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Noise Impact Assessment

For The

Hoole Power Generation & Data Infrastructure Project at 16-36-080-25 W4M

Prepared for:

Armada Nowlit Energy Ltd.

PERMIT TO PRACTICE
ACI ACOUSTICAL CONSULTANTS INC.
Signature
Date 07/10/2026
PERMIT NUMBER: P 7735
The Association of Professional Engineers, Geologists and Geophysicists of Alberta

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aci Project #: 25-070
July 10, 2026

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Executive Summary

aci Acoustical Consultants Inc., of Edmonton AB, was retained by Armada Nowlit Energy Ltd. (Armada) to conduct a noise impact assessment for the proposed power generation and possible data centre (the Project) at 16-36-080-25 W4M in the Municipal District of Opportunity No. 17, AB. The purpose of the work was to generate a computer noise model under Phase 1 & Phase 2 Case conditions and to compare the noise levels to the applicable noise criteria as specified by the Alberta Utilities Commission (AUC) Rule 012 on Noise Control. A site visit was conducted for aci on July 30, 2025, by P. Froment, B.Sc., B.Ed., P.L.(Eng.).

The modeled Phase 1 L_{eq}Night noise levels at the theoretical 1,500 m receptors range from 20.3 dBA – 22.9 dBA (without ASL) and 35.1 dBA – 35.3 dBA (with ASL). As such, the projected noise levels at all theoretical 1,500 m receptors will be below the AUC's PSLs.

The modeled Phase 2 L_{eq}Night noise levels at the theoretical 1,500 m receptors range from 23.8 dBA – 26.4 dBA (without ASL) and 35.3 dBA – 35.6 dBA (with ASL). As such, the projected noise levels at all theoretical 1,500 m receptors will be below the AUC's PSLs.

In addition, the noise modeling results indicated C-weighted (dBC) sound levels will be less than 20 dB above the dBA sound levels at all residential receptor locations. As specified in AUC Rule 012, if the dBC – dBA sound levels are less than 20 dB, the noise is not considered to have a low frequency tonal component.

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aci Acoustical Consultants Inc., of Edmonton AB, was retained by Armada Nowlit Energy Ltd. (Armada) to conduct a noise impact assessment for the proposed Hoole Power Generation and Data Centre (the Project) at 16-36-080-25 W4M in the Municipal District of Opportunity No. 17, AB. The purpose of the work was to generate a computer noise model under Phase 1 & Phase 2 Case conditions and to compare the noise levels to the applicable noise criteria as specified by the Alberta Utilities Commission (AUC) Rule 012 on Noise Control. A site visit was conducted for aci on July 30, 2025, by P. Froment, B.Sc., B.Ed., P.L.(Eng.).

2.0 Description

2.1. Location Description

The Project is within Municipal District of Opportunity No. 17, AB at 16-36-080-25 W4M as indicated in Figure 1. The southern boundary of the site is approximately 7 km north of Wabasca - Desmarais, AB. Based on the site visit conducted on July 30, 2025, there were no other noise producing energy regulated industrial noise sources within 1.5 km of the Project. Additionally, there are no residential receptor locations within 1.5 km of the Project boundaries.

Topographically the land throughout the study area is relatively flat with minimal changes in elevation. Digital elevation contours for the entire study area were included in the noise model. The vegetation surrounding the Project is primarily thick dense vegetation composed of both deciduous and coniferous trees. As such, the vegetative sound absorption is considered moderate to high.

2.1. Project Description

As part of the project, Armada proposes to complete the project in two (2) phases.

For Phase 1 Armada proposes to add:

- Four (4) MWM MGM TCG 3020 V20 2.2 MW Enclosed Gen-sets
- Four (4) Enclosed Data Centres. Each with:
    - Large Cooling Fans
    - Transformers

For Phase 2 Armada proposes to add:

- Five (5) MWM MGM TCG 3020 V20 2.2 MW Enclosed Gen-sets
- Five (5) Enclosed Data Centres. Each with:
    - Large Cooling Fans
    - Transformers

Therefore, after the completion of Phase 2, as illustrated in Figure 2, there will be a total of:

- Nine (9) MWM MGM TCG 3020 V20 2.2 MW Enclosed Gen-sets
- Nine (9) Enclosed Data Centres. Each with:
  - Large Cooling Fans
  - Transformers

It should be noted that specifications on the mufflers for this system were not available. As such, hospital grade mufflers (or equivalent in terms of noise reduction) **will be required** and has been modeled as such.

Once completed, the Project will operate 24 hours/day, 365 days/year.

3.0 Modeling Methods

3.1. General Modeling Parameters

The computer noise modeling was conducted using the CADNA/A (Version 2026 MR1, build: 215.5625) software package. CADNA/A allows for the modeling of various noise sources such as road, rail, and various stationary sources. In addition, topographical features such as land contours, vegetation, and bodies of water can be included. Finally, meteorological conditions such as temperature, relative humidity, wind-speed and wind-direction can be included in the calculations. Note that all modeling methods used exceed the requirements of the AUC Rule 012 on Noise Control.

The calculation method used for noise propagation follows the ISO standard 9613-2. All receiver locations were assumed as being downwind from the source(s). In particular, as stated in Section 5 of the ISO document:

> *"Downwind propagation conditions for the method specified in this part of IS0 9613 are as specified in 5.4.3.3 of IS0 1996-2:1987, namely*
> - *wind direction within an angle of ± 45^0 of the direction connecting the centre of the dominant sound source and the centre of the specified receiver region, with the wind blowing from source to receiver, and*
> - *wind speed between approximately 1 m/s and 5 m/s, measured at a height of 3 m to 11 m above the ground.*
>
> *The equations for calculating the average downwind sound pressure level LAT(DW) in this part of IS0 9613, including the equations for attenuation given in clause 7, are the average for meteorological conditions within these limits. The term average here means the average over a short time interval, as defined in 3.1.*

These equations also hold, equivalently, for average propagation under a well-developed moderate ground-based temperature inversion, such as commonly occurs on clear, calm nights".

3.2. Noise Modeling Scenarios

As part of the study, two (2) modeling scenarios were conducted, including:

1) Phase 1: This included all noise sources and buildings associated with Phase 1 of the Project in addition to the Ambient Sound Level (ASL, see below).
2) Phase 2: This included all noise sources and buildings associated with Phase 2 of the Project in addition to the Ambient Sound Level (ASL, see below).

3.3. Noise Modeling Parameters

Due to the minimal amount of vegetation, and thus relative ineffectiveness to mitigate the noise climate, vegetation was not included in the model. Similarly, snow cover was not included since there can be variations in absorption/reflection caused by different snow conditions. A ground absorption coefficient of 0.7 was used along with a temperature of 10^{0}C and a relative humidity of 70%[1]. As a result, all sound level propagation calculations are considered conservatively representative of summertime conditions for all surrounding residents.

As previously mentioned, due to the very flat topography of the area digital topographical information was not deemed to be required and as such, was not included in the model.

The computer noise modeling results were calculated in two ways. First, sound levels were calculated at the specific receiver locations (i.e. adjacent residents and theoretical 1,500 m receptors) at a height of 1.5 m. Next, the sound levels were calculated using a 2 m x 2 m grid over the entire study area. This provided color noise contours for easier visualization of the results.

AUC Rule 012 requires the assessment to include background ambient noise levels in the model. As specified in AUC Rule 012, where there is an absence of industrial noise sources the average night-time ambient noise level is approximately 5 dBA less than the basic sound level (BSL) (further discussed in Section 4.1). This is known as the average ambient sound level (ASL). This value was used as the ambient condition in the modeling in addition to the sound power levels associated with the existing and project noise sources.

[1] Consistent with previously completed projects submitted to the AUC.

Refer to Appendix I for a description of the acoustical terminology, Appendix II for a list of common noise sources and Appendix III for a list of the computer noise modeling parameters.

3.4. Noise Sources

The broadband noise data for the proposed gen-sets were provided by the manufacturer. The octave band centre frequencies were then calculated and included the noise model utilizing aci in-house information and calculations using methods presented in various texts. The noise data for the cooling fans and transformers for each of the data mining centres were based on previously completed projects with similar generator KW ratings. Refer to Appendix III for a list of the sound power levels and building sound level attenuation used within the model.

3.5. Modeling Confidence

As previously mentioned, the algorithms used for the noise modeling follow the ISO 9613 standard. The published accuracy for this standard is ±3 dBA between 100 m – 1,000 m. Accuracy levels beyond 1,000 m are not published. Experience based on similar noise models conducted over large distances shows that, as expected, as the distance increases, the associated accuracy in prediction decreases. Experience has shown that environmental factors such as wind, temperature inversions, topography and ground cover all have increasing effects over distances larger than approximately 1,500 m.

4.0 Permissible Sound Levels

Environmental noise levels from various sources (industrial, roads, railways, etc.) are commonly described in terms of equivalent sound levels or L_{eq}. This is the level of a steady sound having the same acoustic energy, over a given time period, as the fluctuating sound. In addition, this energy averaged level is A–weighted to account for the reduced sensitivity of average human hearing to low frequency sounds. These L_{eq} in dBA, which are the most common environmental noise measure, are often given for day-time (07:00 to 22:00) L_{eq}Day and night-time (22:00 to 07:00) L_{eq}Night while other criteria use the entire 24-hour period as L_{eq}24. The criteria used to evaluate the noise in the study area include the AUC Rule 012.

4.1. Alberta Utilities Commission Rule 012

The AUC Rule 012 (2021) on Noise Control sets the PSL at the receiver location based on population density and relative distances to heavily traveled road and rail as shown in Table 1. Firstly, the various residential receptors within the study area are classified in either Category 1, 2 or 3 as indicated in Table 1. Receptors in Category 1 are more than 500 m from heavily travelled roads or rail lines while those in Category 2 are more than 30 m but less than 500 m from heavily travelled roads or rail lines. Category 3 receptors are less than 30 m from heavily travelled roads or rail lines. Secondly, the residential receptors are categorized by the population density per quarter section. This refers to a quarter Section with the affected dwelling at the centre (i.e. a 451 radius).

Table 1. Basic Night-Time Sound Levels (as per the AUC Rule 012)

Proximity to Transportation	Dwelling Density per Quarter Section of Land				
	1-8 Dwellings	9-160 Dwellings	161 to 400 Dwellings	400 to 1,000 Dwellings	>1,000 Dwellings
Category 1	40 dBA	43 dBA	46 dBA	48 dBA	53 dBA
Category 2	45 dBA	48 dBA	51 dBA	51 dBA	53 dBA
Category 3	50 dBA	53 dBA	56 dBA	56 dBA	56 dBA
Category 1	Dwelling units more than 500m from heavily travelled roads and/or rail lines and not subject to frequent aircraft flyovers				
Category 2	Dwelling units more than 30m but less than 500m from heavily travelled roads and/or rail lines and not subject to frequent aircraft flyovers				
Category 3	Dwelling units less than 30m from heavily travelled roads and/or rail lines and not subject to frequent aircraft flyovers				

As previously mentioned, there are no residential receptor locations with 1.5 km of the Project boundaries. As such, the AUC Rule 012 also specifies that new or modified facilities must meet a PSL-Night of 40 dBA at 1,500 m from the facility fence-line if there are no closer dwellings. As such, the PSLs at a distance of 1,500 m are an **L_{eq}Night of 40 dBA and an L_{eq}Day of 50 dBA.**

Refer to Appendix IV for the table used to determine of the PSL's.

5.0 Results and Discussion

5.1. Phase 1 Scenario Results

The results of the Phase 1 noise modeling are presented in Table 2 and illustrated in Figure 3. The Phase 1 noise sources will operate 24/7, therefore only the night-time results will be presented and discussed.

Table 2. Phase 1 Case Noise Modeling Results

Receptor (Distance from Centre of Site)	ASL-Night (dBA)	Phase 1 Case L_{eq}Night (dBA)	ASL + Phase 1 Case L_{eq}Night (dBA)	PSL-Night (dBA)	Compliant		Phase 1 Case L_{eq}Night (dBC)	dBC - dBA	Tonal
Theoretical 1,500 m Receptors									
North (1,500 m)	35.0	21.5	35.2	40.0	YES		43.6	22.1	POSSIBLE
Northeast (1,500 m)	35.0	20.8	35.2	40.0	YES		43.0	22.2	POSSIBLE
East (1,500 m)	35.0	20.3	35.1	40.0	YES		42.6	22.3	POSSIBLE
Southeast (1,500 m)	35.0	20.5	35.2	40.0	YES		42.7	22.2	POSSIBLE
South (1,500 m)	35.0	20.9	35.2	40.0	YES		43.2	22.3	POSSIBLE
Southwest (1,500 m)	35.0	21.8	35.2	40.0	YES		43.7	21.9	POSSIBLE
West (1,500 m)	35.0	22.9	35.3	40.0	YES		44.2	21.3	POSSIBLE
Northwest (1,500 m)	35.0	22.2	35.2	40.0	YES		44.1	21.9	POSSIBLE

The modeled Phase 1 L_{eq}Night noise levels at the theoretical 1,500 m receptors range from 20.3 dBA – 22.9 dBA (without ASL) and 35.1 dBA – 35.3 dBA (with ASL). As indicated in Table 2, the projected noise levels at all theoretical 1,500 m receptors will be below the AUC's PSLs. As such, noise mitigation **will not** be required for Phase 1 operations.

In addition to the broadband dBA sound levels, the modeling results at the theoretical 1,500 m receptors indicated that the dBC sound levels will be higher than 20 dB above the dBA sound levels, as shown in Table 2. As specified in AUC Rule 012, since the dBC – dBA sound levels are greater than 20 dB, the noise will possibly have a low frequency tonal component. However, since the overall dBA noise levels are below 30 dBA for all locations, it is not anticipated that there will be issues with any tonal noise for the nearby residents.

5.2. Phase 2 Scenario Results

The results of the Phase 2 noise modeling scenario are presented in Table 3 and illustrated in Figure 4. The Mitigation Case noise sources will operate 24/7, therefore only the night-time results will be presented and discussed.

Table 3. Phase 2 Case Noise Modeling Results

Receptor (Distance from Drill Entry Point)	ASL-Night (dBA)	Phase 2 Case L_{eq}Night (dBA)	ASL + Phase 2 Case L_{eq}Night (dBA)	PSL-Night (dBA)	Compliant		Phase 2 Case L_{eq}Night (dBC)	dBC - dBA	Tonal
Theoretical 1,500 m Receptors									
North (1,500 m)	35.0	24.8	35.4	40.0	YES		46.9	22.1	POSSIBLE
Northeast (1,500 m)	35.0	24.2	35.3	40.0	YES		46.4	22.2	POSSIBLE
East (1,500 m)	35.0	23.8	35.3	40.0	YES		46.1	22.3	POSSIBLE
Southeast (1,500 m)	35.0	24.1	35.3	40.0	YES		46.3	22.2	POSSIBLE
South (1,500 m)	35.0	24.7	35.4	40.0	YES		46.9	22.2	POSSIBLE
Southwest (1,500 m)	35.0	25.5	35.5	40.0	YES		47.4	21.9	POSSIBLE
West (1,500 m)	35.0	26.4	35.6	40.0	YES		47.7	21.3	POSSIBLE
Northwest (1,500 m)	35.0	25.8	35.5	40.0	YES		47.6	21.8	POSSIBLE

The modeled Phase 2 L_{eq}Night noise levels at the theoretical 1,500 m receptors range from 23.8 dBA – 26.4 dBA (without ASL) and 35.3 dBA – 35.6 dBA (with ASL). As indicated in Table 3, the projected noise levels at all theoretical 1,500 m receptors will be below the AUC's PSLs. As such, noise mitigation **will not** be required for Phase 2 operations.

In addition to the broadband dBA sound levels, the modeling results at the theoretical 1,500 m receptors indicated that the dBC sound levels will be higher than 20 dB above the dBA sound levels, as shown in Table 3. As specified in AUC Rule 012, since the dBC – dBA sound levels are greater than 20 dB, the noise will possibly have a low frequency tonal component. However, since the overall dBA noise levels are below 30 dBA for all locations, it is not anticipated that there will be issues with any tonal noise for the nearby residents.

5.3. Construction Noise

Although there are no specific construction noise level limits detailed by AUC Rule 012, there are general recommendations for construction noise mitigation. This includes all activities associated with construction of the station. The document states:

> "*Licensees must take the following mitigating measures to reduce the impact of construction noise on nearby dwellings:*
>
> - *Conduct construction activity between the hours of 07:00 and 22:00 to reduce the potential impact of construction noise;*
> - *Advise nearby residents of significant noise-causing activities and schedule these events to reduce disruption to them;*
> - *Ensure all internal combustion engines are fitted with appropriate muffler systems; and*
>
> *Should a noise complaint be filed during construction, the licensee must respond expeditiously and take action to ensure that the compliant has been addressed.*"

6.0 Conclusion

The modeled Phase 1 L_{eq}Night noise levels at the theoretical 1,500 m receptors range from 20.3 dBA – 22.9 dBA (without ASL) and 35.1 dBA – 35.3 dBA (with ASL). As such, the projected noise levels at all theoretical 1,500 m receptors will be below the AUC's PSLs.

The modeled Phase 2 L_{eq}Night noise levels at the theoretical 1,500 m receptors range from 23.8 dBA – 26.4 dBA (without ASL) and 35.3 dBA – 35.6 dBA (with ASL). As such, the projected noise levels at all theoretical 1,500 m receptors will be below the AUC's PSLs.

In addition, the noise modeling results indicated C-weighted (dBC) sound levels will be less than 20 dB above the dBA sound levels at all residential receptor locations. As specified in AUC Rule 012, if the dBC – dBA sound levels are less than 20 dB, the noise is not considered to have a low frequency tonal component.

A short form (AUC Rule 012 form) noise impact assessment is presented in Appendix V.

7.0 References

- Alberta Utilities Commission (AUC), *Rule 012 on Noise Control*, *2024* Calgary, Alberta.
- International Organization for Standardization (ISO), *Standard 1996-1, Acoustics – Description, measurement and assessment of environmental noise – Part 1: Basic quantities and assessment procedures, 2003*, Geneva Switzerland.
- International Organization for Standardization (ISO), *Standard 9613-1, Acoustics – Attenuation of sound during propagation outdoors – Part 1: Calculation of absorption of sound by the atmosphere, 1993,* Geneva Switzerland.
- International Organization for Standardization (ISO), *Standard 9613-2, Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation, 1996,* Geneva Switzerland.

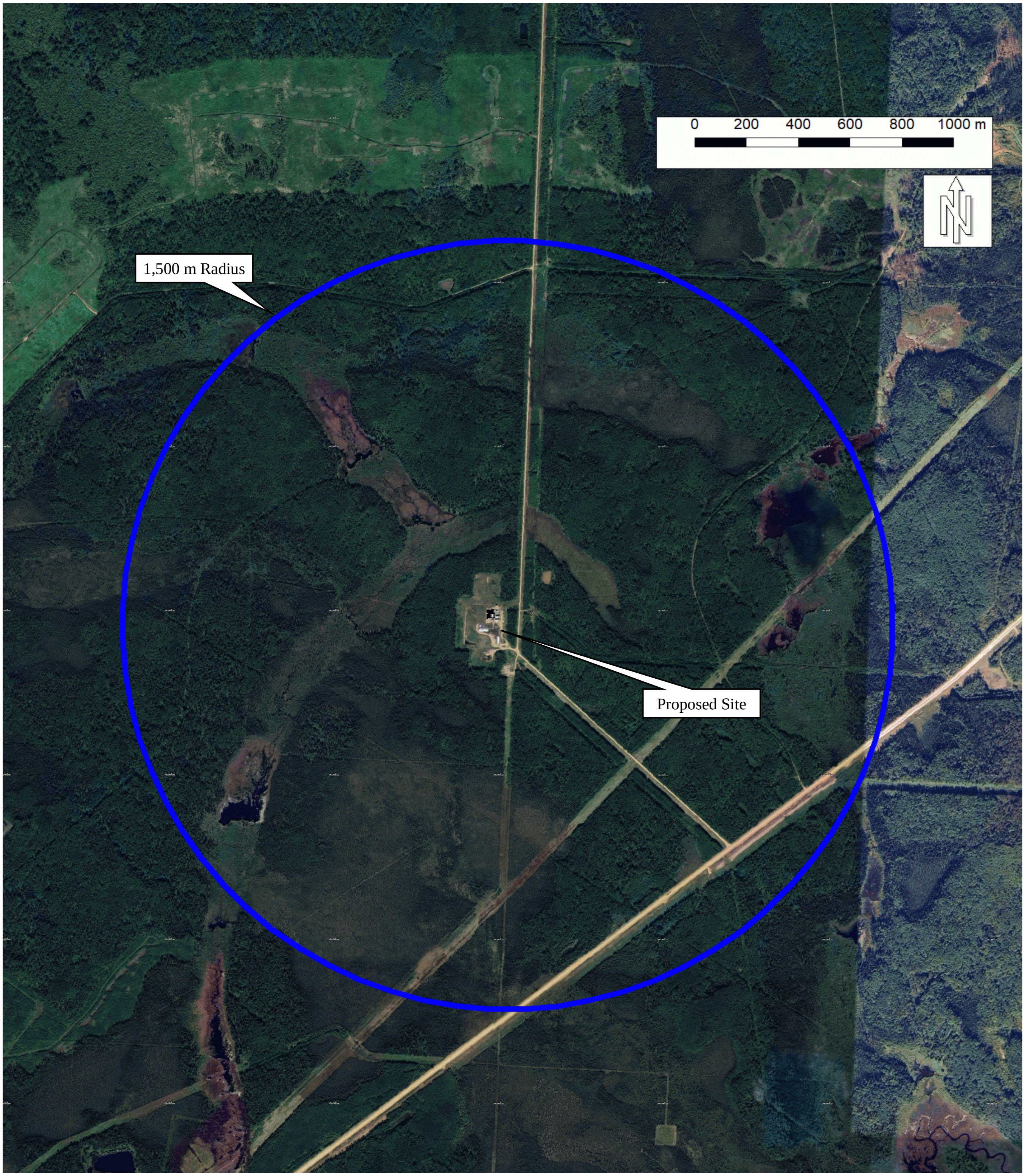


Figure 1. Study Area

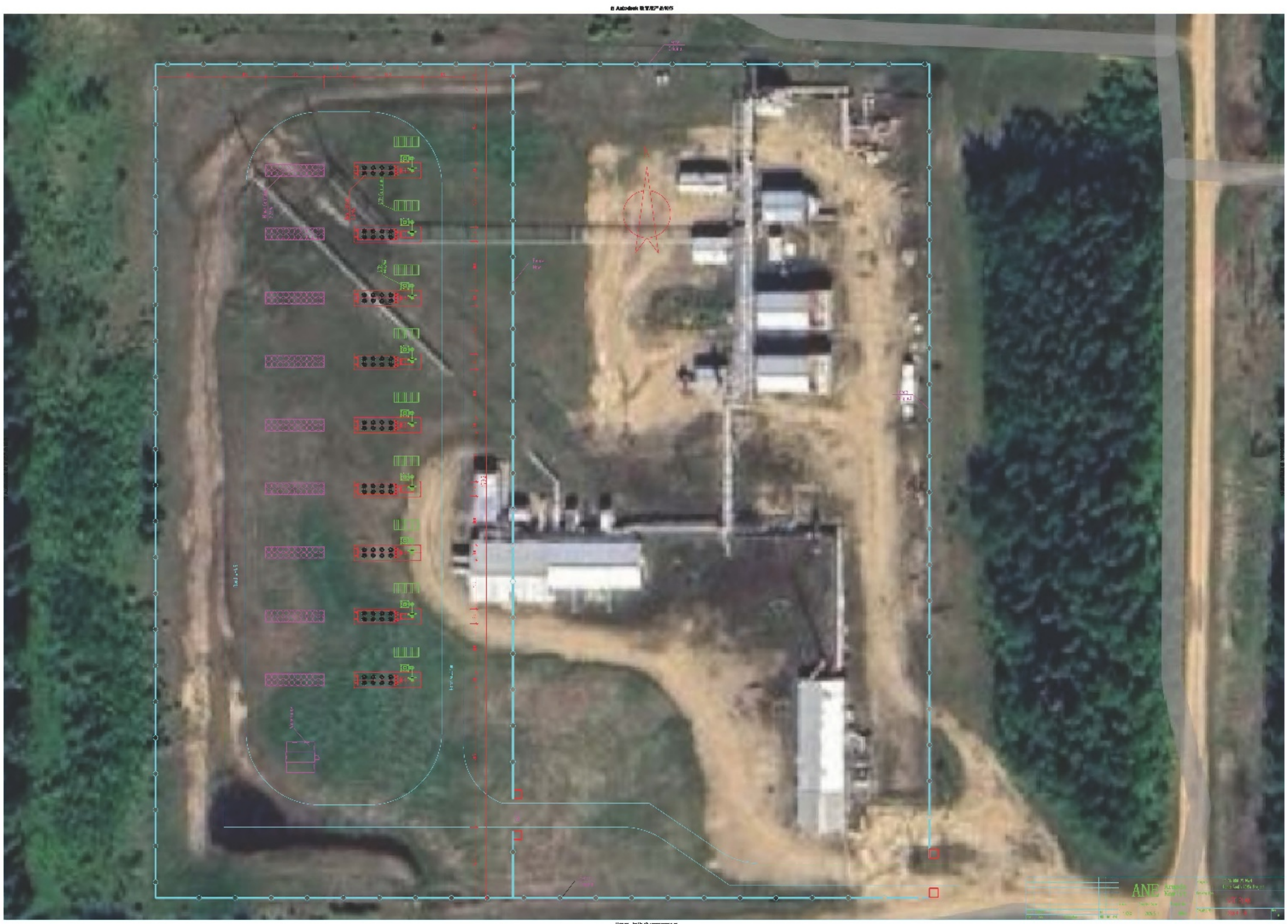


Figure 2. Site Plan

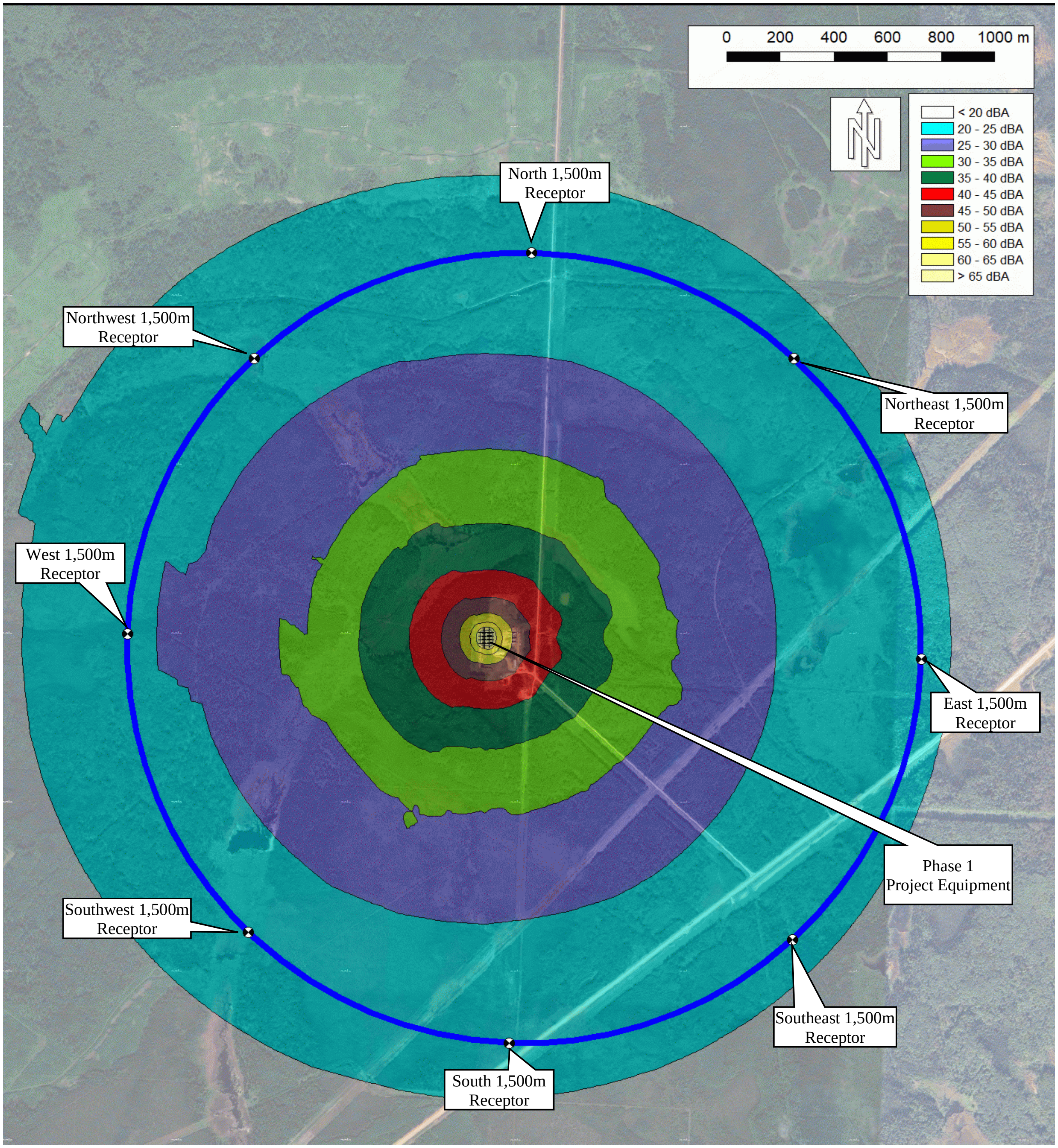


Figure 3. Phase 1 Case Noise Modeling L_{eq}Night (Without ASL)

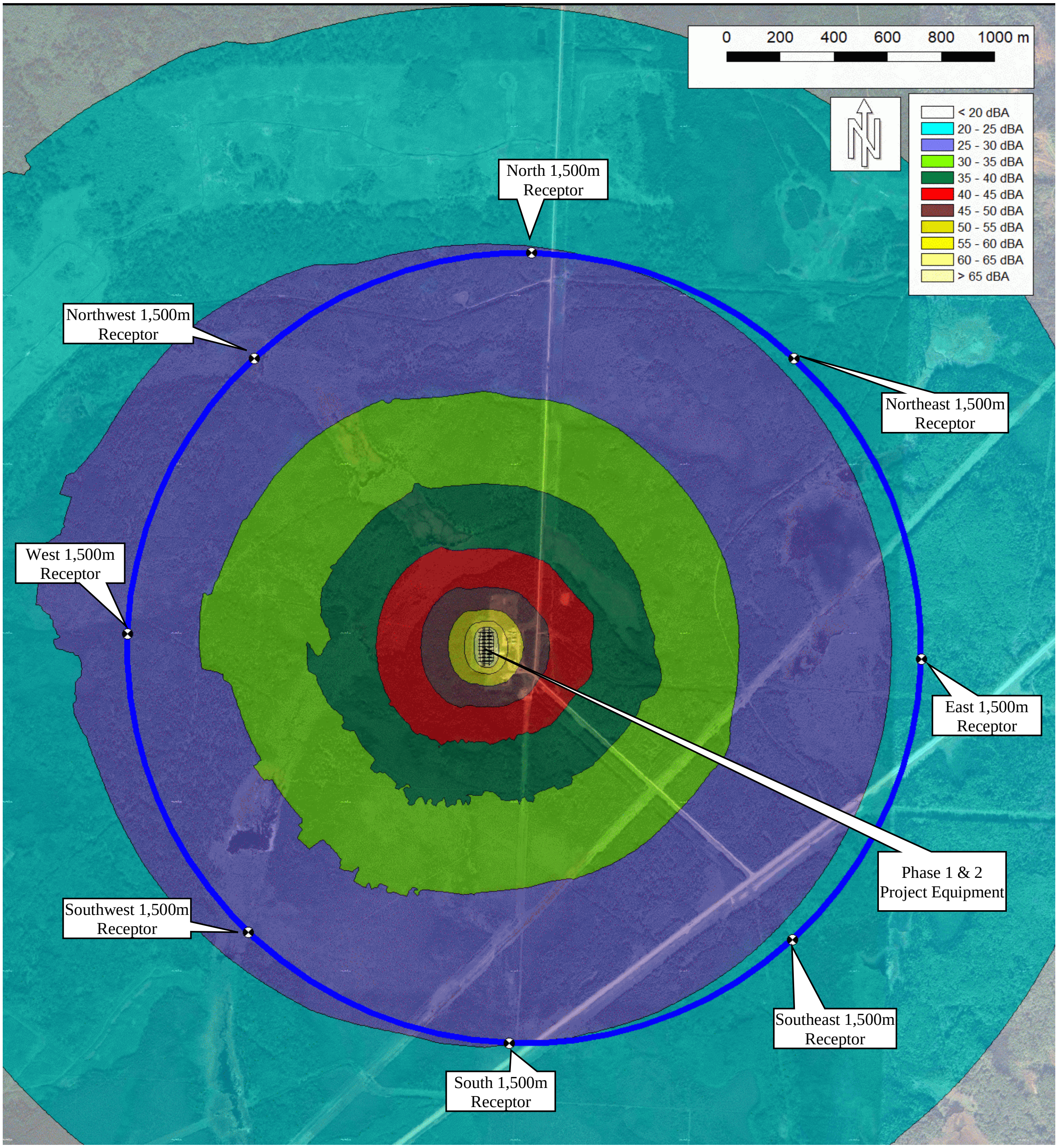


Figure 4. Phase 2 Case Noise Modeling L_{eq}Night (Without ASL)

Appendix I. THE ASSESSMENT OF ENVIRONMENTAL NOISE (GENERAL)

Sound Pressure Level

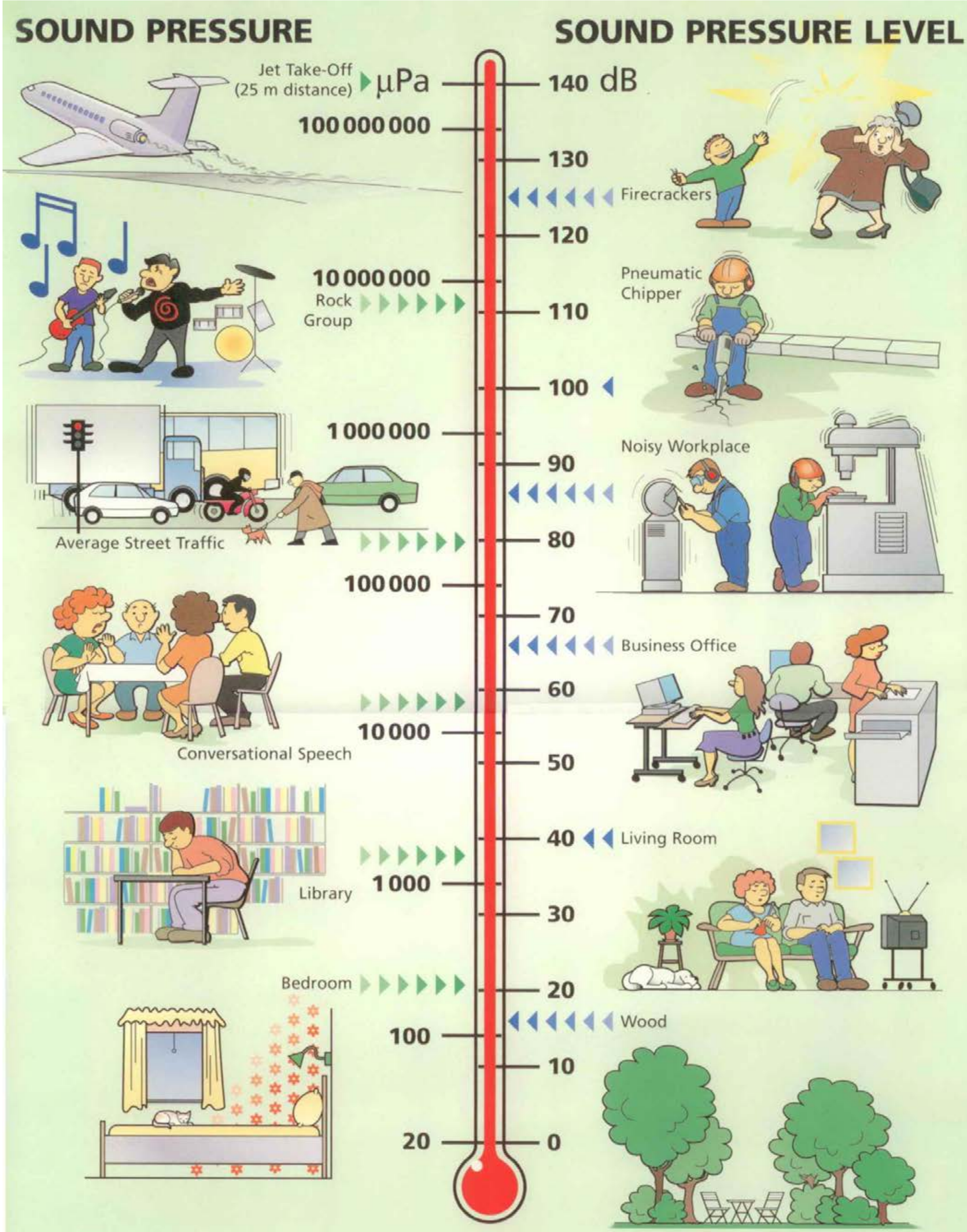
Sound pressure is initially measured in Pascal's (Pa). Humans can hear several orders of magnitude in sound pressure levels, so a more convenient scale is used. This scale is known as the decibel (dB) scale, named after Alexander Graham Bell (telephone guy). It is a base 10 logarithmic scale. When we measure pressure we typically measure the RMS sound pressure.

$$SPL = 10\log_{10}\left[\frac{P_{RMS}^{2}}{P_{ref}^{2}}\right] = 20\log_{10}\left[\frac{P_{RMS}}{P_{ref}}\right]$$

Where: SPL = Sound Pressure Level in dB
P_{RMS} = Root Mean Square measured pressure (Pa)
P_{ref} = Reference sound pressure level ($P_{ref} = 2\text{x}10^{-5}$ Pa = 20 μPa)

This reference sound pressure level is an internationally agreed upon value. It represents the threshold of human hearing for "typical" people based on numerous testing. It is possible to have a threshold which is lower than 20 μPa which will result in negative dB levels. As such, zero dB does not mean there is no sound!

In general, a difference of 1 – 2 dB is the threshold for humans to notice that there has been a change in sound level. A difference of 3 dB (factor of 2 in acoustical energy) is perceptible and a change of 5 dB is strongly perceptible. A change of 10 dB is typically considered a factor of 2. This is quite remarkable when considering that 10 dB is 10-times the acoustical energy!



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Frequency

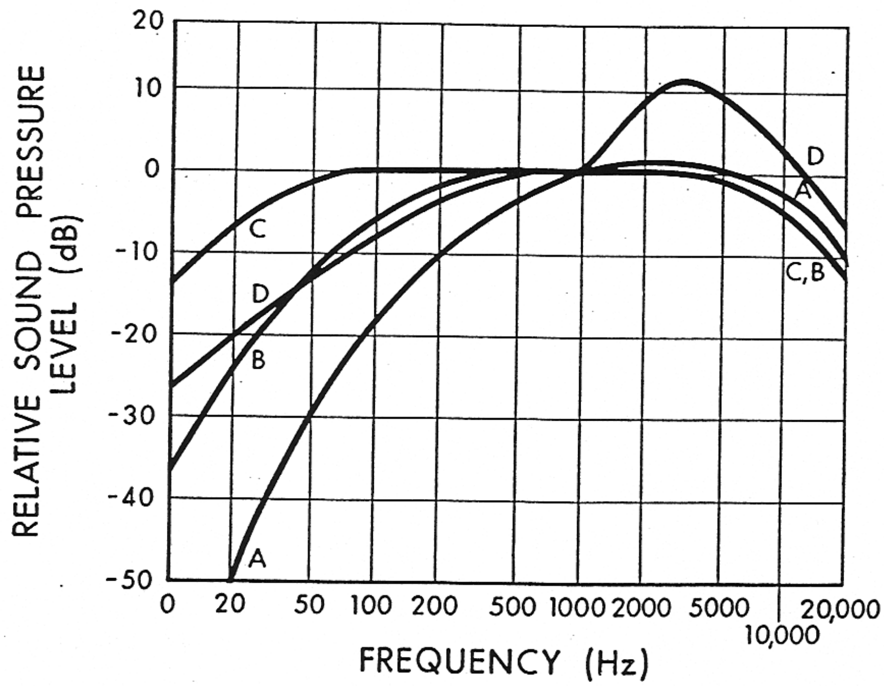
The range of frequencies audible to the human ear ranges from approximately 20 Hz to 20 kHz. Within this range, the human ear does not hear equally at all frequencies. It is not very sensitive to low frequency sounds, is very sensitive to mid frequency sounds and is slightly less sensitive to high frequency sounds. Due to the large frequency range of human hearing, the entire spectrum is often divided into 31 bands, each known as a 1/3 octave band.

The internationally agreed upon center frequencies and upper and lower band limits for the 1/1 (whole octave) and 1/3 octave bands are as follows:

	Whole Octave	
Lower Band Limit	**Center Frequency**	**Upper Band Limit**
11	**16**	22
22	**31.5**	44
44	**63**	88
88	**125**	177
177	**250**	355
355	**500**	710
710	**1000**	1420
1420	**2000**	2840
2840	**4000**	5680
5680	**8000**	11360
11360	**16000**	22720

	1/3 Octave	
Lower Band Limit	**Center Frequency**	**Upper Band Limit**
14.1	**16**	17.8
17.8	**20**	22.4
22.4	**25**	28.2
28.2	**31.5**	35.5
35.5	**40**	44.7
44.7	**50**	56.2
56.2	**63**	70.8
70.8	**80**	89.1
89.1	**100**	112
112	**125**	141
141	**160**	178
178	**200**	224
224	**250**	282
282	**315**	355
355	**400**	447
447	**500**	562
562	**630**	708
708	**800**	891
891	**1000**	1122
1122	**1250**	1413
1413	**1600**	1778
1778	**2000**	2239
2239	**2500**	2818
2818	**3150**	3548
3548	**4000**	4467
4467	**5000**	5623
5623	**6300**	7079
7079	**8000**	8913
8913	**10000**	11220
11220	**12500**	14130
14130	**16000**	17780
17780	**20000**	22390

Human hearing is most sensitive at approximately 3500 Hz which corresponds to the ¼ wavelength of the ear canal (approximately 2.5 cm). Because of this range of sensitivity to various frequencies, we typically apply various weighting networks to the broadband measured sound to more appropriately account for the way humans hear. By default, the most common weighting network used is the so-called "A-weighting". It can be seen in the figure that the low frequency sounds are reduced significantly with the A-weighting.



Combination of Sounds

When combining multiple sound sources the general equation is:

$$\Sigma SPL_n = 10\log_{10}\left[\sum_{i=1}^{n} 10^{\frac{SPL_i}{10}}\right]$$

Examples:

- Two sources of 50 dB each add together to result in 53 dB.
- Three sources of 50 dB each add together to result in 55 dB.
- Ten sources of 50 dB each add together to result in 60 dB.
- One source of 50 dB added to another source of 40 dB results in 50.4 dB

It can be seen that, if multiple similar sources exist, removing or reducing only one source will have little effect.

Sound Level Measurements

Over the years a number of methods for measuring and describing environmental noise have been developed. The most widely used and accepted is the concept of the Energy Equivalent Sound Level (L_{eq}) which was developed in the US (1970's) to characterize noise levels near US Air-force bases. This is the level of a steady state sound which, for a given period of time, would contain the same energy as the time varying sound. The concept is that the same amount of annoyance occurs from a sound having a high level for a short period of time as from a sound at a lower level for a longer period of time.
The L_{eq} is defined as:

$$L_{eq} = 10\log_{10}\left[\frac{1}{T}\int_0^T 10^{\frac{dB}{10}}\,dT\right] = 10\log_{10}\left[\frac{1}{T}\int_0^T \frac{P^2}{P_{ref}^2}\,dT\right]$$

We must specify the time period over which to measure the sound. i.e. 1-second, 10-seconds, 15-seconds, 1-minute, 1-day, etc**. An L_{eq} is meaningless if there is no time period associated**.

In general there a few very common L_{eq} sample durations which are used in describing environmental noise measurements. These include:

- L_{eq}24 - Measured over a 24-hour period
- L_{eq}Night - Measured over the night-time (typically 22:00 – 07:00)
- L_{eq}Day - Measured over the day-time (typically 07:00 – 22:00)
- L_{DN} - Same as L_{eq}24 with a 10 dB penalty added to the night-time

Statistical Descriptor

Another method of conveying long term noise levels utilizes statistical descriptors. These are calculated from a cumulative distribution of the sound levels over the entire measurement duration and then determining the sound level at xx % of the time.

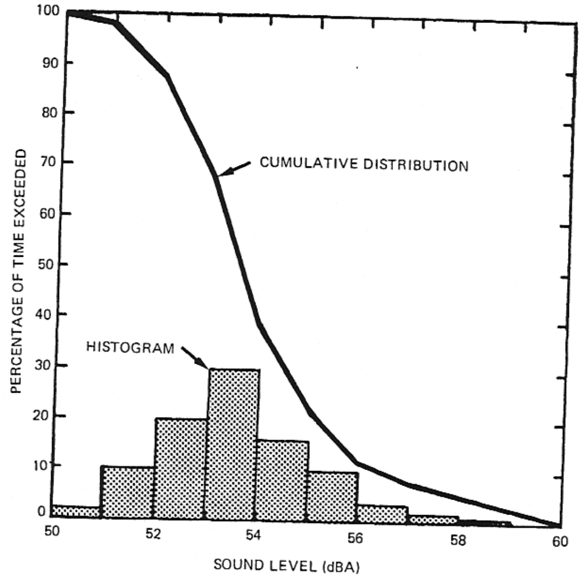


Figure 16.6 Statistically processed community noise showing histogram and cumulative distribution of A weighted sound levels.

Industrial Noise Control, Lewis Bell, Marcel Dekker, Inc. 1994

The most common statistical descriptors are:

- L_{min} - minimum sound level measured
- L_{01} - sound level that was exceeded only 1% of the time
- L_{10} - sound level that was exceeded only 10% of the time.
  - Good measure of intermittent or intrusive noise
  - Good measure of Traffic Noise
- L_{50} - sound level that was exceeded 50% of the time (arithmetic average)
  - Good to compare to L_{eq} to determine steadiness of noise
- L_{90} - sound level that was exceeded 90% of the time
  - Good indicator of typical “ambient” noise levels
- L_{99} - sound level that was exceeded 99% of the time
- L_{max} - maximum sound level measured

These descriptors can be used to provide a more detailed analysis of the varying noise climate:

- If there is a large difference between the L_{eq} and the L_{50} (L_{eq} can never be any lower than the L_{50}) then it can be surmised that one or more short duration, high level sound(s) occurred during the time period.
- If the gap between the L_{10} and L_{90} is relatively small (less than 15 – 20 dBA) then it can be surmised that the noise climate was relatively steady.

Sound Propagation

In order to understand sound propagation, the nature of the source must first be discussed. In general, there are three types of sources. These are known as 'point', 'line', and 'area'. This discussion will concentrate on point and line sources since area sources are much more complex and can usually be approximated by point sources at large distances.

Point Source

As sound radiates from a point source, it dissipates through geometric spreading. The basic relationship between the sound levels at two distances from a point source is:

$$\therefore SPL_1 - SPL_2 = 20\log_{10}\left(\frac{r_2}{r_1}\right)$$

Where: SPL_1 = sound pressure level at location 1, SPL_2 = sound pressure level at location 2
r_1 = distance from source to location 1, r_2 = distance from source to location 2

Thus, the reduction in sound pressure level for a point source radiating in a free field is **6 dB per doubling of distance**. This relationship is independent of reflectivity factors provided they are always present. Note that this only considers geometric spreading and does not take into account atmospheric effects. Point sources still have some physical dimension associated with them, and typically do not radiate sound equally in all directions in all frequencies. The directionality of a source is also highly dependent on frequency. As frequency increases, directionality increases.

Examples (note no atmospheric absorption):

- A point source measuring 50 dB at 100m will be 44 dB at 200m.
- A point source measuring 50 dB at 100m will be 40.5 dB at 300m.
- A point source measuring 50 dB at 100m will be 38 dB at 400m.
- A point source measuring 50 dB at 100m will be 30 dB at 1000m.

Line Source

A line source is similar to a point source in that it dissipates through geometric spreading. The difference is that a line source is equivalent to a long line of many point sources. The basic relationship between the sound levels at two distances from a line source is:

$$SPL_1 - SPL_2 = 10\log_{10}\left(\frac{r_2}{r_1}\right)$$

The difference from the point source is that the '20' term in front of the 'log' is now only 10. Thus, the reduction in sound pressure level for a line source radiating in a free field is **3 dB per doubling of distance**.

Examples (note no atmospheric absorption):

- A line source measuring 50 dB at 100m will be 47 dB at 200m.
- A line source measuring 50 dB at 100m will be 45 dB at 300m.
- A line source measuring 50 dB at 100m will be 44 dB at 400m.
- A line source measuring 50 dB at 100m will be 40 dB at 1000m.

Atmospheric Absorption

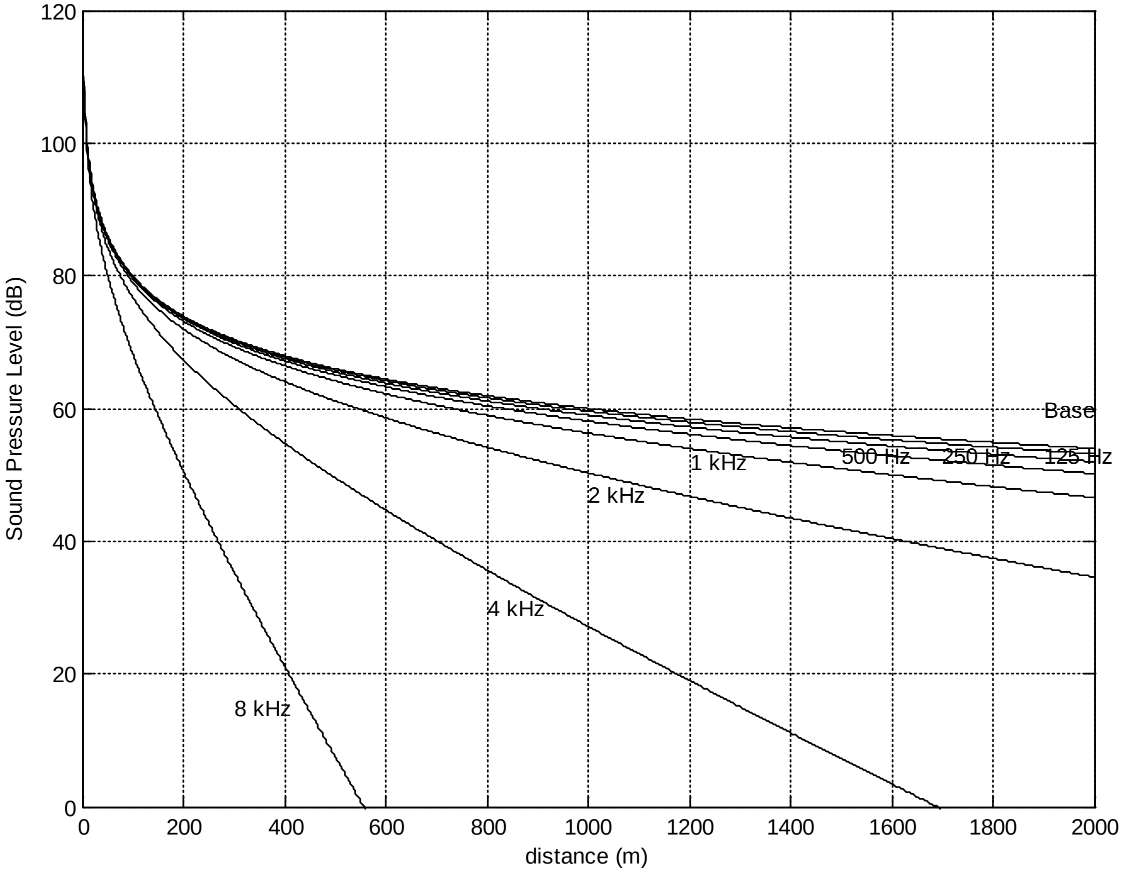
As sound transmits through a medium, there is an attenuation (or dissipation of acoustic energy) which can be attributed to three mechanisms:

1) **Viscous Effects** - Dissipation of acoustic energy due to fluid friction which results in thermodynamically irreversible propagation of sound.
2) **Heat Conduction Effects** - Heat transfer between high and low temperature regions in the wave which result in non-adiabatic propagation of the sound.
3) **Inter Molecular Energy Interchanges** - Molecular energy relaxation effects which result in a time lag between changes in translational kinetic energy and the energy associated with rotation and vibration of the molecules.

The following table illustrates the attenuation coefficient of sound at standard pressure (101.325 kPa) in units of dB/100m.

Temperature °C	Relative Humidity (%)	Frequency (Hz) 125	250	500	1000	2000	4000
30	20	0.06	0.18	0.37	0.64	1.40	4.40
	50	0.03	0.10	0.33	0.75	1.30	2.50
	90	0.02	0.06	0.24	0.70	1.50	2.60
20	20	0.07	0.15	0.27	0.62	1.90	6.70
	50	0.04	0.12	0.28	0.50	1.00	2.80
	90	0.02	0.08	0.26	0.56	0.99	2.10
10	20	0.06	0.11	0.29	0.94	3.20	9.00
	50	0.04	0.11	0.20	0.41	1.20	4.20
	90	0.03	0.10	0.21	0.38	0.81	2.50
0	20	0.05	0.15	0.50	1.60	3.70	5.70
	50	0.04	0.08	0.19	0.60	2.10	6.70
	90	0.03	0.08	0.15	0.36	1.10	4.10

- As frequency increases, absorption tends to increase
- As Relative Humidity increases, absorption tends to decrease
- There is no direct relationship between absorption and temperature
- **The net result of atmospheric absorption is to modify the sound propagation of a point source from 6 dB/doubling-of-distance to approximately 7 – 8 dB/doubling-of-distance (based on anecdotal experience)**



Atmospheric Absorption at 10ºC and 70% RH

Meteorological Effects

There are many meteorological factors which can affect how sound propagates over large distances. These various phenomena must be considered when trying to determine the relative impact of a noise source either after installation or during the design stage.

Wind

- Can greatly alter the noise climate away from a source depending on direction
- Sound levels downwind from a source can be increased due to refraction of sound back down towards the surface. This is due to the generally higher velocities as altitude increases.
- Sound levels upwind from a source can be decreased due to a “bending” of the sound away from the earth’s surface.
- Sound level differences of ±10dB are possible depending on severity of wind and distance from source.
- Sound levels crosswind are generally not disturbed by an appreciable amount
- Wind tends to generate its own noise, however, and can provide a high degree of masking relative to a noise source of particular interest.

Temperature

- Temperature effects can be similar to wind effects
- Typically, the temperature is warmer at ground level than it is at higher elevations.
- If there is a very large difference between the ground temperature (very warm) and the air aloft (only a few hundred meters) then the transmitted sound refracts upward due to the changing speed of sound.
- If the air aloft is warmer than the ground temperature (known as an *inversion*) the resulting higher speed of sound aloft tends to refract the transmitted sound back down towards the ground. This essentially works on Snell’s law of reflection and refraction.
- Temperature inversions typically happen early in the morning and are most common over large bodies of water or across river valleys.
- Sound level differences of ±10dB are possible depending on gradient of temperature and distance from source.

Rain

- Rain does not affect sound propagation by an appreciable amount unless it is very heavy
- The larger concern is the noise generated by the rain itself. A heavy rain striking the ground can cause a significant amount of highly broadband noise. The amount of noise generated is difficult to predict.
- Rain can also affect the output of various noise sources such as vehicle traffic.

Summary

- In general, these wind and temperature effects are difficult to predict
- Empirical models (based on measured data) have been generated to attempt to account for these effects.
- Environmental noise measurements must be conducted with these effects in mind. Sometimes it is desired to have completely calm conditions, other times a “worst case” of downwind noise levels are desired.

Topographical Effects

Similar to the various atmospheric effects outlined in the previous section, the effect of various geographical and vegetative factors must also be considered when examining the propagation of noise over large distances.

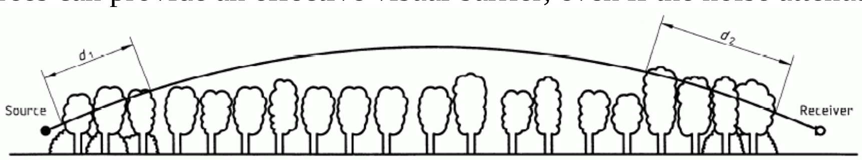
Topography
- One of the most important factors in sound propagation.
- Can provide a natural barrier between source and receiver (i.e. if berm or hill in between).
- Can provide a natural amplifier between source and receiver (i.e. large valley in between or hard reflective surface in between).
- Must look at location of topographical features relative to source and receiver to determine importance (i.e. small berm 1km away from source and 1km away from receiver will make negligible impact).

Grass
- Can be an effective absorber due to large area covered
- Only effective at low height above ground. Does not affect sound transmitted direct from source to receiver if there is line of sight.
- Typically less absorption than atmospheric absorption when there is line of sight.
- Approximate rule of thumb based on empirical data is:

$$A_g = 18\log_{10}(f) - 31 \qquad (dB/100m)$$

Where: A_g is the absorption amount

Trees
- Provide absorption due to foliage
- Deciduous trees are essentially ineffective in the winter
- Absorption depends heavily on density and height of trees
- No data found on absorption of various kinds of trees
- Large spans of trees are required to obtain even minor amounts of sound reduction
- In many cases, trees can provide an effective visual barrier, even if the noise attenuation is negligible.



NOTE — $d_f = d_1 + d_2$

For calculating d_1 and d_2, the curved path radius may be assumed to be 5 km.

Figure A.1 — Attenuation due to propagation through foliage increases linearly with propagation distance d_f through the foliage

Table A.1 — Attenuation of an octave band of noise due to propagation a distance d_f through dense foliage

Propagation distance d_f m	Nominal midband frequency Hz 63	125	250	500	1 000	2 000	4 000	8 000
$10 \leq d_f \leq 20$	Attenuation, dB: 0	0	1	1	1	1	2	3
$20 \leq d_f \leq 200$	Attenuation, dB/m: 0,02	0,03	0,04	0,05	0,06	0,08	0,09	0,12

Tree/Foliage attenuation from ISO 9613-2:1996

Bodies of Water

- Large bodies of water can provide the opposite effect to grass and trees.
- Reflections caused by small incidence angles (grazing) can result in larger sound levels at great distances (increased reflectivity, Q).
- Typically air temperatures are warmer high aloft since air temperatures near water surface tend to be more constant. Result is a high probability of temperature inversion.
- Sound levels can “carry” much further.

Snow

- Covers the ground for approximately 1/2 of the year in northern climates.
- Can act as an absorber or reflector (and varying degrees in between).
- Freshly fallen snow can be quite absorptive.
- Snow which has been sitting for a while and hard packed due to wind can be quite reflective.
- Falling snow can be more absorptive than rain, but does not tend to produce its own noise.
- Snow can cover grass which might have provided some means of absorption.
- Typically sound propagates with less impedance in winter due to hard snow on ground and no foliage on trees/shrubs.

Appendix II. SOUND LEVELS OF FAMILIAR NOISE SOURCES

Used with Permission Obtained from the Alberta Energy Regulator Directive 038 (2007)

Source[1]	Sound Level (dBA)
Bedroom of a country home	30
Soft whisper at 1.5 m	30
Quiet office or living room	40
Moderate rainfall	50
Inside average urban home	50
Quiet street	50
Normal conversation at 1 m	60
Noisy office	60
Noisy restaurant	70
Highway traffic at 15 m	75
Loud singing at 1 m	75
Tractor at 15 m	78-95
Busy traffic intersection	80
Electric typewriter	80
Bus or heavy truck at 15 m	88-94
Jackhammer	88-98
Loud shout	90
Freight train at 15 m	95
Modified motorcycle	95
Jet taking off at 600 m	100
Amplified rock music	110
Jet taking off at 60 m	120
Air-raid siren	130

[1] Cottrell, Tom, 1980, *Noise in Alberta*, Table 1, p.8, ECA80 - 16/1B4 (Edmonton: Environment Council of Alberta).

SOUND LEVELS GENERATED BY COMMON APPLIANCES

Used with Permission Obtained from the Alberta Energy Regulator Directive 038 (2007)

Source[1]	Sound level at 3 feet (dBA)
Freezer	38-45
Refrigerator	34-53
Electric heater	47
Hair clipper	50
Electric toothbrush	48-57
Humidifier	41-54
Clothes dryer	51-65
Air conditioner	50-67
Electric shaver	47-68
Water faucet	62
Hair dryer	58-64
Clothes washer	48-73
Dishwasher	59-71
Electric can opener	60-70
Food mixer	59-75
Electric knife	65-75
Electric knife sharpener	72
Sewing machine	70-74
Vacuum cleaner	65-80
Food blender	65-85
Coffee mill	75-79
Food waste disposer	69-90
Edger and trimmer	81
Home shop tools	64-95
Hedge clippers	85
Electric lawn mower	80-90

[1] Reif, Z. F., and Vermeulen, P. J., 1979, "Noise from domestic appliances, construction, and industry," Table 1, p.166, in Jones, H. W., ed., *Noise in the Human Environment*, vol. 2, ECA79-SP/1 (Edmonton: Environment Council of Alberta).

Appendix III. NOISE MODELING PARAMETERS

Noise Source Octave Band Sound Power Levels (Re 10^{-12} Watts, un-mitigated)

Item	Qty	Source Height (m)	SWL (dBA)	32 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz
MWM MGM TCG 3020 V20 2.2 MW	9	2.0	135.4	123.0	130.0	143.0	133.0	131.0	129.0	128.0	125.0	121.0
Data Centre Building Fan (each)	5	1.5	92.7	93.5	96.5	96.5	93.5	90.5	86.5	83.5	80.5	72.5
Data Centre Building Transformer (each)	5	1.5	85.8	82.4	88.4	90.4	85.4	85.4	79.4	74.4	69.4	62.4

Silencer Sound Level Attenuation

	31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz
Hospital Plus Silencer	8	15	38	43	41	39	39	40	41

Noise Modeling Parameters

Parameter	Value
Modeling Software	CADNA/A (Version 2026 MR1, build: 215.5625)
Standard Followed	ISO 9613-2
Ground Sound Absorption Coefficient	0.7
Wind Speed	1 - 5 m/s (3.6 - 18 km/hr)
Wind Direction	Downwind from all sources to all receptors
Temperature	10 °C
Humidity	70%
Topography	Digital Terrain Model Contours obtained from AltaLis

Appendix IV. PERMISSIBLE SOUND LEVEL DETERMINATION

Permissible Sound Levels for 1,500 m Theoretical Receptors

Basic Sound Level

	Dwelling Density (Per Quarter Section of Land)						Night-Time	Day-Time
Proximity to Transportation	1 - 8 Dwellings	9 - 160 Dwellings	161 to 400 Dwellings	400 to 1,000 Dwellings	>1,000 Dwellings	>1,000 Dwellings		
Category 1	40 dBA	43 dBA	46 dBA	48 dBA	53 dBA	53 dBA	40	40
Category 2	45 dBA	48 dBA	51 dBA	51 dBA	53 dBA	53 dBA		
Category 3	50 dBA	53 dBA	56 dBA	56 dBA	56 dBA	56 dBA		
Basic Sound Level (dBA)							40	40

Time of Day Adjustment

Time of Day	Adjustment (dBA)	Night-Time	Day-Time
Night-time adjustment for hours 22:00 - 07:00	0	0	n/a
Day-time adjustment for hours 07:00 - 22:00	10	n/a	10
Time of day adjustment (dBA)		0	10

Class A Adjustments

Class	Reason for Adjustment	Adjustment (dBA)	Night-Time	Day-Time
A1	Seasonal Adjustment (Winter)	0 to +5	0	0
A2	Ambient Monitoring Adjustment	-10 to +10	0	0
Sum of A1 and A2 cannot exceed maximum of 10 dBA Leq				
Class A Adjustment (dBA)			0	0

Class B Adjustments

Class	Duration of Activity	Adjustment (dBA)	Night-Time	Day-Time
B1	≤ 1 Day	15	0	0
B2	≤ 7 Days	10	0	0
B3	≤ 60 Days	5	0	0
B4	> 60 Days	0	0	0
Can only apply one of B1, B2, B3, or B4				
Class B Adjustment (dBA)			0	0

	Night-Time	Day-Time
Total Permissible Sound Level (PSL) [dBA]	40	50

acoustical consultants inc

Appendix V NOISE IMPACT ASSESSMENT

Licensee: **Armada Energy**

Facility name: **Hoole Power Generation & Data Infrastructure** Type: **Power Generation & Data Site**

Legal location: **16-36-080-25 W4M**

Contact: **Alicia Wang** Email: **alicia.wang@vlenergy.ca**

1. Permissible Sound Level (PSL) Determination (*AUC Rule 012,* Section 2)

(Note that the PSL for a pre-1988 facility undergoing modifications is the equivalent noise level (L_{eq}) that currently exists at the dwelling if no prior complaint exists and the current sound level L_{eq} exceeds the calculated PSL from Section 2.1.)

Complete the following for the most impacted dwelling(s) or at a distance of 1.5 km where there are no dwellings:

Dwelling Distance from facility	Dwelling Direction from facility	BSL (dBA)	Daytime adjustment (dBA)	Nighttime PSL (dBA)	Daytime PSL(dBA)
1,500 m Theoretical	**West**	**40**	**10**	**40**	**50**

2. Sound Source Identification

For the new and existing equipment, identify major sources of noise from the facility, their associated sound power level (PWL) or sound pressure level (SPL).

New and/or Existing Equipment Noise Sources (include make and model, power rating)	Predicted X PWL (dBA) X SPL (dBA)	OR	Measured X PWL (dBA) X SPL (dBA)	Data source (Vendor Measurement, Theoretical, etc.)	Distance SPL measured from the noise source (m)
Provided in Appendix III				**Measurements / Calculations**	

Provide a Tentative Schedule and timing for the operation, maintenance, and testing of the equipment

Completion of Phase 1 will be in Q4 2026. Phase 2 will be completed in June 2027.

3. Normal Operating Conditions

When using manufacturer's data for expected performance, it may be necessary to modify the data to account for actual operating conditions (for example, indicate conditions such as operating with window/doors open or closed). Describe any considerations and assumptions used in conducting engineering estimates:

Equipment assumed to be operating at all times at maximum capacity

4. Modelling Parameters

If modelling was conducted, identify the parameters used (see Section 3.2):

Ground absorption 0.7, Temperature 10^{0}C, Relative Humidity 70%, all receptors downwind, Following ISO 9613

5. Predicted Sound Level/Compliance Determination

Identify the predicted sound level at the most impacted dwelling(s) or at a distance of 1.5 km where there are no dwellings. Typically, only the nighttime sound level is necessary, as levels do not often change from daytime to nighttime. However, if there are differences between day and night operations, both levels must be calculated.

Predicted sound level contribution from the new or modified facility alone at the nearest or most impacted dwelling(s) or at a distance of 1.5 km where there are no dwellings.

Phase 1 Case

Predicted sound level at the most impacted dwelling(s) or at a distance of 1.5 km where there are no dwellings, from the new or modified facility including the cumulative effects of noise from energy-related facilities and the assumed ambient level (ASL + new facility + existing energy-related facilities + proposed energy-related facilities).

Nighttime sound level: **35.3 dBA L_{eq}** Assumed ambient nighttime sound level: **35.0 dBA L_{eq}**

Is the predicted sound level less than the permissible sound level by a margin of three dBA? **NO**
If No, conduct a detailed NIA as per Section 3 of AUC Rule 012.

Phase 2 Case

Predicted sound level at the most impacted dwelling(s) or at a distance of 1.5 km where there are no dwellings, from the new or modified facility including the cumulative effects of noise from energy-related facilities and the assumed ambient level (ASL + new facility + existing energy-related facilities + proposed energy-related facilities).

Nighttime sound level: **35.6 dBA L_{eq}** Assumed ambient nighttime sound level: **35.0 dBA L_{eq}**

Is the predicted sound level less than the permissible sound level by a margin of three dBA? **NO**
If No, conduct a detailed NIA as per Section 3 of AUC Rule 012.

6. Supply any other relevant information you want to provide to the AUC. Submit additional pages if required

N/A

7. If the nighttime permissible sound level is higher than 40 dBA L_{eq}, provide supplementary information to support the use of such permissible sound level.

NIA Attached

8. Explain what measures have been taken to address construction noise.

Advising nearby residents of significant noise sources and appropriately scheduling
Mufflers on all internal combustion engines
Taking advantage of acoustical screening
Limiting vehicle access during night-time

9. Acoustical practitioner's information (See Section 3.2 (12)):

Company: **ACI Acoustical Consultants Inc.**
Name: **Patrick Froment, B.Sc., B.Ed., P.L.(Eng.)**
Experience: **- Acoustical Consultant since 2007**
- Hundreds of Noise Impact Assessments
- Responsible Member with APEGA

Title: **Director** Telephone: **(780) 499-1591** Date: **July 10, 2026**