Motive Acoustics

Noise Impact Assessment

(NIA)

NU-E Corporation

Lethbridge 02 and 03 Solar Facilities

SW/SE-36-007-22 W4M

Date: February 25th, 2024

Executive Summary

NU-E Corporation (NU-E) retained Motive Acoustics Inc. (Motive) to conduct a Noise Impact Assessment (NIA) for the proposed Lethbridge 02 and 03 Solar Facilities located at LSD SW/SE-36-007-22 W4M, Alberta. The purpose of this NIA is to quantify the cumulative noise level at the identified residences located in the study area.

The NU-E proposed facilities are 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. There are other significant energy related facilities located in the study area. The modelling was performed using the DGMR iNoise V2023.01 Enterprise modelling software.

According to the results of this NIA study, the predicted noise levels at all identified residences located in the study area are expected to be within the AUC Rule 012 Permissible Sound Level (PSL).

Additional noise control measures are not required for the Lethbridge 02 and 03 Solar Facilities located at LSD SW/SE-36-007-22 W4M to comply with AUC Rule 012 Noise Control.

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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 02 and 03 Solar Facilities located at LSD SW/SE-36-007-22 W4M, Alberta. The purpose of this NIA is to quantify the cumulative noise level at the identified residences located in the study area.

The NU-E proposed facilities are 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.

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 Rule 012, the subjected facility must meet the Permissible Sound Level (PSL) of 40 dBA (L_{eq}) night-time at 1500 meters 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. PSL is derived from the BSL by adding the daytime adjustment, Class A adjustment, and Class B adjustment. As per Rule 012, the PSL definition is based on summertime conditions.

If there are dwellings within 1500 meters, the PSL is determined as per Table 1 of Rule 012 (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 Rule 012 and minimum BSL is determined to be 40 dBA L_{eq} (5 dBA L_{eq} above ambient level).

As per Rule 012 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 Rule 012 show the adjustment factors for Class A and Class B (refer Appendix A).

In this study, eleven (11) residences were identified. Ten (10) residences are existing and one (1) (R01) is a proposed dwelling. Motive Acoustics evaluated the impact at all identified residences to confirm compliance with the regulations Permissible Sound Levels. This study does not qualify for Class A or Class B adjustment.

The following Table 1 shows the permissible sound level at the residences located in the study area.

Table 1: Permissible sound level determination at identified 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**

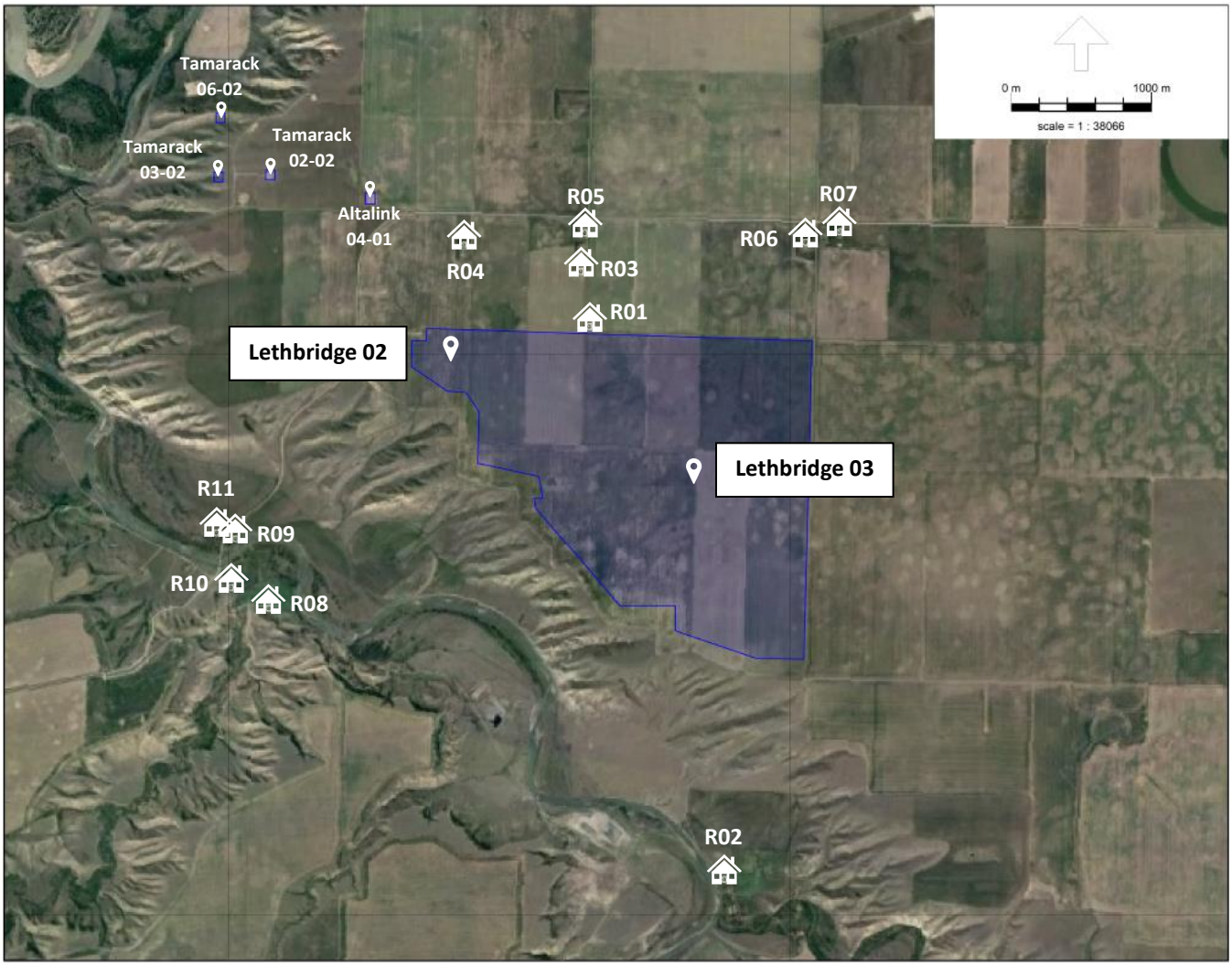
Section 4.5 of AUC Rule 012 specifies the criteria for Low-Frequency Noise (LFN) consideration. If the predicted dBA value is within the permissible level, there may be LFN problem that may increase annoyance at nearby dwellings. If the potential for LFN does exist, the dBC minus dBA sound level is equal 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

Based on the information provided by NU-E's representatives and Google Earth, the site is located South of Lethbridge, Alberta. Eleven (11) residences were identified in the study area. Figure 1 shows the study area, the location of the existing and proposed facilities, and the location of the identified residences.

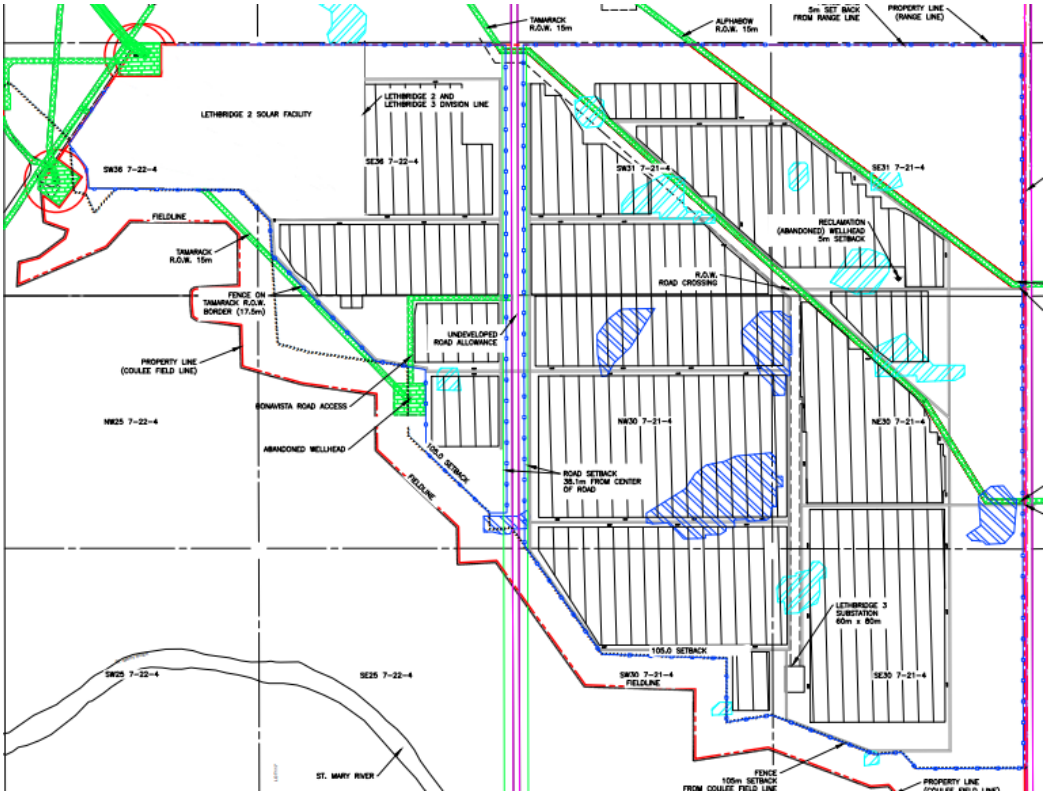
Figure 1: Study Area



Figures 2 and 3 shows Lethbridge 2 and Lethbridge 3 plot plans.

Figure 2: Lethbridge 02 Plot Plan

Figure 3: Lethbridge 03 Plot Plan



Equipment List and Operating Condition

Table 2: NU-E Lethbridge 2 Solar Facility Major Equipment List

Equipment Description	Equipment Details
Transformers (6 Units)	• Six (6) 3.168 MVA Transformers.
Inverters (49 Units)	• Forty-nine (49) SG350-HX inverters.
Motor Controllers (384 units)	• Electric motor model 63ZYT-125-24-F1130 • Units will operate up to 30 minutes during nighttime

Table 3: NU-E Lethbridge 3 Solar Facility Major Equipment List

Equipment Description	Equipment Details
Transformers (48 Units)	• Forty-eight (48) 3.168 MVA Transformers.
Inverters (432 Units)	• Four Hundred and Thirty-Two (432) SG350-HX inverters.
Transformer (01 Unit)	• One (01) 150 MVA Transformer.
Motor Controllers (3057 units)	• Electric motor model 63ZYT-125-24-F1130 • Units will operate up to 30 minutes during nighttime

Nearby Facilities:

Table 4: Altalink Riverbend 618S Equipment List

LSD 04-01-08-22 W4M	
Equipment Description	**Equipment Details**
Transformer	• One (1) Power Transformer rated 138/25kV and 15/20/25 MVA with 4 cooling fans.

Table 5: Tamarack 06-02 Equipment List

LSD 06-02-08-22 W4M	
Equipment Description	**Equipment Details**
Pump	• Pump: Triplex Injection. • Driver: 60hp electric motor. • Equipment enclosed in insulated metal building. Assumed to operate with doors and windows open year-round.
Pump	• Pump 01: Recycle pump. • Driver: 05hp electric motor. • Pump 02: Recycle pump. • Driver: 05hp electric motor. • Equipment enclosed in insulated metal building. Assumed to operate with doors and windows open year-round.
Pump	• Pump: Boost pump. • Driver: 5hp electric motor. • Equipment enclosed in insulated metal building. Assumed to operate with doors and windows open year-round.

Table 6: Tamarack 03-02 Equipment List

LSD 03-02-08-22 W4M	
Equipment Description	**Equipment Details**
Pumpjack (02 Units)	• 02 x 19 HP C96 arrow engine, non-enclosed
Pumpjack	• 13 HP C66 arrow engine, enclosed in wooden shack

Table 7: Tamarack 02-02 Equipment List

LSD 02-02-08-22 W4M	
Equipment Description	**Equipment Details**
Pumpjack (02 Units)	• 02 x 13 HP C66 arrow engine, enclosed in wooden shack

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 proposed facilities were considered in this study.

The sound power levels (PWL) of the NU-E Lethbridge 02 and 03 equipment were determined from theoretical calculations, and manufacturers' data. All sources were modeled as point sources.

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

The predicted levels at the residences located in the study area were compared to the permissible sound level to determine if the proposed facilities will comply with the AUC Rule 012 Noise Control.

Noise Model Parameters

Sound levels were modeled using DGMR iNoise V2023.01 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.

The acoustical properties of each ground region are considered through a ground factor (G). Three categories of reflecting surface are specified by the ISO Standard as follows:

a) Hard Ground, which includes paving, water, ice, concrete, and all other ground surfaces having a low porosity. For Hard ground, G=0.

b) Porous Ground, which includes ground covered by grass, trees or other vegetation, and all other ground surfaces suitable for the growth of vegetation, such as farming land. For porous ground, G=1.

c) Mixed ground: if the surface consists of both hard and porous ground, then G takes on values ranging from 0 to 1, the values being the fraction of the region that is porous.

The Commission Directive (EU) 2015/996 of 19 May 2015 establishing common noise assessment methods according to Directive 2002/49/EC of the European Parliament and of the Council lists the following ground absorption coefficients for different types of grounds:

Table 8: G Values for Different Types of Ground

Description	Type	(kPA.s/m^2)	G Value
Very Soft (Snow or Moss-Like)	**A**	12.5	1
Soft Forest Floor (Short, Dense Heather-Like or Thick Moss)	**B**	31.5	1
Uncompacted, Loose Ground (Turf, Grass, Loose Soil)	**C**	80	1
Normal Uncompacted Ground (Forest Floors, Pasture Field)	**D**	200	1
Compacted Field and Gravel (Compacted Lawns Park Area)	**E**	500	0.7
Compacted Dense Ground (Gravel Road, Car Park)	**F**	2,000	0.3
Hard Surfaces (Most Normal Asphalt, Concrete)	**G**	20,000	0
Very Hard and Dense Surfaces (Dense Asphalt, Concrete, Water)	**H**	200,000	0

According to the table above, Compacted Dense Ground (gravel road, car park and like substation ground) are represented by soil type “F” and have ground absorption coefficient of 0.3. Compacted Field and Gravel (Compacted Lawns Park Area) are represented by soil type “E” and have a ground absorption coefficient of 0.7. These coefficients were selected to conservatively represent the NU-E Lethbridge 02 and 03 Solar Facilities, and surrounding area ground absorption respectively.

Temperature and relative humidity of the model were set to 10^0C and 70% respectively. To predict the worst-case scenario at the residences located in the study area, existing trees were not included in the model.

The DGMR iNoise V2023.01 Enterprise model calculates the cumulative level at the residences from all the sources located in the study area.

Sound Power Levels

Octave Band Sound Power Level for the sources are given in Table 9. These sound power levels have been obtained through theoretical calculations and manufacturer's data.

Table 9: 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	
Lethbridge 3 150MVA Transformer with Fans ON	T&M	117	122	127	121	121	111	103	98	91	130
06-02 Injection Pump Enclosed	T&M	102	100	98	97	98	95	92	87	79	107
04-01 Altalink Transformer	T&M	93	99	101	96	96	90	85	80	73	105
C96 Pumpjack	T&M	88	93	95	94	95	95	93	89	83	102
C66 Pumpjack	T&M	86	91	93	92	93	93	91	87	81	100
06-02 Recycle Pump Enclosed	T&M	88	86	84	84	84	83	80	76	69	93
06-02 Boost Pump Enclosed	T&M	85	83	81	81	81	80	77	73	66	90
Lethbridge 3 Transformer (1 of 48 Units)	T&M	73	79	81	76	76	70	65	60	53	85
Lethbridge 2 Transformer (1 of 06 Units)	T&M	73	79	81	76	76	70	65	60	53	85
Motor Controller (1 of 3441 Units)	T&M	64	64	66	66	67	64	61	55	47	73
Lethbridge 2 Inverter (1 of 49 Units)	T&M	49	55	57	52	52	46	41	36	29	61
Lethbridge 3 Inverter (1 of 432 Units)	T&M	49	55	57	52	52	46	41	36	29	61

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

Accuracy and Limitations

The AUC Rule 012 Noise Control has recommended the ISO 9613 standards as one of the international standards to use in environmental noise model. The DGMR iNoise V2023.01 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 10.

Table 10: 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 levels for 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 identified residences in the area are summarized in Tables 11 and 12.

Table 11: Daytime Predicted Sound Level at the identified residences

Residences	Predicted Sound Level		Ambient Sound Level (dBA)	AUC PSL (dBA)	dBC-dBA
	Without Ambient (dBA)	With Ambient (dBA)			
Residence 01	40.2	46.2	45.0	50.0	10.5
Residence 02	38.4	45.9	45.0	50.0	12.7
Residence 03	36.5	45.6	45.0	50.0	12.0
Residence 04	35.4	45.5	45.0	50.0	12.1
Residence 05	34.8	45.4	45.0	50.0	12.7
Residence 06	34.3	45.4	45.0	50.0	13.1
Residence 07	33.4	45.3	45.0	50.0	13.4
Residence 08	31.7	45.2	45.0	50.0	14.3
Residence 09	30.5	45.2	45.0	50.0	14.6
Residence 10	30.4	45.1	45.0	50.0	14.8
Residence 11	29.9	45.1	45.0	50.0	14.8

Table 12: Nighttime Predicted Sound Level at the identified residences

Residences	Predicted Sound Level		Ambient Sound Level (dBA)	AUC PSL (dBA)	dBC-dBA
	Without Ambient (dBA)	With Ambient (dBA)			
Residence 01	38.0	39.8	35.0	40.0	12.0
Residence 02	38.4	40.0	35.0	40.0	12.7
Residence 03	35.1	38.1	35.0	40.0	13.0
Residence 04	34.6	37.8	35.0	40.0	12.6
Residence 05	33.8	37.5	35.0	40.0	13.4
Residence 06	33.7	37.4	35.0	40.0	13.5
Residence 07	32.9	37.1	35.0	40.0	13.8
Residence 08	31.6	36.6	35.0	40.0	14.4
Residence 09	30.3	36.3	35.0	40.0	14.8
Residence 10	30.3	36.3	35.0	40.0	14.8
Residence 11	29.7	36.1	35.0	40.0	14.9

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 4 and 5 show the daytime and nighttime predicted sound levels for the study area. The sound levels labeled on the noise map are predicted sound levels from the area sources without the ambient sound level.

Figure 4: Daytime Predicted Noise Contour Map of the Study Area

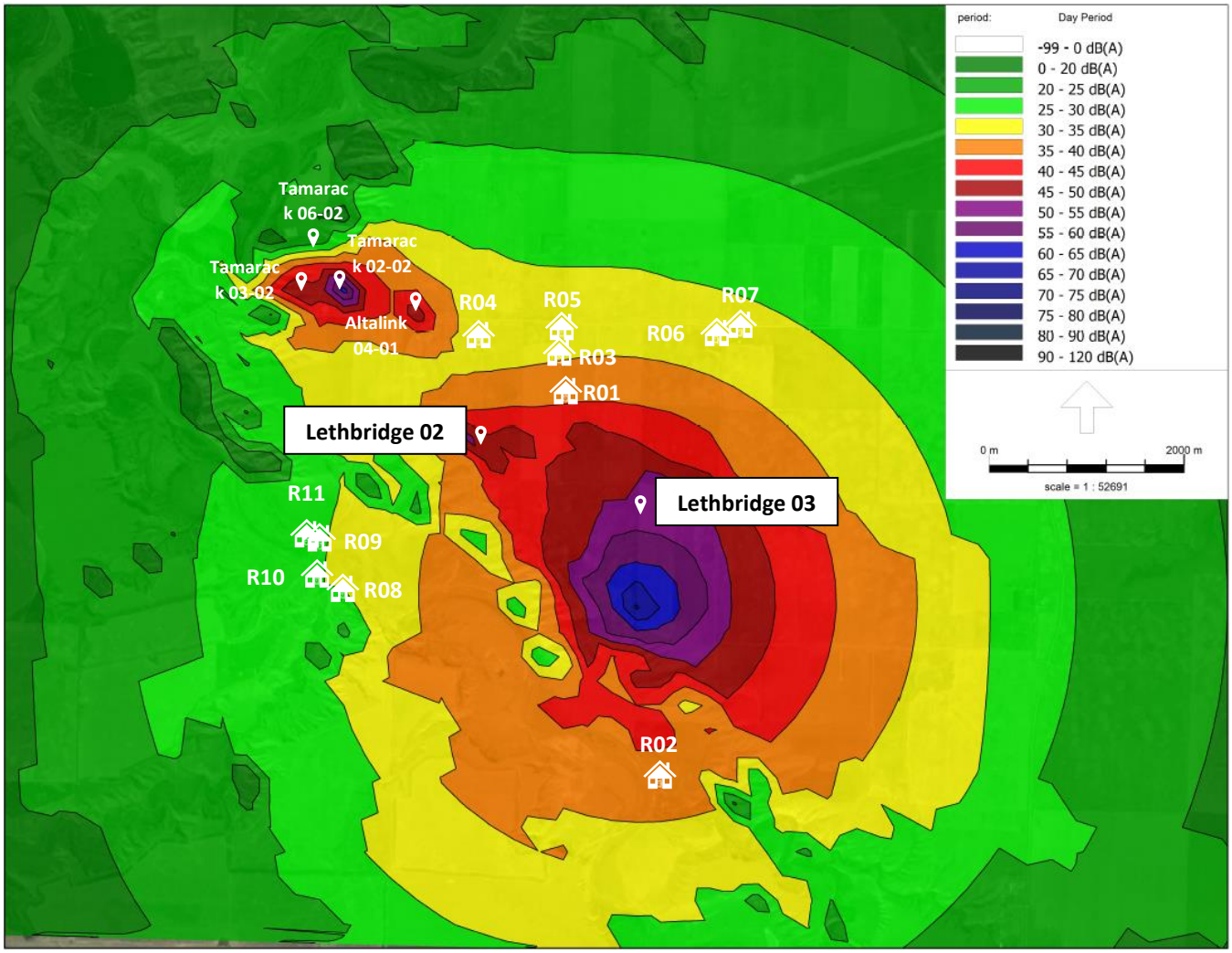
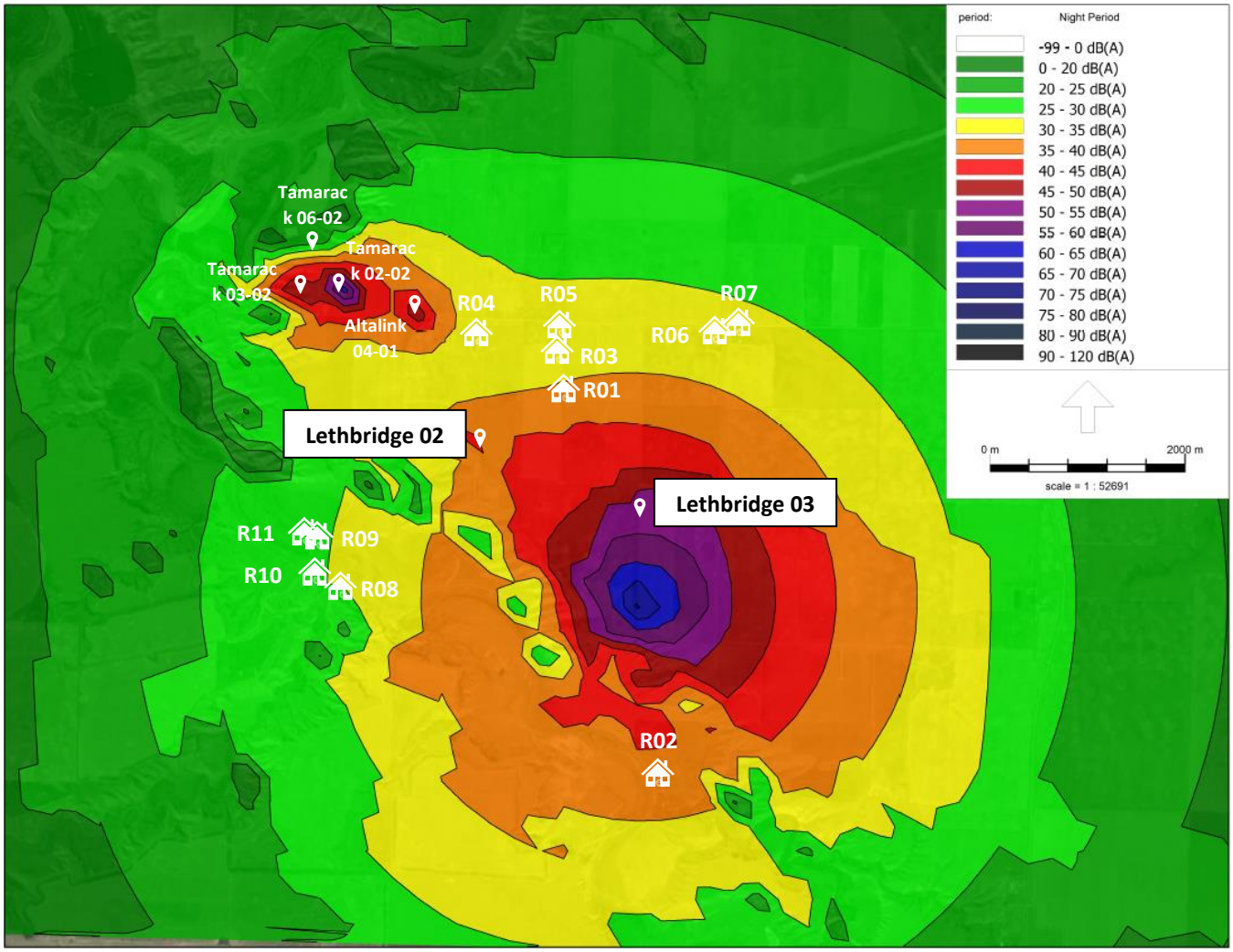


Figure 5: Nighttime Predicted Noise Contour Map of the Study Area



Ranking of the Sources

The predicted noise levels were calculated at the identified residences located in the study area. The daytime and nighttime source order ranking for normal operating conditions at the most impacted identified residences are presented in Table 13 and Table 14.

Table 13: Daytime Source Order Ranking at Most Impacted Identified Residence (R01)

Ranking	Noise Source	Levels (dBA)
1	150MVA Transformer with Fans ON	37.4
2	Lethbridge 2 and 3 Motor Controllers (3441 Units)	36.4
3	Lethbridge 3 Transformers (48 Units)	26.8
4	04-01 Altalink Transformer	19.6
5	Lethbridge 2 Transformers (06 Units)	16.0
6	Lethbridge 3 Inverters (432 Units)	11.8
7	02-02 C66 Pumpjacks (2 Units)	11.5
8	03-02 C96 Pumpjacks (2 Units)	11.0
9	03-02 C66 Pumpjack	6.4
10	06-02 Injection Pump Enclosed	5.6
11	Lethbridge 2 Inverters (49 Units)	1.6
12	06-02 Recycle Pump Enclosed	-3.5
13	06-02 Boost Pump Enclosed	-6.4
	Total Facility Sound Level	**40.2**
	Daytime Average Ambient Level	45.0
	Total Facility Plus Ambient	**46.2**
	Daytime AUC PSL	50.0

Table 14: Nighttime Source Order Ranking at Most Impacted Identified Residence (R02)

Ranking	Noise Source	Levels (dBA)
1	150MVA Transformer with Fans ON	38.4
2	Lethbridge 3 Transformers (48 Units)	7.2
3	Lethbridge 2 and 3 Motor Controllers (3441 Units)	3.8
4	04-01 Altalink Transformer	-1.2
5	03-02 C96 Pumpjacks (2 Units)	-4.2
6	02-02 C66 Pumpjacks (2 Units)	-4.4
7	06-02 Injection Pump Enclosed	-5.1
8	Lethbridge 3 Inverters (432 Units)	-6.9
9	Lethbridge 2 Transformers (06 Units)	-8.2
10	03-02 C66 Pumpjack	-8.8
11	06-02 Recycle Pump Enclosed	-18.4
12	06-02 Boost Pump Enclosed	-21.1
13	Lethbridge 2 Inverters (49 Units)	-23.2
	Total Facility Sound Level	**38.4**
	Nighttime Average Ambient Level	35.0
	Total Facility Plus Ambient	**40.0**
	Nighttime AUC PSL	40.0

Conclusion

According to the results of this NIA study, the predicted noise levels at all identified residences located in the study area 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 02 and 03 Solar Facilities located at LSD SW/SE-36-007-22 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 damage 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.)