Georgetown Solar and Storage Project

Noise Impact Assessment

Client: Georgetown Solar Inc.
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Executive Summary

Georgetown Solar Inc. propose to install a 230 MW_{AC} photovoltaic (PV) electricity generating power plant with 100 MW_{AC} Battery Energy Storage System located in Vulcan County, Alberta, approximately seven kilometres northwest of the Hamlet of Mossleigh. The Project will consist of ground-mounted PV modules, 75 inverter/transformer stations (for the PV electricity generating facility), 80 energy storage containers, 20 inverter/transformer stations (for the battery energy storage system), two AUX transformers and a project substation. These are the significant noise producing project elements and are assumed to operate at full load for the purposes of the noise assessment.

GCR reviewed aerial imagery of the site, identifying six receptors within approximately 1.5 km of the Project as having the potential to be affected by noise from the proposed Project. The area was also checked for other regulated third party energy-related facilities that may produce noise within the vicinity of the Project.

A software model was used to predict sound levels from the Project to determine compliance with Alberta Utilities Commission (AUC) Rule 012: Noise Control requirements. Cumulative sound levels were less than 3dB below the Permissible Sound Level (PSL) for night-time periods, so a detailed noise assessment was carried out as per the AUC Rule 012, Appendix 3 - Summary report, recommendations.

Where applicable, cumulative sound levels incorporated sound from: existing regulated third party energy-related facilities; third party projects; the proposed Project; and ambient sources. Results indicate cumulative sound levels were compliant with permitted sound levels at all receptors assessed. R1 and R6 were identified as the most impacted receptor. A Low Frequency Noise (LFN) assessment determined that sound from the proposed Project was not assessed to contain any significant LFN effects.

The proposed Georgetown Solar and Storage Project is therefore assessed to meet the requirements of AUC Rule 012.

Table of Contents

1 Introduction

Georgetown Solar Inc. retained Green Cat Renewables Canada Corporation (GCR) to conduct a noise impact assessment for the proposed Georgetown Solar and Storage Project (the Project). The Project will have a grid capacity of 230 megawatts (MW_{AC}). The Project will include a 230 MW_{AC} solar photovoltaic (PV) electricity generating facility and a 100 MW_{AC} Battery Energy Storage System (BESS), and will be located in Vulcan County, Alberta, approximately seven kilometres northwest of the Hamlet of Mossleigh. The Project location is shown in **Figure 1-1** below. The assessment considered the cumulative impact of existing and proposed noise sources on nearby receptors.

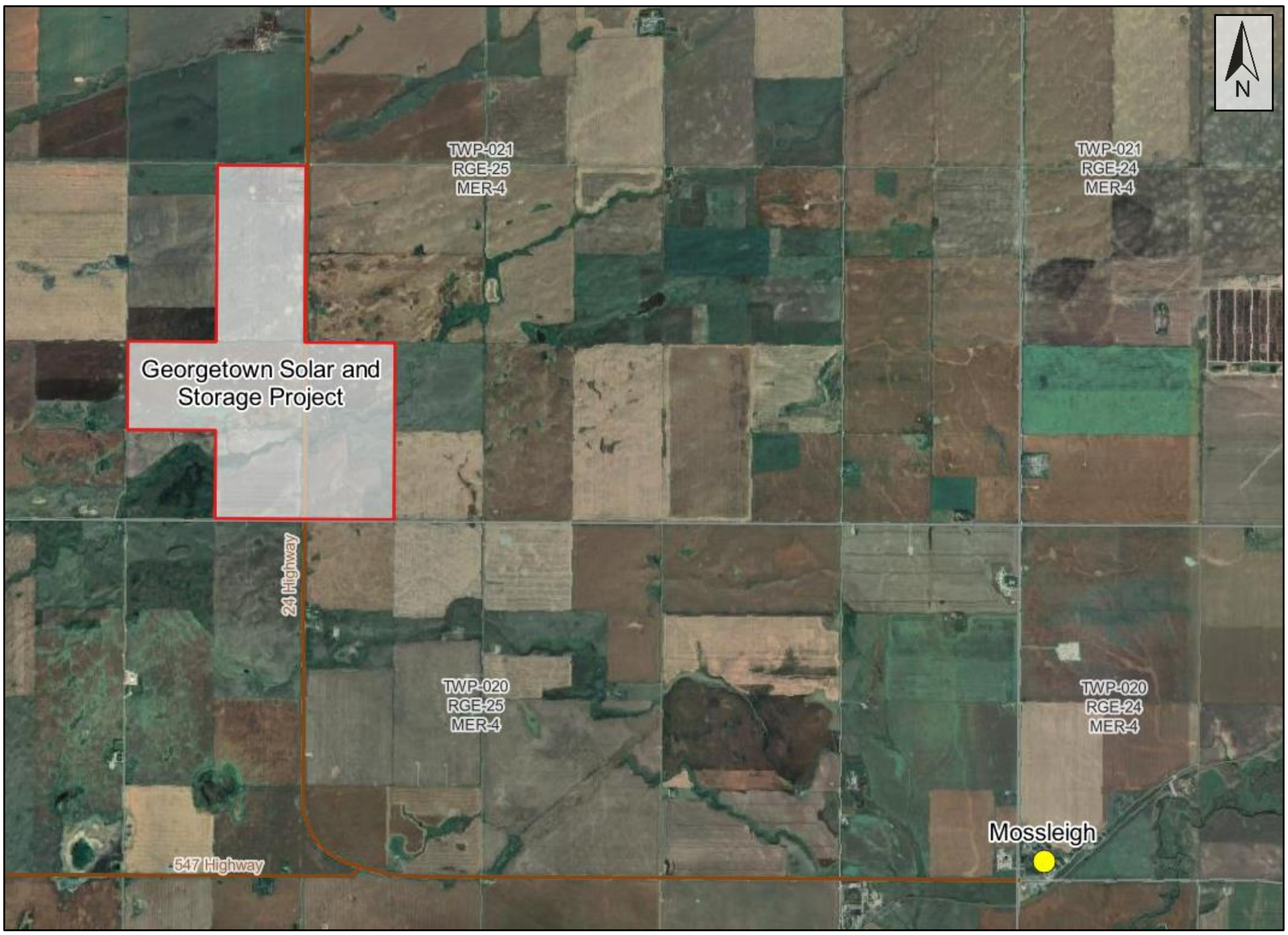


Figure 1-1 – Georgetown Solar and Storage Project Location

2 Rule 012 Assessment Process

The assessment process follows Alberta Utilities Commission (AUC) Rule 012 guidelines. The International Standard 'ISO 9613-2: Acoustics – Attenuation of sound during propagation outdoors', was followed in the prediction of noise levels at nearby receptors. A glossary of relevant AUC Rule 012 terms is reproduced in **Appendix A**.

The following steps give an overview of the process followed in identifying potential noise impacts on the most affected receptors.

- Define study area (distance contour at site boundary + 3km)
- Identify active Alberta Energy Regulated (AER) facilities within the study area
- Identify noise receptor(s) within 1.5km of the site boundary, or along the 1.5km boundary criteria (where no noise receptors exist).

For each noise receptor:

- Determine Basic Sound Level (BSL) and Ambient Sound Level (ASL)
- Predict sound level from existing AER facilities
- Combine facility and Ambient Sound Levels to give baseline sound levels
- Predict sound level from the proposed project
- Assess for Low Frequency Noise (LFN) content due to project
- Calculate Permissible Sound Levels (PSLs)
- Calculate Cumulative Sound Levels
- Assess compliance with AUC Rule 012 requirements.

3 Noise Model

All noise propagation calculations were performed using iNoise from DGMR Software (version Enterprise 2021.0). This is quality assured software with full support of ISO/TR 17534-3, which provides recommendations to ensure uniformity in the interpretation of the ISO 9613 method.

DGMR provide the following information on the function of ISO/TR 17534-3[1]: '*The ISO 9613 standard from 1996 is the most used noise prediction method worldwide. Many countries refer to ISO 9613 in their noise legislation. However the ISO 9613 standard does not contain guidelines for quality assured software implementation, which leads to differences between applications in calculated results. In 2015 this changed with the release of ISO/TR 17534-3. This quality standard gives clear recommendations for interpreting the ISO 9613 method. iNoise fully supports these recommendations. The models and results for the 19 test cases are included in the software...*'.

3.1 Model Parameters

Summer-time climatic conditions were assumed as required by Rule 012. **Table 3-1** shows the modelling parameters that were adopted for all calculations.

Table 3-1 – Model Parameters

Modelling Parameter	Setting
Terrain of Site Area	10m Height Contours[2]
Barrier Effects Included	None
Temperature	10°C
Relative Humidity	70%
Wind	1 – 5ms^{-1} from facility to receptor as per ISO-6913
Ground Attenuation	0.5
Number of Sound Reflections	1
Receptor Height	1.5m for one-storey / 4.5m for two-storey
Operation Condition	Full load
Source Height	2.3m for Inverter/Transformer units 4.0m for Substation Transformers 2.0m for BESS Energy Storage Container 1.9m for BESS Inverter/1.3m for BESS Transformer 1.0m for BESS AUX transformer

[1] https://dgmrsoftware.com/products/inoise/
[2] Data obtained from AltaLIS.

4 Baseline

4.1 Study Area

The development site spans a portion of seven quarter sections of land approximately seven kilometres northwest of the Hamlet of Mossleigh, Alberta. The Project is also about five kilometres south of the Bow River. The study area includes rural/agricultural land, waterbodies, and other wetlands.

Six (6) dwellings located within the 1.5 km boundary criterion have been assessed for cumulative noise impacts from the Project and other nearby facilities, as required by Rule 012.

4.2 Project Description

The Project will encompass a large portion of seven quarter sections of land, consisting of approximately 433,000 PV modules, with a total generating capacity of 230 MW_{AC} and energy storage capacity of 100 MW_{AC}. The solar arrays will use fixed tilt racking system secured to the ground with piles, and they will feed 75 inverter/transformer stations. The BESS would consist of 80 energy storage containers, 20 power conversion stations each having two inverters and a transformer, and two AUX transformers. These elements along with the project substation are the significant sources of noise from the Project.

Daytime periods are defined between 07:00-22:00, while night-time periods fall between 22:00-07:00. The Project is anticipated to normally operate during the defined daytime hours; however, sunrise on the longest days of the year (during summer months) will occur at approximately 05:00, which falls within the night-time period. Therefore, the assessment considers both daytime and night-time operational impacts (i.e., operating 24/7).

4.3 Sensitive Receptors

Residential dwellings regarded as having the potential to be the most impacted were identified and confirmed during a site visit in October 2021. Model receptors were placed at each of the dwellings within approximately 1.5km of the Project boundary. **Table 4-1** shows the location details and the height of each receptor.

Table 4-1 – Receptor Details

Receptor ID	UTM Coordinates (NAD 83, Zone 12N)		Dwelling type	Receptor height (m)	Relative location from site boundary
	Easting	Northing			
R1	328959	5628881	Two-storey	4.5	1200m N
R2	327241	5625431	One-Storey	1.5	350m W
R3	326488	5624524	One-Storey	1.5	1400m SW
R4	327539	5624499	One-Storey	1.5	850m W
R5	329308	5623500	One-Storey	1.5	1000m S
R6	329060	5628848	Two-storey	4.5	1150m N

4.4 Existing Third Party Regulated Energy-Related Facilities

A search for existing regulated energy-related facilities and pumping wells was conducted within 3km of the Project boundary. The AER's Facilities list (ST102) and Wells list (ST037) were consulted. Table 4-2 lists the active facilities and pumping wells identified through the AER databases within 3km of the Project.[3]

Table 4-2 – Third Party Sound Sources

Map Label	Name	Type	Operator Name	UTM Coordinates (NAD 83, Zone 12N)	
				Easting	Northing
AER1	Herronton 13-34-020-25W4 GGS	Gas Gathering System	TAQA North Ltd.	331024	5624250
AER2	CYPRESS HERRONTON 14-5-21-25	GAS MULTIWELL GROUP BATTERY	TAQA North Ltd.	328227	5625938
AER3	KAISER ENERGY LTD	Compressor Station	Seol Energy Inc.	329320	5622292
AER4	KAISER-FRANCIS OIL COMPANY OF	Compressor Station	TAQA North Ltd.	331114	5627906
AER5	KAISER-FRANCIS ARROWWOOD	Gas Gathering System	Seol Energy Inc.	329829	5625081
AER6	CYPRESS HERRONTON 13-27-20-25	Pumping Well (Gas)	TAQA North Ltd.	330937	5622571
AER7	CYPRESS 102 HERRONTON 6-8-21-25	Pumping Well (Gas)	TAQA North Ltd.	328412	5626901
AER8	PRIMEWEST 102 HERRONTON 8-7-21-25	Pumping Well (Gas)	TAQA North Ltd.	327314	5626823
AER9	PRIMEWEST HERRONTON 3-5-21-25	Pumping Well (Gas)	TAQA North Ltd.	328098	5625309
AER10	PRIMEWEST HERRONTON 12-12-21-26	Pumping Well (Gas)	TAQA North Ltd.	325243	5627004
AER11	PWEI HERRONTON 16-3-21-25	Pumping Well (Gas)	TAQA North Ltd.	332161	5625708

[3] An additional AER Facility (ATCO Pipelines Field Meter Station) was also identified through the AER database. It was assumed that the Field Meter Station would not produce any noise. GCR staff visited the facility during the October site visit and confirmed that the facility was inaudible from the fence line.

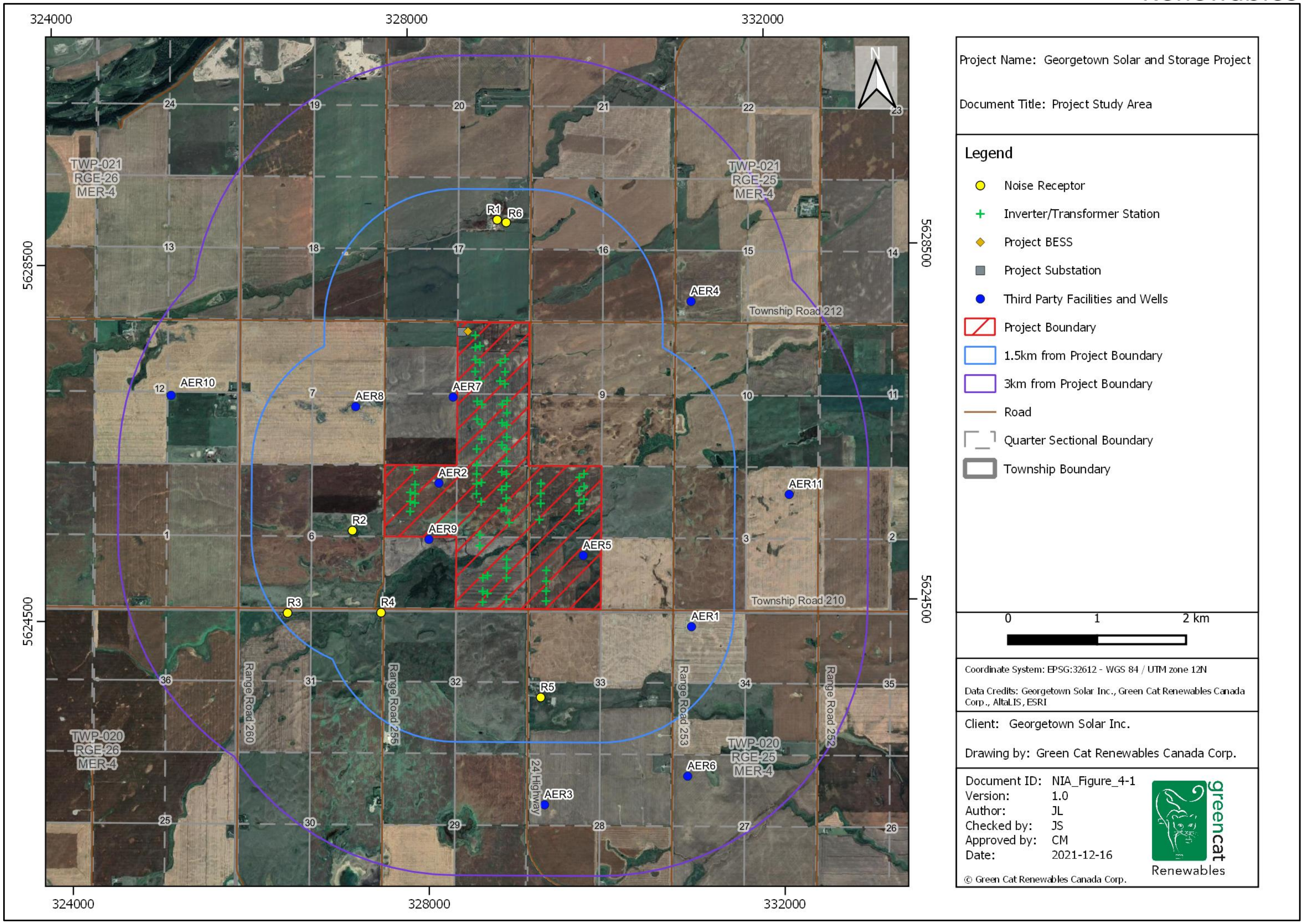


Figure 4-1 – Project Study Area

4.5 Baseline Sound Levels

Baseline sound levels for each receptor should incorporate a contribution from all existing and approved AER and AUC facilities with the addition of the Ambient Sound Level (ASL). ASL is determined from the Basic Sound Level (BSL).

4.5.1 Determination of Basic Sound Level (BSL)

Rule 012 criteria for the determination of BSL include: dwelling density; road and rail traffic noise; and aircraft flyovers. In this case, dwelling density and road & traffic noise are the determining factors. Criteria are given in **Table 4-3**.

Table 4-3 – Rule 012 Criteria for determination of Basic Sound Levels (BSL)

Proximity to transportation	Dwelling density per quarter section of land		
	(1) 1 to 8 dwellings; 22:00 - 07:00 (night-time) (dBA Leq)	(2) 9 to 160 dwellings; 22:00 - 07:00 (night-time) (dBA Leq)	(3) >160 dwellings; 22:00 - 07:00 (night-time) (dBA Leq)
Category 1[4]	40	43	46
Category 2[5]	45	48	51
Category 3[6]	50	53	56

All assessed receptors in the study area have been evaluated as category one for dwelling density. Three receptors are also evaluated as category one for proximity to transportation.

Receptors R1, R5, and R6 are assessed as category 2 for proximity to transportation. Traffic data collected for Highway 24, collected at locations close to the site boundary, indicates a level of traffic flow that well exceeds the Rule 012 'Heavily Travelled Road' criteria of '90 or more vehicles travel during the nine-hour night-time period consistently for any one moth period in a year'. Traffic data is shown in **Appendix B**.

4.5.2 Determination of Ambient Sound Level (ASL)

The Project is located in an area typical of rural Alberta (including agricultural and Oil & Gas industries). Therefore, the Ambient Sound Level was assessed to be 5dB(A) less than the applicable BSL for night-time and 5dB(A) more than the applicable BSL for daytime.[7] This results in a night-time ASL between 35-40 dB(A) and a daytime ASL between 45-50 dB(A) for the receptors. BSLs and ASLs for night-times and daytimes for each location are given in **Table 4-4**.

4.5.3 Determination of Permissible Sound Level (PSL)

For each receptor, the PSL is determined using Basic Sound Level (BSL) plus any allowed adjustments. In this case, as no special conditions exist, the PSL is determined as:

Night-Time (NT) Permissible Sound Level = Basic Sound Level

[4] Category 1—dwelling(s) distance is more than or equal to 500 metres (m) from heavily travelled roads or rail lines and not subject to frequent aircraft flyovers.

[5] Category 2—dwelling(s) distance is more than or equal to 30 m, but less than 500 m from heavily travelled roads or rail lines and not subject to frequent aircraft flyovers.

[6] Category 3—dwelling(s) distance is less than 30 m from heavily travelled roads, or rail lines or subject to frequent aircraft flyovers.

[7] The daytime ASL accounts for the addition of the standard 10db(A) daytime adjustment to the night-time ASL for the hours between 7 a.m. and 10 p.m., without any further adjustments, i.e., Class A, B, and C adjustments were not applied.

Daytime (DT) Permissible Sound Level = Basic Sound Level + Daytime Adjustment (10dB)

BSLs, ASL, and PSLs for night-times and daytimes and for each location are given in Table 4-4.

Table 4-4 – Daytime and Night-time BSL, ASL, and PSL

Dwelling ID	Transportation Category	Dwelling Category	BSL	ASL		PSL	
			NT/DT	NT	DT	NT	DT
R1	2	1	45	40	50	45	55
R2	1	1	40	35	45	40	50
R3	1	1	40	35	45	40	50
R4	1	1	40	35	45	40	50
R5	2	1	45	40	50	45	55
R6	2	1	45	40	50	45	55

4.5.4 Third Party Sound Power Levels

Sound power data for third party regulated energy-related facilities within 3km of the Project were compiled from an internal noise measurement database and third party NIAs that included measurements of similar facilities. In each case, the quoted sound power levels are the average of at least two similar facilities and are deemed typical and representative of each facility type. Table 4-5 shows the octave band sound power levels for third party regulated energy-related facilities within 3km of the Project.

Table 4-5 – Octave Band Sound Power Levels for Regulated Facilities

Map Label	Octave Band Centre Frequency, Hz									Total	
	31.5	63	125	250	500	1000	2000	4000	8000	dB(A)	dB
AER1	119.1	119.8	115.1	106.5	102.9	103.0	102.3	99.3	96.5	109.2	123.4
AER2	112.3	108.4	102.8	98.8	96.7	95.4	94.0	88.6	82.9	100.7	114.4
AER3	127.1	119.2	114.1	106.9	104.4	101.8	100.3	96.4	91.8	108.1	128.0
AER4	127.1	119.2	114.1	106.9	104.4	101.8	100.3	96.4	91.8	108.1	128.0
AER5	119.1	119.8	115.1	106.5	102.9	103.0	102.3	99.3	96.5	109.2	123.4
AER6-11	103.4	96.7	93.3	88.9	90.1	84.9	83.2	83.3	79.5	92.0	104.9

4.6 Modelling Results

Table 4-6 shows the predicted sound levels at each receptor from existing AER regulated Energy-Related Facilities.

Table 4-6 Predicted Sound Levels From Existing AER Regulated Energy-Related Facilities

Dwelling ID	Total Existing Third Party Regulated Energy-Related Facilities Sound levels dB(A)
R1	27.9
R2	28.8
R3	23.5
R4	27.6
R5	31.2
R6	28.1

4.7 Total Baseline Sound Levels

Baseline sound levels include the noise contributions from existing adjacent sound sources and the ambient sound level assessed for the local environment. Table 4-7 shows the cumulative baseline sound levels for night-time (NT) and daytime (DT) periods.

Table 4-7 – Cumulative Baseline Sound Levels for Night-time and Daytime Periods

Dwelling ID	Total Regulated Facilities		ASL		Baseline	
	NT	DT	NT	DT	NT	DT
R1	27.9	27.9	40	50	40.3	50.0
R2	28.8	28.8	35	45	35.9	45.1
R3	23.5	23.5	35	45	35.3	45.0
R4	27.6	27.6	35	45	35.7	45.1
R5	31.2	31.2	40	50	40.5	50.1
R6	28.1	28.1	40	50	40.3	50.0

5 Project Sound Levels

The Project will consist of solar PV arrays using fixed tilt racking system secured to the ground with piles. The arrays will be connected to 75 inverter/transformer stations with a total capacity of 230 MW_{AC}. The BESS will have a total capacity of 100 MW_{AC} with 80 energy storage containers, 20 power conversion stations each having two inverters and a transformer, and two AUX transformers. Additionally, a substation has been proposed to be added within the project boundary and will consist of a 256MVA high voltage (HV) transformer. The Energy storage containers, Inverters, and transformers are the significant noise producing project elements and are assumed to operate at full load 24 hours a day in this assessment.

GCR was provided noise information for these significant noise producing elements by Georgetown Solar Inc. for use in this assessment. The sound power levels of these components were used to model sound emissions for both daytime and night-time periods.

5.1 PV Electricity Generating Facility

5.1.1 Inverter/Transformer Stations

The inverter/transformer stations proposed for the PV electricity generating facility are the Sungrow SG3600UD-MV units. The sound data measurements for these inverters provided by the equipment manufacturer are shown in **Appendix C**, which include noise contributions from the paired transformers.

Table 5-1 shows the linear, 'A', and 'C' frequency weighted octave band sound power spectra for the inverter/transformer stations.

Table 5-1 –Octave Band Inverter/Transformer Stations Sound Power Levels

Octave Band Frequency (Hz)	Sound Power (dB)	Sound Power (dBA)	Sound Power (dBC)
31.5	91	51.6	88.0
63	92	65.8	91.2
125	93	76.9	92.8
250	92	83.4	92.0
500	97	93.8	97.0
1000	88	88.0	88.0
2000	87	88.2	82.2
4000	83	84.0	82.2
8000	80	78.9	77.0
Sum	**100.9**	**95.9**	**100.7**

5.2 BESS

5.2.1 Energy Storage Container

The proposed energy storage containers for the BESS are the Sungrow ST2752UX-US units. The manufacturer's sound measurements data sheet shows that the measurements were taken at 20 measuring points at a distance of 1m around the storage unit and provides the two highest one third octave bands sound measurements. The manufacturer's sound data sheet gives values for one third octave bands from 12.5Hz to 20kHz. For the purposes of this assessment, only one third octave band frequency sound power levels from 25Hz to 10kHz were included in the sound propagation modelling. Details of the measurements for the Sungrow ST2752UX-US energy storage containers are attached in Appendix D. A-weighted sound pressure of 74.7 dB(A) was obtained from logarithmically averaging the provided two highest measurements at 1m. A measurement surface area correction of 21.7 dB(A) was then added to derive the sound power level of 96.5 dB(A).

Table 5-2 shows the linear 'A', and 'C' frequency weighted one third octave band sound power spectra for the energy storage containers.

Table 5-2 One Third Octave Band Energy Storage Container Sound Power Levels

Octave band Frequency (Hz)	Sound Power (dB)	Sound Power (dBA)	Sound Power (dBC)
25	87.5	42.8	84.5
31.5	84.2	44.8	82.2
40	87.4	52.8	86.1
50	92.0	61.8	91.2
63	78.0	51.8	77.5
80	78.3	55.8	78.0
100	85.9	66.8	85.7
125	78.9	62.8	78.8
160	85.2	71.8	85.2
200	85.2	74.3	85.2
250	92.4	83.8	92.4
315	91.4	84.8	91.4
400	90.1	85.3	90.1
500	92.0	88.8	92.0
630	86.7	84.8	86.7
800	86.1	85.3	86.1
1000	86.8	86.8	86.8
1250	83.2	83.8	83.1
1600	83.8	84.8	83.6

Octave band Frequency (Hz)	Sound Power (dB)	Sound Power (dBA)	Sound Power (dBC)
2000	83.6	84.8	83.3
2500	80.5	81.8	80.0
3150	80.6	81.8	79.8
4000	78.8	79.8	77.5
5000	76.3	76.8	74.3
6300	84.9	84.8	81.9
8000	67.9	66.8	63.5
10000	62.8	60.3	62.8
Sum	100.8	96.5	100.5

5.2.2 Inverters

The inverters selected for the BESS are the Sungrow SC2500UD-US units at rated working condition. Measurements were conducted on the front, back, left, and right sides of the inverter at a distance of 1m. The manufacturer's sound data sheet gives values for octave bands from 16Hz to 16kHz. For the purposes of this assessment, only octave band frequency sound power levels from 31.5hZ to 8kHz were included in the sound propagation modelling. Official sound data measurements for the Sungrow SC2500UD-US inverter are attached in **Appendix E**. A-weighted sound pressure of 79.2 dB(A) was obtained from logarithmically averaging the four side measurements at 1m. A measurement surface area correction of 17.4 dB(A) was then added to derive the sound power level of 96.6 dB(A).

Table 5-3 shows the linear, 'A', and 'C' frequency weighted octave band sound power spectra for the BESS inverters.

Table 5-3 Octave Band BESS Inverter Sound Power Levels

Octave Band Frequency (Hz)	Sound Power (dB)	Sound Power (dBA)	Sound Power (dBC)
31.5	95.2	55.8	92.2
63	98.6	72.4	97.8
125	100.5	84.4	100.3
250	94.7	86.1	94.7
500	97.8	94.6	97.8
1000	87.7	87.7	87.7
2000	83.2	84.4	83.0
4000	78.7	79.7	77.9
8000	70.3	69.2	67.3
Sum	105.0	96.6	104.5

5.2.3 Transformer

The proposed medium voltage (MV) transformers for the BESS power conversion stations are 5MVA in size and the manufacturer is yet to specify transformer sound levels. Transformer sound levels are expected to be more than one order of magnitude lower than the equivalent inverters, thereby contributing a negligible amount to cumulative sound levels. As such, a typical transformer of a suitable type was modeled.

The linear 'A', and 'C' frequency weighted octave band sound power spectra for the 5MVA transformers used in this project are shown in Table 5-4.

Table 5-4 Octave Band BESS Transformer Sound Power Levels[8]

Octave band Frequency (Hz)	Sound Power (dB)	Sound Power (dBA)	Sound Power (dBC)
31.5	73.9	34.5	70.9
63	77.9	51.7	77.1
125	80.9	64.8	80.7
250	78.9	70.3	78.9
500	78.9	75.7	78.9
1000	72.9	72.9	72.9
2000	67.9	69.1	67.7
4000	62.9	63.9	62.1
8000	54.9	53.8	51.9
Sum	86.0	79.1	85.6

5.2.4 AUX Transformer

The BESS will consist of two AUX transformers for stations services (for heating during winter and general station services during summer). The proposed MV transformers for the two AUX transformers are 1MVA in size and the manufacturer did not specify the transformer sound levels. The AUX transformers are expected to contribute negligible amount to cumulative sound levels as the sound levels for 1MVA transformers are likely much quieter compared to other noise producing project elements. Therefore, a typical transformer of a suitable type was modeled.

The linear 'A', and 'C' frequency weighted octave band sound power spectra for the 1MVA transformers used in this project are shown in Table 5-5.

[8] Based on theoretical prediction method (Crocker, 2007).

Table 5-5 Octave Band AUX Transformer Sound Levels[8]

Octave band Frequency (Hz)	Sound Power (dB)	Sound Power (dBA)	Sound Power (dBC)
31.5	63.8	24.4	60.8
63	67.8	41.6	67.0
125	70.8	54.7	70.6
250	68.8	60.2	68.8
500	68.8	65.6	68.8
1000	62.8	62.8	62.8
2000	57.8	59.0	57.6
4000	52.8	53.8	52.0
8000	44.8	43.7	41.8
Sum	75.8	69.0	75.5

5.3 Substation

The substation will be comprised of a 256 MVA HV transformer that will be used to transform the electricity generated from the PV system to grid voltage. The transformer has been modelled in Oil Natural Air Forced (ONAF) conditions for a conservative prediction. ONAF is an operation that uses second stage cooling for the transformers when there are higher ambient temperatures. Typically, in ONAF mode, the cooling fan is the source of the loudest noise emissions from the transformer. Octave band levels were derived using published ONAF spectral data, shown in Table 5-6.

Table 5-6 – Octave Band Sound Power Levels for the Project's Substation[9]

Octave Band Frequency (Hz)	Sound Power (dB)	Sound Power (dBA)	Sound Power (dBC)
31.5	98.7	59.3	95.7
63	102.7	76.5	101.9
125	105.7	89.6	105.5
250	103.7	95.1	103.7
500	103.7	100.5	103.7
1000	97.7	97.7	97.7
2000	92.7	93.9	92.5
4000	87.7	88.7	86.9
8000	79.7	78.6	76.7
Sum	110.8	103.9	110.4

[9] Based on theoretical prediction method (Crocker, 2007).

5.4 Modelling Results

Predicted sound levels for the Project are shown in Table 5-7. The results assume full operation 24 hours a day, and they are applicable to night-time and daytime periods.

Table 5-7 – Predicted Project Case Sound Levels

Dwelling ID	Project Sound Level (dBA)
R1	42.4
R2	36.6
R3	27.0
R4	34.1
R5	28.8
R6	42.4

Receptor R1 and R6 are expected to be the receptors most impacted by noise from the Project. The maximum sound pressure level at R1 and R6 are predicted to be 42.4 dB(A). Project sound level contours are shown in Appendix F.

5.5 Low Frequency Assessment

Table 5-8 shows the difference between A and C weighted predicted sound levels at each of the receptors modelled. The results show that the C-weighted and A-weighted receptor levels have differences well below the Rule 012 criterion of 20dB. This indicates that low frequency noise is not expected to be an issue.

Table 5-8 – Low Frequency Noise Assessment

Dwelling ID	Predicted Sound Level (dBA)	Predicted Sound Level (dBC)	Difference dBC – dBA
R1	42.4	51.5	9.1
R2	36.6	45.4	8.8
R3	27.0	39.0	12.0
R4	34.1	43.5	9.4
R5	28.8	39.3	10.5
R6	42.4	51.5	9.1

6 Cumulative Impact Assessment

The cumulative impact assessment incorporates sound level contributions from the baseline and Project case assessments. Compliance with AUC Rule 012 is determined through comparison of cumulative sound levels with PSLs. Table 6-1 shows the results of the cumulative impact and compliance assessment.

Table 6-1 – Cumulative Sound Level Assessment for Night-Time (NT) and Daytime (DT) Periods

Receptor	Baseline Sound Level (dBA)		Project Sound Level (dBA)		Cumulative Sound Level (dBA)		PSL (dBA)		PSL Compliance Margin (dB)	
Dwelling ID	NT	DT	NT	DT	NT	DT	NT	DT	NT	DT
R1	40.3	50.0	42.4	42.4	44	51	45	55	1	4
R2	35.9	45.1	36.6	36.6	39	46	40	50	1	4
R3	35.3	45.0	27.0	27.0	36	45	40	50	4	5
R4	35.7	45.1	34.1	34.1	38	45	40	50	2	5
R5	40.5	50.1	28.8	28.8	41	50	45	55	4	5
R6	40.3	50.0	42.4	42.4	44	51	45	55	1	4

The cumulative sound levels at all assessed receptors are shown to meet PSLs with the Project operating at full capacity. Receptor R1 and R6 are the most affected by the Project sound levels. Worst case Project sound levels are determined to be compliant with the requirements of AUC Rule 012.

7 Conclusions

Six dwellings were identified as having the potential to be impacted by sound emitted from the proposed Project and/or cumulative sound levels. Worst-case sound power levels were used to model sound emissions from the Project during day and night periods.

The Project will generally operate when the sun is out during daytime hours; however, AUC Rule 012 defines night-time hours to be from 22:00 to 07:00 all year long. Due to the sun rising prior to 07:00 during summer months, the Project may operate during the defined night-time period. therefore, the assessment considered worst-case (full operation) noise emission levels 24 hours a day. In practice, there will be periods when the Project operates in standby mode where sound emissions are much lower than the peak sound output levels assumed throughout this assessment.

Cumulative sound levels were assessed to be below PSLs at all receptors. R1 and R6 were identified as the most impacted receptors. A LFN assessment determined that sound from the proposed Project will not contain significant LFN levels and what was present exhibited no tonality as defined by AUC Rule 012, section 4.5.

It is therefore concluded that the proposed Georgetown Solar and Storage Project will operate in compliance with AUC Rule 012 requirements at all assessed receptors.

8 Acoustic Practitioners' Information

Table 8-1 summarizes the information of the authors and technical reviewer.

Table 8-1 – Summary of Practitioners' Information

Name	Justin Lee	Merlin Garnett	Cameron Sutherland
Title	Assistant Noise Consultant	Principal Noise Consultant	Technical Director
Role	• Acoustic noise modelling • Noise Impact Assessment (NIA) co-author	• Discipline lead • Acoustic noise modelling • Fieldwork lead • Noise Impact Assessment (NIA) co-author	• Technical Assessment Lead • Noise Impact Assessment (NIA) Reviewer
Experience	• Experience with acoustic modelling in iNoise. • Analyst on multiple noise assessments for renewable energy projects in Alberta.	• Over 8 years of acoustic and environmental consultancy. • Completed the UK Institute of Acoustics (IOA) diploma in 2015. • Full member of the IOA. • Author on multiple NIAs for renewable energy projects in Alberta.	• 16 years of acoustic and environmental consultancy. • Acoustics (IOA) diploma (2012). • Expert witness experience in wind turbine noise in the UK (2017/18). • Expert witness experience in technical solar development in Canada (2019/20).

Appendix A: Rule 012 Glossary

Ambient sound level (ASL)

The sound level that is a composite of different airborne sounds from many sources far away from and near the point of measurement. The ambient sound level does not include noise from any energy-related facilities or from wind and must be determined without it. The average night-time ambient sound level in rural Alberta is 35 dBA. The ambient sound level can be measured when the sound level in an area is not believed to be represented by the basic sound levels in Table 1[10]. The ambient sound level must be determined under representative conditions and does not constitute absolute worst-case conditions (e.g. an unusually quiet day) but conditions that portray typical conditions for the area.

In the absence of measurement, the night-time ambient sound level is assumed to be 5 dBA less than the basic sound level and the daytime ambient sound level is assumed to be 5 dBA less than the basic sound level plus the daytime adjustment.

A-weighted sound level

The sound level as measured on a sound level meter using a setting that emphasizes the middle frequency components similar to the frequency response of the human ear at levels typical of rural backgrounds in mid frequencies. Sound levels are denoted: dB(A).

Basic sound level (BSL)

The night-time A-weighted Leq sound level commonly observed to occur in the designated land-use categories with industrial presence and is assumed to be five dB(A) above the ambient sound level, as set out in Table 1 of Rule 012.

Comprehensive sound level

The comprehensive sound level includes ambient sound level, noise from existing facilities and energy-related facilities.

Cumulative sound level

The cumulative sound level includes the comprehensive sound level, noise from proposed facilities, energy-related facilities approved but not yet constructed, and the predicted noise from the applicant's proposed facility.

C-weighted sound level

The C-weighting approximates the sensitivity of human hearing at industrial noise levels (above about 85 dBA). The C-weighted sound level (e.g., measured with the C-weighting) is more sensitive to sounds at low frequencies than the A-weighted sound level and is sometimes used to assess the low-frequency content of complex sound environments.

Daytime

Defined as the hours from 7 a.m. to 10 p.m.

Daytime adjustment

An adjustment that allows a 10 dBA increase because daytime ambient sound levels are generally about 10 dBA higher than night-time values.

[10] Table 1. Basic sound levels (BSL) for night-time (AUC Rule 12, Page 5, http://www.auc.ab.ca/Shared%20Documents/Rules/Rule012.pdf)

Density per quarter section

Refers to a quarter section with the affected dwelling at the centre (a 451-metre radius). For quarter sections with various land uses or with mixed densities, the density chosen must be factored for the area under consideration.

Down wind

The wind direction from the noise source towards the receiver (± 45 degrees), measured at either dwelling height or source height. The 45 degrees requirement is consistent with the definition for downwind conditions, as included in ISO 9613-1996, Attenuation of Sound During Propagation Outdoors – Part 2: general method of calculation.

Dwelling

Any permanently or seasonally occupied structure used for habitation for the purpose of human rest; including a nursing home or hospital with the exception of an employee or worker residence, dormitory, or construction camp located within an energy-related industrial plant boundary. Trailer parks and campgrounds may qualify as a dwelling if it can be demonstrated that they are in regular and consistent use.

A permanent dwelling is a fixed residence occupied on a full-time basis.

The most impacted dwelling(s) are those subject to the highest average weighted sound level relative to the permissible sound level.

Energy equivalent sound level (Leq)

The Leq is the average weighted sound level over a specified period of time. It is a single-number representation of the cumulative acoustical energy measured over a time interval. The time interval used should be specified in brackets following the Leq—e.g., Leq (9 hours) is a nine-hour Leq.

Energy-related facility

A facility under the jurisdiction of the Commission or other regulatory agency, used for energy generation, transport (except by road or rail line) and resource extraction. These include mining, extraction, processing and transportation (except by road or rail line) as well as federally regulated electrical transmission lines and pipelines.

Far field

The far field is that area far enough away from the noise source that the noise emissions can be treated as if they come from a single point or line source and the individual components of the noise source are not apparent as separate sources. This is typically at a distance of at least three to five times the major dimensions of the noise source, such as length, width, height or diameter.

Heavily travelled road

Includes highways and any other road where 90 or more vehicles travel during the nine-hour night-time period consistently for any two month period in a year. The following methods to validate the travel volume are acceptable:

Alberta Transportation's Average Annual Summer Daily Traffic (ASDT) value. If the ASDT is not available, the Alberta Transportation's Average Annual Daily Traffic (AADT) value can be used. In the case of using the ASDT or AADT, 10 per cent of the daily traffic volume can be assumed to be the night-time period traffic.

Linear weighting (or Z-weighting)

The sound level measured without any adjustment for the sensitivity of human hearing. It is a direct measure in decibels of the variation in air pressure and is often referred to as the "sound pressure level". This level is sometimes called the “linear weighted level” or “the unweighted level,” as it includes no frequency weighting beyond the tolerances and limits of the sound level meter being used for the measurements.

Low frequency noise

Where a clear tone is present below and including 250 Hz and the difference between the overall C-weighted sound level and the overall A-weighted sound level exceeds 20 dB.

Night-time

Defined as the hours from 10 p.m. to 7 a.m.

No net increase

The logarithmic addition of sound pressure levels when predicting noise where the sum does not exceed the permissible sound level by 0.4 dBA.

Noise

The unwanted portion of sound.

Permissible sound level (PSL)

The maximum daytime or nighttime sound level as determined in Table 1 at a point 15 m from the dwelling(s) in the direction of the facility. The permissible sound level is the sum of the basic sound level, daytime adjustment, Class A adjustments and Class B adjustment, or Class C adjustments.

Proposed facility

A proposed facility is a facility for which an application has been deemed complete by the Commission, but is not yet approved or for which an approval has been issued, but is not yet constructed.

Sound power level

The decibel equivalent of the rate of energy (or power) emitted in the form of noise. The sound power level is an inherent property of a noise source.

Sound pressure level

The decibel equivalent of the pressure of sound waves at a specific location, which is measured with a microphone. Since human reaction and material behaviours vary with frequency, the sound pressure level may be measured using frequency bands or with an overall weighting scale such as the A-weighting system. The sound pressure level depends on the noise sources, as well as the location and environment of the measurement path.

Summertime conditions

Ground cover and temperatures that do not meet the definition for wintertime conditions. These can occur at any time of the year.

Tonal components

The test for the presence of tonal components consists of two parts. The first must demonstrate that the sound pressure level of any one of the slow-response, linear, one-third octave bands between 20 and 250 Hz is 10 dBA or more than the sound pressure level of at least one of the adjacent bands within two one-third octave bandwidths. In addition, there must be a minimum of a 5 dBA drop from the band containing the tone within two bandwidths on the opposite side.

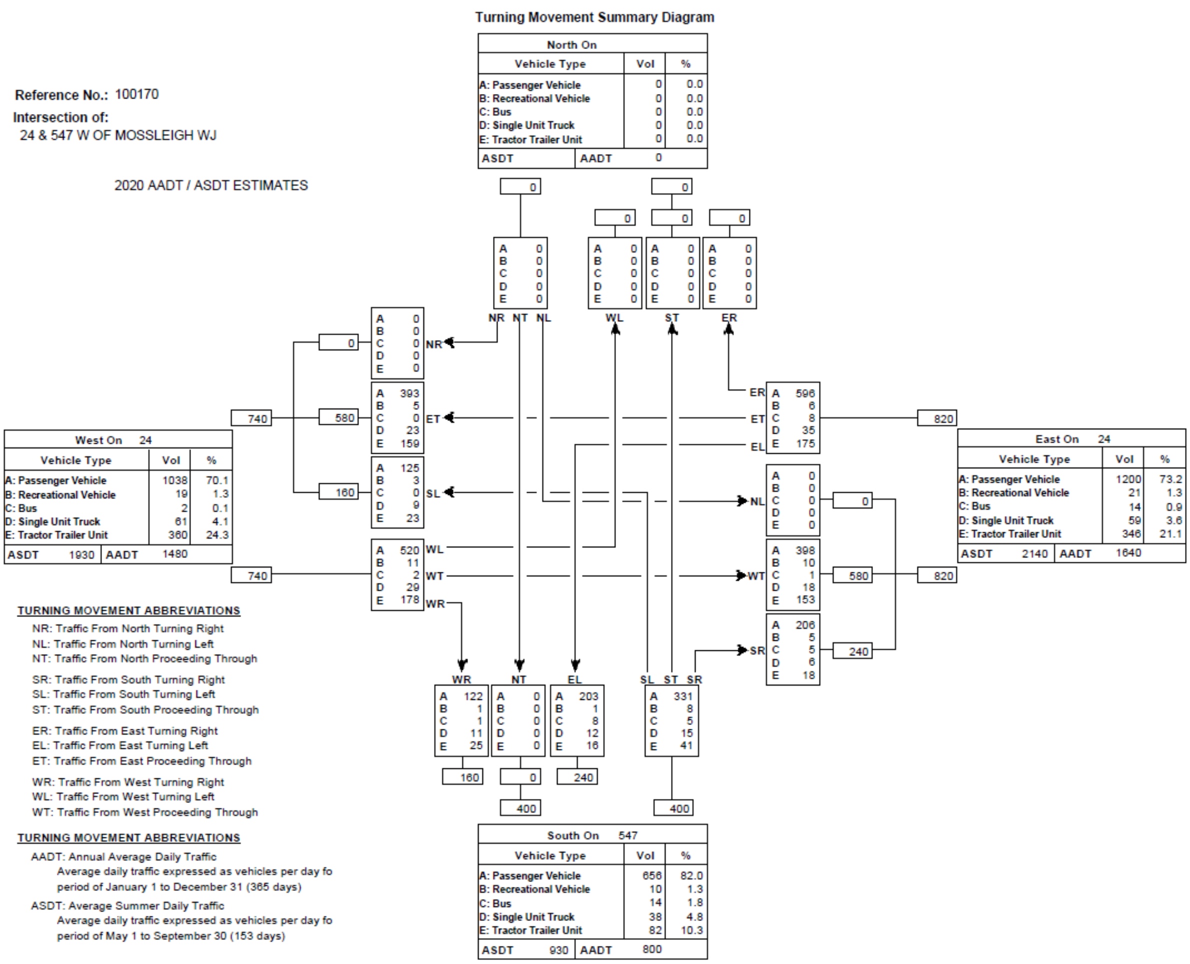
The second part is that the tonal component must be a pronounced peak clearly obvious within the spectrum.

Wind speed

The speed of the wind, expressed in metres per second (m/s), measured in and averaged over 10-minute intervals at the same height as the microphone, but not more than 10 metres above ground level.

Appendix B: Alberta Traffic Volume History

The following chart shows the relevant section of the traffic volume history for the portion of Highway 24 intersecting with Highway 547, south of the site. Using the '10% of ASDT' calculation to determine whether the highway is a 'Heavily Travelled Road', the available data show that the Rule 012 criteria of '90 or more vehicles travel during the nine-hour night-time period consistently for any one-month period in a year' is exceeded for vehicles travelling on Highway 24.



Appendix C: Vendor's Sound Power Data (Sungrow SG3600UD-MV)

Table 1. Sound Measurement Data, dB

Position	Octave Band Center Frequency, Hz									dBA	dBZ
	31.5	63	125	250	500	1000	2000	4000	8000		
1	69	68	68	67	68	63	62	57	52	69.2	75.6
2	66	67	68	67	67	63	63	57	51	68.9	74.6
3	69	68	70	71	75	66	64	62	58	74.3	79.0
4	71	71	74	71	78	71	71	66	64	78.0	81.8
5	69	68	70	71	76	66	63	60	59	74.3	79.2
6	66	67	65	66	69	62	60	56	51	68.7	74.2
7	61	64	64	58	58	54	45	40	35	58.7	69.0
8	65	68	71	65	66	64	59	56	50	68.2	75.2
9	69	69	69	72	75	65	66	61	55	74.0	79.0
10	70	73	74	71	81	71	68	67	62	78.6	83.3
11	69	69	72	72	73	67	65	60	55	73.6	79.0
12	67	68	67	66	70	63	62	58	52	69.9	75.3
13	64	68	68	65	71	60	56	51	47	68.5	74.9
14	69	71	73	71	74	64	63	57	51	72.4	79.2
Average	**68**	**69**	**71**	**69**	**74**	**66**	**64**	**61**	**57**	**73.3**	**78.4**
L_W	**91**	**92**	**93**	**92**	**97**	**88**	**87**	**83**	**80**	**95.9**	**100.9**

Appendix D: Vendor's Sound Power Data (ST2752UX-US)

SUNGROW Clean power for all

Noise Test Report for ST2752UX-US

1. Test information

Liquid-cooled ST2752UX-US energy storage container noise test, the test location is Sungrow factory Outdoor, the test time is October 13, 2021. The scene is shown in Figure 1, and the measurement point distribution and orientation definition are shown in Figure 2.

Figure 1. Field test picture

密级：秘密

SUNGROW Clean power for all

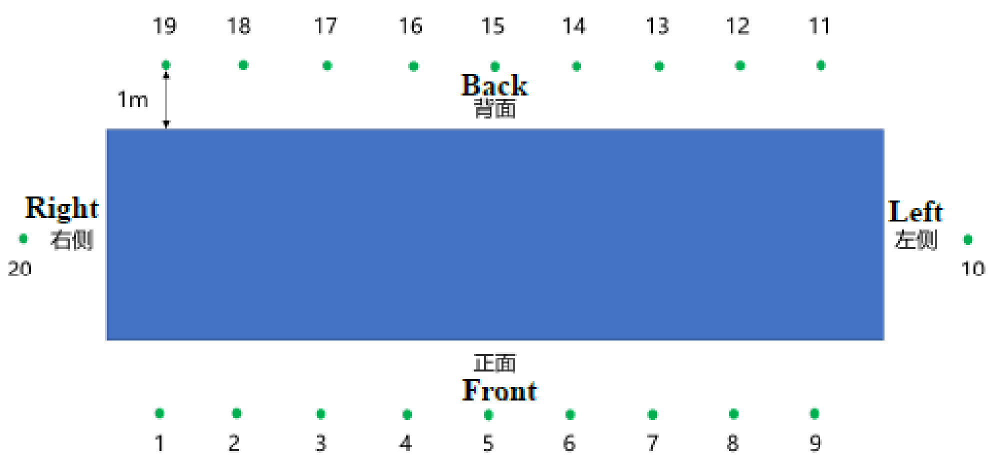


Figure 2. Schematic diagram of measuring point distribution and azimuth definition

2. Test conditions

2.1 Test information

- The whole machine runs at 100% power, reflecting the worst situation.
- Test the noise of each surface, and record the 1/3 octave frequency spectrum of each measurement point.

2.2 Testing process

Test the noise at each measuring point as shown in Figure 2 respectively. The noise sensor is arranged at a distance of 1 m from the wall of the whole machine and a height of 1.5 m.

3. Data processing results and analysis

The background noise test results are as follows, the background noise is 48.43dBA.

密级：秘密

SUNGROW Clean power for all

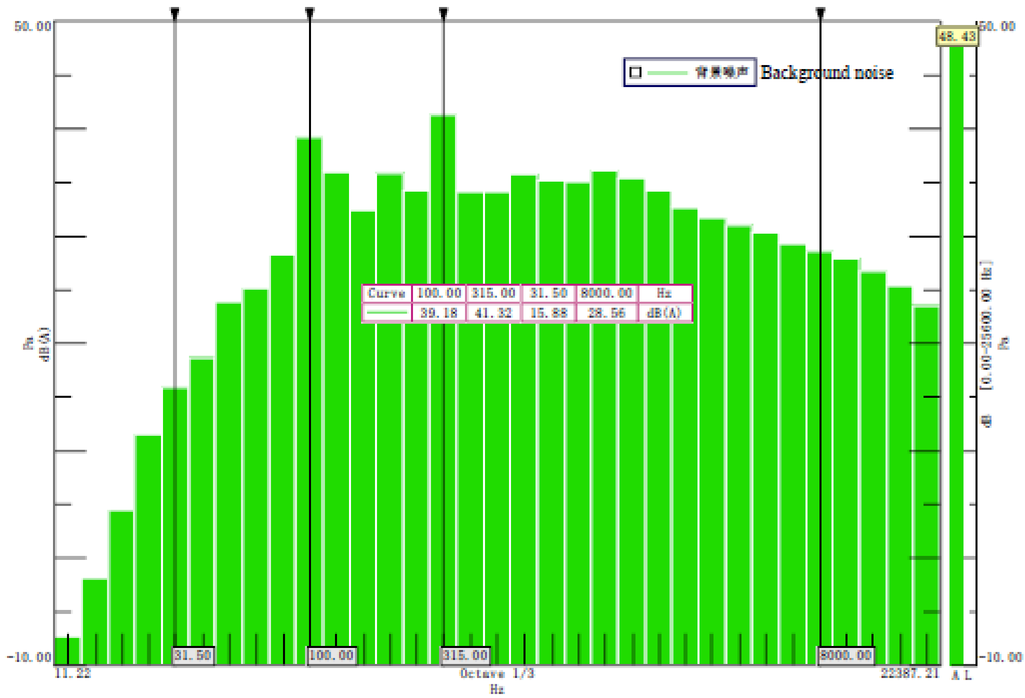


Figure 3. Background noise spectrum

The sound pressure level (dBA) test data of each measuring point is as follows, the noise of the measuring point is more than 10dBA larger than the background noise, no correction is needed:

Num.	Noise	Num.	Noise	Num.	Noise	Num.	Noise	Num.	Noise
1	68.91	5	74.68	9	69.04	13	72.34	17	70.04
2	69.39	6	74.81	10	69.21	14	72.42	18	67.93
3	70.28	7	72.92	11	70.63	15	72.07	19	67.88
4	71.9	8	71.1	12	70.44	16	71.96	20	62.66

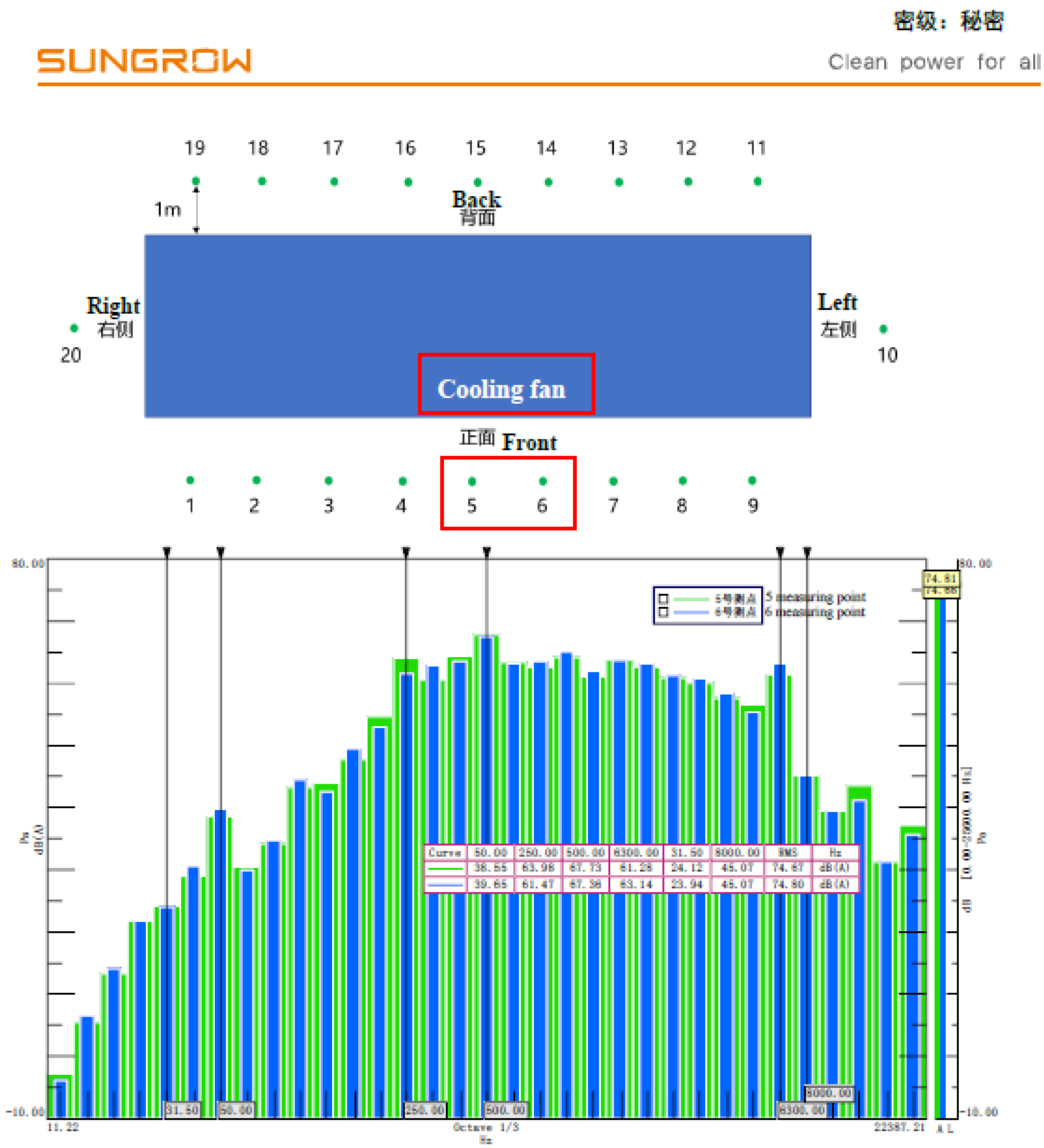


Figure 4. Maximum noise position (measurement points 5 and 6) 1/3 octave frequency spectrum

From the noise data of all measuring points, the main noise source is the cooling fan of the battery module. The maximum noise is at measuring points 5 and 6, which are 74.68dBA and 74.81dBA, respectively.

Appendix E: Vendor's Sound Power Data (SC2500UD-US)

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Website: www.sungrowpower.com

SUNGROW

Noise Test Report

TYPE TEST SHEET

This Type Test sheet shall be used to record the results of the type testing of Generating Unit			
Type Tested reference number		SC2000UD-US SC2500UD-US	
Generating Unit technology		Power Conversion System	
System supplier name		Sungrow Power Supply Co., Ltd.	
Address		No.1699 Xiyou Rd., New & High Technology Industrial Development Zone, Hefei, P.R. China	
Tel	+86 551 65327834	Fax	+86 551 6532 7800
E:mail	info@sungrow.cn	Web site	www.sungrowpower.com
Maximum export capacity, use separate sheet if more than one connection option.	N/A	kW single phase, single, split or three phase system	
	2500	kW three phase	
	N/A	kW two phases in three phase system	
	N/A	kW two phases split phase system	
Compiled by	张文[illegible]	On behalf of	Sungrow Power Supply Co., Ltd.
Approved by	王凯	Test Date	2021-09-11
Note that testing can be done by the manufacturer of an individual component, by an externaltest house, or by the supplier of the complete system, or any combination of them as appropriate. Where parts of the testing are carried out by persons or organisations other than the supplier then the supplier shall keep copies of all test records and results supplied to them to verify that the testing has been carried out by people with sufficient technical competency to carry out thetests.			

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Website: www.sungrowpower.com

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The aim of this test is to determine the noise level when the PV Grid inverter in rated working condition and maximum reactive power output.

Used settings of the measurement device for Noise measurement:

Measurement device	Calibration Date	Expire Date
AWA6228	2021-05-11	2022-05-10

The condition s during testing are specified below:

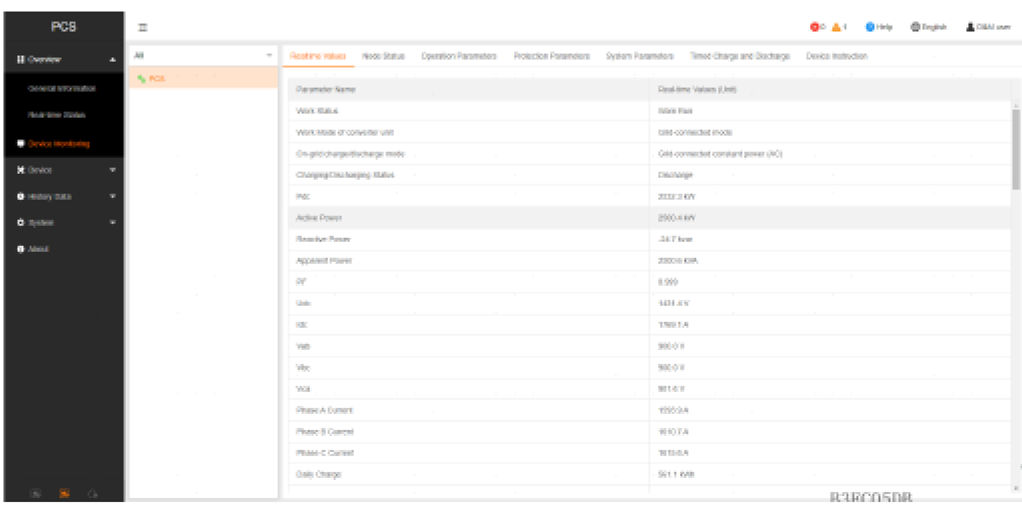
PGU operation mode	Rated working condition
Voltage range	1300-1500V
Grid frequency range	60Hz
Distance	1 m
Date	2021-09-11

The system noise level please check the table below:

Rated working condition

Orientation	Noise(dB/Leq_A)
Front	78.9
Behind	80.1
Left	79.1
Right	78.5
Maximum Noise	80.1

Photo:
Rated working condition



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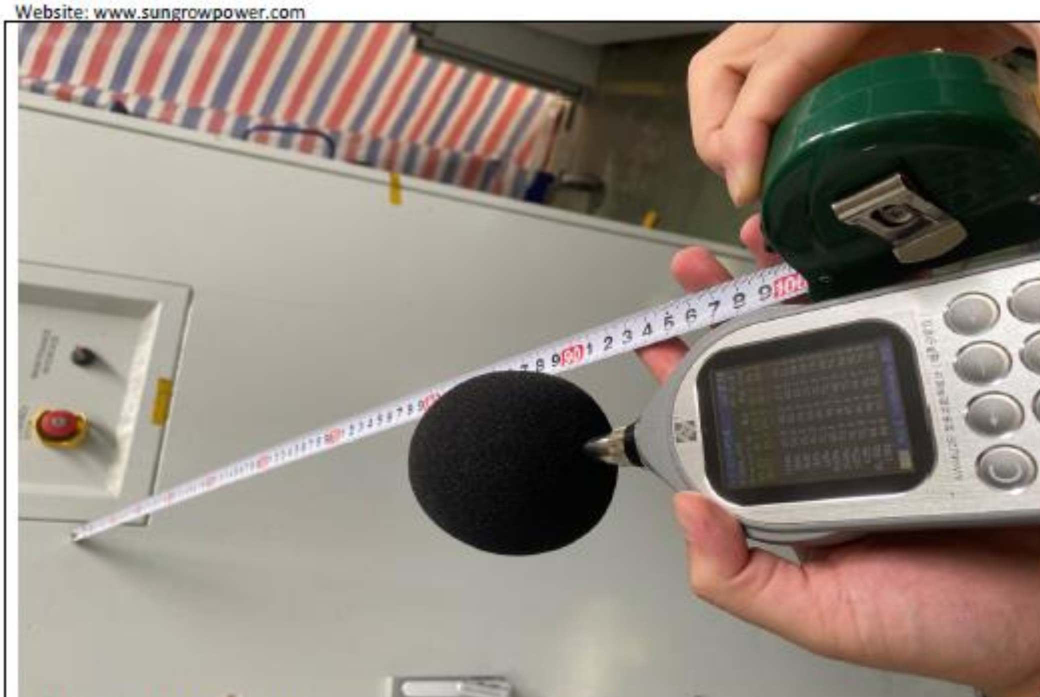

Test Record(Octave band)			
Frequency(Hz)	Noise(dB/Leq_A)	Frequency(Hz)	Noise(dB/Leq_A)
16	78.2	1K	70.3
31.5	79.8	2K	64.6
63	82.8	4K	59.6
125	84.5	8K	51.5
250	78.1	16K	35.2
500	80.6	**SPL_A**	**78.9**

Front

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Test Record(Octave band)			
Frequency(Hz)	Noise(dB/Leq_A)	Frequency(Hz)	Noise(dB/Leq_A)
16	74.1	1K	71.9
31.5	76.5	2K	68.6
63	81.1	4K	63.2
125	83.3	8K	54.8
250	79.1	16K	38.1
500	81.6	**SPL_A**	**80.1**

Behind

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Test Record(Octave band)			
Frequency(Hz)	Noise(dB/Leq_A)	Frequency(Hz)	Noise(dB/Leq_A)
16	77.4	1K	70.5
31.5	79.0	2K	64.7
63	82.0	4K	62
125	83.8	8K	53.4
250	77.5	16K	35.8
500	81.1	**SPL_A**	**79.1**

Left

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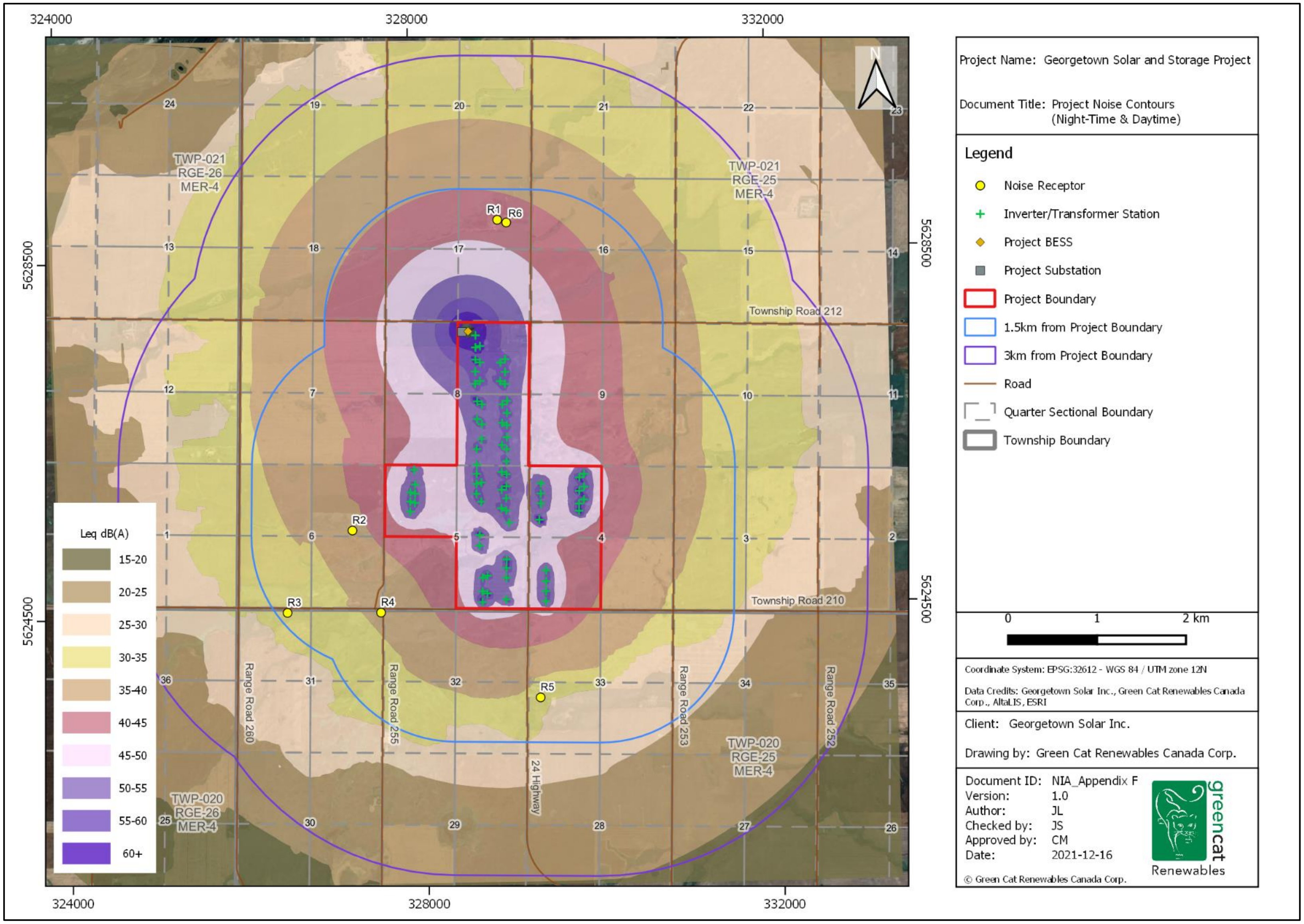
Test Record(Octave band)			
Frequency(Hz)	Noise(dB/Leq_A)	Frequency(Hz)	Noise(dB/Leq_A)
16	75.7	1K	70.6
31.5	77.4	2K	66.0
63	80.7	4K	62.0
125	82.5	8K	53.3
250	76.2	16K	36.4
500	80.4	**SPL_A**	**78.5**

Right

Additional comments
N/A

Appendix F: Project Sound Level Contours



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