Motive Acoustics

Noise Impact Assessment

(NIA)

NU-E Corporation

Lethbridge Solar One Solar Power Farm

1/4-10-9-22 W4M

Date: September 23rd, 2022

Executive Summary

NU-E Corporation (NU-E) retained Motive Acoustics Inc. (Motive) to conduct a Noise Impact Assessment (NIA) for the proposed Lethbridge One Solar Power Farm at LSD 1/4-10-9-22 W4M, Alberta. There are multiple residences within 1500 m from the Solar Farm. The purpose of this NIA is to quantify the cumulative noise level at the residences located within 1500 m from the NU-E Solar Power Farm.

The NU-E facility is regulated by the Alberta Utilities Commission (AUC). Therefore, this noise impact assessment was conducted following the methodology set by the AUC Rule 012 Noise Control.

The equipment sound power levels (PWL) were obtained from theoretical calculations, and published manufacturers' data. The modelling was performed using the DGMR iNoise V2021.1 Enterprise modelling software.

According to the results of this NIA study, the predicted noise levels at all residences located within 1500 meters from the proposed Lethbridge One Solar Power Farm located at LSD 1/4-10-9-22 W4M are expected to be within the AUC Rule 012 Permissible Sound Level (PSL).

Additional noise control measures are not required for the Lethbridge One Solar Power Farm located at LSD 1/4-10-9-22 W4M to comply AUC Rule 012 Noise Control.

Motive Acoustics

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Introduction

NU-E Corporation (NU-E) retained Motive Acoustics Inc. (Motive) to conduct a Noise Impact Assessment (NIA) for the proposed Lethbridge One Solar Power Farm at LSD 1/4-10-9-22 W4M, Alberta. There are multiple residences within 1500 m from the Solar Farm. The purpose of this NIA is to quantify the cumulative noise level at the residences located within 1500 m from the NU-E Solar Power Farm.

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Noise Descriptors

Noise is frequently described as unwanted sound and within this context environmental noise is present in some form in all areas of human activity. The most common measurement of environmental noise is the dB(A) level. The descriptor most often used is $L_{Aeq,T}$, i.e. conventional dB(A) level, which would have produced the same A-weighted sound energy at the same time as the actual noise history. The "A-weighting" is the most common frequency weighting in current use, which corresponds approximately to the response of the human ear.

When reporting $L_{eq,T}$, the period of observation T is frequently understood to be 24 hours unless otherwise stated. The Alberta Utilities Commission Rule 012 Noise Control Best establishes L_{eq} criteria for 'Day' defined as the hours of 07:00 to 22:00, and 'Night' defined as the hours of 22:00 to 07:00. The L_{eq} during daytime periods is the 15-hour A-weighted energy equivalent sound level and is denoted as the L_{eq} (Day). Similarly, the L_{eq} during night-time periods is a 9-hour A-weighted energy equivalent sound level and is denoted as the L_{eq} (Night).

The term Sound Pressure Level (SPL) is most often used in measuring the magnitude of sound. It is a relative quantity in that it is the ratio between the actual sound pressure and the fixed reference pressure. Sound pressure is measured at a particular point and may result from several sources of sound.

Sound power is the total amount of sound energy emitted per second by a noise source. A sound source has a given constant sound power that does not change if it is placed in a different environment. The decibel counterpart of sound power is called sound power level abbreviated PWL.

Noise Criteria

This NIA report and analysis have been completed according to the requirements of the AUC Rule 012 Noise Control.

As specified in the Guideline, subjected facility must meet the Permissible Sound Level (PSL) of 40 dBA (L_{eq}) night-time at 1500 meter from the facility fence line if there are no closer dwellings. The Permissible Sound Level is the maximum sound level that a facility must not exceed at a point 15 m from the nearest or most impacted dwelling unit. The PSL is derived from the BSL by adding the daytime adjustment, Class A adjustment, and Class B adjustment. As per the Guideline, the PSL definition is based on summertime condition.

If there are dwellings within 1500 meters, the PSL is determined as per the Table 1 of the Guideline (Appendix A). This table shows the night-time Basic Sound level (BSL). To determine Daytime noise level, 10 dBA L_{eq} is to be added to the BSL. The Ambient Sound Level is assumed to be 35 dBA L_{eq} (nighttime) as indicated on the Guideline and minimum BSL is determined to be 40 dBA L_{eq} (5 dBA L_{eq} above ambient level).

As per the Guideline section 2.3, there are two adjustments to the BSL to define the PSL. Those are Class A adjustment and Class B adjustment. Class A adjustments are based on the nature of the activity and/or the actual ambient sound level in an area. Class B adjustment allows some additional tolerance based upon people's response to temporary noise generation activities. Table 2 and Table 3 of the Guideline shows the adjustment factors for Class A and Class B (refer Appendix A).

In this study, there are multiple residences within 1500 m from the NU-E Solar Power Farm. Motive Acoustics selected the most impact residences to represent the overall impact in the area. This study is not qualified for Class A or Class B adjustment.

The following Table 1 shows the permissible sound level at the residences within 1500 m of the NU-E Lethbridge One Solar Power Farm at LSD 1/4-10-9-22 W4M.

Table 1: Permissible sound level determination at residences

Basic Sound Level (BSL) as per Table 1	Nighttime L_{eq} (dBA)	Daytime L_{eq} (dBA)
Category 1	40	50
Day Time Adjustment	-	10
Class A Adjustment	NA	NA
Class B Adjustment	NA	NA
Permissible Sound Level	**40**	**50**

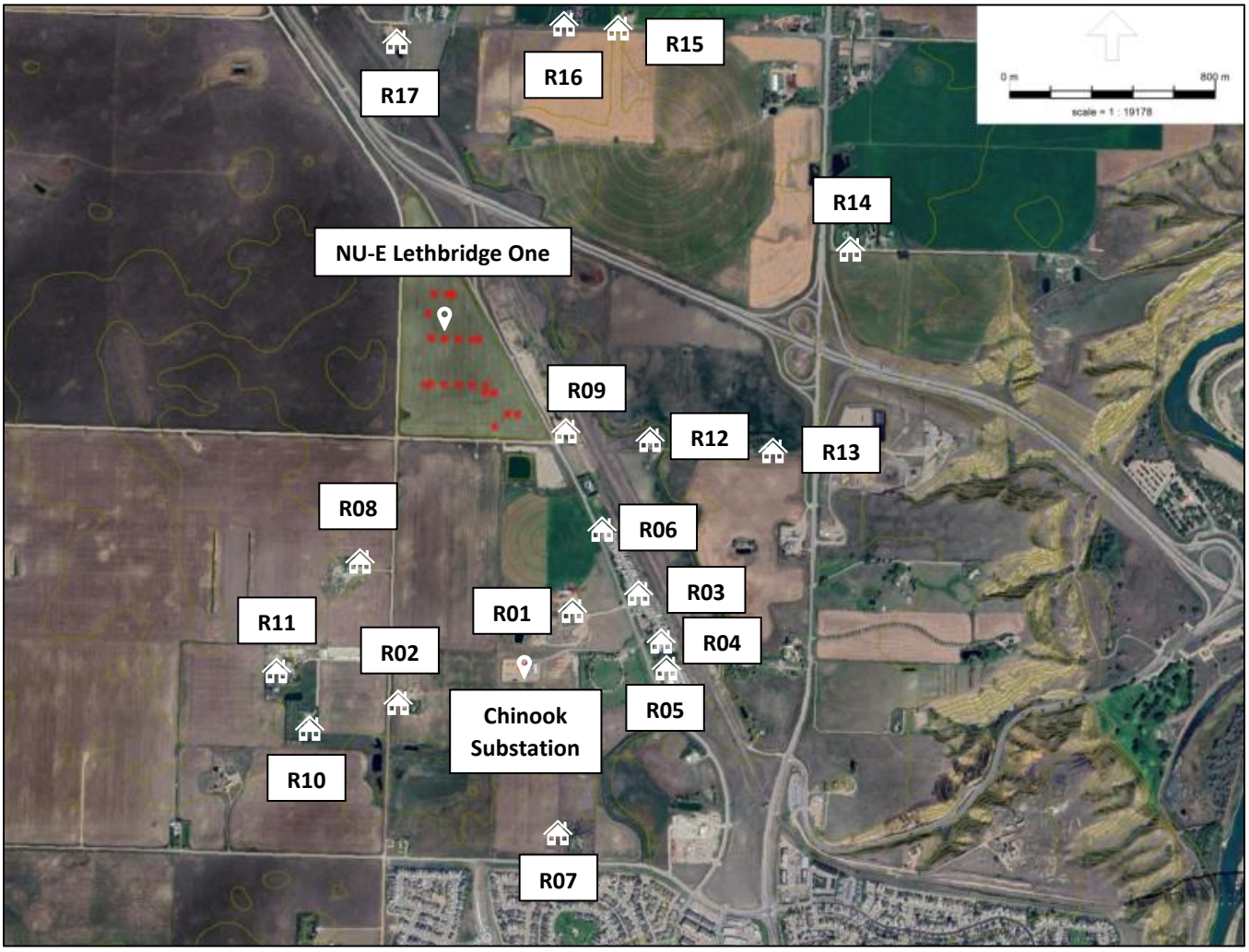
Section 4.2.1 of the Guideline specifies the criteria for Low-Frequency Noise (LFN) consideration. If the predicted dBA value is within the permissible level, there may be LFN problem that may increase annoyance at nearby dwellings. If the potential for LFN does exist, the dBC minus dBA sound level is

equal to or greater than 20 dB, and there is a clear tonal component at a 1/3 octave frequency of 250 Hz or below. If an LFN is confirmed to exist, a 5 dBA penalty will be added to the measured sound level. As this NIA conducted using theoretically calculated Sound Power Levels (PWL), the data is insufficient to predict the existence of a tonal component at a residence location. If Low Frequency Noise is a concern, measurements at the dwelling/s should be performed to confirm the existence of LFN and tonal component.

Study Area Description

The NU-E facility is located at LSD 1/4-10-9-22 W4M. Based on the information provided by NU-E representatives and Google Earth, the site is located Northwest of Lethbridge, Alberta, and surrounding area is mainly flat farmland. There are multiple residences within 1500 m from the solar power farm. Figure 1 shows the study area, the location of the farm, and the location of the selected residences.

Figure 1: Study Area



Equipment List and Operating Condition

Table 2: Major Equipment List

NU-E 1/4-10-9-22 W4M	
Equipment Description	**Equipment Details**
Transformers (3 Units)	• Three (3) 3500 kVA 3 Phase Pad-Mounted Transformer.
Inverters (36 Units)	• Thirty-six (36) SG250HX-US Multi-MPPT String Inverters for 1500 Vdc System.

Nearby Facilities:

Table 3: Nearby Facility Equipment List

Chinook Substation	
Equipment Description	**Equipment Details**
Transformers	• One (1) Power Transformer rated 138/13.8kV and 18/24/30 MVA with 7.5% impedance.

Analysis Methodology and Assumptions

The equipment and study area information were provided by NU-E representatives. Motive Acoustics consultants observed the aerial image of the area to identify the existence of residences in the area and topographical significances. All the major noise sources at the facility were considered for the calculation.

The sound power levels (PWL) of the equipment located at the NU-E Solar Power Farm at LSD 1/4-10-9-22 W4M were determined from theoretical calculations, and manufacturers' data. All sources were modeled as point sources.

Topographic map of the site was obtained from the National Topographic Data Base (NTDB), Canada and was used to model the ground elevation at the site and surrounding area.

The predicted levels at the residences located within 1500 meters from the site were compared to the permissible sound level to determine if the facility will comply with the AUC Rule 012 Noise Control.

Noise Model Parameters

Sound levels were modeled using DGMR iNoise V2021.1 Enterprise noise prediction software. This software is designed to model the environmental sound propagation calculation methods prescribed by the International Organization for Standardization (ISO) Standard 9613 (ISO 1993, 1996). This software also considers geometric spreading, atmospheric sound absorption, ground impedance effects, site topography and geometry, vegetation, and environmental conditions. The ISO 9613 sound propagation method predicts noise levels under moderately developed temperature inversion and downwind conditions, which enhance sound propagation to the receptor.

Ground attenuation affects the sound propagation from the source to receiver. This model uses the porous ground category for the study area, and ISO 9613 classification of porous ground includes ground covered by grass, trees or other vegetation, and any other ground surfaces suitable for growth of vegetation i.e., farmland. Temperature and relative humidity of the model were set to 20 ^{0}C and 80% respectively. The ground absorption coefficients were set to 0.7 for the surrounding area and 0.3 within the facility fence line. In order to predict the worst-case scenario at the residences located at 1500 meters from the site, existing trees were not included in the model.

The DGMR iNoise V2021.1 Enterprise model calculates the cumulative level at the receiver from all the sources within the study area.

Sound Power Levels

Octave Band Sound Power Level for the sources are given in Table 4. These sound power levels have been obtained through theoretical calculations and manufacturer's data.

Table 4: Octave Band Sound Power Level of Modeled Sources

Noise Source	Data Source*	Linear Octave Band Centre Frequency (dB, ref 1 pW)									Overall (dB)
		31.5	63	125	250	500	1k	2k	4k	8k	
Chinook Substation Transformer	T&M	93	99	101	96	96	90	85	80	73	105
NU-E Transformer	T&M	81	87	89	84	84	78	73	68	61	93
NU-E Inverter	T&M	53	59	61	56	56	50	45	40	33	65

* Data Source T&M stands for Theoretical Calculations and Manufacturer's data.

Accuracy and Limitations

The AUC Rule 012 Noise Control have recommended the ISO 9613 standards as one of the international standards to use in environmental noise model. The DGMR iNoise V2021.1 Enterprise noise modeling software follows the ISO 9613 calculation algorithm. According to the standards, the attenuation of sound propagating outdoors between fixed source and the receiver fluctuates due to variations in the meteorological conditions along the propagation path.

As per the standard, the estimated accuracy of the broadband noise of downwind calculation is given in Table 5.

Table 5: Estimated Accuracy of the Noise Propagation

Height (h)[1]	**Distance (d)[2]**	
	0<d<100m	100<d<1000 m
0<h<5m	+/- 3dB	+/-3 dB
5m<h<30m	+/- 1 dB	+/- 3 dB

1. h is the mean height of the source and receiver.
2. d is the distance between the source and receiver.

The estimates have been made from situations where there are no effects due to reflection or attenuation due to screening. Accuracy level for the distance greater than 1000 m are not published in the standard and assumed same as 100 m to 1000 m based on professional experience.

Modeling Results

The predictions for the residences located in the study area are summarized in the Table 6 along with the permissible sound levels (PSLs).

Table 6: Predicted Sound Level at the residences located within 1500 m

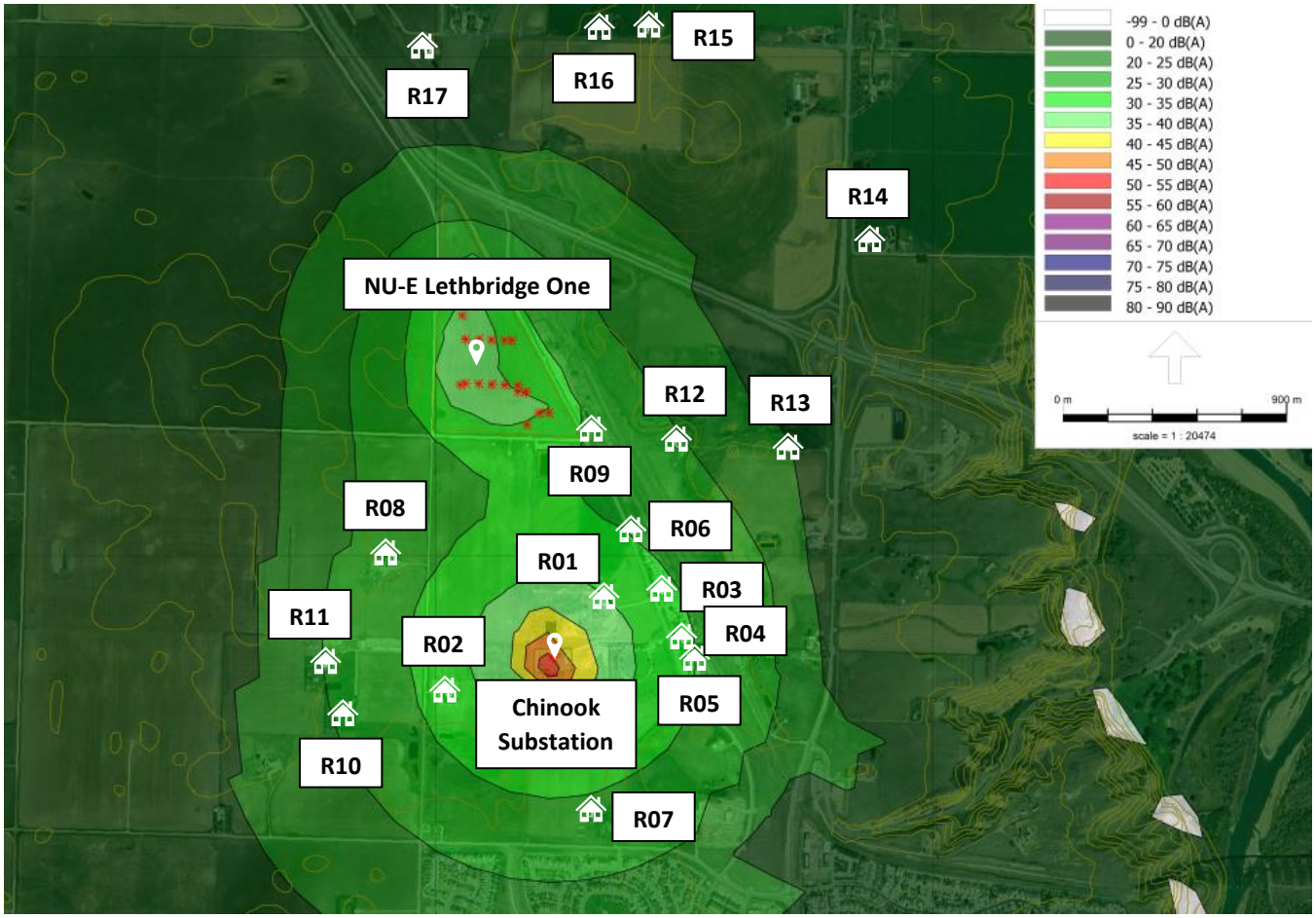
Residences	Residences Distance & Direction	Predicted Sound Level		Ambient Sound Level (dBA)	AUC PSL (dBA)	dBC-dBA
		Without Ambient (dBA)	With Ambient (dBA)			
R01	661 m SSE	35.6	43.7	43	48	11
R02	1060 m SSW	32.5	36.9	35	40	12
R03	710 m SSE	31.2	48.1	48	53	12
R04	1000 m SSE	30.7	48.1	48	53	12
R05	950 m SSE	30.4	48.1	48	53	12
R06	430 m SSE	29.7	48.1	48	53	12
R07	1500 m SSE	28.7	35.9	35	40	12
R08	500 m SSW	27.6	48.0	48	53	13
R09	60 m W	29.0	45.1	45	50	12
R10	1200 m SW	25.6	35.5	35	40	13
R11	1000 m SW	25.0	35.4	35	40	13
R12	400 m E	25.3	35.4	35	40	13
R13	850 m E	21.4	35.2	35	40	14
R14	1380 m NE	14.1	35.0	35	40	15
R15	1000 m NE	14.5	35.0	35	40	16
R16	930 m NNE	15.0	35.0	35	40	16
R17	600 m N	15.6	35.0	35	40	14

If Low Frequency Noise is a concern, measurements at the dwelling/s should be performed to confirm the existence of LFN and tonal component.

Predicted Noise Contour Map

Figures 2 shows the predicted sound levels for the study area. The sound levels labeled on the noise map are predicted sound levels from the energy industry facility without the ambient sound level.

Figure 2: Predicted Noise Contour Map of the Study Area



Ranking of the Sources

The predicted noise levels were calculated at the residences located within 1500 meters from the site. The source order ranking for normal operating conditions at the most impacted residence (MIR), R01, is presented in Table 7.

Table 7: Source Order Ranking at MIR (R01)

Ranking	Noise Source	Levels (dBA)
1	Chinook Substation Transformer	35.5
2	NU-E Transformer Southeast	14.9
3	NU-E Transformer Southwest	11.8
4	NU-E Transformer North	9.6
5	All 36 Inverters	-3.6
	Total Facility Sound Level	**35.6**
	Average Ambient Level	43.0
	Total Facility Plus Ambient	**43.7**
	AUC PSL	48.0

Conclusion

According to the results of this NIA study, the predicted noise levels at all residences located within 1500 meters from NU-E Lethbridge One Solar Power Farm located at LSD 1/4-10-9-22 W4M are expected to be within the AUC Rule 012 Permissible Sound Level (PSL).

Additional noise control measures are not required for the NU-E Lethbridge One Solar Power Farm located at LSD 1/4-10-9-22 W4M to comply with AUC Rule 012 Noise Control.

Notice

This report has been prepared by Motive Acoustics Inc. (Motive) in response to a specific request for service from, and for the exclusive use of, the Client to whom it is addressed. The findings contained in this report are based, in part, upon information provided by others. The information contained in this study is not intended for the use of, nor is it intended to be relied upon, by any person, firm, or corporation other than the Client to whom it is addressed, except for the applicable regulating authority to whom this document may be submitted. Motive accepts no liability or responsibility for any damages that may be suffered or incurred by any third party as a result of the use, reliance on, or any decision made based on this report.

Acoustical Practitioner's Information

MICHEL FREITAS, INCE, PMP, MBA | MANAGING PRINCIPAL

Mr. Freitas is an accomplished acoustician with extensive experience in Conventional and Renewable Power Generation, Transmission and Distribution, Oil & Gas Upstream, Midstream and Downstream, Manufacturing, Food Processing, and Mining projects. He has managed and designed noise and vibration mitigation for thousands of facilities in USA, Canada, South America and Oceania.

Appendix A

Permissible Sound Level Determination Table

Table 1: Nighttime Basic Sound Level

	Dwelling Unit Density per Quarter Section of Land		
Proximity to Transportation	**1-8 Dwelling dBA L_{eq}**	**9-160 Dwellings dBA L_{eq}**	**>160 Dwellings dBA L_{eq}**
Category 1	40	43	46
Category 2	45	48	51
Category 3	50	53	56

- Category 1: Dwelling units more than 500 m from heavily travelled roads and/or rail lines and not subject to frequent aircraft flyovers.
- Category 2: Dwelling units more than 30 m but less than 500 m from heavily travelled roads and/or rail lines and not subject to frequent aircraft flyovers.
- Category 3: Dwelling units less than 30 m from heavily travelled roads and/or rail lines and/or subject to frequent aircraft flyovers.
  - Density per quarter section: Refers to a quarter section with the affected dwelling at the centre (a 451 m radius). For quarter sections with various land uses or with mixed densities. the density chosen is then averaged for the area under consideration.

(Source: AUC.)

Table 2: Class A Adjustment

Class	**Reason for Adjustment**	**Value (dBA L_{eq})**
A1	Seasonal Adjustment (wintertime Condition)	0 to +5
A2	Ambient monitoring adjustment	-10 to +10

(Source: AUC.)

Table 3: Class B Adjustment

Class	**Duration of the Activity**	**Value (dBA L_{eq})**
B1	1 day	+15
B2	30 days	+10
B3	<= 60 days	+5
B4	>60 days	0

(Source: AUC.)