Noise Monitoring Survey,

EnCana Corporation
LSD 7-13-27-22 W4M
Compressor Station

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Executive Summary

Patching Associates Acoustical Engineering Ltd. was requested by EnCana Corporation to perform a noise survey northwest of Rosebud, Alberta. The results of this survey will be used to determine the noise levels in the vicinity of the 7-13-27-22 W4M EnCana Compressor Station. Measurements were taken over a one-day period at the Rosebud Community Center. Measurements were also taken at the compressor site to assess the noise emissions from the equipment.

The results of these measurements will be used to predict the noise levels at three potentially noise sensitive areas (NSA's) in the vicinity of the compressor facility.

The measured and predicted sound levels with the Permissible Sound Levels of the Alberta Energy and Utilities Board Directive are presented below for the sites studied. The survey results contained large amounts of traffic noise from Highway 840, train noise from the nearby railway and aircraft noise. These three sources dominate the noise measurements and will be the dominant noise sources at all three NSA's. The table below shows the measured noise levels as well as the predicted noise. The sound levels with and without traffic, trains, and aircraft are presented to show the dominance of these types of noise in the area.

Results of Measurements and Predictions, September 2004

Date (2004)	Daytime/ Nighttime	Sound Level With Traffic, Train, Aircraft, and Facility L_{eq} (dBA)		Sound Level with Facility Only L_{eq} (dBA)		Permissible Sound Level (dBA)
		One Compressor (K-102)	Both Compressors (K-101, K-102)	One Compressor (K-102)	Both Compressors (K-101, K-102)	
(NSA 3), Measured Levels at Rosebud Community Center, 1250 m ESE of Compressor Site						
Sept. 16	Day	39.6	N/A	N/A	N/A	**58**
Sept. 16-17	Night	45.7	N/A	**<25.6**	N/A	**48**
Sept 17	Day	42.1	N/A	N/A	N/A	**58**
(NSA 3), Predicted Levels at Rosebud Community Center, 1250 m ESE of Compressor Site						
Nighttime*	Calm	~45	~45	10	**19**	**48**
	Downwind**	~45	~45	17	**29**	**48**
(NSA 2,) Predicted Level at furthest Residence west in Rosebud, 870 m SE of Compressor Site						
Nighttime*	Calm	~45	~45	10	**16**	**45**
	Downwind**	~45	~45	14	**21**	**45**
(NSA 1), Predicted Level at closest Residence to the Compressor Site, 375m SW of Compressor Site						
Nighttime*	Calm	~36	~39	28	**36**	**40**
	Downwind**	~37	~40	29	**38**	**40**

*Modeled with Grass Ground Cover.
**Represents close to worst-case sound propagation from the facility to the residence

The table above shows that the noise levels in NSA 2 and 3 will be dominated by traffic, aircraft, and railway noise. The table also shows that the facility will be well within the permissible sound level at NSA 2 and NSA 3 and comfortably below at NSA 1.

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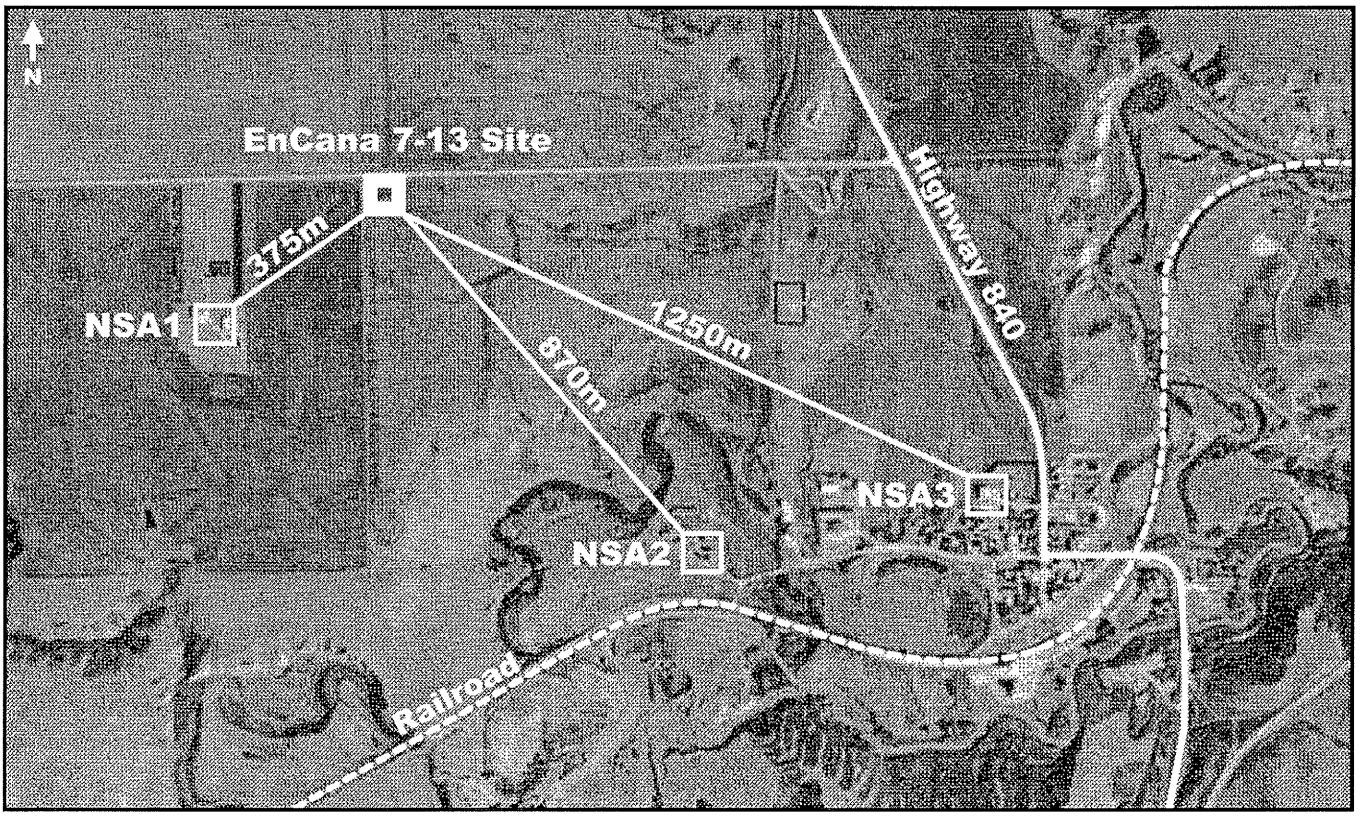
Introduction

Patching Associates Acoustical Engineering Ltd. (PAAE) was requested by EnCana Corporation to perform a noise survey northwest of Rosebud, Alberta. The results of this survey will be used to determine the noise levels in the vicinity of the 7-13-27-22 W4M EnCana Compressor Station (facility). Measurements were taken over a one-day period at the Rosebud Community Center. Measurements were also taken at the compressor site close to each compressor. The results of these measurements will be used to predict the noise levels at three potentially noise sensitive areas in the vicinity of the compressor facility.

Site Description

There are three areas in the vicinity of the facility that are potentially noise sensitive. These noise sensitive areas (NSA's) are shown in Figure 1. NSA 1 will be the most impacted area; it is the closest residence to the facility at 375 metres southwest. There is a direct line-of-sight from the facility to NSA 1 as both the facility and NSA 1 are on flat ground. NSA 2 is the furthest residence west in the town of Rosebud (approximately 650 m west of the center of Rosebud). This residence is located on the Rosebud River valley bottom and the shoulder of the valley breaks the line-of-sight from the facility to NSA 2. NSA 3 is the main town of Rosebud itself, as represented by the closest possible receiver to the facility, the Rosebud Community Center. NSA 3 is also in the Rosebud River valley bottom and there is no direct line-of-sight between the facility and NSA 3. Appendix A contains a figure of the contour cross-sections showing major land forms between the NSA's and the facility.

Figure 1: Map of Study Area



Noise Criteria

The AEUB Directive permits specified cumulative sound levels attributable to energy industry facilities at designated receptor points. These allowable limits are dependent on the population density, proximity to heavily traveled transportation routes (motor vehicles, rail and aircraft) and other specified adjustments. The AEUB Directive permits the daytime sound level to be 10 dB above the nighttime sound level. The Permissible Sound Level is the limit that the sound emanating from a facility may not exceed over a specified period, as measured in the yard of the nearest, most impacted, or complainant's residence.

The Permissible Sound Levels (PSL), calculated in accordance with the AEUB directive for NSA 1 are 40 dBA L_{eq} (nighttime) and 50 dBA L_{eq} (daytime). The PSL for NSA 2 is 45 dBA L_{eq} (nighttime) and 55 dBA L_{eq} (daytime); NSA 2 qualifies for the Category 2 adjustment because it is 180 metres from a heavily traveled rail line. The PSL for NSA 3 is 48 dBA L_{eq} (nighttime) and 58 dBA L_{eq} (daytime). The town of Rosebud does qualify for the Category 2 adjustment because it is less than 500 metres from a heavily traveled rail line and less than 500 metres from Highway 840. The town of Rosebud also has a dwelling density above 9 per quarter section. The AEUB Permissible Sound Level calculations are shown in Appendix B.

The L_{eq} is the A-weighted equivalent-continuous sound level. This index is an energy average of the varying sound levels over a specified period of time. The use of this index permits the description of a varying sound level environment as a single number. As the L_{eq} is an "average" level, the measured sound level may exceed the criterion level for a short period, provided that the duration is limited. The L_{eq} value considers both the sound level and the length of time that the sound level occurs. Appendix C provides a detailed explanation of the L_{eq} index.

Methodology

The measurement methodology follows the procedures set forth in the AEUB Directive ID 99-8, and the accompanying supplement and guide G-38. The sound monitoring survey was conducted at NSA 3 with a Brüel & Kjær Model 2236 Precision Integrating Sound Level Meter which was equipped with a Brüel & Kjær 4188 microphone. The microphone was mounted with a windscreen to reduce the potential for wind-induced noise at the microphone, as required by the Directive. The sound level meter was calibrated at the beginning and the end of the survey with a Brüel & Kjær Model 4231 Sound Level Calibrator. The diagnostic measurements close to the facility were taken with a Brüel & Kjær type 2260 Sound Analyzer in 1/3-octave bands. This equipment meets or exceeds the requirements of the Directive.

Sound power levels were determined from measurement for all of the major noise sources on the facility. Sound propagation calculations were then undertaken to predict the sound pressure level that will exist at the NSA's residences. Acoustical analysis and prediction was also done to predict the noise contribution from the rail line and Highway 840 at all NSA's to compare to the relative impact of these types of noises to the facility noise.

Facility Operating Conditions

During the measurement period at NSA 3 on September 16-17, 2004 the facility was operating with one compressor of the two on site. The compressor running was K-102; this compressor is the newer of the two at the facility and was installed in June 2004. During the on-site measurements taken on September 17, 2004 the K-102 compressor was operating normally. The K-102 compressor was installed in a full acoustic enclosure and emits a relatively small amount of noise compared to the other older compressor (measurements taken on September 17, 2004 indicated that K-102 produces less than 47 dBA at 40 metres). During the on-site measurements taken on January 15, 2004 the K-101 compressor was operating normally and the K-102 compressor was not yet installed. During these measurements the facility had been operating since July 2003 under similar operating conditions. In June 2004, additional noise control was installed on the K-101 compressor to further reduce the noise emissions.

According to EnCana representatives the K-101 compressor was not operating from September 13, 2004 to at least September 22, 2004.

Environmental Conditions

The hourly observation records of wind velocity and direction measured at the Drumheller weather station and reported by Environment Canada on September 16-17, 2004 are presented in Appendix C. The Drumheller weather station is approximately 25 km from the study area. The weather conditions reported at the weather station may not match exactly what was experienced at the study area but are indicative of it.

Appendix D shows that the wind speed was between 0 and 11 km/hr for most of the night of September 16-17. This is within the allowably wind speeds according to Guide 38. The wind direction during the same night was variable.

Sound Propagation Calculations

Sound propagation calculations and generally accepted acoustical theory were used to predict the facility noise level at each residence. The sound propagation calculations were undertaken using the **ENM** noise propagation software package. **ENM** is an advanced noise propagation model that considers geometric spreading, atmospheric sound absorption, ground impedance effects, site topography and geometry, vegetation and environmental conditions. Octave-band sound power level information was used for all of the major noise sources. The frequency dependency of sound propagation calculations such as ground absorption and air absorption are considered in the model, as was the barrier effect from the shoulder of the valley.

The ground type used in the model to predict the noise levels was grass. The weather conditions modeled were 10°C with 80% relative humidity with a 7.5-kph wind from the facility to the point of reception (i.e. downwind condition). The downwind modeling conditions will yield worst-case sound level predictions at each residence. Calm wind conditions with 10°C and 80% relative humidity were also modeled.

Sound Power Levels used for Model

Octave band sound power levels were calculated for both compressor units. The sound power levels along with the source of the data are shown in Table 1.

Table 1 - Source Octave Band Sound Power Levels

Source Description	Data Source	Total dBA	Linear Octave Band Centre Frequency (dB, ref 1 pW)								
			31.5	63	125	250	500	1k	2k	4k	8k
K-101 Existing w/ NSI Cooler Intake Silencer	Measurement* / Manufacturer	**98**	113	113	105	98	95	93	87	80	71
K-102 Existing	Measurement**	**88**	108	111	98	86	78	75	73	69	71

* Measured January 15, 2004
** Measured September 17, 2004

Results and Discussion

The measured and predicted sound levels with the Permissible Sound Levels of the Alberta Energy and Utilities Board Directive are presented below for the NSA's. The survey results contained large amounts of noise from Highway 840, aircraft and the nearby rail line. These noise sources were the dominant noise sources at NSA 3 and will be the dominant noise sources at NSA 2. The sound levels with and without traffic, aircraft and railway noise are presented to show the impact of these types of noise in the area. Appendix E contains graphs of the measured noise levels at the measurement location NSA 3.

Table 2: Results of Measurements and Predictions, September 2004

Date (2004)	Daytime/ Nighttime	Sound Level With Traffic, Train, Aircraft, and Facility L_{eq} (dBA)		Sound Level with Facility Only L_{eq} (dBA)		Permissible Sound Level (dBA)
		One Compressor (K-102)	Both Compressors (K-101, K-102)	One Compressor (K-102)	Both Compressors (K-101, K-102)	
(NSA 3), Measured Levels at Rosebud Community Center, 1250 m ESE of Compressor Site						
Sept. 16	Day	39.6	N/A	N/A	N/A	**58**
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(NSA 3), Predicted Levels at Rosebud Community Center, 1250 m ESE of Compressor Site						
Nighttime*	Calm	~45	~45	10	**19**	**48**
	Downwind**	~45	~45	17	**29**	**48**
(NSA 2,) Predicted Level at furthest Residence west in Rosebud, 870 m SE of Compressor Site						
Nighttime*	Calm	~45	~45	10	**16**	**45**
	Downwind**	~45	~45	14	**21**	**45**
(NSA 1), Predicted Level at closest Residence to the Compressor Site, 375m SW of Compressor Site						
Nighttime*	Calm	~36	~39	28	**36**	**40**
	Downwind**	~37	~40	29	**38**	**40**

*Modeled with Grass Ground Cover.
**Represents close to worst-case sound propagation from the facility to the residence

The table above shows that the measured sound levels were dominated by traffic, aircraft and railway noise. The predicted sound levels at all NSA's are below the permissible sound levels. On the night of September 16-17 the facility with only K-102 operating was barely audible (on PAAE's recording) at NSA 3 sometimes during the night (most of the night it was not audible on PAAE's recording). There was an audible intermittent "distinct" tone at 200 Hz that was apparent throughout the night of the measurement. This tone was not likely attributable to the facility as the facility (with only K-102 operating) did not produce a tonal component at 200 Hz when PAAE visited the site the night of September 16 and the afternoon of September 17. Regardless whether the 200 Hz tone was attributable to the facility or not the noise levels measured at NSA 3 did not exceed ~32 dBA because of the 200 Hz tone. It is unknown if the 200 Hz tone is audible at NSA 1 or 2, and further study may be required to determine the source of this tone and its impact on NSA 1 and 2.

Table 2 indicates that the noise levels at NSA 2 and 3 will be dominated by activity not related to the facility. Noise from trains, vehicles, aircraft and animals account for almost all of the noise measured at NSA 3 and will account for almost all of the noise at NSA 2. When averaged on a L_{eq} (nighttime) scale the noise attributable to non-facility noises contribute ~45 dBA L_{eq} (Nighttime) at NSA 2 and ~45 dBA L_{eq} (Nighttime) at NSA 3. The facility with **both** compressors operating will contribute <0.1 dBA L_{eq} (Nighttime) at NSA 2 and <0.1 dBA L_{eq} (Nighttime) at NSA 3 under downwind conditions to the total sound levels.

The above dominance of non-facility noises does not mean that the facility will not be audible at NSA 2 and 3. The noise measurements at NSA 3 show that the background noise levels are less than 25 dBA during the night when no traffic, aircraft, railway or animal noise is present. This means that the facility could be the dominant noise source if the facility contributed 21 – 29 dBA under ideal weather conditions for sound propagation. The K-102 compressor also produces a tone in the 50 Hz 1/3 octave band that will sound "distinct" during quiet times between vehicle or aircraft passes. This tone will not exceed 21 dBA at NSA 2 or 29 dBA at NSA 3 under normal, downwind weather conditions.

By far the most impacted location is NSA 1 as it is much closer than NSA 2 or 3 to the facility. As well there are no "barrier" landforms between NSA 1 and the facility. The "barrier" effect from the shoulder of the valley substantially reduces the noise levels experienced at NSA 2 when compared to a flat ground situation. The "barrier" effect from the shoulder of the valley has less impact on NSA 3 because the interruption in the line of sight is not as pronounced. See Appendix A for a graphical description of the contours and the line of sights from the facilities and the NSA's.

The results of the modeling shown in Table 2 only accounted for worst case downwind conditions from the facility to the NSA's. There is a possibility that on rare occasions a temperature inversion or stratification will fill the valley with cold air. This could possibly increase the noise levels at NSA 2 and NSA 3. Previous studies by PAAE as well as modeling indicate that a maximum increase of 10 dBA over the downwind predicted levels could be realized at NSA 2 and 3 if a temperature inversion filled the valley with colder air than the air at the facility. Even if this temperature inversion was present the sound levels at NSA 2 and NSA 3 would still be well below the PSL's and the facility would be in compliance with the EUB Directive ID 99-8.

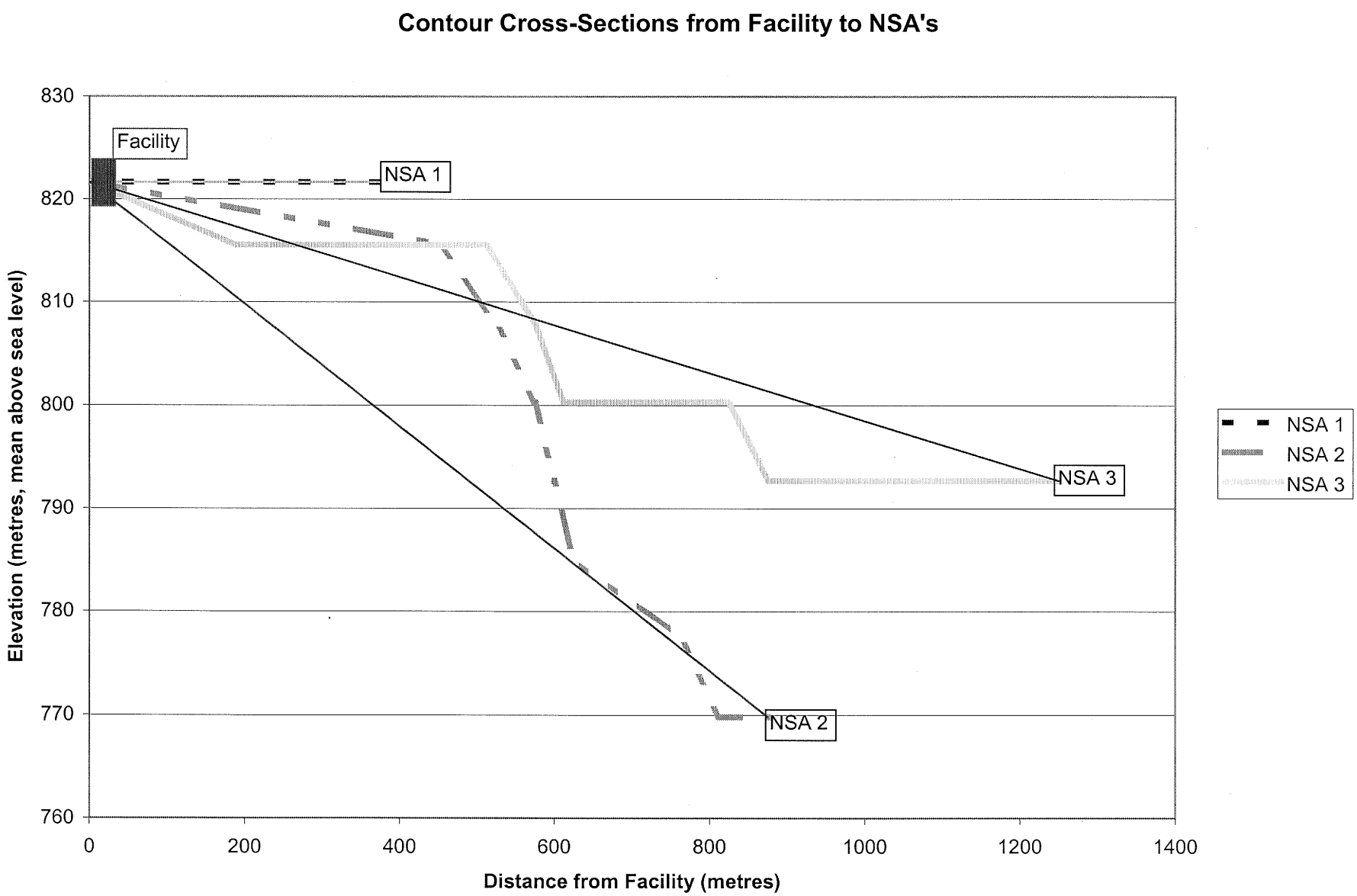
The facility does not need additional noise suppression measures to comply with the EUB Directive ID 99-8.

Conclusion

The noise levels due to the EnCana Compressor Station in LSD 7-13-27-22 W4M are currently well below the EUB's Permissible Sound Level in the town of Rosebud with one compressor (K-102) operating. The predicted sound levels indicate that the facility will be in compliance with the PSL at all potentially noise sensitive areas with both compressors operating normally. Additional noise control measures are not required to meet the EUB Directive ID 99-8.

APPENDIX A

Figure Showing Land Contours


Contour Cross-Sections from Facility to NSA's
Facility
NSA 1
NSA 2
NSA 3
Elevation (metres, mean above sea level)
830
820
810
800
790
780
770
760
0
200
400
600
800
1000
1200
1400
Distance from Facility (metres)
NSA 1
NSA 2
NSA 3

APPENDIX B

AEUB Permissible Sound Level Calculation

EnCana Compressor Station (7-13-27-22 W4M)
AEUB Noise Control Directive
Permissible Sound Level Determination
For Residence: 375m southwest (NSA 1)

Basic Night time Sound Level

Proximity to Transportation	Dwelling Unit Density per ¼ Section of Land 1 - 8 Dwellings	9 - 160 Dwellings	>160 Dwellings	Night time	Daytime
Category 1	40	43	46		
Category 2	45	48	51		
Category 3	50	53	56	40	40
			Daytime Adjustment	N/A	10

Class A Adjustments

Class	Reason for Adjustment	Value (dBA L_{eq})
A1	Seasonal Adjustment (1 Nov - 31 Mar)	+5
A2	Absence of Both Tonal and Impulse/Impact Components	+5
A3	Ambient Monitoring Adjustment	-10 to +10
	Class Adjustment = Sum of A1, A2 and A3 (as applicable), but not to exceed a maximum of 10 dBA L_{eq}	

	Night time	Daytime
Total Class A Adjustments	0	0

Class B Adjustments

Class	Duration of Activity	Value (dBA L_{eq})
B1	1 day	+15
B2	1 week	+10
B3	< or = to 2 months	+5
B4	> 2 months	0
Class B Adjustment = one only of B1, B2, B3 or B4		

	Night time	Daytime
Class B Adjustment	0	0
PERMISSIBLE SOUND LEVEL (dBA)	**40**	**50**

EnCana Compressor Station (7-13-27-22 W4M)
AEUB Noise Control Directive
Permissible Sound Level Determination
For Residence: 870m southeast (NSA 2)

Basic Night time Sound Level

Proximity to Transportation	Dwelling Unit Density per ¼ Section of Land 1 - 8 Dwellings	9 - 160 Dwellings	>160 Dwellings	Night time	Daytime
Category 1	40	43	46		
Category 2	45	48	51		
Category 3	50	53	56	45	45
			Daytime Adjustment	N/A	10

Class A Adjustments

Class	Reason for Adjustment	Value (dBA L_{eq})
A1	Seasonal Adjustment (1 Nov - 31 Mar)	+5
A2	Absence of Both Tonal and Impulse/Impact Components	+5
A3	Ambient Monitoring Adjustment	-10 to +10
	Class Adjustment = Sum of A1, A2 and A3 (as applicable), but not to exceed a maximum of 10 dBA L_{eq}	

	Night time	Daytime
Total Class A Adjustments	0	0

Class B Adjustments

Class	Duration of Activity	Value (dBA L_{eq})
B1	1 day	+15
B2	1 week	+10
B3	< or = to 2 months	+5
B4	> 2 months	0
Class B Adjustment = one only of B1, B2, B3 or B4		

	Night time	Daytime
Class B Adjustment	0	0
PERMISSIBLE SOUND LEVEL (dBA)	**45**	**55**

EnCana Compressor Station (7-13-27-22 W4M)
AEUB Noise Control Directive
Permissible Sound Level Determination
For Town of Rosebud: 1250 m east-southeast (NSA 3)

Basic Night time Sound Level

Proximity to Transportation	Dwelling Unit Density per ¼ Section of Land 1 - 8 Dwellings	9 - 160 Dwellings	>160 Dwellings	Night time	Daytime
Category 1	40	43	46		
Category 2	45	48	51		
Category 3	50	53	56	48	48
			Daytime Adjustment	N/A	10

Class A Adjustments

Class	Reason for Adjustment	Value (dBA L_{eq})
A1	Seasonal Adjustment (1 Nov - 31 Mar)	+5
A2	Absence of Both Tonal and Impulse/Impact Components	+5
A3	Ambient Monitoring Adjustment	-10 to +10
	Class Adjustment = Sum of A1, A2 and A3 (as applicable), but not to exceed a maximum of 10 dBA L_{eq}	

	Night time	Daytime
Total Class A Adjustments	0	0

Class B Adjustments

Class	Duration of Activity	Value (dBA L_{eq})
B1	1 day	+15
B2	1 week	+10
B3	< or = to 2 months	+5
B4	> 2 months	0
Class B Adjustment = one only of B1, B2, B3 or B4		

	Night time	Daytime
Class B Adjustment	0	0
PERMISSIBLE SOUND LEVEL (dBA)	**48**	**58**

APPENDIX C

Explanation of Technical Details Regarding Sound Measurement and Analysis

Technical Details

Sound is the phenomena of vibrations transmitted through air, or other medium such as water or a building structure. The range of pressure amplitudes, intensities, and frequencies of the sound energy is very wide, and many specialized fields have developed using different ranges of these variables, such as room acoustics and medical ultrasound.

Due to the wide range of intensities, which are perceived as sound, standard engineering units become inconvenient. Sound levels are commonly measured on a logarithmic scale, with the level (in decibels, or dB) being proportional to ten times the common logarithm of the sound energy or intensity. Normal human hearing covers a range of about twelve to fourteen orders of magnitude in energy, from the threshold of hearing to the threshold of pain. On the decibel scale, the threshold of hearing is set as zero, written as 0 dB, while the threshold of pain varies between 120 to 140 dB. The most usual measure of sound is the sound pressure level (SPL), with 0 dB SPL set at 2.0×10^{-5} N/m^2 (also written 20 μPa), which corresponds to a sound intensity of 10^{-12} Watts/m^2 (or 1 picoWatt/m^2, written 1 pW/m^2).

Normal human hearing spans a frequency range from about 20 Hertz (Hz, or cycles per second) to about 20,000 Hz (written 20 KHz). However, the sensitivity of human hearing is not the same at all frequencies. To accommodate the variation in sensitivity, various frequency-weighting scales have been developed. The most common is the A-weighting scale, which is based on the sensitivity of human hearing at moderate levels; this scale reflects the low sensitivity to sounds of very high or very low frequencies. Sound levels measured on the A-weighted scale are written in A-weighted decibels, commonly shown as dBA or dB(A).

When sound is measured using the A-weighting scale, the reading is often called the "Noise level", to confirm that human sensitivity and reactions are being addressed. A table of some common noise sources and their associated noise levels are shown in Table A1.

When the A-weighting scale is <u>not</u> used, the measurement is said to have a "linear" weighting, or to be unweighted, and may be called a "linear" level. As the linear reading is an accurate measurement of the physical (sound) pressure, the term "Sound Pressure Level", or SPL, is usually (but not universally) reserved for unweighted measurements.

Noise is usually defined as "unwanted sound", which indicates that it is not just the physical sound that is important, but also the human reaction to the sound that leads to the perception of sound as noise. It implies a judgment of the quality or quantity of sound experienced. As a human reaction to sound is involved, noise levels are usually given in A-weighted decibels (dBA). An alternate definition of noise is "sound made by somebody else", which emphasizes that the ability to control the level of the sound alters the perception of noise.

Table A2- Noise Levels of Familiar Sources

Source Or Environment	Noise Level (dBA)
High Pressure Steam Venting To Atmosphere (3m)	121
Steam Boiler (2m)	90-95
Drilling Rig (10m)	80-90
Pneumatic Drill (15m)	85
Pump Jack (10m)	68-72
Truck (15m)	65-70
Business Office	65
Conversational Speech (1m)	60
Light Auto Traffic (30m)	50
Living Room	40
Library	35
Soft Whisper (5m)	20-35

The single number A-weighted level is often inadequate for engineering purposes, although it does supply a good estimate of people's reaction to a noise environment. As noise sources, control measures, and materials differ in the frequency dependence of their noise responses or production, sound is measured with a narrower frequency bandwidth; the specific methodology varies with the application. For most work, the acoustic frequency range is divided into frequency bands where the center frequency of each band is twice the frequency of the next lower band; these are called "Octave" bands, as their frequency relation is called an "Octave" in music, where the field of acoustics has its roots. For more detailed work, the octave bands, and certain standard octave and 1/3 octave bands have been specified by international agreements.

Where the noise at the receiver is steady, it is easy to assess the noise level. However, both the production of noise at the source and the transmission of noise can vary with time; most noise levels are not constant, either because of the motion of the noise source (as in traffic noise), because the noise source itself varies, or because the transmission of sound to the receiver location is not steady as over long distances. This is almost always the case for environmental noise studies. Several single number descriptors have been developed and are used to assess noise in these conditions.

The most common is the measurement of the "equivalent continuous" sound level, or L_{eq}, which is the level of a hypothetical source of a constant level which would give the same total sound energy as is measured during the sampling period. This is the "energy" average noise level. Typical sampling periods are one hour, nighttime (9 hours) or one day (24 hours); the sampling period used must be reported when using this unit.

The greatest value of the L_{eq} is that the contributions of different sources to the total noise level can be assessed, or in a case where a new noise source is to be added to an existing environment, the total noise level from new and old sources can be easily calculated. It is also sensitive to short term high noise levels.

Statistical noise levels are sometimes used to assess an unsteady noise environment. They indicate the levels that are exceeded a fixed percentage of the measurement time period measured. For example, the 10%-ile level, written L_{10}, is the levels exceeded 10% of the time; this level is a good measure of frequent noisy occurrences such as steady road traffic. The 90% level, L_{90}, is the level exceeded 90% of the time, and is the background level, or noise floor. A steady noise source will modify the background level, while an intermittent noise source such as road or rail traffic will affect the short-term levels only.

One disadvantage with the L_{eq} measure, when used alone, is that nearby loud sources (e.g. dogs barking, or birds singing) can confuse the assessment of the situation when it is the noise from a distant plant that is the concern. For this reason, the equivalent level and the statistical levels can be used together to better understand the noise environment. One such indication is the difference between the L_{eq} and the L_{90} levels. A large difference between the L_{eq} and L_{90}, greater than 10 dB, indicates the intrusion of short-term noise events on the general background level. A small difference, less than 5 dB, indicates a very steady noise environment. If the L_{eq} value exceeds the L_{10} value this indicates the presence of significant short-term loud events.

For most noise measurement, instruments are adjusted so that the time response of the instrument is similar to the response of the human ear; this is the "Fast" setting. Measurement with the "Fast" setting therefore assesses the sound environment according to the way humans would hear it and react to it. Where the noise level varies substantially and an average level is wanted without the complexity of and L_{eq} or statistical measurement, the "Slow" setting is used on the sound level meter. The "Slow" setting is also typically used in industrial settings where hearing damage is a concern. Where the noise level changes very rapidly, for example due to impacts or detonations, the "Fast" and "Slow" settings do not respond quickly enough to assess the maximum levels, and the "Impulse" meter setting us used.

The Sound Power Level (abbreviated L_w, SWL or PWL) is the decibel equivalent of the total energy emitted from a source in the form of noise. The reference level for the sound power is 10^{-12} Watts, or 1 picoWatt (abbreviated pW). The sound power level is given by:

$$L_w, \text{SWL}, \text{PWL} = 10 \times \log_{10} (\text{Emitted Power} / 1 \text{ pW}) \text{ dB}$$

Therefore, a source emitting 1 Watt of power in the form of sound would have a sound power level of 120 dB. Sound power levels can be expressed in terms of frequency bands, an overall linear-weighted level or A-weighted, as is the case for sound pressure levels. However, sound power levels are inherent to the source of noise, whereas the sound pressure level is dependant on the source, but also on the distance from the source and other environmental factors.

APPENDIX D

Weather Data

EnCana Rosebud
7-13-27-22 W4M
Drumheller East Weather Data

Date	Time	Temperature (°C)	Wind Speed (kph)	Wind Direction
September 16, 2004	0:00	10.1	6	WNW
	1:00	9.6	6	WNW
	2:00	8.8	6	WNW
	3:00	9.8	4	SSW
	4:00	9.6	2	SW
	5:00	9.4	4	W
	6:00	8.5	0	Calm
	7:00	7.4	0	Calm
	8:00	6.4	6	SE
	9:00	7.5	4	ESE
	10:00	10.4	4	ESE
	11:00	13.2	6	E
	12:00	15	7	SE
	13:00	17.5	11	E
	14:00	17.1	9	SE
	15:00	17.4	13	S
	16:00	17.1	11	S
	17:00	16.6	11	S
	18:00	16.5	9	S
	19:00	16.2	6	S
	20:00	12.9	4	S
	21:00	10.3	7	SE
	22:00	9.3	11	SE
	23:00	8.3	7	SE
September 17, 2004	0:00	6.9	9	SE
	1:00	5.8	7	SE
	2:00	5.6	6	SE
	3:00	4.8	6	SE
	4:00	3.7	0	Calm
	5:00	3.1	7	NW
	6:00	2.6	2	SW
	7:00	2.4	2	WNW
	8:00	2.4	0	Calm
	9:00	4.8	2	ESE
	10:00	7.6	2	NNE
	11:00	10.3	6	NNW
	12:00	14.9	2	NNW
	13:00	18.2	2	ENE
	14:00	20.6	6	S
	15:00	21	9	S
	16:00	20.5	11	S
	17:00	20.3	4	SSE
	18:00	20.2	17	S
	19:00	18.8	9	SSE
	20:00	16.3	9	S
	21:00	13	6	SSE
	22:00	12.1	4	SE
	23:00	11.5	9	SE

APPENDIX E

Measurement Results
Graphs of 1-Minute L_{eq}, L_{10} and L_{90} Data

Table 1.1
EnCana Rosebud
Rosebud Community Hall
Daily Leq Values

Date	Time	Measured		Residual	
		Leq	Hours	Leq	Hours
Sep. 16, 2004	07:00 - 21:59	39.6	1.7	33.2	1.4
Sep. 16, 2004 - Sep. 17, 2004	22:00 - 06:59	45.7	9.0	25.6	5.8
Sep. 17, 2004	07:00 - 21:59	42.1	9.8	42.1	9.8
Sep. 16, 2004 - Sep. 17, 2004	22:00 - 06:59	All Trains		45.2	9.0
Sep. 16, 2004 - Sep. 17, 2004	22:00 - 06:59	All Vehicles		26.3	9.0
Sep. 16, 2004 - Sep. 17, 2004	22:00 - 06:59	All Airplanes		33.0	9.0
Sep. 16, 2004 - Sep. 17, 2004	22:00 - 06:59	All Animals		18.9	9.0
Sep. 16, 2004 - Sep. 17, 2004	22:00 - 06:59	All Unknown		29.4	9.0

Patching Associates Acoustical Engineering Ltd.

Consultants in Acoustics, Noise Control and Vibrations

Table 1.2
EnCana Rosebud
Rosebud Community Hall
Hourly Leq Values

Date	16-Sep-04		17-Sep-04		18-Sep-04	
Start Time	Comprehensive Sound Level (dBA Leq)	Residual Sound Level (dBA Leq)	Comprehensive Sound Level (dBA Leq)	Residual Sound Level (dBA Leq)	Comprehensive Sound Level (dBA Leq)	Residual Sound Level (dBA Leq)
0:00			29.2	25.4		
1:00			32.4	25.1		
2:00			53.5	24.8		
3:00			25.1	25.1		
4:00			27.9	25.3		
5:00			49.6	25.5		
6:00			39.1	26.4		
7:00			40.9	41.0		
8:00			40.5	40.5		
9:00			39.1	39.1		
10:00			39.6	39.6		
11:00			41.9	41.9		
12:00			38.8	38.8		
13:00			35.5	35.5		
14:00			34.7	34.7		
15:00			36.3	36.3		
16:00			50.3	50.3		
17:00						
18:00						
19:00						
20:00	42.6	33.6				
21:00	34.3	32.9				
22:00	34.6	25.6				
23:00	33.2	27.1				

Figure 1.1
EnCana Rosebud
Rosebud Community Hall

Sep. 16, 2004 14:30 - 21:59

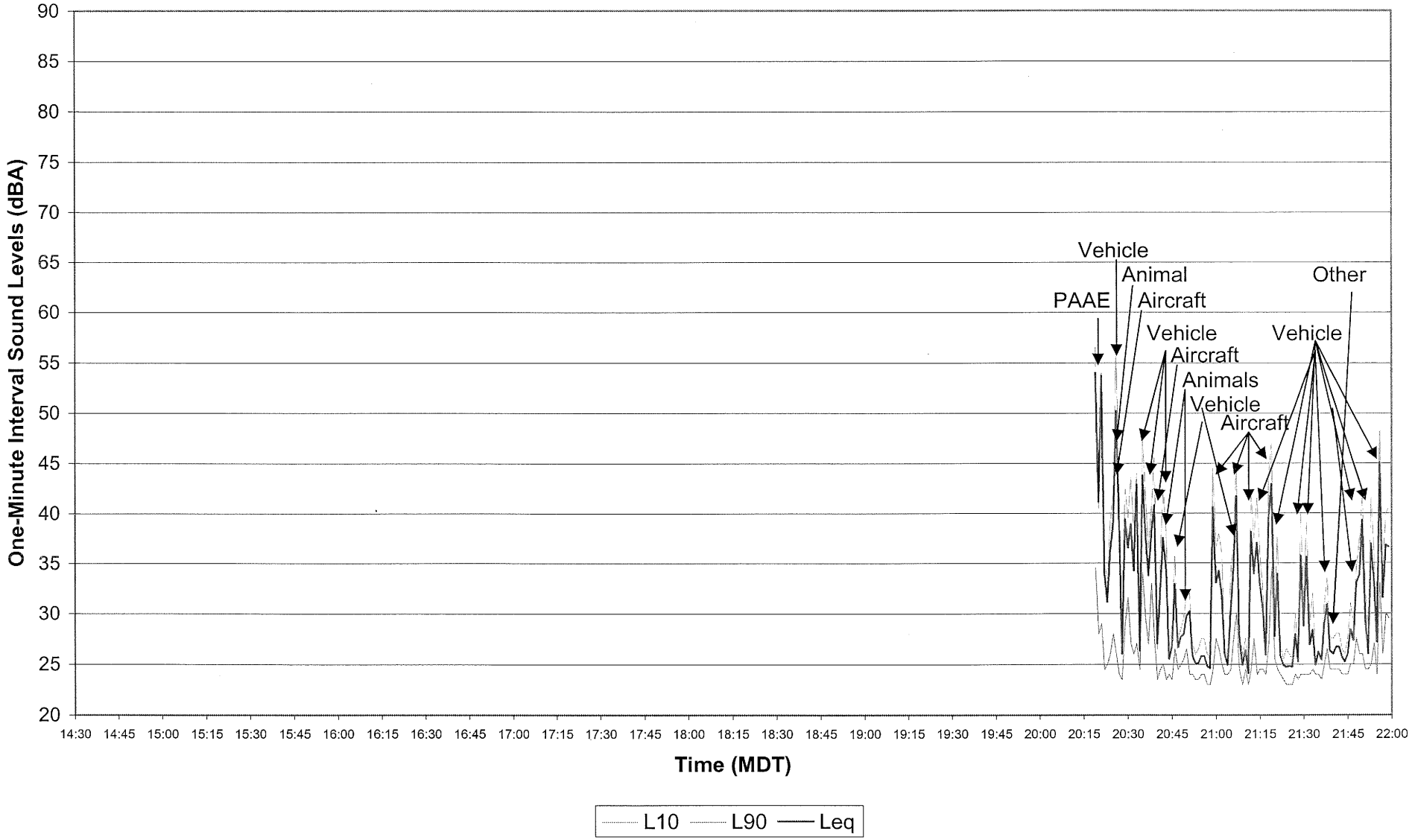


Figure 1.2
EnCana Rosebud
Rosebud Community Hall

Sep. 16, 2004 - Sep. 17, 2004 22:00 - 06:59

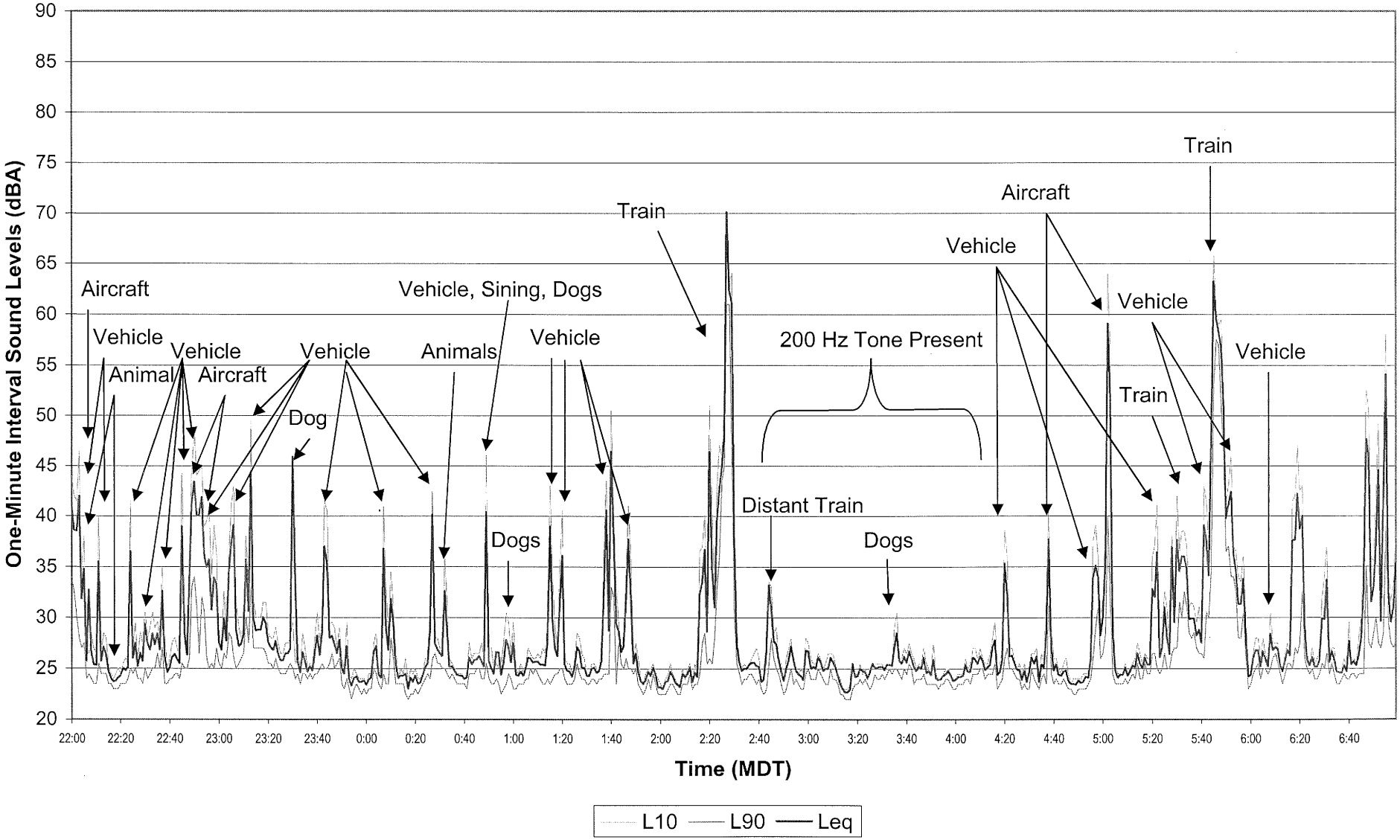


Figure 1.2i Residual
EnCana Rosebud
Rosebud Community Hall

Sep. 16, 2004 - Sep. 17, 2004 22:00 - 06:59

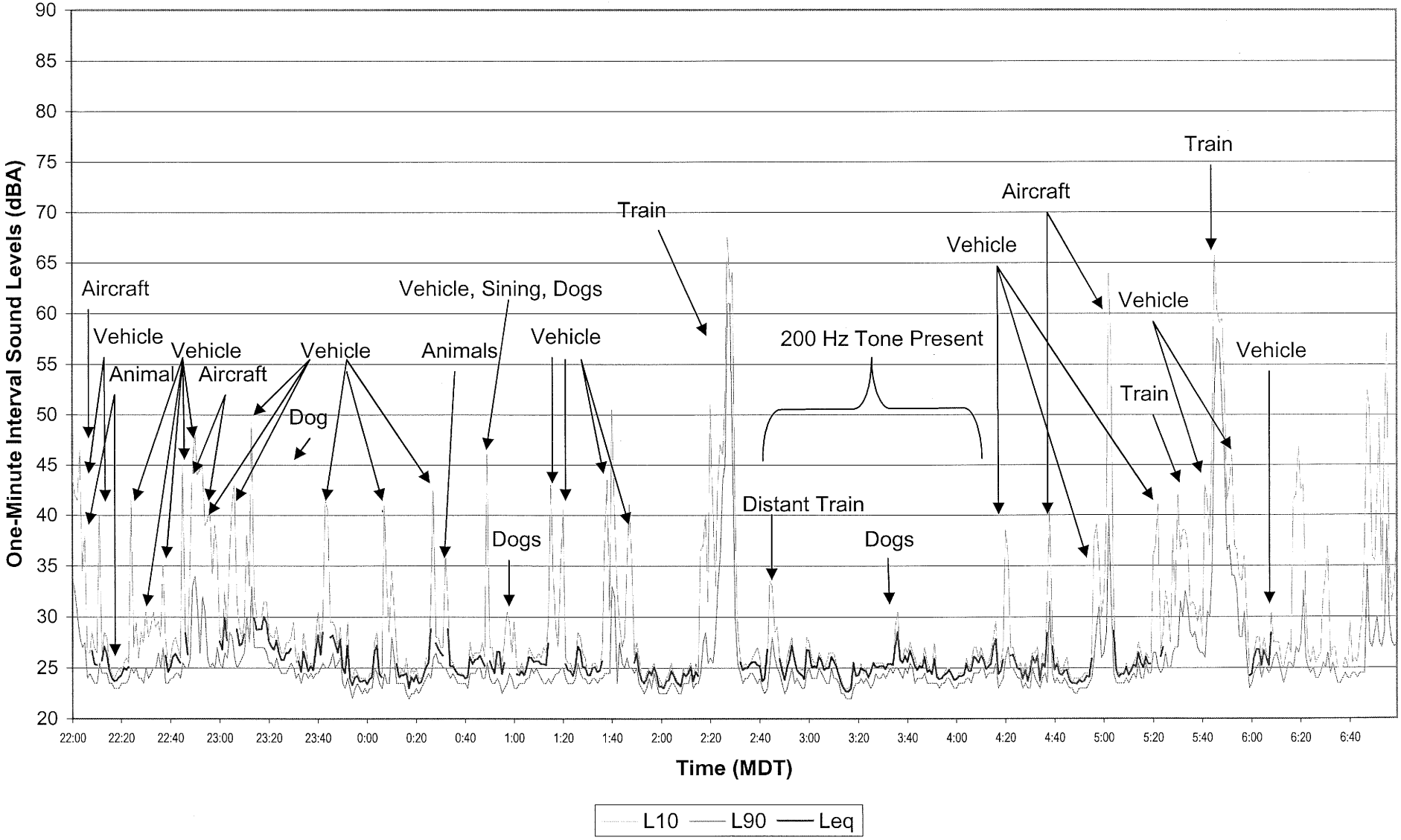


Figure 1.3
EnCana Rosebud
Rosebud Community Hall
Sep. 17, 2004 07:00 - 14:29

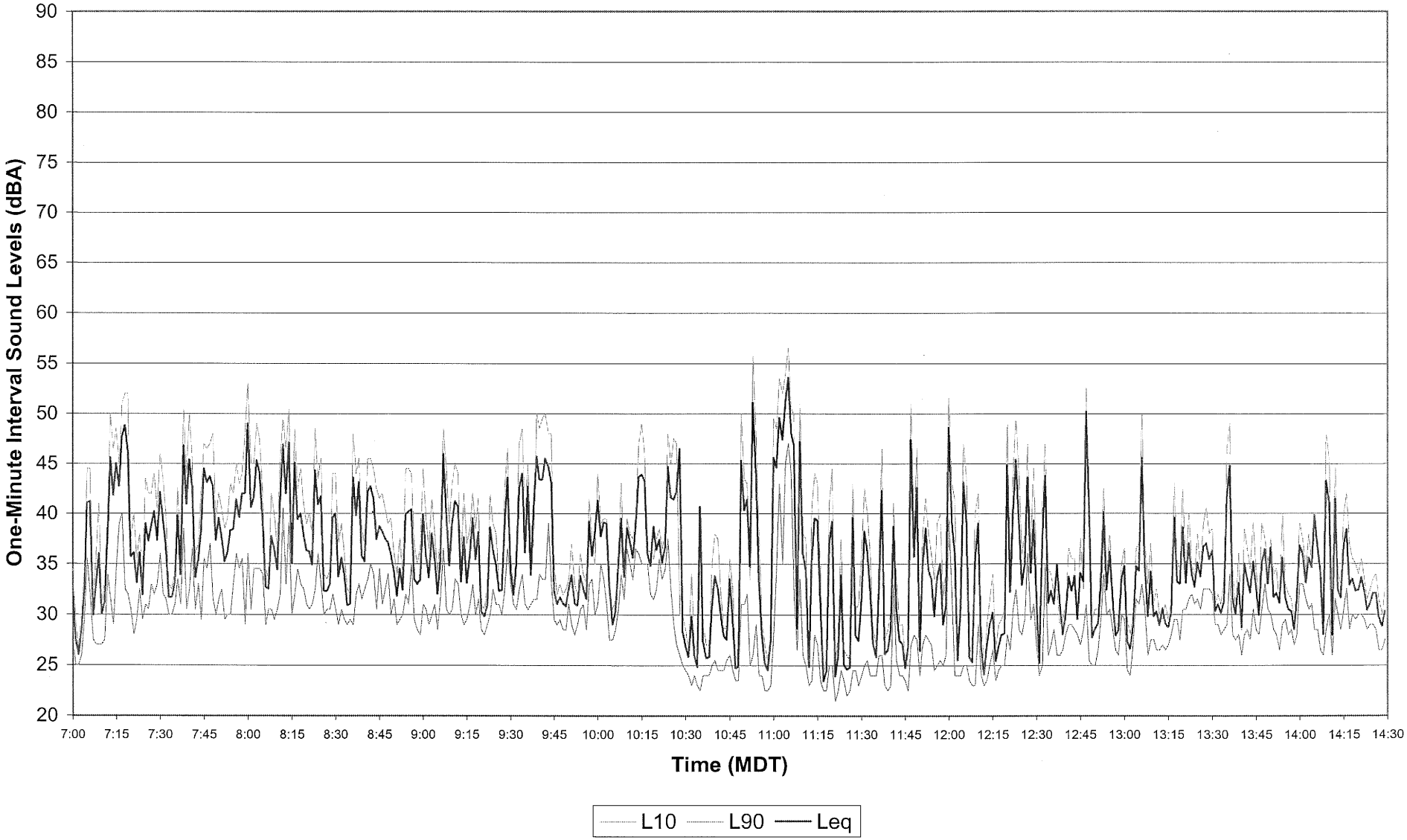
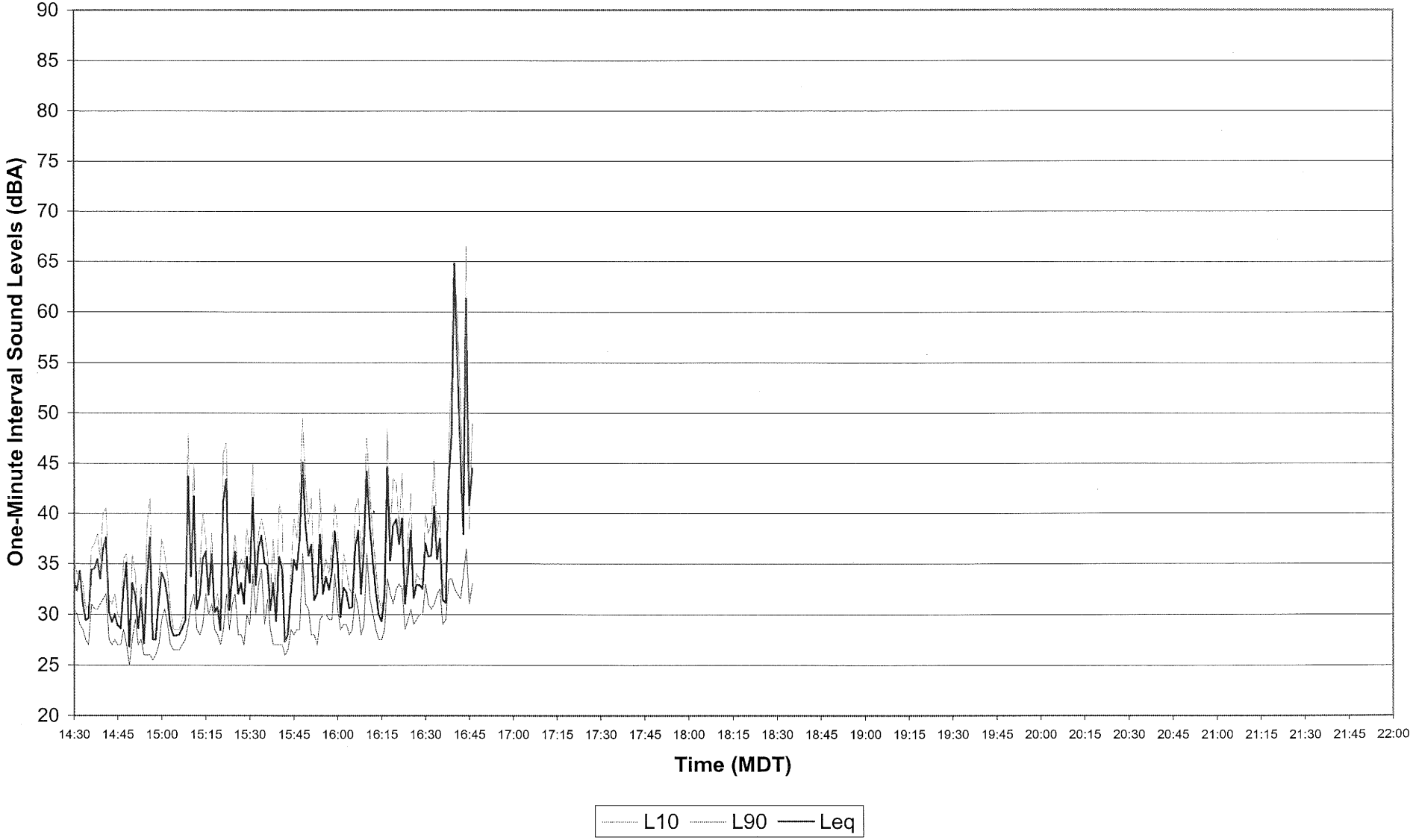



Figure 1.4
EnCana Rosebud
Rosebud Community Hall
Sep. 17, 2004 14:30 - 21:59