarize and describe the model used to evaluate potential noise emissions while the Project is operating?

A The noise level that can be perceived once the Project is operational is a logarithmic sum of background and Project sounds. A wind project's noise level at a particular receptor will be determined primarily by the wind speed occurring at the turbine and the distance from a receptor to the nearest turbine.

Three-dimensional modeling was conducted for the Application for Site Certification to create a map that depicts the distance at which the Project sound levels reach certain noise levels (see Figure 4.1-1 – Noise Level Contours). The Cadna/A® Noise Prediction Model (Version 3.71.125) was used to estimate sound pressure levels at property lines and noise-sensitive receptors. Cadna/A® is one of the leading tools among a class of popular, currently adopted, commercially-available software programs that are based on internationally-accepted algorithms and numerical techniques. It is routinely used by acoustical professionals to develop sound level predictions from a variety of complex industrial sources, including wind turbines.

Cadna/A® utilizes algorithms based on International Organization for Standardization (ISO) 9613-2 standards for noise propagation calculations. It uses industry-accepted propagation algorithms and accepts sound power levels for the nine standard octave bands ranging from 31.5 Hz to 8,000 Hz, as provided by equipment manufacturers and other sources. Table 4.1-7 of the Application summarizes octave band sound power level inputs from each type of pre-defined noise source. The calculations account for classical sound wave divergence, attenuation factors resulting

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from air absorption, basic ground effects, and barrier/shielding. Intervening natural and man-made topographical barrier effects, such as those from structures, natural terrain, and regions of trees, were considered in the model for the Project as appropriate.

While the exact turbine model to be used for the Project has not yet been determined, conservative yet realistic and representative values for the type of equipment being considered for the Project were used. The model utilized data from an industry leading 1.8 MW 50/60 Hz wind turbine at wind speeds of approximately six meters per second and nine meters per second at 33 feet (10 meters). This is in accordance with the protocol established in International Electrotechnical Commission Standard 61400-11:2002. The decibel values shown in Table 4.1-7 of the Application for the two wind speeds at each octave band center frequency include a +2 dB margin, which produces an A-weighted overall level that represents the top end of a range associated with the manufacturer's warranty values.

The Project layout (arrangement of turbines and ancillary equipment) and topographical features of the Project area were imported into the Cadna/A® program. Cadna/A® utilizes those data inputs and applies top range sound power levels and conservative inputs such as dimensionless absorption constants and cumulative effects of all expected wind turbines associated with the proposed Project layout to predict the operational noise levels at the two existing and one proposed residence nearest to the Project.

Q Could you please explain why the model used treats ground absorption conservatively?

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A The ISO 9613-2 algorithms used in Cadna/A® include the following algorithm to estimate dBA ground attenuation over "porous ground" (*e.g.*, forests, lands covered with vegetation or land that supports vegetation growth), which is representative of the Project area and vicinity:

$$A_{gr} = 4.8 - (2h_m/d)[17+(300/d)]$$

where h_m is the mean height of the propagation path above ground, and d is the source-to-receiver distance (both are in meters). If the proposed wind turbines and receivers were on level terrain, the mean height of the propagation path (h_m) would be approximately 41 meters (*i.e.*, the average height of the path between an 262-foot (80-meter) high hub and a 6-foot (2-meter) high receiver). However, because in this situation the proposed wind turbines are generally going to be built on grade elevations that are substantially higher than those of the receivers, h_m values larger than 41 meters will occur. As noted on page 4.1-4 of the Application, the two closest residences are 2,560 feet (approximately 775 meters) and 4,265 feet (approximately 1,300 meters) from the nearest proposed turbine site. A potential future residence is located 2,000 feet (approximately 600 meters) from the nearest proposed turbine site. Using these values, the table below shows how ground attenuation (A_{gr}) in the ISO 9613-2 algorithm used in Cadna/A® effectively drops to zero at these three sites as the mean height of the propagation path values (h_m) becomes larger:

	h_m (meters)				
	41	82	164	328	656
d (meters)	600	600	600	600	600
A_{gr} (dBA)	**2.4**	**0.0**	**0.0**	**0.0**	**0.0**
d	775	775	775	775	775
A_{gr}	**2.9**	**1.0**	**0.0**	**0.0**	**0.0**
d	1300	1300	1300	1300	1300
A_{gr}	**3.7**	**2.6**	**0.3**	**0.0**	**0.0**

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In other words, ground attenuation under Cadna/A® decreases as the turbines are evaluated at progressively higher grade elevations relative to the receiver. Consequently, while the terrain around the Project site may be porous and *offer* acoustical absorption under the right conditions, the Project's elevated wind turbine hub heights relative to the receivers create sound paths to the receivers that typically result in little or no predicted ground absorptive influence. Acoustical ground absorption is therefore treated conservatively under Cadna/A® for this Project.

Q Will the terrain of the area in and around the Project site likely reflect or amplify sound generated by the wind turbines?

A The modeled elevated hub heights tend to be distant from terrain that might reflect noise (*e.g.*, a sheer, smooth cliffside). Because the sound has to travel a considerable distance before reflecting off of a qualifying surface, it will have attenuated by the time it reaches such a surface and thus have less influence on the aggregate sound at the given distant receiver. Also, much in the same way a concert hall or interior performance space can be found to feature hard, irregular shapes and surfaces that diffuse incoming sound by reflecting it in many different directions, the irregular shapes and facets of rocks, boulders and cliffs would be expected to generally diffuse noise generated by wind turbines, rather than concentrate or amplify it. In addition, the model for the Project included detailed topographical contour lines to reflect the actual Project site and vicinity terrain features.

Q What were the results of this modeling?

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A The Application depicts the night time noise levels at the three existing or proposed residences nearest the Project at Tables 4.1-8 and 4.1-9 (nighttime levels) and the daytime noise levels at the same three residences at Tables 4.1-10 and 4.1-11. At both wind speeds modeled, the Project night noise levels for the three potential noise receivers near the Project do not exceed 43 dBA, which is below the more restrictive nighttime limit of 50 dBA for dwellings in residential areas. The Project's noise levels are consistent with the applicable state and county noise limits.

Q Would you please summarize and briefly describe the evaluation of potential low frequency noise emissions from the operation of the Whistling Ridge Energy Project?

A Low frequency sound is that typically ranging from 100 Hz to 20 Hz. The limit of sound audible to the human ear is generally 20 Hz. Low frequency sound emitted from a wind turbine can include tonal components produced by the generator and gearbox within the nacelle downstream of the rotor hub and atop the tower mast. Low frequency sound emissions from wind turbines are included as noise contributors in the Application's noise analysis (see Table 4.1-7 of the Application). Modern wind turbines typically include sound attenuation features in the nacelle to reduce the magnitude of these noise components. As a result, the spectrum of sound levels at the octave band center frequencies in Table 4.1-7 largely describe the aerodynamic effects of the rotor blades interacting with the passing wind. The upwind rotor configuration of modern wind turbines, including all models considered for this Project, eliminates blade rotor ingestion of aerodynamic turbulence generated by the tower mast, a situation that resulted in considerable low frequency noise for earlier generations of wind turbines. Today, at the low frequency end of the spectrum, ambient noise levels far exceed anticipated aggregate Project operation noise.

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Q Would you please summarize and briefly describe the evaluation of potential infrasound emissions from the operation of the Whistling Ridge Energy Project?

A The term infrasound describes sound with frequencies of 20 Hz or less that are generally considered below the threshold of human hearing. Infrasound, if sufficiently high in magnitude, can be perceived or even heard as induced by vibration. Infrasound occurs naturally in the environment, emanating from sources such as waves, thunder, wind and even certain species of wildlife. Studies noted in the Application on page 4.1-15 have described usage of 85-90 dBG as a criterion for human perception of infrasound and, by reasonable extension, the likely threshold for infrasound complaints. The G-weighting scale, like the A-weighted scale for audible sound spectra, is a filter applied to low-frequency sound as described in ISO 7196:1995E.

Operation of modern wind turbines with the rotors upwind of tubular tower masts generate infrasound in the range of 70 G-weighted decibels at a distance of 100 meters. The horizontal distances of the Whistling Ridge Energy Project's wind turbines to the nearest noise-sensitive receives are at least 600 meters, which provides sufficient attenuation to offset the amount of decibels added to account for the quantity of Project wind turbines. Expected aggregate infrasound at the nearest existing receivers should be under a value of 70 dBG, which is 15 dBG lower than the criteria above. Consequently, the Project's infrasound potential impacts are considered to be either non-existent or less than significant.

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