LINE 3 REPLACEMENT PROJECT

Application for Pipeline Routing Permit

Minnesota Public Utilities Commission
Appendix M

Noise Impact Analysis

Appendix M

Noise Analysis

Appendix M.1

Donaldson Pumping Station

DONALDSON PUMPING STATION
(KITTSON COUNTY, MINNESOTA)

RESULTS OF A NOISE IMPACT ANALYSIS OF A NEW L67 PUMP STATION AT THE EXISTING DONALDSON PUMP STATION ASSOCIATED WITH THE ENBRIDGE MAINLINE EXPANSION ("MLE") PHASE II PROJECT

H&K Report No. 2957

H&K Job No. 4707

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REPORT SUMMARY

This report includes the results of a noise impact analysis of a new pumping station for Line 67 ("L67 Pump Station" or "L67 Station") at the existing **Donaldson (MN) Pumping Station** ("Station") associated with the **Enbridge Energy Mainline Expansion ("MLE") Phase II Project** ("Project" or "MLE Ph II Project"). The purpose of the noise impact analysis is to project the sound contribution of the Donaldson Pumping Station (referred to as "Station" in the report) and compare the results of the noise assessment to applicable sound criteria and/or proposed noise level guideline. In addition, the results of a recent "pre-construction" sound survey at the Donaldson Station are included.

The following table summarizes the measured sound level environment around the Station (i.e., Leq) at the nearby noise-sensitive areas ("NSAs", such as residences) and the estimated sound contribution of the Donaldson Station after installation of the new L67 Station at the Donaldson Station along with the potential increase in the existing sound level at the nearby NSAs after installation of the new L67 Pump Station. The results in this table are defined as the "Noise Quality Analysis".

Noise Quality Analysis for Donaldson Pumping Station (Sound Level Contribution of the Station at the Closest NSA(s) after Installation of New L67 Station and Potential Increase above Existing Sound Level)

Closest NSA(s) and Type of NSA	Distance & Direction of NSA to Station Site Center	Distance & Direction of NSA to New L67 Pump Station	Est'd "Lowest" A-Wt. Sound Level (Leq) based on Recent Survey	Est'd Sound Contribution of New L67 Pump Station	Est'd Sound Level of new L67 Station plus Existing Sound Level	Potential Noise Increase
NSA #1 (Residence)	560 feet (west)	1,660 feet (NW)	40.7 dBA	23.6 dBA	40.8 dBA	0.1 dB

The results of the recent sound survey and acoustical analysis of the planned new L67 Station at the Terminal indicates the following:

- Sound level contribution of the existing Donaldson Pumping Station during operation complies with the MPCA Standard (< **50 dBA** at nighttime) at the surrounding NSAs (i.e., residences);
- Estimated total sound level contribution of the modified Station (i.e., addition of the new L67 Pump Station plus the current sound level of the existing Station) should comply with the MPCA Standard (< **50 dBA** at nighttime); and
- Potential noise increase in the "pre-existing" sound level due to the planned Station modifications should be less than **3 dB** at the nearby NSAs (i.e., residences). Consequently, the noise of the Terminal modifications may be perceivable by the human ear but should have minimum impact on the surrounding acoustical environment.

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FIGURES/DRAWINGS, SOUND DATA AND ACOUSTICAL ANALYSES

1.0 INTRODUCTION

In this report, **Hoover & Keith Inc.** ("H&K") presents the results of a noise impact analysis of the new pumping station for Line 67 ("L67 Pumping Station" or "L67 Station") at the existing **Donaldson (MN) Pumping Station** (referred to as "Station" in the report) associated with the **Enbridge Energy Mainline Expansion ("MLE") Project** ("Project" or "MLE Ph. II Project"). The purpose of the noise impact analysis is to estimate the sound contribution of the Station at the property line and at nearby noise-sensitive areas ("NSAs"), such as residences, due to the installation of the new L67 Station. The results of the noise assessment are then compared to applicable noise regulations and/or a proposed noise level guideline. In addition, the results of a recent "pre-construction" sound survey at the Station during operation are included.

2.0 BRIEF DESCRIPTION OF THE STATION/EQUIPMENT

Figure 1 (p. 7) shows an area layout around the Station showing the surrounding and nearest NSAs (i.e., primarily residences) and the reported sound measurement position(s) near the closest NSA during the sound survey. The Donaldson Station is located along Hwy. 11 in Kittson County, Minnesota, approximately 2 miles west of Donaldson, MN. The closest residence, identified as "NSA #1", is located approximately 560 feet west of the Station site center.

Figure 2 (p. 8) provides a layout of existing buildings/equipment, Station fenceline (i.e., property line), the anticipated location of equipment for the new L67 Station and the reported sound measurement positions around the Station property. For reference, **Figure 3** (p. 9) provides a photo showing existing buildings/equipment/piping from the West Side of the Station. The following **Table 1** lists the existing pumping stations located within the property of the Donaldson Pumping Station along with a list of associated pumping units/horsepower ("HP"). Pumps for each respective site pump station are enclosed inside respective buildings (i.e., L2 Pumphouse Building, L3 Pumphouse Building, L4 Pumphouse Building and L65 Pumphouse Building).

Station & associated Line Number	Unit Number	Rated HP
Station 2 ("L2 Station"); station that serves Line No. 2	2-U-1	1,500 HP
	2-U-2	2,250 HP
	2-U-3	2,250 HP
	2-U-4	2,500 HP
Station 3 ("L3 Station"); station that serves Line No. 3	3-U-1	3,500 HP
	3-U-2	3,500 HP
	3-U-3	3,500 HP
Station 4 ("L4 Station"); station that serves Line No. 4	4-U-1	5,000 HP
	4-U-2	5,000 HP
	4-U-3	5,000 HP
Station 65 ("L65 Station"); station that serves Line No. 65	65-U-1	2,000 HP
	65-U-2	2,000 HP
	65-U-3	2,500 HP

Table 1: Summary of the Stations and associated Pump Units at the Donaldson Pumping Station

Station Modifications for the Project: The new L67 Station will be installed at the Station, which will serve Line 67, and currently there are no pumps associated with Line 67 at the Station. The new L67 Station will be designed with three (3) 6,000 HP electric motor-driven pumps, an electrical substation that serves the L67 pumps, and a Variable Frequency Drive ("VFD") Building ("VFD Building") along with an adjacent Electrical Service Building ("ESB" or "Switchgear Bldg."). The motors/pumps of L67 Station motor-driven pumps and associated aboveground piping will be located inside a metal building ("L67 Pumphouse Building"), and the associated VFD Building/ESB are anticipated to be "modular-type" buildings.

3.0 ACOUSTICAL TERMINOLOGY AND SOUND CRITERIA

3.1 Acoustical Terminology and Example of Typical Environmental Sound Levels

For the reader's information, a summary of acoustical terminology and list of typical metrics used to measure/regulate environmental noise is provided in the **Appendix** (pp. 14–16). There are several metrics for quantifying and regulating environmental noise level although the most common metric used by state and municipal agencies is the A-wt. sound level ("dBA"). There are also other metrics, such as L_{eq} and day-night average sound level ("L_{dn}"), that are used to correlate human reaction to an intruding sound. In addition, to gain an understanding and comparison of the predicted Station noise level, a Table is provided in the **Appendix** (p. 16) that shows a list of some common environmental noise sources.

3.2 State of Minnesota and Local Noise Regulations

The Minnesota Pollution Control Agency ("MPCA") has a receiver-based standard intended to limit noise levels and to protect the health and welfare of the general public, as included in the *Noise Rules and Statutes* (MPCA Standards). In general, the MPCA Standard limits the sound contribution from a facility to a receiver according to land activities by the noise area classification ("NAC") system established in the MPCA Standard, as follows:

Noise Area Classification (NAC)	Daytime (dBA)		Nighttime (dBA)	
	L50	L10	L50	L10
1 (e.g., residence, church)	60	65	50	55
2 (e.g., commercial business)	65	70	65	70
3 (e.g., pumping station)	75	80	75	80

Notes:

1. The worst case MPCA Standard for the Alberta Clipper Project is for land activities within NAC Group 1, which includes residences (i.e., NSAs).
2. The L50 is the sound level in dBA which is exceeded 50% of the time for a one hour measurement. The L10 is the sound level in dBA which is exceeded 10% of the time for a 1-hour measurement (i.e., sound levels are known as exceedence levels).
3. Daytime is defined as the hours from 7:00 AM to 10:00 PM. Nighttime is defined as the hours from 10:00 PM to 7:00 AM.

The MPCA Standard states that a one-hour measurement period is to be utilized for verification of the L10 and L50 requirements. However, a typical pump station will have an essentially constant sound level which is mostly dependent upon the number of pump units operating to meet flow requirements. Therefore, it is not necessary to perform a one-hour measurement to determine the sound level contribution of a pump station at an adjacent NSA, as the sound level is essentially constant. In addition, a much shorter duration measurement can permit the sound level contribution of the nearby pump station/terminal for an NSA to be isolated from other potential sound sources, or to document a representative background ambient sound level at an NSA where the facility is not audible. For the reasons above, H&K has utilized shorter term measurements to document the sound level contribution of a Station at the nearby NSAs. Our measurement approach was confirmed with a representative at the MPCA. We are not aware of any local and/or county noise regulations that are applicable to the Station.

3.3 Discussion of the Noise Impact of a New Pump Station

This section provides a proposed "noise level guideline" that could be utilized for this pump station, as related to the potential noise impact at any NSA due to the installation of the new L67 Station at the Donaldson Pump Station. If an intruding noise (e.g., noise generated by the pumping station) causes less than a **3 dB** increase in the overall ("pre-existing") sound level at the surrounding NSAs (i.e., defined as "potential noise increase"), the Station noise should be barely perceivable by the human ear and should have minimum impact on the acoustical environment. If the intruding noise causes an increase in the overall sound level of between **4 dB** and **6 dB**, the noise of the Station may be audible by the human ear but should still have minimum impact on the acoustical environment.

4.0 MEASUREMENT LOCATIONS, METHODOLOGY AND MEASUREMENT RESULTS

4.1 Sound Measurement Locations, Data Acquisition and Station Operating Conditions

During the recent sound survey, daytime sound levels (i.e., Ld) was measured near the closest NSA (i.e., residence identified as "NSA #1"), and sound levels were measured around the Station fenceline (i.e., property line). The following is a description of the identified closest NSA and reported sound measurement positions during the recent sound survey:

Pos. 1: "NSA #1" (closest NSA); Residence approx. 560 feet west of the Station site center and approx. 1,660 feet NW from the new L67 Pumphouse Building for new L67 Station;
Pos. 2: South Side of Station, near Station main entrance gate (just off Hwy. 11);
Pos. 3: West fenceline of the Station, in line with L4 Pump Building;
Pos. 4: North fenceline of the Station, near L3 Pump Building & L65 Pump Building;
Pos. 5: East fenceline of the Station, in line with L65 Pump Building; and
Pos. 6: SSE of the Station, near the anticipated location of new L67 Pump Station.

Sound measurements were performed by Paul Kiteck of H&K during the daytime (morning) of November 1, 2013. At each sound measurement position, the equivalent A-wt. sound level (i.e., L_{eq}) and unweighted octave-band ("O.B.") sound pressure levels ("SPLs") were measured at 5 feet above ground. Typically, several sample periods of the ambient noise were measured at each NSA sound measurement position (e.g., 5 to 20 minutes in length). Sound measurements attempted to exclude "extraneous sound" such as cars or trucks passing immediately by the measurement location or other intermittent sources not typical of the ambient noise environment. The sound measurement system consisted of a Larson-Davis ("LD") Model 2900 Real Time Analyzer/SLM (a Type I SLM per ANSI Standard S1.4 & S1.11) with a 1/2-in. LD condenser microphone covered by a windscreen, and the analyzer/SLM was calibrated with a LD Model CA250 microphone calibrator that was calibrated within one (1) year of the test date.

Conditions: During the sound survey tests, Unit 2-U-2 (L2 Station), Unit 3-U-1 (L3 Station), Unit 4-U-2 (L4 Station), and Unit 65-U-2 (L65 Station) were operating at full capacity along with substation equipment (e.g., transformers) and respective VFDs.

4.2 Results of the Sound Survey and Observations

Table A (p. 10) summarizes the measured daytime Leq (i.e., Ld) at the sound measurement locations near surrounding NSAs along with the average of the measured Ld. In addition, **Table A** includes the resulting Ldn, as calculated from the measured Ld along with the observations during the sound survey regarding contributors to the measured sound levels. Meteorological conditions during the sound survey are summarized in **Table B** (p. 10). The measured ambient daytime A-wt. sound levels and associated unweighted ambient O.B. SPLs during the sound survey at the nearest NSAs are provided in **Table C** (p. 11).

The following **Table 2** summarizes the measured daytime A-wt. sound level and the estimated nighttime A-wt. sound level at the closest NSA(s) during the Station operating conditions that occurred during the sound survey.

Meas. Pos.	Description of the Sound Measurement Location	Meas'd Daytime A-Wt. Sound Level	Est'd Nighttime A-Wt. Sound Level
Pos. 1	NSA #1: Residence approx. 560 ft. west of Station site center	43.7 dBA	40.7 dBA

Table 2: Summary of the Meas'd Daytime A-Wt. Sound Level and Est'd Nighttime A-Wt. Sound Level near the Closest NSA(s) during Station Operation.

During the sound tests at NSA #1 (i.e., Pos. 1), the noise of the Station was audible and was considered to be a significant noise source (i.e., Station noise contributed to the measured A-wt. sound levels). Other sources of sound that contributed to the measured A-wt. sound level at NSA #1 was the noise of distant vehicle traffic and noise of a silo exhaust fan located on the property of the farmhouse. It is our opinion, the nighttime sound levels could be lower than the daytime sound levels since there would be less vehicle traffic. Consequently, estimated nighttime sound level was also included in the summary of the sound data (i.e., **Table A**).

At the sound measurement positions around the Station fenceline (i.e., Pos. 2, 3, 4 & 5), the noise generated by the Station pumping unit(s) and substation equipment was the most dominant noise sources, which would be expected since these measurement positions are relatively close to the Station equipment and/or the existing substation.

5.0 ACOUSTICAL ASSESSMENT

The noise assessment considers the noise produced by all equipment that could contribute to the noise generated by new L67 Station, based on the current design and the anticipated noise-generating equipment in the area of the new electric motor-driven pumps for the new L67 Station (i.e., L67 Pumphouse Building). A description of the acoustical assessment methodology of new L67 Station at the Donaldson Pumping Station and the source of sound data are provided toward the end of the report (p. 13).

The predicted sound contribution of new L67 Station was performed at the “closest residence” (i.e., NSA #1) and at the “closest” property line to the new L67 Station (i.e., north property line of L67 Station) since the sound contribution at other Station property lines and at more distant residences should be lower than the estimated sound contribution at the closest property line for L67 Station and at the closest residence(s). For the noise assessment of the Station, the following equipment were considered significant and potential noise sources:

- Noise of electric motor-driven product pumps/piping inside L67 Pumphouse Building;
- Noise of the air-supply fans (“building cooling fans”) for L67 Pumphouse Building;
- Noise associated with the electrical substation (e.g., transformers, etc.); and
- Noise associated with the VFD Building and ESB consisting primarily the noise generated by the VFD air exhaust system and noise of “wall-mounted” AC units.

Table D (p. 12) shows the spreadsheet calculation of the estimated A-wt. sound level and unweighted O.B. SPLs contributed by the new L67 Station at the closest NSA (i.e., NSA #1) for standard day propagating conditions (i.e., no wind, 60 deg. F., 70% R.H.). In addition, **Table D** includes estimated total sound level at NSA #1 after installation of the new L67 Station (i.e., sound level of L67 Station plus the “lowest” existing sound level, which is the estimated nighttime sound level), and the estimated potential increase in the existing sound level at NSA #1 as a result of the installation and operation of the new L67 Pump Station.

For reference, **Table E** (p. 12) provides the estimated A-wt. sound level of new L67 Station at the “closest” property line of new L67 Station (i.e., north property line of new L67 Station) based on the estimated sound level contribution of L67 Station in **Table D**.

6.0 SUMMARY AND FINAL COMMENT

The following **Table 3** summarizes the measured noise environment around the Station (i.e., estimated "lowest" A-wt. sound level at the closest NSA) via the recent pre-construction sound survey, the estimated sound contribution of the new L67 Station at the closest NSA (i.e., residence) and the estimated total sound level of the Station after installation of new L67 Station along with the potential increase in the existing sound level at the closest NSA(s) after installation of new L67 Station. The results in this table are defined as the "Noise Quality Analysis".

Closest NSA(s) and Type of NSA	Distance & Direction of NSA to Station Site Center	Distance & Direction of NSA to New L67 Pump Station	Est'd "Lowest" A-Wt. Sound Level (Leq) based on Recent Survey	Est'd Sound Contribution of New L67 Pump Station	Est'd Sound Level of new L67 Station plus Existing Sound Level	Potential Noise Increase
NSA #1 (Residence)	560 feet (west)	1,660 feet (NW)	40.7 dBA	23.6 dBA	40.8 dBA	0.1 dB

Table 3: Noise Quality Analysis for the Donaldson Pumping Station related to Installation of L67 Station

The results of the recent sound survey and acoustical analysis of the planned new L67 Station pump units at the Terminal indicates the following:

- Sound level contribution of the existing Donaldson Pump Station during operation complies with the MPCA Standard (< **50 dBA** at nighttime) at the surrounding NSAs;
- Estimated total sound level contribution of the modified Station (i.e., addition of the new L67 Station pump units plus the current sound level of the existing Station) should comply with the MPCA Standard (< **50 dBA** at nighttime);
- Potential noise increase in the "pre-existing" sound level due to the planned Station modifications should be less than **3 dB** at the nearby NSAs (i.e., residences). Consequently, the noise of the Terminal modifications may be perceivable by the human ear but should have minimum impact on the surrounding acoustical environment; and
- In addition, the acoustical analysis also estimates that the A-wt. sound level at the property line of new L67 Station will be equal to or less than **48 dBA**.

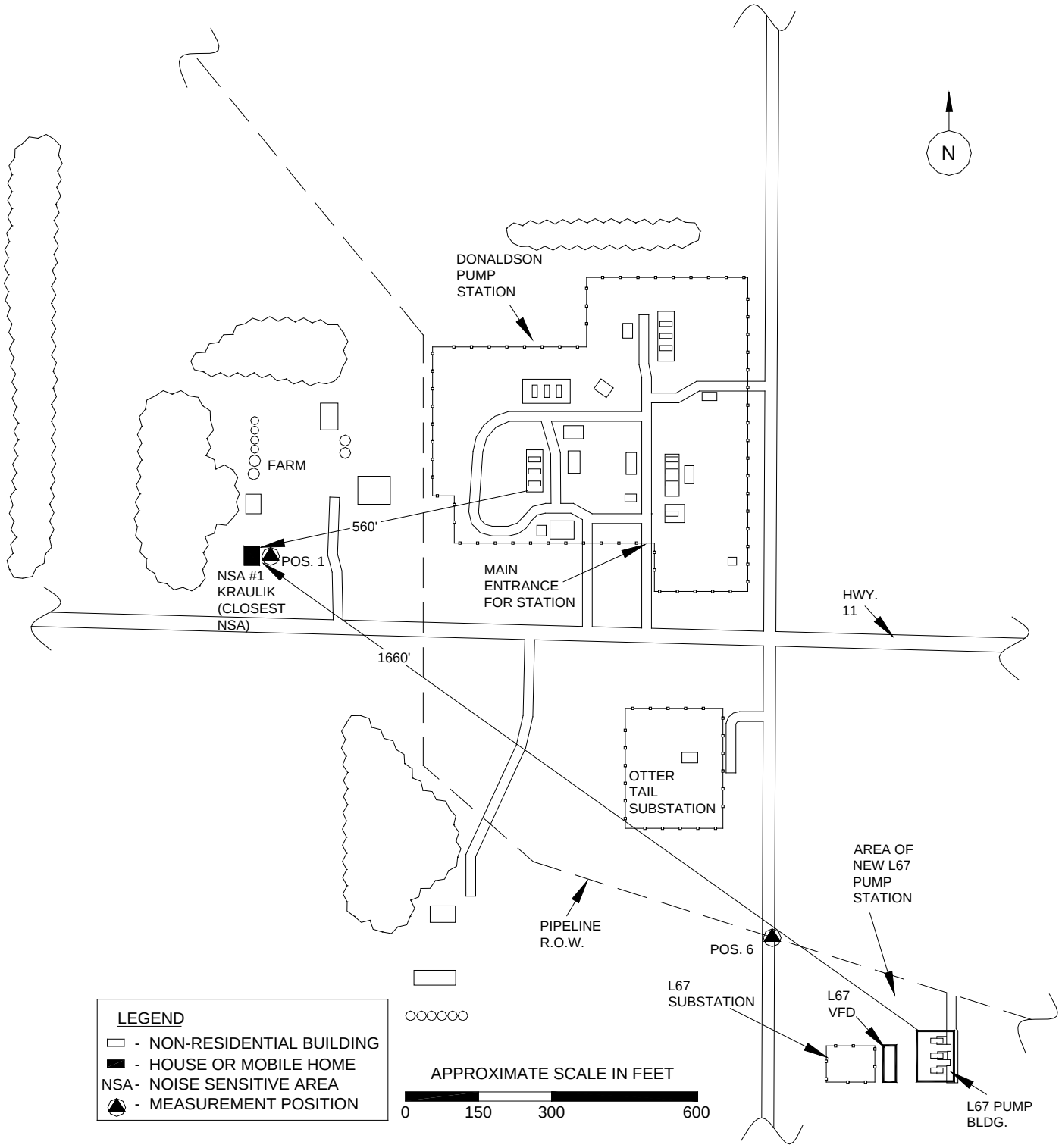


Figure 1: Enbridge Donaldson Pumping Station: Area Layout showing the Closest NSA (i.e., Residence) and Reported Sound Measurement Positions near the Closest NSA and near new L67 Pump Station.

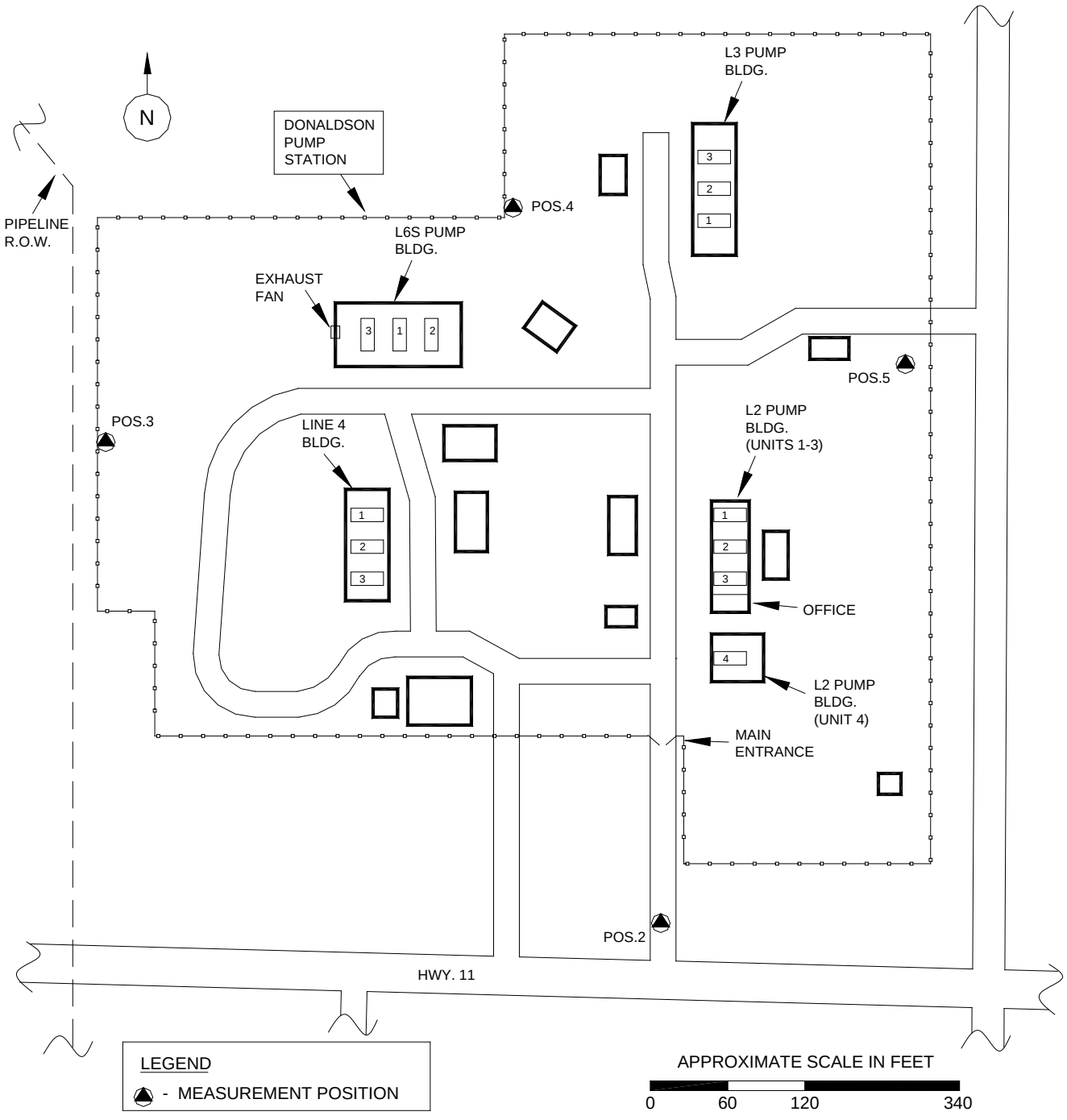


Figure 2: Enbridge Donaldson Pumping Station: Layout of the Existing Station and Conceptual Layout (Plot Plan) of Buildings/Equipment associated with new L67 Station along with the Location of Reported Sound Measurement Positions around the Station Property.

Figure 3: Enbridge Donaldson Pumping Station: Photo showing Buildings and Equipment/Piping (i.e., L4 & L65 Pump Buildings shown in the Foreground of Photo) from Viewpoint of the West Side of the Station.

Measurement Set		Meas'd/Calc'd A-Wt. Sound Levels (dBA)					
		Day-time	Avg'd of		Night-time	Calc'd Ldn	
Meas. Position	**Time of Test**	Leq(Ld)	Ld		Leq(Ln)	Note (1)	**Notes/Observations**
Pos. 1 (NSA #1)	9:00 AM	44.6					Station noise was audible and significant
Residence located	9:16 AM	44.4	**43.7**		**40.7**	**47.7**	contributor to A-wt. sound level. Also, noise of
560 ft. west of Station	9:30 AM	43.4			Note (1)	Note (2)	exhaust fan for a silo on site of farmhouse, and
(North Side of Hwy. 11)							at times, noise of distant traffic along Hwy. 11.

Table A: **Enbridge Donaldson Pumping Station: Summary of the Meas'd Daytime Leq (i.e., Ld) at the Closest NSA as Meas'd on November 1, 2013 during Station Operation along with the Est'd Nighttime Leq (i.e., Ln) and Resulting Ldn, as Calc'd via the Meas'd Ld & Est'd Ln.**

Note (1): Although nighttime levels (Ln) were not measured, the ambient nighttime A-wt. sound level (Ln) should be slightly lower (i.e., approximately 3 to 5 dB lower) than the measured ambient daytime sound levels (Ld).

Note (2): If only the daytime Leq (i.e., Ld) is measured, the Ldn is calculted by adding 6.4 dB to the meas'd Ld. If both Ld and Ln are measured and/or estimated, Ldn is calculated using the following formula:

$$L_{\mathrm{dn}} = 10\log_{10}\left(\frac{15}{24}10^{L_{\mathrm{d}}/10} + \frac{9}{24}10^{(L_{\mathrm{n}}+10)/10}\right)$$

Operating Conditions of Station Equipment during the Sound Survey:
> Unit #2 of Line #2 was operating at full speed;
> Unit #1 of Line #3 was operating at full speed;
> Unit #2 of Line #4 was operating at full speed; and
> Unit #2 of Line #65 was operating at full speed.

Measurement Set		Temp.	R.H.	Wind	Wind	Peak	
Meas. Pos.	**Time Frame of Tests**	**(°F)**	**(%)**	**Direction**	**Speed**	**Wind**	**Sky Conditions**
Meas. Pos. 1 to 6	9:00 AM to 11:30 AM	28 - 34	75 - 80	Wind from west & NW	1 - 3 mph	3 - 4 mph	Mostly cloudy

Table B: **Enbridge Donaldson Pumping Station: Summary of the Meteorological Conditions during the Sound Survey Measurements on November 1, 2013.**

Measurement Set		Sound Pressure Level (SPL) in dB per Octave-Band Frequency (in Hz)									A-Wt.
Meas. Position	**Time of Test**	**31.5**	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	**Level**
Pos. 1 (NSA #1)	9:00 AM	49.0	50.0	50.4	46.0	40.5	37.0	38.5	28.0	28.0	44.6
Residence located	9:16 AM	54.0	60.0	54.6	40.0	38.0	37.2	36.8	32.0	22.0	44.4
560 ft. west of Station	9:30 AM	51.0	57.0	47.7	38.7	35.8	36.2	38.8	33.0	21.0	43.4
(North Side of Hwy. 11)											
	Average SPL	**51.3**	**55.7**	**50.9**	**41.6**	**38.1**	**36.8**	**38.0**	**31.0**	**23.7**	**43.7**
Pos. 2	9:40 AM	52.0	53.0	60.5	50.6	52.6	43.0	46.8	31.5	23.0	53.4
South Side of the	9:42 AM	50.0	52.0	60.0	51.0	53.0	42.0	47.0	30.0	25.0	53.5
Station, near the Main											
Entrance Gate	**Average SPL**	**51.0**	**52.5**	**60.3**	**50.8**	**52.8**	**42.5**	**46.9**	**30.8**	**24.0**	**53.4**
Pos. 3	9:50 AM	61.0	59.0	55.0	52.4	49.0	45.7	50.7	37.0	30.0	54.2
West fenceline of	9:52 AM	61.2	59.3	56.4	52.3	47.2	48.0	50.7	38.0	28.0	54.5
Station, in line with											
L4 Pump Bldg.	**Average SPL**	**61.1**	**59.2**	**55.7**	**52.4**	**48.1**	**46.9**	**50.7**	**37.5**	**29.0**	**54.3**
Pos. 4	9:55 AM	63.4	60.0	64.5	56.6	56.4	52.2	58.7	41.0	33.0	61.7
North fenceline of the	9:58 AM	63.0	64.6	63.5	56.2	55.2	52.0	58.5	40.0	33.0	61.3
Station, near L3 &											
L65 Pump Bldgs.	**Average SPL**	**63.2**	**62.3**	**64.0**	**56.4**	**55.8**	**52.1**	**58.6**	**40.5**	**33.0**	**61.5**
Pos. 5	10:10 AM	59.0	70.0	59.0	48.7	48.4	46.0	47.0	42.0	34.0	53.3
East fenceline of the	10:15 AM	57.0	69.0	59.0	50.4	49.0	45.6	46.5	42.2	34.0	53.2
Station, in line with											
L65 Pump Bldg.	**Average SPL**	**58.0**	**69.5**	**59.0**	**49.6**	**48.7**	**45.8**	**46.8**	**42.1**	**34.0**	**53.2**
Pos. 6	11:00 AM	59.0	57.0	51.0	33.0	35.0	36.0	33.0	24.0	23.0	41.2
SSE of the station;	11:05 AM	60.0	58.0	51.0	36.0	34.0	35.0	32.0	23.0	21.0	40.8
near location of new											
L67 Pump Station	**Average SPL**	**59.5**	**57.5**	**51.0**	**34.5**	**34.5**	**35.5**	**32.5**	**23.5**	**22.0**	**41.0**

Table C: **Enbridge Donaldson Pumping Station: Meas'd A-Wt. Sound Levels (Leq) and Unweighted O.B. SPLs at the Closest NSA and around Station Fenceline/Property as Meas'd on Nov. 1, 2013.**

Source No. & Dist (Ft)	Noise Sources and Other Conditions/Factors associated with Acoustical Analysis	PWL or SPL in dB Per Octave-Band Center Frequency (Hz) 31.5	63	125	250	500	1000	2000	4000	8000	A-Wt. Level
1)	PWL of Unenclosed Pumps & Piping	100	102	106	110	106	105	102	100	95	110
	Atten. of Noise Control (Pumphouse Bldg.)	-6	-10	-15	-20	-25	-28	-30	-32	-35	
	Misc. Atten. (Shielding or Ground Effect)	0	0	0	0	0	0	0	0	0	
1660	Hemispherical Radiation	-62	-62	-62	-62	-62	-62	-62	-62	-62	
1660	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	-1	-1	-2	-5	-13	-23	
1660	Source Sound Level Contribution	32	30	29	27	18	12	5	0	0	21
2)	PWL of Pumphouse Building Air Supply Fans	90	92	85	82	80	75	70	68	65	81
	Atten. of Additional Noise Control	0	0	0	0	0	0	0	0	0	
	Misc. Atten. (Shielding or Ground Effect)	0	0	0	0	0	0	0	0	0	
1660	Hemispherical Radiation	-62	-62	-62	-62	-62	-62	-62	-62	-62	
1660	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	-1	-1	-2	-5	-13	-23	
1660	Source Sound Level Contribution	28	30	23	19	17	10	3	0	0	18
3)	PWL of Electrical Equipment (VFD/Switchgear)	85	88	90	78	72	65	60	55	50	77
	Atten. of Additional Noise Control	0	0	0	0	0	0	0	0	0	
	Misc. Atten. (Shielding or Ground Effect)	0	0	0	0	0	0	0	0	0	
1660	Hemispherical Radiation	-62	-62	-62	-62	-62	-62	-62	-62	-62	
1660	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	-1	-1	-2	-5	-13	-23	
1660	Source Sound Level Contribution	23	26	28	15	9	0	0	0	0	14
4)	PWL of Outdoor Aboveground Piping	80	85	78	75	70	68	62	55	50	73
	Atten. of Additional Noise Control	0	0	0	0	0	0	0	0	0	
	Misc. Atten. (Shielding or Ground Effect)	0	0	0	0	0	0	0	0	0	
1660	Hemispherical Radiation	-62	-62	-62	-62	-62	-62	-62	-62	-62	
1660	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	-2	-1	-2	-5	-13	-23	
1660	Source Sound Level Contribution	18	23	16	11	7	3	0	0	0	10
Est'd Total Sound Contribution of Station at NSA #1		**34**	**34**	**32**	**28**	**21**	**15**	**8**	**0**	**0**	**23.6**

Est'd "Lowest" A-Wt. Sound Level per Recent Survey	**40.7**
Sound Level of L67 Station plus Current A-Wt. Sound Level	40.8
Potential Increase above Ambient Noise (dB)	0.1

Table D: Enbridge Donaldson Pumping Station: Est'd Sound Contribution of L67 Station at the Closest NSA (i.e., NSA #1; Residence located approx. 1,660 Ft. NW of L67 Pumphouse Bldg.) due to Operation of New L67 Station Motor-Driven Pumps. Included is the Potential Increase in the Existing Sound Level after Installation of the New L67 Station.

Source No. & Dist (Ft)	Noise Sources and Other Conditions/Factors associated with Acoustical Analysis	SPL in dB Per O.B. Center Frequency (Hz) 31.5	63	125	250	500	1000	2000	4000	8000	A-Wt. Level
	Est'd SPLs of Station at 1,660 Ft. (RE: Table D)	34	34	32	28	21	15	8	0	0	24
200	Hemisph Radiation [20*log(1660/200) = 18 dB]	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	
200	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	1	1	2	4	8	7	
Est'd Total Sound Contribution of L67 Station at N. Prop. Line		**52**	**52**	**50**	**47**	**40**	**35**	**31**	**26**	**25**	**43**

Est'd "Lowest" A-Wt. Sound Level per Recent Survey	**41.0**
Sound Level of L67 Station plus Current A-Wt. Sound Level	45.0

Table E: Enbridge Floodwood Pumping Station: Est'd Sound Contribution of Pump Station at the Closest Property Line to L67 Station (i.e., North Prop. Line; 200 Ft. from L67 Pumphouse Building) due to Operation of New L67 Station Motor-Driven Pumps. Also, Total Est'd Sound Level of the Station at the Closest Station Property Line after Installation of the New L67 Station.

ANALYSIS METHODOLOGY AND SOURCE OF SOUND DATA

In general, the predicted sound level contributed by the pumping station equipment was calculated as a function of frequency from estimated unweighted octave-band ("O.B.") sound power levels ("PWLs") for each significant sound source. The following summarizes the acoustical analysis procedure for the new L67 Pump Station:

- Initially, unweighted O.B. PWL values of the significant noise sources were determined from equipment manufacturer's sound data and/or actual sound level measurements performed by H&K at similar type of equipment/components expected for this facility.

- Then, expected noise reduction or attenuation in dB per O.B. frequency due to any noise control measures, hemispherical sound propagation (discussed in more detail below*) and atmospheric sound absorption (discussed in more detail below**) were subtracted from the unweighted O.B. PWLs to obtain the unweighted O.B. SPLs of each noise source. Since sound shielding by buildings and/or enclosures can influence the sound level contributed at the NSAs, we also included the sound shielding due to buildings, if appropriate. The sound attenuation effect due to foliage or land contour was not considered in the analysis since there is probably minimum attenuation due to foliage.

- Finally, the resulting estimated unweighted O.B. SPLs for all noise sources associated with the Station (with noise control and other sound attenuation effects) were logarithmically summed, and the total O.B. SPLs for all noise sources were corrected for A-weighting to provide the estimated overall A-wt. sound level contributed by the Station at the receptor/location. The predicted sound contribution of the Station at the Station property line/location was utilized to estimate the Station noise contribution at the closest NSAs.

*Attenuation due to hemispherical sound propagation: Sound propagates outwards in all directions (i.e., length, width, height) from a point source, and the sound energy of a noise source decreases with increasing distance from the source. In the case of hemispherical sound propagation, the source is located on a flat continuous plane/surface (e.g., ground), and the sound radiates hemispherically (i.e., outward, over and above the surface) from the sound source. The following equation is the theoretical decrease of sound energy when determining the resulting SPL values of a noise source at a specific distance ("r") of a receiver from the estimated PWL values:

> Decrease in SPL ("hemispherical propagation") from a noise source = **20*log(r) – 2.3 dB**
> where "r" is distance of the receiver from the noise source.

Attenuation due to air absorption: Air absorbs sound energy, and the amount of absorption ("attenuation") is dependent on the temperature and relative humidity (R.H.) of air and frequency of sound. For example, the attenuation due to air absorption for 1000 Hz O.B. SPL is approximately **1.5 dB per 1,000 feet for standard day conditions (i.e., no wind, 60 deg. F. and 70% or 50% R.H.).

The estimated unweighted O.B. PWLs of the motor-driven pumps, piping, substation equipment and any other site equipment were estimated from field sound measurements by H&K on similar equipment and/or from sound data provided by the equipment manufacturer.

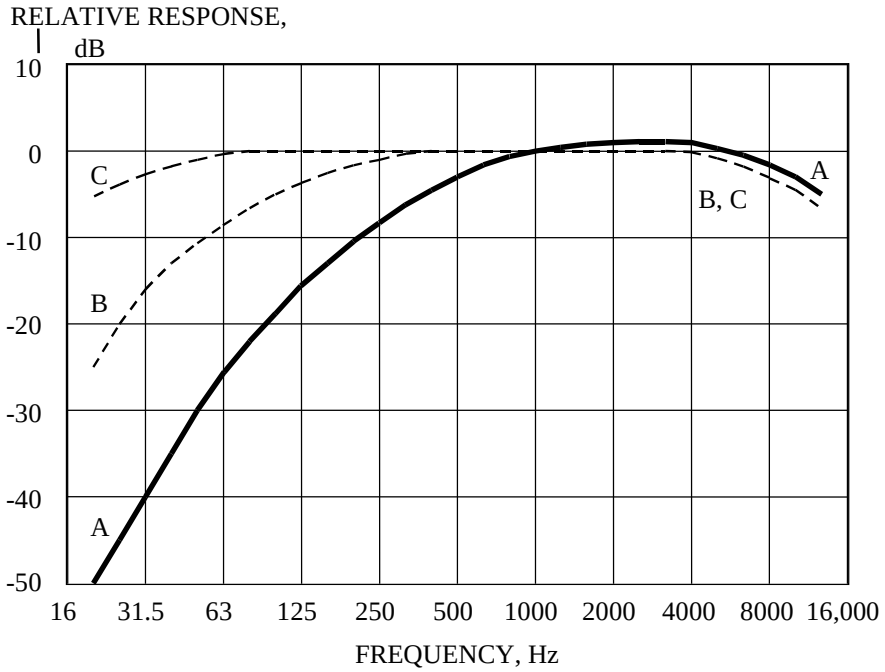
APPENDIX: Summary of Acoustical Terminology, Typical Metrics for Regulating Environmental Noise and Sound Levels for Typical Activities

(1) Decibel ("dB"): A unit for expressing the relative power level difference between acoustical or electrical signals. It is ten times the common logarithm of the ratio of two related quantities that are proportional to power. When adding dB or dBA values, the values must be added logarithmically. For example, the logarithmic addition of **35 dB** plus **35 dB** is **38 dB**.

(2) A-Weighted Sound Level ("dBA"): The A-wt. sound level is a single-figure sound rating, expressed in decibels (Re 20 μPa), which correlates to the human perception of the loudness of sound. The dBA level is commonly used to measure industrial and environmental noise since it is easy to measure and provides a reasonable indication of the human annoyance value of the noise. The dBA measurement is not a good descriptor of a noise consisting of strong low-frequency components or for a noise with tonal components.

The A-weighted curve approximates the response of the average ear at sound levels of 20 to 50 decibels. The following are the relative response of A-weighted filter per octave band frequency, and a graph/curve is provided that shows a graphical representation of the A-wt. filter response per frequency (in Hz).

31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1,000 Hz	2,000 Hz	4,000 Hz	8,000 Hz	16,000 Hz
-39.4 dB	-26.2 dB	-16.1 dB	-8.6 dB	-3.2 dB	0 dB	+1.2 dB	+1.0 dB	-1.1 dB	-6.6 dB



(3) Human Perception of Change in Sound Level

- A **3 dB** change of sound level is barely perceivable by the human ear
- A **5 or 6 dB** change of sound level is noticeable
- If sound level increases by **10 dB**, it appears as if the sound intensity has doubled.

(4) Background or Ambient Noise: The total noise produced by all other sources associated with a given environment in the vicinity of a specific source of interest, and includes any Residual Noise.

(5) Sound Pressure Level ("L_p or SPL"): Ten times the common logarithm to the base 10 of the ratio of the mean square sound pressure to the square of a reference pressure. Therefore, the sound pressure level is equal to 20 times the common logarithm of the ratio of the sound pressure to a reference pressure (20 micropascals or 0.0002 microbar).

(6) Octave Band SPL: Sound is typically measured in frequency ranges (e.g., high-pitched sound, low-pitched sound, etc.) that provides more meaningful sound data regarding the sound character of the noise. When measuring two noise sources for comparison, it is better to measure the spectrum of each noise, such as in octave band SPL frequency ranges. Then, the relative loudness of two sounds can be compared frequency range by frequency range. As an illustration, two noise sources can have the same dBA rating and yet sound completely different. For example, a high-pitched sound concentrated at a frequency of 2000 Hz could have the same dBA rating as a much louder low-frequency sound concentrated at 50 Hz.

(7) Daytime Sound Level ("L_d") & Nighttime Sound Level ("L_n"): L_d is the equivalent A-weighted sound level, in decibels, for a 15 hour time period, between 07:00 to 22:00 Hours (7:00 a.m. to 10:00 p.m.). L_n is the equivalent A-weighted sound level, in decibels, for a 9 hour time period, between 22:00 to 07:00 Hours (10:00 p.m. to 7:00 a.m.).

(8) Equivalent Sound Level ("L_{eq}"): The equivalent sound level (L_{eq}) can be considered an average sound level measured during a period of time, including any fluctuating sound levels during that period. In this report, the L_{eq} is equal to the level of a steady (in time) A-weighted sound level that would be equivalent to the sampled A-weighted sound level on an energy basis for a specified measurement interval. The concept of the measuring L_{eq} has been used broadly to relate individual and community reaction to aircraft and other environmental noises.

(9) L-Percent Sound Levels: The L percent levels (e.g., L_{50}, L_{90} & L_{10}) refer to the A-wt. sound levels that are exceeded for 90, 50 and 10 percent of the time, respectively, during a measurement period. For example, the 90-percentile exceeded sound level, designated to as L_{90}, is the A-wt. sound levels that are exceeded for 90 percent of the time and is considered the typical lowest anticipated sound levels. The range between the L_{10} and L_{90} values usually provides a good indication of the variability of the sound levels during the period of measurement.

(10) Sound Level Meter ("SLM"): An instrument used to measure sound pressure level, sound level, octave-band SPL, or peak sound pressure level, separately or in any combinations thereof. The measured weighted SPL (i.e., A-Wt. Sound Level or dBA) is obtained by the use of a SLM having a standard frequency-filter for attenuating part of the sound spectrum.

(11) Sound Power Level ("L_W or PWL"): Ten times the common logarithm of the ratio of the total acoustic power radiated by a sound source to a reference power. A reference power of a picowatt or 10^{-12} watt is conventionally used.

(12) Tone: A tone is a sound sensation-having pitch, which is a listener's perception of the frequency (for example, the higher the frequency, the higher the pitch). For a measured sound spectrum, a tone is represented as a "peak" in the spectrum curve. Noise that contains significant tones is considered a tonal type of noise.

(13) List of Common Environmental (i.e., Man-Made & Natural) Noise Sources: For reference, the following **Table** presents a list of some common environmental (i.e., man-made and natural) noise sources as compared to the estimated sound level of the pumping station at the closest NSAs. Note that inside a typical house, the noise level of an outdoor noise source is approximately **15 to 20 dB** quieter (i.e., house typically provides at least **15 to 20 dB** noise reduction).

Type of Noise Source	Approx. A-Wt. Sound Level	Approximate Distance To Noise Source
Lawn mower (outdoor)	50 – 55 dBA	150 to 200 feet
Passenger cars @ 50 – 60 mph (outdoor)	50 – 55 dBA	250 to 300 feet
Residential AC unit (outdoor)	50 – 60 dBA	40 to 50 feet
Residential AC unit (outdoor)	35 – 45 dBA	200 to 250 feet
Chemical plant (outdoor)	40 – 50 dBA	½ mile from plant
Cicadas (outdoor, summertime @ night)	50 – 55 dBA	General area of insects
Window AC unit (indoor)	50 – 60 dBA	5 to 20 feet
TV @ normal listening level (indoor)	60 – 70 dBA	10 to 15 feet
Vacuum cleaner (indoor)	70 – 75 dBA	10 to 15 feet

List of Some Common Environmental Noise Sources compared to Station Sound Level at Closest NSAs

End of Report

Appendix M.2

Plummer Pumping Station

PLUMMER PUMPING STATION
(RED LAKE COUNTY, MINNESOTA)

RESULTS OF A NOISE IMPACT ANALYSIS OF A NEW L67 PUMP STATION AT THE EXISTING PLUMMER PUMP STATION ASSOCIATED WITH THE ENBRIDGE MAINLINE EXPANSION ("MLE") PHASE II PROJECT

H&K Report No. 2956

H&K Job No. 4707

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REPORT SUMMARY

This report includes the results of a noise impact analysis of a new pumping station for Line 67 ("L67 Pump Station" or "L67 Station") at the existing **Plummer (MN) Pumping Station** ("Station") associated with the **Enbridge Energy Mainline Expansion ("MLE") Phase II Project** ("Project" or "MLE Ph II Project"). The purpose of the noise impact analysis is to project the sound contribution of the Plummer Pumping Station (referred to as "Station" in the report) and compare the results of the noise assessment to applicable sound criteria and/or proposed noise level guideline. In addition, the results of a recent "pre-construction" sound survey at the Plummer Station are included.

The following table summarizes the measured sound level environment around the Station (i.e., Leq) at the nearby noise-sensitive areas ("NSAs", such as residences) and the estimated sound contribution of the Plummer Station after installation of the new L67 Station at the Plummer Station along with the potential increase in the existing sound level at the nearby NSAs after installation of the new L67 Pump Station. The results in this table are defined as the "Noise Quality Analysis".

Noise Quality Analysis for Plummer Pumping Station (Sound Level Contribution of the Station at the Closest NSA(s) after Installation of New L67 Station and Potential Increase above Existing Sound Level)

Closest NSA(s) and Type of NSA	Distance & Direction of NSA to Station Site Center	Distance & Direction of NSA to New L67 Pump Station	Est'd "Lowest" A-Wt. Sound Level (Leq) based on Recent Survey	Est'd Sound Contribution of New L67 Pump Station	Est'd Sound Level of new L67 Station plus Existing Sound Level	Potential Noise Increase
NSA #1 (Residence)	1,475 feet (WSW)	1,300 feet (SSW)	34.8 dBA	25.9 dBA	35.3 dBA	0.5 dB
NSA #2 (Residence)	1,350 feet (east)	2,150 feet (ESE)	32.7 dBA	21.0 dBA	33.0 dBA	0.3 dB

The results of the recent sound survey and acoustical analysis of the planned new L67 Station at the Station indicates the following:

- Sound level contribution of the existing Plummer Pumping Station during operation complies with the MPCA Standard (< **50 dBA** at nighttime) at the surrounding NSAs (i.e., residences);

- Estimated total sound level contribution of the modified Station (i.e., addition of the new L67 Pump Station plus the current sound level of the existing Station) should comply with the MPCA Standard (< **50 dBA** at nighttime); and

- Potential noise increase in the "pre-existing" sound level due to the planned Station modifications should be less than **3 dB** at the nearby NSAs (i.e., residences). Consequently, the noise of the Station modifications may be perceivable by the human ear but should have minimum impact on the surrounding acoustical environment.

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FIGURES/DRAWINGS, SOUND DATA AND ACOUSTICAL ANALYSES

1.0 INTRODUCTION

In this report, **Hoover & Keith Inc.** ("H&K") presents the results of a noise impact analysis of the new pumping station for Line 67 ("L67 Pumping Station" or "L67 Station") at the existing **Plummer (MN) Pumping Station** (referred to as "Station" in the report) associated with the **Enbridge Energy Mainline Expansion ("MLE") Project** ("Project" or "MLE Ph. II Project"). The purpose of the noise impact analysis is to estimate the sound contribution of the Station at the property line and at nearby noise-sensitive areas ("NSAs"), such as residences, due to the installation of the new L67 Station. The results of the noise assessment are then compared to applicable noise regulations and/or a proposed noise level guideline. In addition, the results of a recent "pre-construction" sound survey at the Station during operation are included.

2.0 BRIEF DESCRIPTION OF THE STATION/EQUIPMENT

Figure 1 (p. 7) shows an area layout around the Station showing the surrounding and nearest NSAs (i.e., residences) and the reported sound measurement positions near the closest NSAs. The Plummer Station is located along CR-1 in Red Lake County, Minnesota, 1 mile east-southeast of Plummer, MN. The closest residences to the Station, identified as "NSA #1" and "NSA #2", are located approximately 1,475 feet and 1,350 feet from the Station site center.

Figure 2 (p. 8) provides a layout of existing buildings/equipment, Station fenceline (i.e., property line) and reported sound measurement positions around the Station. **Figure 3** (p. 9) provides the anticipated location of equipment for new L67 Station. For reference, **Figure 4** (p. 10) provides a photo showing buildings/equipment from the East Side of the Station. The following **Table 1** lists the existing pumping stations located within the property of the Plummer Pumping Station along with a list of associated pumping units/horsepower ("HP"). Pumps for each respective site pump station are enclosed inside respective buildings (i.e., L2 Pumphouse Building, L3 Pumphouse Building, L4 Pumphouse Building and L65 Pumphouse Building).

Station & associated Line Number	Unit Number	Rated HP
Station 2 ("L2 Station"); station that serves Line No. 2	2-U-1	2,000 HP
	2-U-2	2,000 HP
	2-U-3	2,000 HP
Station 3 ("L3 Station"); station that serves Line No. 3	3-U-1	3,500 HP
	3-U-2	3,500 HP
	3-U-3	3,500 HP
Station 4 ("L4 Station"); station that serves Line No. 4	4-U-1	5,000 HP
	4-U-2	5,000 HP
	4-U-3	5,000 HP
Station 65 ("L65 Station"); station that serves Line No. 65	65-U-1	2,000 HP
	65-U-2	2,000 HP
	65-U-3	2,500 HP

Table 1: Summary of the Stations and associated Pump Units at the Plummer Pumping Station

Station Modifications for the Project: The new L67 Station will be installed at the Station, which will serve Line 67, and currently there are no pumps associated with Line 67 at the Station. The new L67 Station will be designed with three (3) 6,000 HP electric motor-driven pumps, an electrical substation that serves the L67 pumps, and a Variable Frequency Drive ("VFD") Building ("VFD Building") along with an adjacent Electrical Service Building ("ESB" or "Switchgear Bldg."). The motors/pumps of L67 Station motor-driven pumps/piping will be located inside a metal building ("L67 Pumphouse Building"), and VFD Building/ESB will be "modular-type" buildings.

3.0 ACOUSTICAL TERMINOLOGY AND SOUND CRITERIA

3.1 Acoustical Terminology and Example of Typical Environmental Sound Levels

For the reader's information, a summary of acoustical terminology and list of typical metrics used to measure/regulate environmental noise is provided in the **Appendix** (pp. 16–18). There are several metrics for quantifying and regulating environmental noise level although the most common metric used by state and municipal agencies is the A-wt. sound level ("dBA"). There are also other metrics, such as L_{eq} and day-night average sound level ("L_{dn}"), that are used to correlate human reaction to an intruding sound. In addition, to gain an understanding and comparison of the predicted Station noise level, a Table is provided in the **Appendix** (p. 18) that shows a list of some common environmental noise sources.

3.2 State of Minnesota and Local Noise Regulations

The Minnesota Pollution Control Agency ("MPCA") has a receiver-based standard intended to limit noise levels and to protect the health and welfare of the general public, as included in the *Noise Rules and Statutes* (MPCA Standards). In general, the MPCA Standard limits the sound contribution from a facility to a receiver according to land activities by the noise area classification ("NAC") system established in the MPCA Standard, as follows:

Noise Area Classification (NAC)	Daytime (dBA)		Nighttime (dBA)	
	L50	L10	L50	L10
1 (e.g., residence, church)	60	65	50	55
2 (e.g., commercial business)	65	70	65	70
3 (e.g., pumping station)	75	80	75	80

Notes:

1. The worst case MPCA Standard for the Alberta Clipper Project is for land activities within NAC Group 1, which includes residences (i.e., NSAs).
2. The L50 is the sound level in dBA which is exceeded 50% of the time for a one hour measurement. The L10 is the sound level in dBA which is exceeded 10% of the time for a 1-hour measurement (i.e., sound levels are known as exceedence levels).
3. Daytime is defined as the hours from 7:00 AM to 10:00 PM. Nighttime is defined as the hours from 10:00 PM to 7:00 AM.

The MPCA Standard states that a one-hour measurement period is to be utilized for verification of the L10 and L50 requirements. However, a typical pump station will have an essentially constant sound level which is mostly dependent upon the number of pump units operating to meet flow requirements. Therefore, it is not necessary to perform a one-hour measurement to determine the sound level contribution of a pump station at an adjacent NSA, as the sound level is essentially constant. In addition, a much shorter duration measurement can permit the sound level contribution of the nearby pump station for an NSA to be isolated from other potential sound sources, or to document a representative background ambient sound level at an NSA where the facility is not audible. For the reasons above, H&K has utilized shorter term measurements to document the sound level contribution of a Station at the nearby NSAs. Our measurement approach was confirmed with a representative at the MPCA. We are not aware of any local and/or county noise regulations that are applicable to the Station.

3.3 Discussion of the Noise Impact of a New Pump Station

This section provides a proposed "noise level guideline" that could be utilized for a pump station, as related to the potential noise impact at any NSA due to the installation of L67 Station at the Station. If an intruding noise (e.g., noise generated by new L67 Station) causes less than a **3 dB** increase in the overall ("pre-existing") sound level at the surrounding NSAs (i.e., defined as "potential noise increase"), the Station noise should be barely perceivable by the human ear and should have minimum impact on the acoustical environment. If the intruding noise causes an increase in the sound level of between **4 dB** and **6 dB**, the increase of Station noise may be audible by the human ear but should still have minimum impact on the environment.

4.0 MEASUREMENT LOCATIONS, METHODOLOGY AND MEASUREMENT RESULTS

4.1 Sound Measurement Locations, Data Acquisition and Station Operating Conditions

During the recent sound survey, daytime sound levels (i.e., Ld) was measured near the closest NSAs, and sound levels were measured around the Station fenceline (i.e., property line). The following is a description of the identified closest NSAs and reported sound measurement positions during the recent sound survey:

Pos. 1: "NSA #1"; Residence approx. 1,475 feet WSW of the Station site center and approx. 1,300 feet SSW from the new L67 Pumphouse Building for new L67 Station;
Pos. 2: "NSA #2"; Residence approx. 1,350 feet east of the Station site center and approx. 2,150 feet ESE from the new L67 Pumphouse Building for new L67 Station;
Pos. 3: North fenceline of the Station (near CR-1);
Pos. 4: East fenceline of the Station, in line with L3 Pump Building;
Pos. 5: South fenceline of the Station, in line with L3 Pump Building;
Pos. 6: West fenceline of the Station, in line with L3 Pump Building; and
Pos. 7: NE corner of the Station, near the Main Entrance Gate.

Sound measurements were performed by Paul Kiteck of H&K during the daytime (afternoon) of October 31, 2013. At each sound measurement position, the equivalent A-wt. sound level (i.e., L_{eq}) and unweighted octave-band ("O.B.") sound pressure levels ("SPLs") were measured at 5 feet above ground. Typically, several sample periods of the ambient noise were measured at each NSA sound measurement position (e.g., 5 to 20 minutes in length). Sound measurements attempted to exclude "extraneous sound" such as cars or trucks passing immediately by the measurement location or other intermittent sources not typical of the ambient noise environment. The sound measurement system consisted of a Larson-Davis ("LD") Model 2900 Real Time Analyzer/SLM (a Type I SLM per ANSI Standard S1.4 & S1.11) with a 1/2-in. LD condenser microphone covered by a windscreen, and the analyzer/SLM was calibrated with a LD Model CA250 microphone calibrator that was calibrated within one (1) year of the test date.

Conditions: During the sound survey tests, Unit 2-U-2 (L2 Station), Unit 3-U-3 (L3 Station) and Units 4-U-2 & 4-U-4 (L4 Station) were operating at full capacity along with substation equipment (e.g., transformers) and respective VFDs. Pumps for L65 Station were not operating.

4.2 Results of the Sound Survey and Observations

Table A (p. 11) summarizes the measured daytime Leq (i.e., Ld) at the sound measurement locations near surrounding NSAs along with the average of the measured Ld. In addition, **Table A** includes the resulting Ldn, as calculated from the measured Ld along with the observations during the sound survey regarding contributors to the measured sound levels. Meteorological conditions during the sound survey are summarized in **Table B** (p. 11). The measured ambient daytime A-wt. sound levels and associated unweighted ambient O.B. SPLs during the sound survey at all reported sound measurement positions are provided in **Table C** (p. 12).

The following **Table 2** summarizes the measured daytime A-wt. sound level and the estimated nighttime A-wt. sound level at the closest NSA(s) during the Station operating conditions that occurred during the sound survey.

Meas. Pos.	Description of the Sound Measurement Location	Meas'd Daytime A-Wt. Sound Level	Est'd Nighttime A-Wt. Sound Level
Pos. 1	NSA #1: Residence approx. 1,475 ft. WSW of Station site center	37.8 dBA	34.8 dBA
Pos. 2	NSA #1: Residence approx. 1,350 ft. east of Station site center	37.7 dBA	32.7 dBA

Table 2: Summary of the Meas'd Daytime A-Wt. Sound Level and Est'd Nighttime A-Wt. Sound Level near the Closest NSA(s) during Station Operation.

During sound tests at NSA #1 (i.e., Pos. 1), the noise of the Station was not audible (i.e., Station noise did not contribute to the measured A-wt. sound levels), and the noise sources that contributed to the measured A-wt. sound level at NSA #1 was the noise of distant vehicle traffic (Hwy. 59) and the noise associated with operations at the Red River Grain Plant. At NSA #2 (i.e., Pos. 2), the noise of the Station was audible and considered to be a significant noise source (i.e., Station noise contributed to the measured A-wt. sound levels). At NSA #2, the noise of distant vehicle traffic (Hwy. 59) was also audible and contributed to the measured A-wt. sound levels. It

is our opinion, the nighttime sound levels could be lower than the daytime sound levels since there would be less vehicle traffic. Consequently, estimated nighttime sound levels were also included in the summary of the sound data (i.e., **Table A**).

At the sound measurement positions around the Station fenceline (i.e., Pos. 3, 4, 5, 6 & 7), the noise generated by the Station was the most dominant noise sources, which would be expected since these measurement positions are relatively close to the Station equipment.

5.0 ACOUSTICAL ASSESSMENT

The noise assessment considers the noise produced by all equipment that could contribute to the noise generated by new L67 Station, based on the current design and the anticipated noise-generating equipment in the area of the new electric motor-driven pumps for the new L67 Station (i.e., L67 Pumphouse Building). A description of the acoustical assessment methodology of new L67 Station and source of sound data are provided toward the end of the report (p. 15).

The predicted sound contribution of new L67 Station was performed at the closest residence (i.e., NSA #1 & NSA #2) and at the "closest" property line to the new L67 Station (i.e., south property line of new L67 Station) since the sound contribution at other Station property lines and at more distant residences should be lower than the estimated sound contribution at the closest property line for L67 Station and at the closest residence(s). For the noise assessment of the Station, the following equipment were considered significant and potential noise sources:

- Noise of electric motor-driven product pumps/piping inside L67 Pumphouse Building;
- Noise of the air-supply fans ("building cooling fans") for L67 Pumphouse Building;
- Noise associated with the electrical substation (e.g., transformers, etc.); and
- Noise associated with the VFD Building and ESB consisting primarily the noise generated by the VFD air exhaust system and noise of "wall-mounted" AC units.

Table D (p. 13) shows the spreadsheet calculation of the estimated A-wt. sound level and unweighted O.B. SPLs contributed by the new L67 Station at NSA #1 for standard day propagating conditions (i.e., no wind, 60 deg. F., 70% R.H.). In addition, **Table D** includes estimated total sound level at NSA #1 after installation of the new L67 Station (i.e., sound level of L67 Station plus the "lowest" existing sound level, which is the estimated nighttime sound level), and the estimated potential increase in the existing sound level at NSA #1 as a result of the installation and operation of the new L67 Pump Station.

Table E (p. 14) provides the estimated A-wt. sound level and unweighted O.B. SPLs of the new L67 Station at NSA #2 based on the estimated Station sound level contribution in **Table D**. In addition, **Table E** includes estimated total sound level at NSA #2 after installation of the L67 Station and the estimated potential increase in the existing sound level at NSA #2 as a result of the installation of Station modifications.

For reference, **Table F** (p. 14) provides the estimated A-wt. sound level of new L67 Station at the "closest" property line of new L67 Station (i.e., south property line of new L67 Station) based on the estimated sound level contribution of L67 Station in **Table D**.

6.0 SUMMARY AND FINAL COMMENT

The following **Table 3** summarizes the measured noise environment around the Station (i.e., estimated "lowest" A-wt. sound level at the closest NSA) via the recent pre-construction sound survey, the estimated sound contribution of the new L67 Station at the closest NSAs (i.e., residences) and the estimated total sound level of the Station after installation of new L67 Station along with the potential increase in the existing sound level at the closest NSA(s) after installation of new L67 Station. The results in this table are defined as the "Noise Quality Analysis".

Closest NSA(s) and Type of NSA	Distance & Direction of NSA to Station Site Center	Distance & Direction of NSA to New L67 Pump Station	Est'd "Lowest" A-Wt. Sound Level (Leq) based on Recent Survey	Est'd Sound Contribution of New L67 Pump Station	Est'd Sound Level of new L67 Station plus Existing Sound Level	Potential Noise Increase
NSA #1 (Residence)	1,475 feet (WSW)	1,300 feet (SSW)	34.8 dBA	25.9 dBA	35.3 dBA	0.5 dB
NSA #2 (Residence)	1,350 feet (east)	2,150 feet (ESE)	32.7 dBA	21.0 dBA	33.0 dBA	0.3 dB

Table 3: Noise Quality Analysis for the Plummer Pumping Station related to Installation of L67 Station

The results of the recent sound survey and acoustical analysis of the planned new L67 Station pump units at the Station indicates the following:

- Sound level contribution of the existing Plummer Pump Station during operation complies with the MPCA Standard (< **50 dBA** at nighttime) at the surrounding NSAs;
- Estimated total sound level contribution of the modified Station (i.e., addition of the new L67 Station pump units plus the current sound level of the existing Station) should comply with the MPCA Standard (< **50 dBA** at nighttime);
- Potential noise increase in the "pre-existing" sound level due to the planned Station modifications should be less than **3 dB** at the nearby NSAs (i.e., residences). Consequently, the noise of the Station modifications may be perceivable by the human ear but should have minimum impact on the surrounding acoustical environment; and
- In addition, the acoustical analysis also estimates that the A-wt. sound level at the property line of new L67 Station will be equal to or less than **48 dBA**.

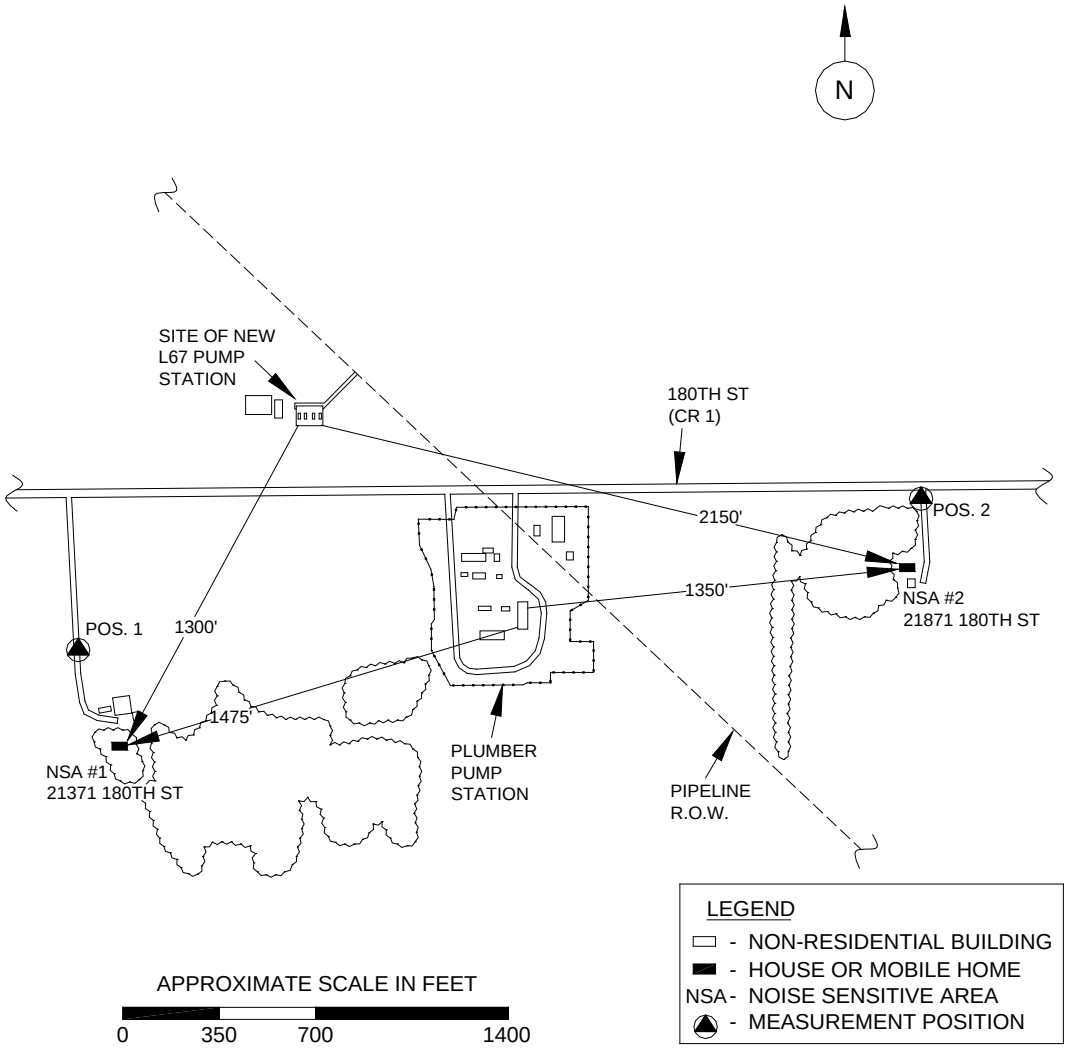


Figure 1: Enbridge Plummer Pumping Station: Area Layout showing the Closest NSAs (i.e., Residences) and Reported Sound Measurement Positions near the Closest NSAs.

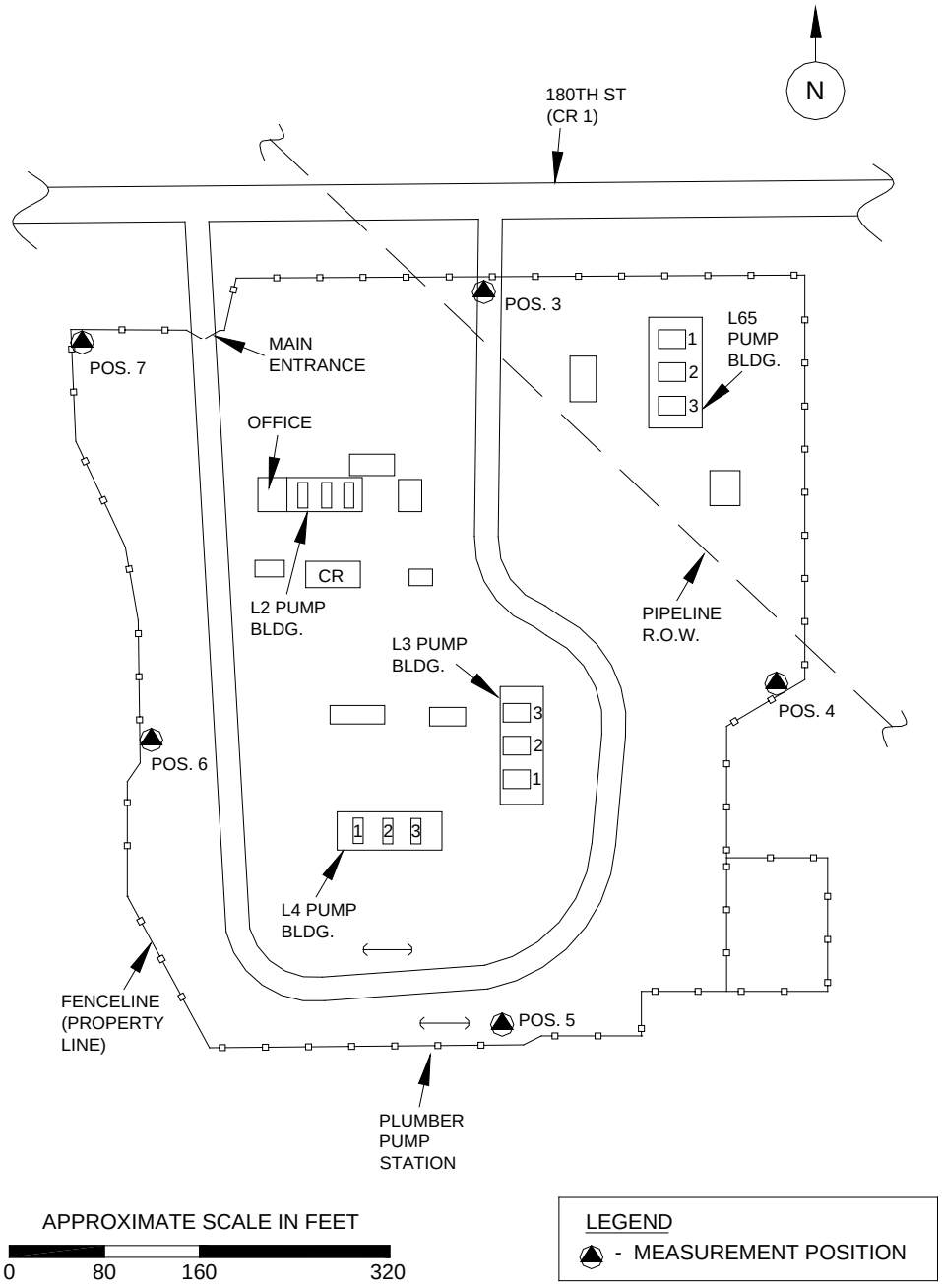


Figure 2: Enbridge Plummer Pumping Station: Layout of the Existing Station along with the Location of Reported Sound Measurement Positions around the Station Property.

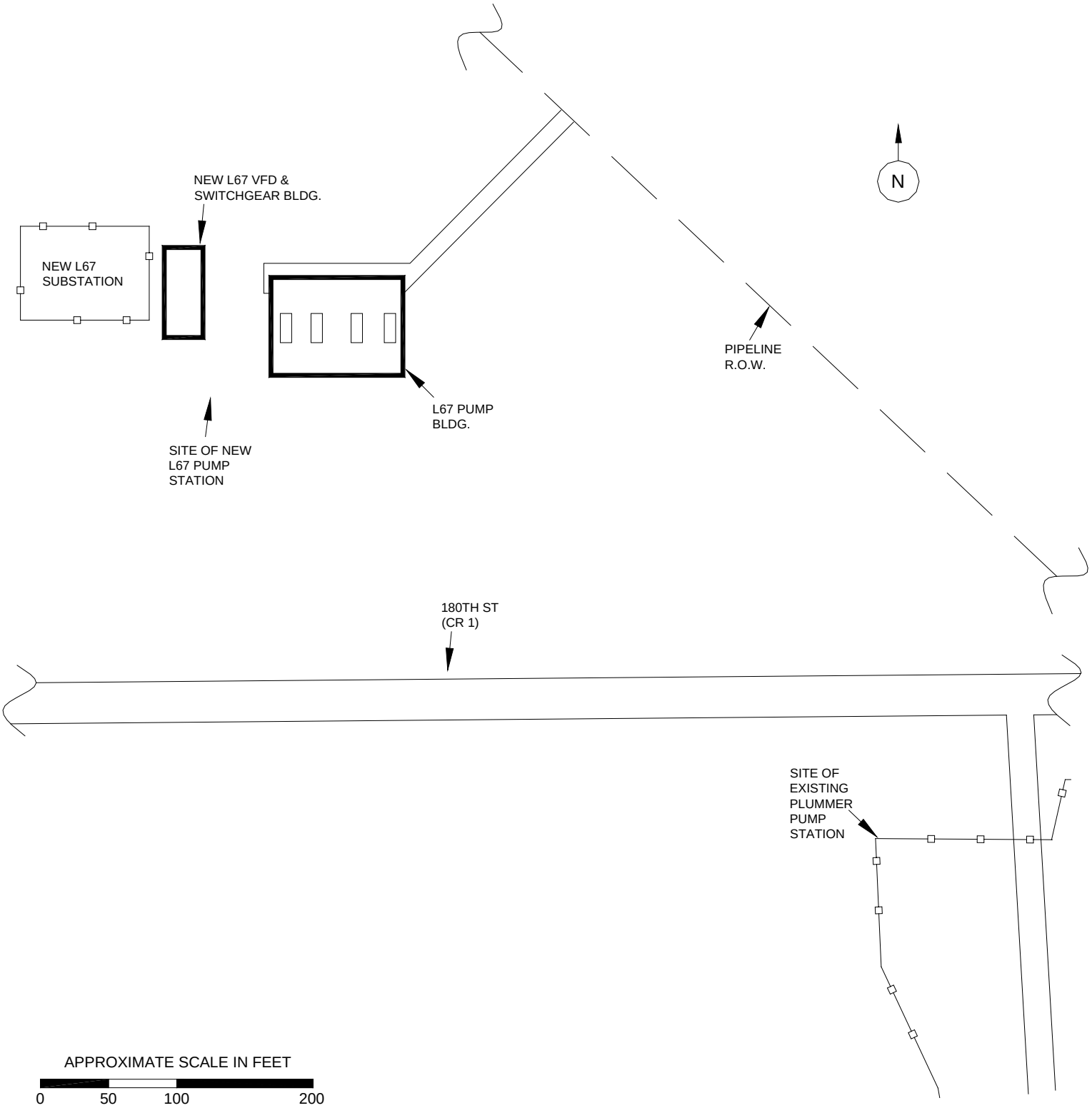


Figure 3: Enbridge Plummer Pumping Station: Layout of the Conceptual Layout (Plot Plan) of Buildings/Equipment associated with new L67 Station.

Figure 4: Enbridge Plummer Pumping Station: Photo showing Buildings and Equipment/Piping (i.e., L65 & L3 Pump Buildings shown in the Foreground of Photo) from Viewpoint of the East Side of the Station (near Meas. Pos. 2).

Measurement Set		Meas'd/Calc'd A-Wt. Sound Levels (dBA)					
		Day-time	Avg'd of		Night-time	Calc'd Ldn	
Meas. Position	**Time of Test**	Leq(Ld)	Ld		Leq(Ln)	Note (1)	**Notes/Observations**
Pos. 1 (NSA #1)	12:30 PM	36.3					Station noise was not audible. Noise of distant
Residence located	12:42 PM	38.7	**37.8**		**34.8**	**41.8**	traffic along Hwy. 59 was dominant noise source.
WSW of Station, on	12:55 PM	39.5			Note (1)	Note (2)	Also, noise of Red River Grain Plant was
south side of 180th St.							audible.
Pos. 2 (NSA #2)	1:05 PM	40.1					Noise of station was audible and significant
Residence located	1:12 PM	37.2	**37.7**		**32.7**	**40.2**	noise source. Also, noise of distant vehicle
east of Station, on	1:25 PM	36.0			Note (1)	Note (2)	noise contributed to A-wt. sound level.
south side of 180th St.							

Table A: **Enbridge Plummer Pumping Station: Summary of the Meas'd Daytime Leq (i.e., Ld) at the Closest NSAs as Meas'd on October 31, 2013 during Station Operation along with the Resulting Ldn, as Calc'd via the Meas'd Ld.**

Note (1): Although nighttime levels (Ln) were not measured, the ambient nighttime A-wt. sound level (Ln) should be slightly lower (i.e., approximately 3 to 5 dB lower) than the measured ambient daytime sound levels (Ld).

Note (2): If only the daytime Leq (i.e., Ld) is measured, the Ldn is calculted by adding 6.4 dB to the meas'd Ld. If both Ld and Ln are measured and/or estimated, Ldn is calculated using the following formula:

$$L_{\mathrm{dn}} = 10\log_{10}\left(\frac{15}{24}10^{L_{\mathrm{d}}/10} + \frac{9}{24}10^{(L_{\mathrm{n}}+10)/10}\right)$$

Operating Conditions of Station Equipment during the Sound Survey:
> Unit #2 of Line #2 was operating at full speed;
> Unit #3 of Line #3 was operating at full speed;
> Units #2 & #3 of Line #4 were operating at full speed;
> Units of Line #65 were not operating.

Measurement Set		Temp.	R.H.	Wind	Wind	Peak	
Meas. Pos.	**Time Frame of Tests**	**(°F)**	**(%)**	**Direction**	**Speed**	**Wind**	**Sky Conditions**
Meas. Pos. 1 to 7	12:30 PM to 2:30 PM	40 - 42	45 - 50	Light wind from the west	1 - 3 mph	3 - 5 mph	Overcast

Table B: **Enbridge Plummer Pumping Station: Summary of the Meteorological Conditions during the Sound Survey Measurements on October 31, 2013.**

Measurement Set		Sound Pressure Level (SPL) in dB per Octave-Band Frequency (in Hz)									A-Wt.
Meas. Position	**Time of Test**	**31.5**	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	**Level**
Pos. 1 (NSA #1)	12:30 PM	50.0	55.0	41.0	32.0	33.7	31.0	24.0	20.0	21.0	36.3
Residence located	12:42 PM	48.0	51.2	45.0	30.0	34.0	36.0	27.6	20.0	20.8	38.7
WSW of Station, on	12:55 PM	49.0	50.5	46.5	27.0	31.5	37.5	28.0	20.2	21.0	39.5
south side of 180th St.											
	Average SPL	**49.0**	**52.2**	**44.2**	**29.7**	**33.1**	**34.8**	**26.5**	**20.1**	**20.9**	**37.8**
Pos. 2 (NSA #2)	1:05 PM	50.2	47.0	38.2	29.7	37.0	36.0	34.0	21.0	21.0	40.1
Residence located	1:12 PM	51.5	47.7	37.3	28.5	35.4	33.0	28.0	21.0	21.8	37.2
east of Station, on	1:25 PM	52.5	49.0	37.2	28.0	33.0	31.5	28.3	21.3	21.7	36.0
south side of 180th St.											
	Average SPL	**51.4**	**47.9**	**37.6**	**28.7**	**35.1**	**33.5**	**30.1**	**21.1**	**21.5**	**37.7**
Pos. 3	1:35 PM	57.0	55.0	54.5	50.6	43.7	42.2	45.0	33.0	27.0	49.7
North fenceline of	1:37 PM	54.0	52.3	54.3	50.0	42.5	41.0	43.0	32.7	24.0	48.4
the Station											
	Average SPL	**55.5**	**53.7**	**54.4**	**50.3**	**43.1**	**41.6**	**44.0**	**32.9**	**25.5**	**49.0**
Pos. 4	1:45 PM	57.0	55.6	58.7	48.5	45.3	46.3	48.4	34.0	28.0	52.5
East fenceline of	1:48 PM	57.3	55.0	58.8	48.0	45.4	46.0	46.4	38.0	31.0	51.7
Station, in line with											
Station 3 Pump Bldg.	**Average SPL**	**57.2**	**55.3**	**58.8**	**48.3**	**45.4**	**46.2**	**47.4**	**36.0**	**29.5**	**52.1**
Pos. 5	1:55 PM	56.0	54.0	56.5	46.0	42.6	43.3	43.0	34.0	27.0	48.8
South fenceline of the	1:57 PM	56.0	53.8	56.3	46.0	41.8	42.8	47.0	34.0	24.3	50.4
Station, in line with											
Stat 3 & 4 Pump Bldgs.	**Average SPL**	**56.0**	**53.9**	**56.4**	**46.0**	**42.2**	**43.1**	**45.0**	**34.0**	**25.7**	**49.5**
Pos. 6	2:00 PM	60.6	65.6	66.0	54.0	49.0	46.2	47.0	38.0	28.0	54.7
West fenceline of the	2:03 PM	62.0	55.0	54.7	52.0	49.4	47.4	48.5	38.0	33.0	53.5
Station, in line with											
Station 3 Pump Bldg.	**Average SPL**	**61.3**	**60.3**	**60.4**	**53.0**	**49.2**	**46.8**	**47.8**	**38.0**	**30.5**	**53.6**
Pos. 7	2:15 PM	52.4	52.8	51.4	44.0	40.0	41.0	37.0	29.5	27.0	45.1
NW corner of station	2:20 PM	52.8	52.0	51.6	44.7	41.2	38.8	36.4	27.7	23.0	44.5
fencelilne, near											
station entrance gate	**Average SPL**	**52.6**	**52.4**	**51.5**	**44.4**	**40.6**	**39.9**	**36.7**	**28.6**	**25.0**	**44.8**

Table C: **Enbridge Plummer Pumping Station: Meas'd A-Wt. Sound Levels (Leq) and Unweighted O.B. SPLs at the Closest NSAs and around Station Fenceline/Property as Meas'd on Oct. 31, 2013.**

Source No. & Dist (Ft)	Noise Sources and Other Conditions/Factors associated with Acoustical Analysis	PWL or SPL in dB Per Octave-Band Center Frequency (Hz) 31.5	63	125	250	500	1000	2000	4000	8000	A-Wt. Level
1)	PWL of Unenclosed Pumps & Piping	100	102	106	110	106	105	102	100	95	110
	Atten. of Noise Control (Pumphouse Bldg.)	-6	-10	-15	-20	-25	-28	-30	-32	-35	
	Misc. Atten. (Shielding or Ground Effect)	0	0	0	0	0	0	0	0	0	
1300	Hemispherical Radiation	-60	-60	-60	-60	-60	-60	-60	-60	-60	
1300	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	-1	-1	-2	-4	-10	-18	
1300	Source Sound Level Contribution	34	32	31	30	20	15	8	0	0	24
2)	PWL of Pumphouse Building Air Supply Fans	90	92	85	82	80	75	70	68	65	81
	Atten. of Additional Noise Control	0	0	0	0	0	0	0	0	0	
	Misc. Atten. (Shielding or Ground Effect)	0	0	0	0	0	0	0	0	0	
1300	Hemispherical Radiation	-60	-60	-60	-60	-60	-60	-60	-60	-60	
1300	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	-1	-1	-2	-4	-10	-18	
1300	Source Sound Level Contribution	30	32	25	22	19	13	6	0	0	20
3)	PWL of Electrical Equipment (VFD/Switchgear)	85	88	90	78	72	65	60	55	50	77
	Atten. of Additional Noise Control	0	0	0	0	0	0	0	0	0	
	Misc. Atten. (Shielding or Ground Effect)	0	0	0	0	0	0	0	0	0	
1300	Hemispherical Radiation	-60	-60	-60	-60	-60	-60	-60	-60	-60	
1300	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	-1	-1	-2	-4	-10	-18	
1300	Source Sound Level Contribution	25	28	30	18	11	3	0	0	0	16
4)	PWL of Outdoor Aboveground Piping	80	85	78	75	70	68	62	55	50	73
	Atten. of Additional Noise Control	0	0	0	0	0	0	0	0	0	
	Misc. Atten. (Shielding or Ground Effect)	0	0	0	0	0	0	0	0	0	
1300	Hemispherical Radiation	-60	-60	-60	-60	-60	-60	-60	-60	-60	
1300	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	-2	-1	-2	-4	-10	-18	
1300	Source Sound Level Contribution	20	25	18	13	9	6	0	0	0	12
Est'd Total Sound Contribution of Station at NSA #1		**36**	**36**	**34**	**30**	**23**	**18**	**11**	**0**	**0**	**25.9**

Est'd "Lowest" A-Wt. Sound Level per Recent Survey	**34.8**
Sound Level of L67 Station plus Current A-Wt. Sound Level	35.3
Potential Increase above Ambient Noise (dB)	0.5

Table D: Enbridge Plummer Pumping Station: Est'd Sound Contribution of L67 Station at the Closest NSA (i.e., NSA #1; Residence located approx. 1,300 Ft. SW of L67 Pumphouse Bldg.) due to Operation of New L67 Station Motor-Driven Pumps. Included is the Potential Increase in the Existing Sound Level after Installation of the New L67 Station.

Note: Equipment PWL values on this spreadsheet should not be used as the specified values. Refer to "Noise Control Measures" section in noise report or company specifications for actual specified values.

Source No. & Dist (Ft)	Noise Sources and Other Conditions/Factors associated with Acoustical Analysis	SPL in dB Per O.B. Center Frequency (Hz) 31.5	63	125	250	500	1000	2000	4000	8000	A-Wt. Level
	Est'd SPLs of Station at 1300 Ft. (RE: Table D)	36	36	34	30	23	18	11	0	0	25.9
2150	Hemisph Radiation [20*log(2150/1300) = 4.4 dB]	-4.4	-4.4	-4.4	-4.4	-4.4	-4.4	-4.4	-4.4	-4.4	
2150	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	0	-1	-1	-3	-6	-12	
Est'd Total Sound Contribution of Station at NSA #2		**31**	**32**	**29**	**26**	**18**	**12**	**4**	**0**	**0**	**21.0**

Est'd "Lowest" A-Wt. Sound Level per Recent Survey	**32.7**
Sound Level of L67 Station plus Current A-Wt. Sound Level	33.0
Potential Increase above Ambient Noise (dB)	0.3

Table E: Enbridge Plummer Pumping Station: Est'd Sound Contribution of L67 Station at the NSA #2 (i.e., Residence located approx. 2,150 Ft. ESE of L67 Pumphouse Bldg.) due to Operation of New L67 Station Motor-Driven Pumps. Included is the Potential Increase in the Existing Sound Level after Installation of the New L67 Station.

Source No. & Dist (Ft)	Noise Sources and Other Conditions/Factors associated with Acoustical Analysis	SPL in dB Per O.B. Center Frequency (Hz) 31.5	63	125	250	500	1000	2000	4000	8000	A-Wt. Level
	Est'd SPLs of Station at 1300 Ft. (RE: Table D)	36	36	34	30	23	18	11	0	0	26
200	Hemisph Radiation [20*log(1300/200) = 16.3 dB]	16.3	16.3	16.3	16.3	16.3	16.3	16.3	16.3	16.3	
200	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	0	1	2	3	8	7	
Est'd Total Sound Contribution of L67 Station at S. Prop. Line		**52**	**52**	**50**	**47**	**40**	**36**	**31**	**25**	**23**	**43**

Est'd "Lowest" A-Wt. Sound Level per Recent Survey	**44.8**
Sound Level of L67 Station plus Current A-Wt. Sound Level	47.1

Table F: Enbridge Plummer Pumping Station: Est'd Sound Contribution of Pump Station at the Closest Property Line to L67 Station (i.e., South Prop. Line; 200 Ft. from L67 Pumphouse Building) due to Operation of New L67 Station Motor-Driven Pumps. Also, Total Est'd Sound Level of the Station at the Closest Station Property Line after Installation of the New L67 Station.

ANALYSIS METHODOLOGY AND SOURCE OF SOUND DATA

In general, the predicted sound level contributed by the pumping station equipment was calculated as a function of frequency from estimated unweighted octave-band ("O.B.") sound power levels ("PWLs") for each significant sound source. The following summarizes the acoustical analysis procedure for the new L67 Pump Station:

- Initially, unweighted O.B. PWL values of the significant noise sources were determined from equipment manufacturer's sound data and/or actual sound level measurements performed by H&K at similar type of equipment/components expected for this facility.

- Then, expected noise reduction or attenuation in dB per O.B. frequency due to any noise control measures, hemispherical sound propagation (discussed in more detail below*) and atmospheric sound absorption (discussed in more detail below**) were subtracted from the unweighted O.B. PWLs to obtain the unweighted O.B. SPLs of each noise source. Since sound shielding by buildings and/or enclosures can influence the sound level contributed at the NSAs, we also included the sound shielding due to buildings, if appropriate. The sound attenuation effect due to foliage or land contour was not considered in the analysis since there is probably minimum attenuation due to foliage.

- Finally, the resulting estimated unweighted O.B. SPLs for all noise sources associated with the Station (with noise control and other sound attenuation effects) were logarithmically summed, and the total O.B. SPLs for all noise sources were corrected for A-weighting to provide the estimated overall A-wt. sound level contributed by the Station at the receptor/location. The predicted sound contribution of the Station at the Station property line/location was utilized to estimate the Station noise contribution at the closest NSAs.

*Attenuation due to hemispherical sound propagation: Sound propagates outwards in all directions (i.e., length, width, height) from a point source, and the sound energy of a noise source decreases with increasing distance from the source. In the case of hemispherical sound propagation, the source is located on a flat continuous plane/surface (e.g., ground), and the sound radiates hemispherically (i.e., outward, over and above the surface) from the sound source. The following equation is the theoretical decrease of sound energy when determining the resulting SPL values of a noise source at a specific distance ("r") of a receiver from the estimated PWL values:

> Decrease in SPL ("hemispherical propagation") from a noise source = **20*log(r) – 2.3 dB**
> where "r" is distance of the receiver from the noise source.

Attenuation due to air absorption: Air absorbs sound energy, and the amount of absorption ("attenuation") is dependent on the temperature and relative humidity (R.H.) of air and frequency of sound. For example, the attenuation due to air absorption for 1000 Hz O.B. SPL is approximately **1.5 dB per 1,000 feet for standard day conditions (i.e., no wind, 60 deg. F. and 70% or 50% R.H.).

The estimated unweighted O.B. PWLs of the motor-driven pumps, piping, substation equipment and any other site equipment were estimated from field sound measurements by H&K on similar equipment and/or from sound data provided by the equipment manufacturer.

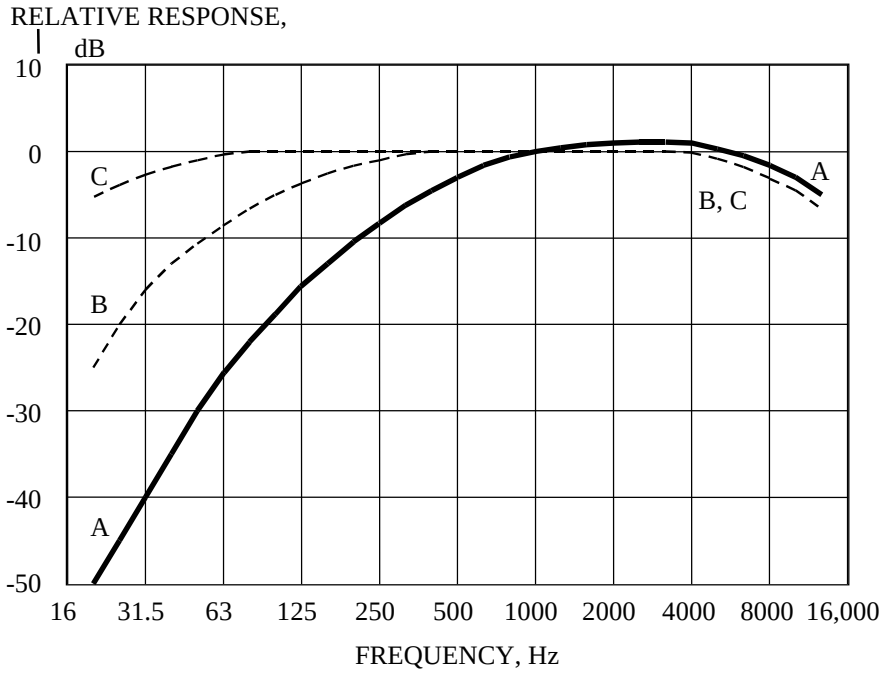
APPENDIX: Summary of Acoustical Terminology, Typical Metrics for Regulating Environmental Noise and Sound Levels for Typical Activities

(1) Decibel ("dB"): A unit for expressing the relative power level difference between acoustical or electrical signals. It is ten times the common logarithm of the ratio of two related quantities that are proportional to power. When adding dB or dBA values, the values must be added logarithmically. For example, the logarithmic addition of **35 dB** plus **35 dB** is **38 dB**.

(2) A-Weighted Sound Level ("dBA"): The A-wt. sound level is a single-figure sound rating, expressed in decibels (Re 20 μPa), which correlates to the human perception of the loudness of sound. The dBA level is commonly used to measure industrial and environmental noise since it is easy to measure and provides a reasonable indication of the human annoyance value of the noise. The dBA measurement is not a good descriptor of a noise consisting of strong low-frequency components or for a noise with tonal components.

The A-weighted curve approximates the response of the average ear at sound levels of 20 to 50 decibels. The following are the relative response of A-weighted filter per octave band frequency, and a graph/curve is provided that shows a graphical representation of the A-wt. filter response per frequency (in Hz).

31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1,000 Hz	2,000 Hz	4,000 Hz	8,000 Hz	16,000 Hz
-39.4 dB	-26.2 dB	-16.1 dB	-8.6 dB	-3.2 dB	0 dB	+1.2 dB	+1.0 dB	-1.1 dB	-6.6 dB



(3) Human Perception of Change in Sound Level

- A **3 dB** change of sound level is barely perceivable by the human ear
- A **5 or 6 dB** change of sound level is noticeable
- If sound level increases by **10 dB**, it appears as if the sound intensity has doubled.

(4) Background or Ambient Noise: The total noise produced by all other sources associated with a given environment in the vicinity of a specific source of interest, and includes any Residual Noise.

(5) Sound Pressure Level ("L_p or SPL"): Ten times the common logarithm to the base 10 of the ratio of the mean square sound pressure to the square of a reference pressure. Therefore, the sound pressure level is equal to 20 times the common logarithm of the ratio of the sound pressure to a reference pressure (20 micropascals or 0.0002 microbar).

(6) Octave Band SPL: Sound is typically measured in frequency ranges (e.g., high-pitched sound, low-pitched sound, etc.) that provides more meaningful sound data regarding the sound character of the noise. When measuring two noise sources for comparison, it is better to measure the spectrum of each noise, such as in octave band SPL frequency ranges. Then, the relative loudness of two sounds can be compared frequency range by frequency range. As an illustration, two noise sources can have the same dBA rating and yet sound completely different. For example, a high-pitched sound concentrated at a frequency of 2000 Hz could have the same dBA rating as a much louder low-frequency sound concentrated at 50 Hz.

(7) Daytime Sound Level ("L_d") & Nighttime Sound Level ("L_n"): L_d is the equivalent A-weighted sound level, in decibels, for a 15 hour time period, between 07:00 to 22:00 Hours (7:00 a.m. to 10:00 p.m.). L_n is the equivalent A-weighted sound level, in decibels, for a 9 hour time period, between 22:00 to 07:00 Hours (10:00 p.m. to 7:00 a.m.).

(8) Equivalent Sound Level ("L_{eq}"): The equivalent sound level (L_{eq}) can be considered an average sound level measured during a period of time, including any fluctuating sound levels during that period. In this report, the L_{eq} is equal to the level of a steady (in time) A-weighted sound level that would be equivalent to the sampled A-weighted sound level on an energy basis for a specified measurement interval. The concept of the measuring L_{eq} has been used broadly to relate individual and community reaction to aircraft and other environmental noises.

(9) L-Percent Sound Levels: The L percent levels (e.g., L_{50}, L_{90} & L_{10}) refer to the A-wt. sound levels that are exceeded for 90, 50 and 10 percent of the time, respectively, during a measurement period. For example, the 90-percentile exceeded sound level, designated to as L_{90}, is the A-wt. sound levels that are exceeded for 90 percent of the time and is considered the typical lowest anticipated sound levels. The range between the L_{10} and L_{90} values usually provides a good indication of the variability of the sound levels during the period of measurement.

(10) Sound Level Meter ("SLM"): An instrument used to measure sound pressure level, sound level, octave-band SPL, or peak sound pressure level, separately or in any combinations thereof. The measured weighted SPL (i.e., A-Wt. Sound Level or dBA) is obtained by the use of a SLM having a standard frequency-filter for attenuating part of the sound spectrum.

(11) Sound Power Level ("L_W or PWL"): Ten times the common logarithm of the ratio of the total acoustic power radiated by a sound source to a reference power. A reference power of a picowatt or 10^{-12} watt is conventionally used.

(12) Tone: A tone is a sound sensation-having pitch, which is a listener's perception of the frequency (for example, the higher the frequency, the higher the pitch). For a measured sound spectrum, a tone is represented as a "peak" in the spectrum curve. Noise that contains significant tones is considered a tonal type of noise.

(13) List of Common Environmental (i.e., Man-Made & Natural) Noise Sources: For reference, the following **Table** presents a list of some common environmental (i.e., man-made and natural) noise sources as compared to the estimated sound level of the pumping station at the closest NSAs. Note that inside a typical house, the noise level of an outdoor noise source is approximately **15 to 20 dB** quieter (i.e., house typically provides at least **15 to 20 dB** noise reduction).

Type of Noise Source	Approx. A-Wt. Sound Level	Approximate Distance To Noise Source
Lawn mower (outdoor)	50 – 55 dBA	150 to 200 feet
Passenger cars @ 50 – 60 mph (outdoor)	50 – 55 dBA	250 to 300 feet
Residential AC unit (outdoor)	50 – 60 dBA	40 to 50 feet
Residential AC unit (outdoor)	35 – 45 dBA	200 to 250 feet
Chemical plant (outdoor)	40 – 50 dBA	½ mile from plant
Cicadas (outdoor, summertime @ night)	50 – 55 dBA	General area of insects
Window AC unit (indoor)	50 – 60 dBA	5 to 20 feet
TV @ normal listening level (indoor)	60 – 70 dBA	10 to 15 feet
Vacuum cleaner (indoor)	70 – 75 dBA	10 to 15 feet

List of Some Common Environmental Noise Sources compared to Station Sound Level at Closest NSAs

End of Report

Appendix M.3

Viking Pumping Station

VIKING PUMPING STATION

(MARSHALL COUNTY, MINNESOTA)

RESULTS OF A NOISE IMPACT ANALYSIS OF

MODIFICATIONS AT THE EXISTING VIKING PUMP

STATION ASSOCIATED WITH THE ENBRIDGE

MAINLINE EXPANSION ("MLE") PROJECT

H&K Report No. 2860

H&K Job No. 4559

Date of Report: May 15, 2013

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REPORT SUMMARY

This report includes the results of a noise impact analysis of modifications at the existing **Viking (MN) Pumping Station** associated with the **Enbridge Energy Mainline Expansion Project** ("MLE Project" or "Project"). The purpose of the noise impact analysis is to estimate the sound contribution of planned modifications (i.e., installation of a new Station 67 pump unit) at the Viking Pumping Station (referred to as "Station" in the report) and compare the results of the noise assessment to applicable sound criteria and/or proposed noise level guideline. In addition, the results of a recent "pre-construction" sound survey at the Station are included.

The following table summarizes the measured sound level environment around the Station (i.e., Leq) at the nearby noise-sensitive areas ("NSAs", such as residences) and the estimated sound contribution of the Viking Station after installation of modifications at the Viking Station along with the potential increase in the existing sound level at the nearby NSAs after installation of Project modifications. The results in this table are defined as the "Noise Quality Analysis".

Noise Quality Analysis for Viking Pumping Station (Sound Contribution of the Station at the Closest NSAs after Installation of Project Modifications and Potential Increase above Existing Sound Levels)

Closest NSAs and Type of NSA	Distance & Direction of NSA to a new Station 67 Pump Unit	Meas'd ("Existing") A-Wt. Sound Level (Leq)	Est'd Sound Contribution of the new Station 67 Pump Unit	Est'd Sound Level of the new Pump Unit plus Existing Sound Level	Potential Noise Increase
NSA #1 (Residence)	2,550 feet (south)	33.5 dBA	24.8 dBA	34.1 dBA	0.6 dB
NSA #2 (Residence)	4,100 feet (NE)	33.2 dBA	18.8 dBA	33.4 dBA	0.2 dB

The results of the recent sound survey and acoustical analysis of the planned new Station 67 pump unit at the Viking Station indicates the following:

- Sound level contribution of the existing Viking Station during operation complies with the MPCA Standard (< **50 dBA** at nighttime) at the surrounding NSAs;
- Estimated total sound level contribution of the modified Viking Station (i.e., addition of the new Station 67 pump unit plus the current sound level of the existing Station) should comply with the MPCA Standard (< **50 dBA** at nighttime);
- Potential noise increase in the "pre-existing" sound level due to the planned Station modifications should be less than **3 dB** at the nearby NSAs (i.e., residences). Consequently, the noise of the Station modifications may be perceivable by the human ear but should have minimum impact on the surrounding acoustical environment.

TABLE OF CONTENTS

1.0 INTRODUCTION

In this report, **Hoover & Keith Inc.** ("H&K") presents the results of a noise impact analysis of the planned modifications at the **Viking (MN) Pumping Station** (referred to as "Station" in the report) associated with the **Enbridge Energy Mainline Expansion Project** ("MLE Project" or "Project"). The purpose of the noise impact analysis is to estimate the sound contribution of Station modifications (i.e., installation of a new Station 67 pump unit) at the property line and at nearby noise-sensitive areas ("NSAs"), such as residences, and the results of the noise assessment are compared to applicable sound requirements and/or a proposed noise level guideline. In addition, the results of a recent "pre-construction" sound survey at the Viking Station are included.

2.0 BRIEF DESCRIPTION OF THE STATION/EQUIPMENT

Figure 1 (p. 7) shows an area layout around the Station showing the surrounding NSAs (i.e., residences) and the reported sound measurement positions at the closest NSAs during the recent sound survey. The Station is located in Marshall County, Minnesota, approximately 1-1/2 miles southwest of the small community of Viking, MN. The closest residence is located approximately 2,550 feet south of the Station (i.e., area of Station 67). **Figure 2** (p. 8) provides a layout of existing buildings/equipment and the approximate location of the Station fenceline at the existing Station. The following **Table 1** lists the existing different pumping stations located within the property of the Viking Station along with a list of associated pumping unit horsepower ("HP") for each site Station.

Station & associated Line Number	Unit Number	Rated HP
Station 1 (Line No. 1)	1-U1	3,500 HP
	1-U2	3,500 HP
	1-U3	3,500 HP
	1-U4	3,500 HP
Station 2 (Line No. 2)	2-U1	2,500 HP
	2-U2	2,500 HP
	2-U3	1,500 HP
Station 3 (Line No. 3)	3-U1	3,500 HP
	3-U2	3,500 HP
	3-U3	3,500 HP
Station 4 (Line No. 4)	4-U1	5,000 HP
	4-U2	5,000 HP
	4-U3	5,000 HP
Station 13 (Line No. 13)	13-U1	2,500 HP
	13-U2	2,500 HP
Station 67 (Line No. 67)	67-U1	6,000 HP
	67-U2	6,000 HP

Table 1: Summary of the Stations and associated Pump Units at the Viking Station

Station Modifications for the MLE Project: One (1) additional 6,000 horsepower ("HP") pump unit will be installed at the Viking Station that serves Line 67 (i.e., Station 67) along with impeller replacements for existing Station 67 pump units. The motor/pump of the new motor-driven pump and associated aboveground piping will be located inside an extended section of the Pumphouse Building 67 ("P.H. 67"), which will be modified to accommodate the new pump unit.

3.0 ACOUSTICAL TERMINOLOGY AND SOUND CRITERIA

3.1 Acoustical Terminology and Example of Typical Environmental Sound Levels

For the reader's information, a summary of acoustical terminology and list of typical metrics used to measure/regulate environmental noise is provided in the **Appendix** (pp. 13–15). There are several metrics for quantifying and regulating environmental noise level although the most common metric used by state and municipal agencies is the A-wt. sound level ("dBA"). There are also other metrics, such as L_{eq} and day-night average sound level ("L_{dn}"), that are used to correlate human reaction to an intruding sound. In addition, to gain an understanding and comparison of the predicted Station noise level, a Table is provided in the **Appendix** (p. 15) that shows a list of some common environmental noise sources.

3.2 State of Minnesota and Local Noise Regulations

The Minnesota Pollution Control Agency ("MPCA") has a receiver-based standard intended to limit noise levels and to protect the health and welfare of the general public, as included in the *Noise Rules and Statutes* (MPCA Standards). In general, the MPCA Standard limits the sound contribution from a facility to a receiver according to land activities by the noise area classification ("NAC") system established in the MPCA Standard, as follows:

Noise Area Classification (NAC)	Daytime (dBA)		Nighttime (dBA)	
	L50	L10	L50	L10
1 (e.g., residence, church)	60	65	50	55
2 (e.g., commercial business)	65	70	65	70
3 (e.g., pumping station)	75	80	75	80

Notes:

1. The worst case MPCA Standard for the Alberta Clipper Project is for land activities within NAC Group 1, which includes residences (i.e., NSAs).
2. The L50 is the sound level in dBA which is exceeded 50% of the time for a one hour measurement. The L10 is the sound level in dBA which is exceeded 10% of the time for a one hour measurement. In acoustics, these types of sound levels are known as exceedence levels.
3. Daytime is defined as the hours from 7:00 AM to 10:00 PM. Nighttime is defined as the hours from 10:00 PM to 7:00 AM.

The MPCA Standard states that a one-hour measurement period is to be utilized for verification of the L10 and L50 requirements. However, a typical pump station will have an essentially constant sound level which is mostly dependent upon the number of pump units operating to meet flow requirements. Therefore, it is not necessary to perform a one-hour measurement to determine the sound level contribution of a pump station at an adjacent NSA, as the sound level is essentially constant. In addition, a much shorter duration measurement can permit the sound level contribution of the nearby pump station for an NSA to be isolated from other potential sound sources, or to document a representative background ambient sound level at an NSA where the pump station is not audible. For the reasons above, H&K has utilized shorter term measurements to document the sound level contribution of a Station at the nearby NSAs. Our measurement approach was confirmed with a representative at the MPCA. We are not aware of any local and/or county noise regulations that are applicable to the Viking Station.

3.3 Discussion of Noise Impact of a Noise Source

This section provides a proposed "noise level guideline" that could be utilized for a facility to determine the subjective nature of the planned Station modifications. If an intruding noise (e.g., noise generated by the pumping station or noise associated by Station modifications) causes less than a **3 dB** increase in the overall ambient noise level at the NSAs (i.e., defined as "potential noise increase"), the Station noise should be barely perceivable by the human ear and should have minimum impact on the acoustical environment. If the intruding noise causes an increase in the overall ambient noise of between **4 dB** and **6 dB**, the noise of the Station may be audible by the human ear but should still have minimum impact on the acoustical environment.

4.0 MEASUREMENT LOCATIONS, METHODOLOGY AND MEASUREMENT RESULTS

4.1 Sound Measurement Locations, Data Acquisition and Station Operating Conditions

During the recent sound survey, daytime sound levels were measured near the closest NSAs (i.e., residences) surrounding the Station (i.e., "NSA #1" & "NSA #2"), and sound levels were measured around the Station fenceline (i.e., property line). The following is a description of the nearest NSAs and reported sound measurement positions during the recent sound survey:

Pos. 1: "NSA #1" (considered the closest NSA); Residence located approximately 2,550 feet south of the P.H. #67 for Station 67;
Pos. 2: "NSA #2" (considered the next closest NSA); Residence located approximately 4,100 feet NE of the P.H. #67 for Station 67;
Pos. 3: North Side of the Station, near the Radio Tower;
Pos. 4: East fenceline (i.e., east property line) of the Station;
Pos. 5: South fenceline (i.e., south property line) of the Station, in line with the Office Bldg.;
Pos. 6: West Side of the Station, approximately 200 feet from P.H. #3 & P.H. #13;
Pos. 7: West property line of the Station, just west of P.H. #67.

Sound measurements were performed by Paul Kiteck of H&K during the daytime of April 23, 2013. At each sound measurement position, the equivalent A-wt. sound level (i.e., L_{eq}) and unweighted octave-band ("O.B.") sound pressure levels ("SPLs") were measured at 5 feet above ground. Typically, several sample of the ambient noise were measured at the measurement position (e.g., 5 to 20 minutes in length). Sound measurements attempted to exclude "extraneous sound" such as cars or trucks passing immediately by the sound measurement location. The sound measurement system consisted of a Larson-Davis ("LD") Model 2900 Real Time Analyzer/SLM (a Type I SLM per ANSI Standard S1.4 & S1.11) with a 1/2-in. LD condenser microphone covered by a windscreen, and the analyzer/SLM was calibrated with a LD Model CA250 microphone calibrator that was calibrated within one (1) year of the test date.

Operating Conditions of Equipment/Stations: The following summarizes the equipment (i.e., pump units) at the site "Stations" that were operating during the sound survey tests:

- Line 1 Station Pumps [Pumphouse #1 ("P.H. #1")], no pumps were operating;
- Line 2 Station Pumps (P.H. #2), 1 pump operating (i.e., 2-U3 Pump);
- Line 3 Station Pumps (P.H. #3), no pumps were operating (pumps typically do not operate);
- Line 4 Station Pumps (P.H. #4), 1 pump operating (i.e., 4-U2 Pump);
- Line 13 Station Pumps (P.H. #13), 1 pump operating (i.e., 13-U2 Pump);
- Line 67 Station Pumps (P.H. #67), 2 (both) pumps operating (i.e., U1 Pump & U2 Pump).

4.2 Results of the Sound Survey and Observations

Table A (p. 9) summarizes the measured daytime L_{eq} (i.e., L_d) at the sound measurement locations near surrounding NSAs along with the average of the measured L_d. In addition, **Table A** includes the resulting L_{dn} as calculated from the measured L_d and estimated L_n along with the observations during the sound survey regarding contributors to the measured sound levels. Meteorological conditions during the sound survey are summarized in **Table B** (p. 9). The measured ambient daytime A-wt. sound levels and associated unweighted ambient O.B. SPLs during the sound survey at the nearest NSAs are provided in **Table C** (p. 10).

The following **Table 2** summarizes the measured A-wt. sound levels at the closest NSAs during the Station operating conditions that occurred on April 23, 2013.

Meas. Pos.	Description of the Sound Measurement Location	Meas'd A-Wt. Levels
Pos. 1	NSA #1: Residence located approx. 2,550 feet south of Station 67 (P.H. #67)	33.5 dBA
Pos. 2	NSA #2: Residence located approx. 4,100 feet NE of Station 67 (P.H. #67)	33.2 dBA

Table 2: Summary of the Meas'd A-Wt. Sound Levels near the Closest NSAs during Station Operation

During the sound tests at NSA #1 (i.e., Pos. 1), the noise of the Station was audible but was not considered a significant noise source (i.e., Station noise did not contribute significantly to the measured A-wt. sound levels). The primary sources of sound that contributed to the measured A-wt. sound levels included the sound of geese/birds and sound of wind blowing in the trees.

During the sound tests at NSA #2 (i.e., Pos. 2), the noise of the Station was not audible and the primary sources of sound that contributed to the measured A-wt. sound levels was the noise of distant vehicle traffic, sound of birds, sound of wind blowing in the trees and at times, the noise of distant aircraft.

5.0 ACOUSTICAL ASSESSMENT

The noise assessment considers the noise produced by all equipment that could contribute to the noise generated by the planned Station modifications (i.e., installation of a new Station 67 pump unit), based on the current design and primary noise-generating equipment in the area of the electric motor-driven pumps (i.e., P.H. #67). A description of the acoustical assessment methodology of the new pump unit at the Viking Station and the source of sound data are provided toward the end of the report (p. 12).

The predicted sound contribution of the new Station 67 pump unit was performed at the “closest” property line to Station 67 (i.e., west property line of Station 67) and at the “closest residences” (i.e., NSA #1 & NSA #2) since the Station sound contribution at other Station property lines and more distant residences would be equal to or lower than the estimated sound contribution at the Station west property line and at the closest residences.

Table D (p. 11) shows the spreadsheet calculation of the estimated A-wt. sound level and unweighted O.B. SPLs contributed by the new Station 67 pump unit (assumed to be enclosed in an extended section of P.H. #67) at the closest NSA (i.e., NSA #1) for standard day propagating conditions (i.e., no wind, 60 deg. F., 70% R.H.). In addition, **Table D** includes estimated total sound level at NSA #1 after installation of the new Station 67 pump unit (i.e., sound level of new pump unit plus measured existing sound level), and the estimated potential increase in the existing sound level at NSA #1 as a result of the installation of new pump unit.

Table E (p. 11) provides the estimated A-wt. sound level and unweighted O.B. SPLs of the new Station 67 pump unit at the next closest residence (i.e., NSA #2) based on the sound level calculation for the new Station 67 pump unit in **Table D**. In addition, **Table E** includes estimated total sound level at NSA #2 after installation of the new pump unit and estimated potential increase in the existing sound level at NSA #2 as a result of the installation of the new pump unit.

For reference, **Table F** (p. 11) provides the estimated A-wt. sound level of new Station 67 pump unit at the “closest” Station property line to Station 67 (i.e., west property line of the Station) based on the acoustical analysis/method utilized in **Table D**.

6.0 SUMMARY AND FINAL COMMENT

The following **Table 3** summarizes the measured noise environment around the Station (i.e., closest NSAs) via the recent pre-construction sound survey, and the estimated sound contribution of planned Station modifications (i.e., addition of a new Station 67 pump unit) at the closest residences (i.e., NSAs) and the estimated total sound level of the Station after installation of the new Station 67 pump unit along with the potential increase in the existing sound level at the nearby NSAs after installation of the new Station 67 pump unit. The results in this table are defined as the "Noise Quality Analysis" for the Station.

Closest NSAs and Type of NSA	Distance & Direction of NSA to a new Station 67 Pump Unit	Meas'd ("Existing") A-Wt. Sound Level (Leq)	Est'd Sound Contribution of the new Station 67 Pump Unit	Est'd Sound Level of the new Pump Unit plus Existing Sound Level	Potential Noise Increase
NSA #1 (Residence)	2,550 feet (south)	33.5 dBA	24.8 dBA	34.1 dBA	0.6 dB
NSA #2 (Residence)	4,100 feet (NE)	33.2 dBA	18.9 dBA	33.4 dBA	0.2 dB

Table 3: Noise Quality Analysis for the Viking Station related to Installation of Station Modifications

The results of the recent sound survey and acoustical analysis of the planned new Station 67 pump unit at the Viking Station indicates the following:

- Sound level contribution of the existing Viking Station during operation complies with the MPCA Standard (< **50 dBA** at nighttime) at the surrounding NSAs;

- Estimated total sound level contribution of the modified Viking Station (i.e., addition of new Station 67 pump unit plus the current sound level of the existing Station) should comply with the MPCA Standard (< **50 dBA** at nighttime);

- Potential noise increase in the "pre-existing" sound level due to the planned Station modifications should be less than **3 dB** at the nearby NSAs (i.e., residences). Consequently, the noise of the Station modifications may be perceivable by the human ear but should have minimum impact on the surrounding acoustical environment;

- In addition, the acoustical analysis also estimates that the A-wt. sound level around the Station property line to the planned Station modifications (i.e., installation of a new Station 67 pump unit and other equipment modifications) will be equal to or less than **55 dBA**.

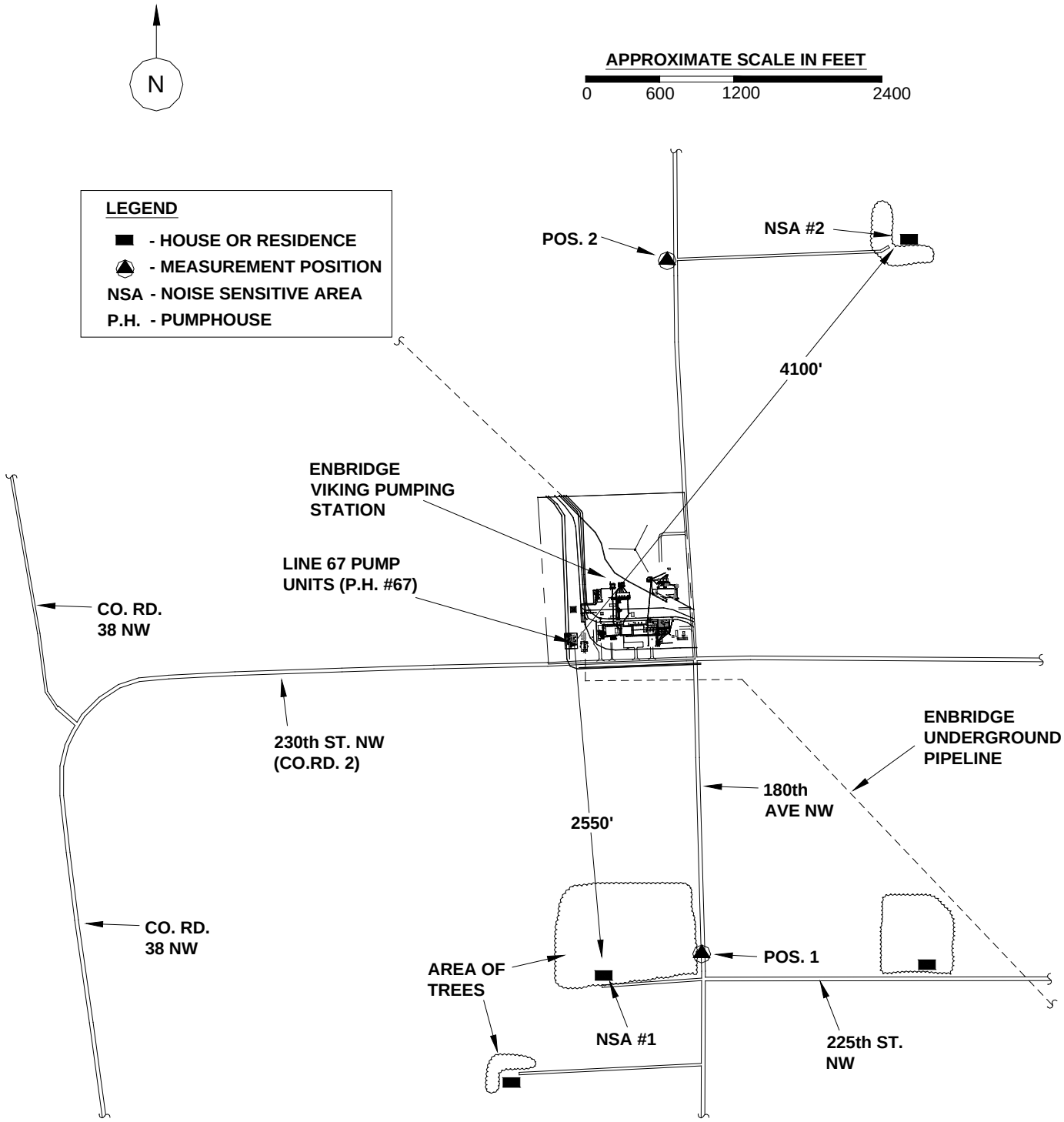


Figure 1: Enbridge Viking Pumping Station: Area Layout showing the Nearest NSAs (i.e., Residences) and Reported Sound Measurement Positions at the Closest NSAs.

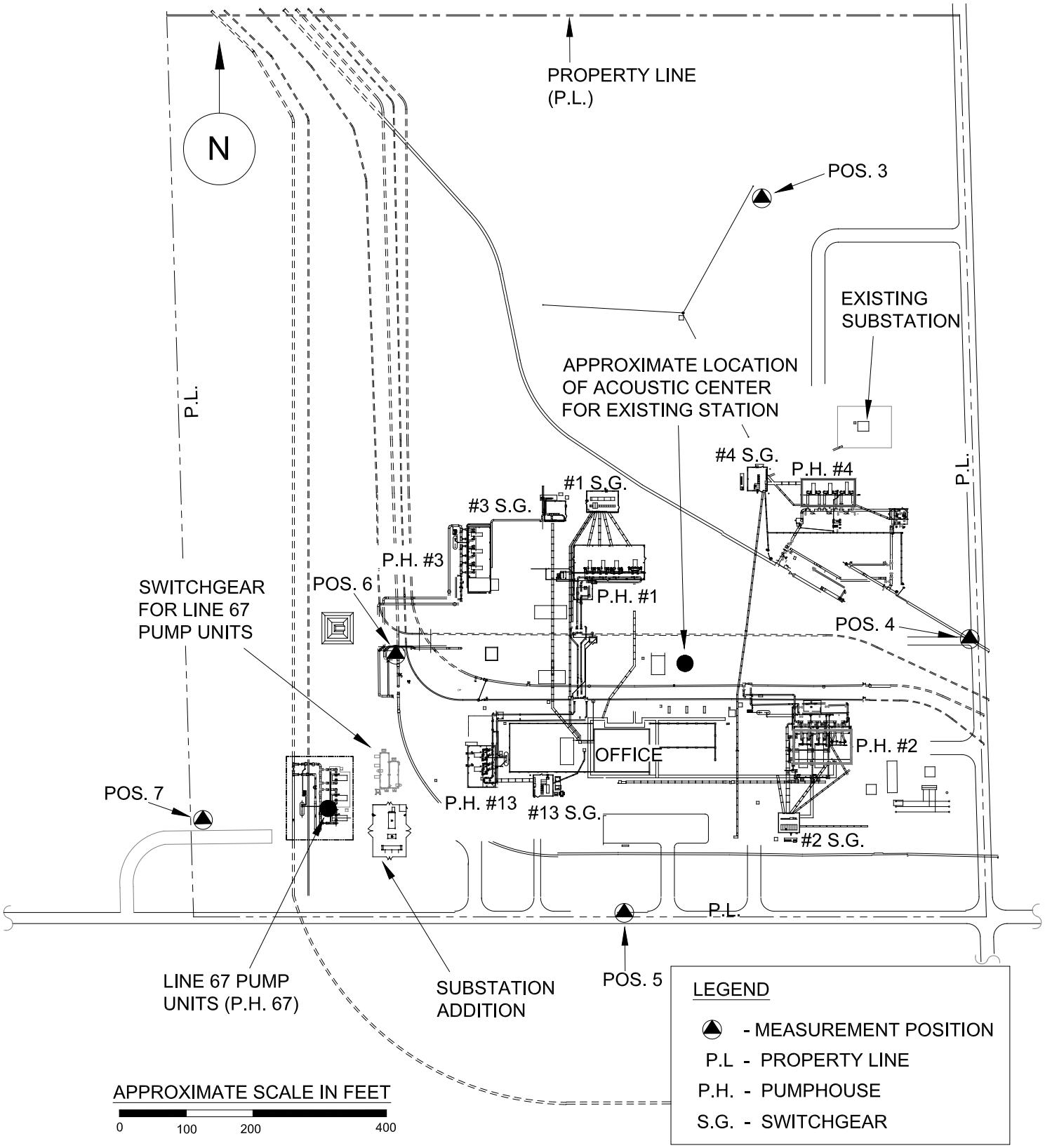


Figure 2: Enbridge Viking Pumping Station: Layout of the Existing Buildings/Equipment and the Location of the Sound Measurement Positions around the Station Property/Fenceline.

Measurement Set		Meas'd & Calc'd A-Wt. Sound Levels (dBA)					
		Day-time	Avg'd of		Night-time	Calc'd Ldn	
Meas. Position	Time of Test	Leq(Ld)	Ld		Leq(Ln)	Note (2)	Notes/Observations
Pos. 1 (NSA #1) Residence on West Side of 180th Ave. NW, south of the Station	1:00 PM 1:10 PM 1:15 PM	31.6 35.0 33.8	**33.5**		**33.5** Note (1)	**39.9** Note (2)	Noise of the Station (i.e., Line #67 pumps) was was audible but not a significant noise source. A-wt. level included sound of geese/birds and wind-related noise.
Pos. 2 (NSA #2) Residence on East Side of 180th Ave. NW, NE of the Station	1:00 PM 1:10 PM 1:15 PM	32.3 35.3 32.8	**33.2**		**33.2** Note (1)	**39.6** Note (2)	Noise of the Station not audible at this location. Environmental noise included noise of distant vehicle traffic, wind-related noise, sound of birds, and at times, noise of distant aircraft.

Table A: **Ebridge Viking (MN) Station+C41: Summary of the Meas'd Daytime Leq (i.e., Ld) at the Closest NSAs during the Sound Survey on April 23, 2013 along with the Resulting Ldn, as Calculated via the Meas'd Ld and Est'd Ln.**

Note (1): Although nighttime levels (Ln) were not measured, the nighttime A-wt. sound level (Ln) should be similar to the measured daytime sound levels (Ld).

Note (2): If only the daytime Leq (i.e., Ld) is measured, the Ldn is calculted by adding 6.4 dB to the meas'd Ld. If both Ld and Ln are measured and/or estimated, Ldn is calculated using the following formula:

$$L_{\text{dn}} = 10\log_{10}\left(\frac{15}{24}10^{L_{\text{d}}/10} + \frac{9}{24}10^{(L_{\text{n}}+10)/10}\right)$$

Summary of Operating Conditions of Terminal/Station Equipment during the Sound Survey:
> For Line 1 Station Pumps [Pumphouse #1 ("P.H. #1")], no pumps were operating;
> For Line 2 Station Pumps (P.H. #2), 1 pump operating (i.e., 2-U3 Pump);
> For Line 3 Station Pumps (P.H. #3), no pumps were operating (pumps typically do not operate);
> For Line 4 Station Pumps (P.H. #4), 1 pump operating (i.e., 4-U2 Pump);
> For Line 13 Station Pumps (P.H. #13), 1 pump operating (i.e., 13-U2 Pump);
> For Line 67 Station Pumps (P.H. #67), 2 (both) pumps operating (i.e., U1 Pump & U2 Pump);

Measurement Set		Temp.	R.H.	Wind	Wind	Peak	
Meas. Pos.	Time Frame of Tests	(°F)	(%)	Direction	Speed	Wind	Sky Conditions
Meas. Pos. 1 to 7	1:00 PM to 3:30 PM	34 - 36	45 - 50	Wind primarily from west/WNW	2 - 4 mph	4 - 6 mph	Mostly clear sky

Table B: **Enbridge Viking (MN) Station: Summary of the Meteorological Conditions during the Sound Survey Measurements on April 23, 2013.**

Measurement Set		Sound Pressure Level (SPL) in dB per Octave-Band Frequency (in Hz)									A-Wt.
Meas. Position	**Time of Test**	**31.5**	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	**Level**
Pos. 1 (NSA #1)	1:00 PM	53.0	46.2	38.0	32.0	26.4	22.5	23.0	22.0	21.0	31.6
Residence on West	1:10 PM	58.0	50.0	44.0	38.0	30.0	26.7	23.0	20.0	20.0	35.0
Side of 180th Ave. NW,	1:15 PM	55.0	48.8	41.0	35.6	29.4	26.0	23.3	20.5	22.0	33.8
south of the Station											
	Average SPL	**55.3**	**48.3**	**41.0**	**35.2**	**28.6**	**25.1**	**23.1**	**20.8**	**21.0**	**33.5**
Pos. 2 (NSA #2)	1:00 PM	55.0	49.0	40.5	34.0	27.8	26.0	17.0	16.0	18.0	32.3
Residence on East	1:10 PM	55.4	51.0	46.6	39.2	30.3	21.0	16.0	16.0	18.0	35.3
Side of 180th Ave. NW,	1:15 PM	56.0	52.3	43.2	36.0	26.0	19.0	15.0	16.0	17.0	32.8
NE of the Station											
	Average SPL	**55.5**	**50.8**	**43.4**	**36.4**	**28.0**	**22.0**	**16.0**	**16.0**	**17.7**	**33.2**
Pos. 3: North Side of	3:15 PM	52.5	46.4	43.0	41.0	43.0	43.6	39.5	32.0	25.0	46.9
Station property,	3:20 PM	50.0	46.6	44.0	42.0	45.4	45.7	41.6	32.0	21.0	48.9
near radio tower	**Average SPL**	**51.3**	**46.5**	**43.5**	**41.5**	**44.2**	**44.7**	**40.6**	**32.0**	**23.0**	**47.9**
Pos. 4: East property	2:15 PM	62.0	58.0	61.0	56.0	52.0	53.7	55.6	45.0	33.0	59.5
line of Station	2:18 PM	57.6	56.2	60.2	56.0	51.4	52.6	54.7	44.0	32.0	58.7
	Average SPL	**59.8**	**57.1**	**60.6**	**56.0**	**51.7**	**53.2**	**55.2**	**44.5**	**32.5**	**59.1**
Pos. 5: South property	2:05 PM	68.0	58.4	51.0	42.0	41.2	39.5	39.0	27.0	25.0	45.3
Station property, in line	2:08 PM	66.0	58.4	50.4	43.0	42.5	43.0	40.0	26.0	22.0	47.0
with the Office Bldg.	**Average SPL**	**67.0**	**58.4**	**50.7**	**42.5**	**41.9**	**41.3**	**39.5**	**26.5**	**23.5**	**46.1**
Pos. 6: West Side of	2:25 PM	58.4	57.2	57.5	51.6	46.2	47.0	55.0	33.0	27.0	57.0
Station, 200 ft. from	2:30 PM	58.0	56.4	57.0	52.0	46.2	45.3	53.3	33.0	25.0	55.6
P.H. #3 & P.H. #13	**Average SPL**	**58.2**	**56.8**	**57.3**	**51.8**	**46.2**	**46.2**	**54.2**	**33.0**	**26.0**	**56.3**
Pos. 7: West Side of	2:42 PM	59.5	54.4	50.4	52.0	52.0	42.0	46.0	29.0	24.0	52.3
P.H. #67, near west	2:45 PM	56.0	54.0	50.8	52.7	51.0	43.0	44.5	30.0	25.0	51.7
property line of Station	**Average SPL**	**57.8**	**54.2**	**50.6**	**52.4**	**51.5**	**42.5**	**45.3**	**29.5**	**24.5**	**52.0**

Table C: **Enbridge Viking (MN) Station: Meas'd A-Wt. Sound Levels (Leq) and Unweighted O.B. SPLs at the Closest NSAs and around the Station Property Line and/or Station Fenceline During the Sound Survey on April 23, 2013.**

Source No. & Dist (Ft)	Noise Sources and Other Conditions/Factors associated with Acoustical Analysis	PWL or SPL in dB Per Octave-Band Center Frequency (Hz) 31.5	63	125	250	500	1000	2000	4000	8000	A-Wt. Level
1)	PWL of New Station 67 Pump inside Bldg. (P.H. #67)	98	96	94	92	90	88	92	80	70	95
	Atten. of any Additional Noise Control Measures	0	0	0	0	0	0	0	0	0	
	Misc. Atten. (Shielding or Ground Effect)	0	0	0	0	0	0	0	0	0	
2550	Hemispherical Radiation	-66	-66	-66	-66	-66	-66	-66	-66	-66	
2550	Atm. Absorption (70% R.H., 60 deg F)	0	0	-1	-1	-2	-4	-8	-19	-35	
Est'd Total Sound Contribution of New Pump at NSA #1		**32**	**30**	**28**	**25**	**22**	**18**	**19**	**0**	**0**	**24.8**

Current A-Wt. Sound Level at NSA via Recent Sound Survey	**33.5**
Sound Level of New Pump plus Current A-Wt. Sound Level	34.1
Potential Increase above Existing Noise (dB)	0.6

Table D: Viking (MN) Pumping Station: Est'd Sound Contribution of New Station 67 Pump Unit at the Closest NSA (i.e., NSA #1; Residence located 2,550 Ft. South of P.H. #67) due to Operation of the new Station 67 Motor-Driven Pump. Included is Potential Increase in the Existing Sound Level Level after Installation of the New Pump.

Source No. & Dist (Ft)	Noise Sources and Other Conditions/Factors associated with Acoustical Analysis	SPL in dB Per O.B. Center Frequency (Hz) 31.5	63	125	250	500	1000	2000	4000	8000	A-Wt. Level
	Est'd SPLs of Station at 2,550 Ft. (RE: Table D)	32	30	28	25	22	18	19	0	0	24.8
4100	Hemisph Radiation [20*log(4100/2550) = 4.1 dB]	-4.1	-4.1	-4.1	-4.1	-4.1	-4.1	-4.1	-4.1	-4.1	
4100	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	-1	-1	-2	-5	-12	-21	
Est'd Total Sound Contribution of Station at NSA #2		**28**	**26**	**23**	**20**	**17**	**12**	**10**	**0**	**0**	**18.8**

Current A-Wt. Sound Level at NSA via Recent Sound Survey	**33.2**
Sound Level of New Pump plus Current A-Wt. Sound Level	33.4
Potential Increase above Existing Noise (dB)	0.2

Table E: Viking (MN) Pumping Station: Est'd Sound Contribution of New Station 67 Pump Unit at Next Closest NSA (i.e., NSA #2; Residence located 4,100 Ft. NE of P.H. #67) due to Operation of the new Station 67 Motor-Driven Pump. Included is Potential Increase in the Existing Sound Level Level after Installation of the New Pump.

Source No. & Dist (Ft)	Noise Sources and Other Conditions/Factors associated with Acoustical Analysis	PWL or SPL in dB Per Octave-Band Center Frequency (Hz) 31.5	63	125	250	500	1000	2000	4000	8000	A-Wt. Level
1)	PWL of New Station 67 Pump inside Bldg. (P.H. #67)	98	96	94	92	90	88	92	80	70	95
	Atten. of Additional Noise Control	0	0	0	0	0	0	0	0	0	
	Misc. Atten. (Shielding or Ground Effect)	0	0	0	0	0	0	0	0	0	
200	Hemispherical Radiation	-44	-44	-44	-44	-44	-44	-44	-44	-44	
200	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	0	0	0	-1	-2	-3	
Est'd Total Sound Contribution of New Pump at Prop. Line		**54**	**52**	**50**	**48**	**46**	**44**	**48**	**35**	**24**	**51.3**

Current A-Wt. Sound Level via Recent Sound Survey	**52.0**
Sound Level of New Pump plus Current A-Wt. Sound Level	54.7

Table F: Viking (MN) Pumping Station: Estimated Sound Contribution of the Station at the Closest Property Line to Station 67 (i.e., West Prop. Line; 200 Ft. from P.H. #67) due to the Operation of new Station 67 Motor-Driven Pump. Also, Total Est'd Sound Level of the Station at the at the Closest Station Property Line after Installation of the New Station 67 Pump.

ANALYSIS METHODOLOGY AND SOURCE OF SOUND DATA

In general, the predicted sound level contributed by the new pumping equipment was calculated as a function of frequency from estimated unweighted octave-band ("O.B.") sound power levels ("PWLs") for significant sound sources. The following summarizes the acoustical analysis procedure:

- Initially, unweighted O.B. PWL values of the significant noise sources for the planned modifications (i.e., installation of new equipment) were determined from equipment manufacturer's sound data and/or actual sound level measurements performed by H&K at similar type of equipment/components expected for this facility;

- Then, expected noise reduction or attenuation in dB per O.B. frequency due to any noise control measures, hemispherical sound propagation (discussed in more detail below*) and atmospheric sound absorption (discussed in more detail below**) were subtracted from the unweighted O.B. PWLs to obtain the unweighted O.B. SPLs of each noise source. Since sound shielding by buildings and/or enclosures can influence the sound level contributed at the NSAs, we also included the sound shielding due to buildings, if appropriate. The sound attenuation effect due to foliage or land contour was not considered in the analysis since there is probably minimum attenuation due to foliage;

- Finally, the resulting estimated unweighted O.B. SPLs for all noise sources associated with planned modifications (with noise control and other sound attenuation effects) were logarithmically summed, and the total O.B. SPLs for all noise sources were corrected for A-weighting to provide the estimated overall A-wt. sound level contributed by the planned modifications and Station at the receptor/location. The predicted sound contribution of the planned Station modifications at the closest NSA was utilized to estimate the Station noise contribution at the other more distant NSAs.

*Attenuation due to hemispherical sound propagation: Sound propagates outwards in all directions (i.e., length, width, height) from a point source, and the sound energy of a noise source decreases with increasing distance from the source. In the case of hemispherical sound propagation, the source is located on a flat continuous plane/surface (e.g., ground), and the sound radiates hemispherically (i.e., outward, over and above the surface) from the sound source. The following equation is the theoretical decrease of sound energy when determining the resulting SPL values of a noise source at a specific distance ("r") of a receiver from the estimated PWL values:

> Decrease in SPL ("hemispherical propagation") from a noise source = **20*log(r) – 2.3 dB**
> where "r" is distance of the receiver from the noise source.

Attenuation due to air absorption: Air absorbs sound energy, and the amount of absorption ("attenuation") is dependent on the temperature and relative humidity (R.H.) of air and frequency of sound. For example, the attenuation due to air absorption for 1000 Hz O.B. SPL is approximately **1.5 dB per 1,000 feet for standard day conditions (i.e., no wind, 60 deg. F. and 70% or 50% R.H.).

The estimated unweighted O.B. PWLs of the motor-driven pumps, piping, substation equipment and any other site equipment were estimated from field sound measurements by H&K on similar equipment and/or from sound data provided by the equipment manufacturer.

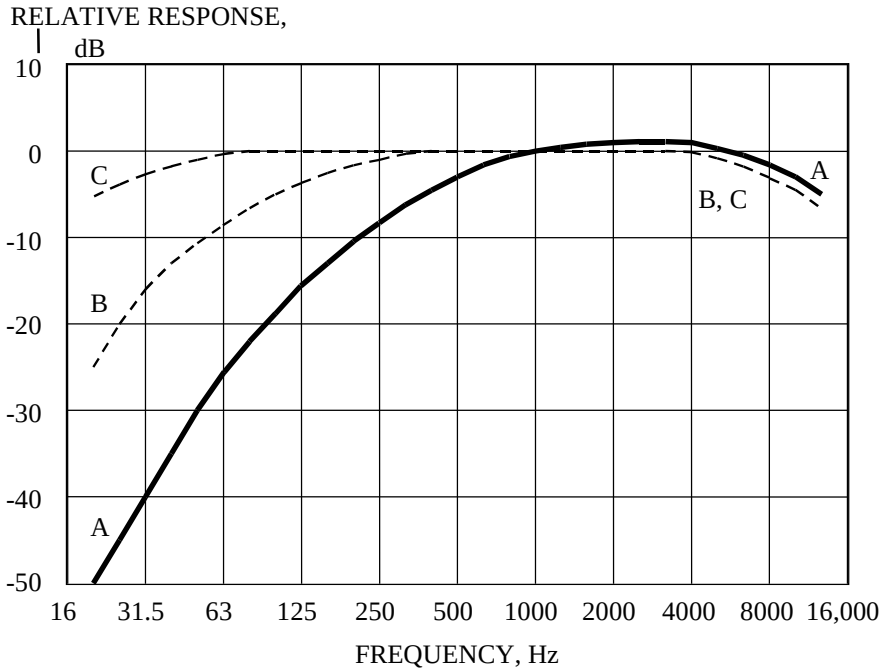
APPENDIX: Summary of Acoustical Terminology, Typical Metrics for Regulating Environmental Noise and Sound Levels for Typical Activities

(1) Decibel ("dB"): A unit for expressing the relative power level difference between acoustical or electrical signals. It is ten times the common logarithm of the ratio of two related quantities that are proportional to power. When adding dB or dBA values, the values must be added logarithmically. For example, the logarithmic addition of **35 dB** plus **35 dB** is **38 dB**.

(2) A-Weighted Sound Level ("dBA"): The A-wt. sound level is a single-figure sound rating, expressed in decibels (Re 20 μPa), which correlates to the human perception of the loudness of sound. The dBA level is commonly used to measure industrial and environmental noise since it is easy to measure and provides a reasonable indication of the human annoyance value of the noise. The dBA measurement is not a good descriptor of a noise consisting of strong low-frequency components or for a noise with tonal components.

The A-weighted curve approximates the response of the average ear at sound levels of 20 to 50 decibels. The following are the relative response of A-weighted filter per octave band frequency, and a graph/curve is provided that shows a graphical representation of the A-wt. filter response per frequency (in Hz).

31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1,000 Hz	2,000 Hz	4,000 Hz	8,000 Hz	16,000 Hz
-39.4 dB	-26.2 dB	-16.1 dB	-8.6 dB	-3.2 dB	0 dB	+1.2 dB	+1.0 dB	-1.1 dB	-6.6 dB



(3) Human Perception of Change in Sound Level

- A **3 dB** change of sound level is barely perceivable by the human ear
- A **5 or 6 dB** change of sound level is noticeable
- If sound level increases by **10 dB**, it appears as if the sound intensity has doubled.

(4) Background or Ambient Noise: The total noise produced by all other sources associated with a given environment in the vicinity of a specific source of interest, and includes any Residual Noise.

(5) Sound Pressure Level ("L_p or SPL"): Ten times the common logarithm to the base 10 of the ratio of the mean square sound pressure to the square of a reference pressure. Therefore, the sound pressure level is equal to 20 times the common logarithm of the ratio of the sound pressure to a reference pressure (20 micropascals or 0.0002 microbar).

(6) Octave Band SPL: Sound is typically measured in frequency ranges (e.g., high-pitched sound, low-pitched sound, etc.) that provides more meaningful sound data regarding the sound character of the noise. When measuring two noise sources for comparison, it is better to measure the spectrum of each noise, such as in octave band SPL frequency ranges. Then, the relative loudness of two sounds can be compared frequency range by frequency range. As an illustration, two noise sources can have the same dBA rating and yet sound completely different. For example, a high-pitched sound concentrated at a frequency of 2000 Hz could have the same dBA rating as a much louder low-frequency sound concentrated at 50 Hz.

(7) Daytime Sound Level ("L_d") & Nighttime Sound Level ("L_n"): L_d is the equivalent A-weighted sound level, in decibels, for a 15 hour time period, between 07:00 to 22:00 Hours (7:00 a.m. to 10:00 p.m.). L_n is the equivalent A-weighted sound level, in decibels, for a 9 hour time period, between 22:00 to 07:00 Hours (10:00 p.m. to 7:00 a.m.).

(8) Equivalent Sound Level ("L_{eq}"): The equivalent sound level (L_{eq}) can be considered an average sound level measured during a period of time, including any fluctuating sound levels during that period. In this report, the L_{eq} is equal to the level of a steady (in time) A-weighted sound level that would be equivalent to the sampled A-weighted sound level on an energy basis for a specified measurement interval. The concept of the measuring L_{eq} has been used broadly to relate individual and community reaction to aircraft and other environmental noises.

(9) L-Percent Sound Levels: The L percent levels (e.g., L_{50}, L_{90} & L_{10}) refer to the A-wt. sound levels that are exceeded for 90, 50 and 10 percent of the time, respectively, during a measurement period. For example, the 90-percentile exceeded sound level, designated to as L_{90}, is the A-wt. sound levels that are exceeded for 90 percent of the time and is considered the typical lowest anticipated sound levels. The range between the L_{10} and L_{90} values usually provides a good indication of the variability of the sound levels during the period of measurement.

(10) Sound Level Meter ("SLM"): An instrument used to measure sound pressure level, sound level, octave-band SPL, or peak sound pressure level, separately or in any combinations thereof. The measured weighted SPL (i.e., A-Wt. Sound Level or dBA) is obtained by the use of a SLM having a standard frequency-filter for attenuating part of the sound spectrum.

(11) Sound Power Level ("L_W or PWL"): Ten times the common logarithm of the ratio of the total acoustic power radiated by a sound source to a reference power. A reference power of a picowatt or 10^{-12} watt is conventionally used.

(12) Tone: A tone is a sound sensation-having pitch, which is a listener's perception of the frequency (for example, the higher the frequency, the higher the pitch). For a measured sound spectrum, a tone is represented as a "peak" in the spectrum curve. Noise that contains significant tones is considered a tonal type of noise.

(13) List of Common Environmental (i.e., Man-Made & Natural) Noise Sources: For reference, the following **Table** presents a list of some common environmental (i.e., man-made and natural) noise sources as compared to the estimated sound level of the pumping station at the closest NSAs. Note that inside a typical house, the noise level of an outdoor noise source is approximately **15 to 20 dB** quieter (i.e., house typically provides at least **15 to 20 dB** noise reduction).

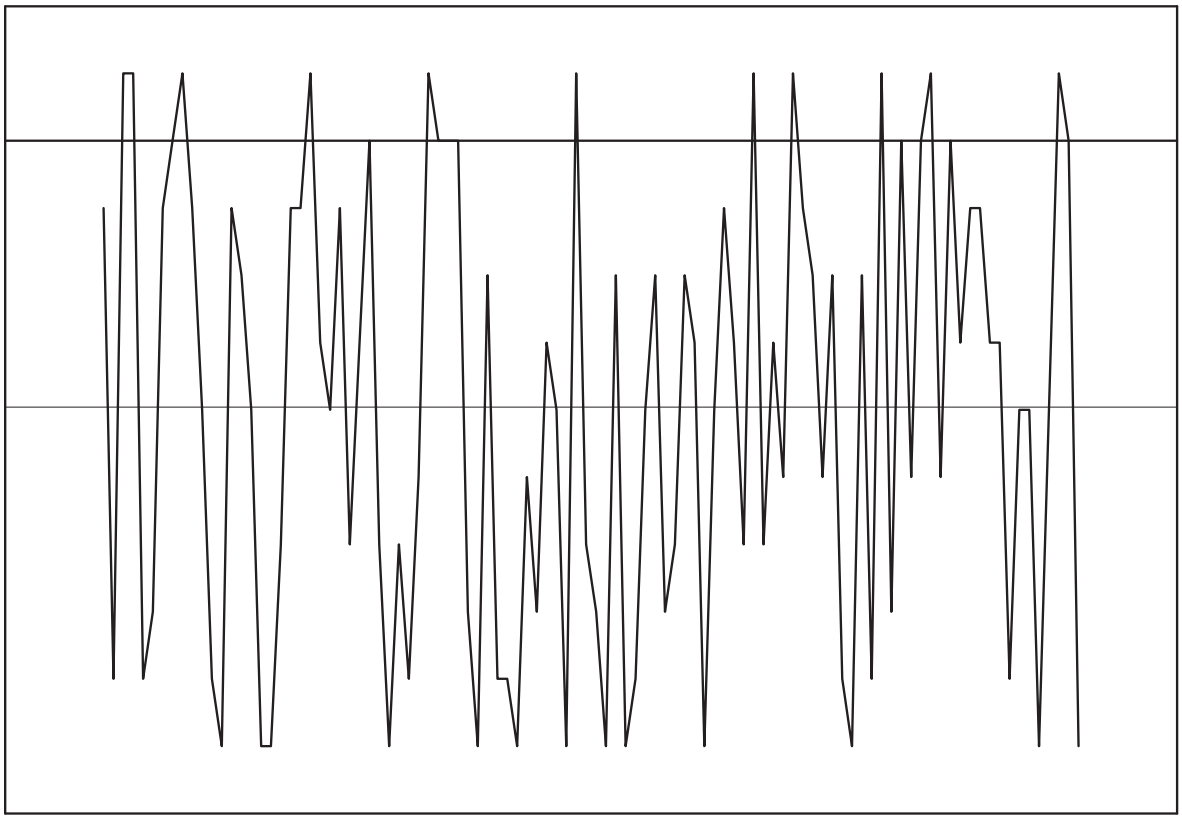
Type of Noise Source	Approx. A-Wt. Sound Level	Approximate Distance To Noise Source
Lawn mower (outdoor)	50 – 55 dBA	150 to 200 feet
Passenger cars @ 50 – 60 mph (outdoor)	50 – 55 dBA	250 to 300 feet
Residential AC unit (outdoor)	50 – 60 dBA	40 to 50 feet
Residential AC unit (outdoor)	35 – 45 dBA	200 to 250 feet
Chemical plant (outdoor)	40 – 50 dBA	½ mile from plant
Cicadas (outdoor, summertime @ night)	50 – 55 dBA	General area of insects
Window AC unit (indoor)	50 – 60 dBA	5 to 20 feet
TV @ normal listening level (indoor)	60 – 70 dBA	10 to 15 feet
Vacuum cleaner (indoor)	70 – 75 dBA	10 to 15 feet

List of Some Common Environmental Noise Sources compared to Station Sound Level at Closest NSAs

End of Report

Appendix M.4

A Guide to Noise Control in Minnesota



A Guide to Noise Control in Minnesota

Acoustical Properties, Measurement, Analysis and Regulation

Minnesota Pollution Control Agency

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p-gen6-01

Forward

The Minnesota Pollution Control Agency (MPCA) is empowered to enforce the state of Minnesota noise rules. These rules and supporting acoustical information can be viewed in the document, A Guide to Noise Control in Minnesota.

This publication is intended to provide information on the basics of sound and noise regulation.

Revised 2008

Table of Contents

Figures

Summary of Key Points

Minnesota's noise pollution rules are based on statistical calculations that quantify noise levels according to duration over a one-hour monitoring period. The L10 calculation is the noise level that is exceeded for 10 percent, or six minutes, of the hour, and the L50 calculation is the noise level exceeded for 50 percent, or 30 minutes, of the hour. There is not a limit on maximum noise.

The statutory limits for a residential location are L10 = 65 dBA and L50 = 60 dBA during the daytime (7:00 a.m – 10:00 p.m.) and L10 = 55 dBA and L50 = 50 dBA during the nighttime (10:00 p.m. – 7:00 a.m.) (Minn. State Noise Pollution Control Rules 7030.0040). This means that during the one-hour period of monitoring, daytime noise levels cannot exceed 65 dBA for more than 10 percent of the time, and cannot exceed 60 dBA more than 50 percent of the time.

Decibel levels of common noise sources

140 ----------	Jet Engine (at 25 meters)
130 ----------	Jet Aircraft (at 100 meters)
120 ----------	Rock Concert
110 ----------	Pneumatic Chipper
100 ----------	Jackhammer (at one meter)
90 ----------	Chainsaw, Lawn Mower (at one meter)
80 ----------	Heavy Truck Traffic
70 ----------	Business Office, Vacuum Cleaner
60 ----------	Conversational Speech, Typical TV Volume
50 ----------	Library
40 ----------	Bedroom
30 ----------	Secluded Woods
20 ----------	Whisper

Distance attenuation

When the distance is doubled from a *point* source, such as a building, the sound level decreases by *six* decibels.

Example: *50 feet = 60 decibels*
100 feet = 54 decibels
200 feet = 48 decibels

When the distance is doubled from a *line* source, like a busy roadway, the sound level decreases by *three* decibels.

Example: *50 feet = 70 decibels*
100 feet = 67 decibels
200 feet = 64 decibels

Addition and subtraction of sources

A doubling of energy, or doubling of identical sources, yields an increase of *three* decibels.

Example: 85 decibels + 85 decibels = 88 decibels

Change in decibel level and perceived change in loudness

± 1 dBA……..	Not Noticeable
± 3 dBA……..	Threshold of Perception
± 5 dBA……..	Noticeable Change
± 10 dBA……	Twice (Half) As Loud
± 20 dBA……	Four Times (One Fourth) As Loud

Monitoring guidelines

The noise source being measured should be at least 10 dBA above the background noise level.
Keep at least as far away from any large reflecting object as from the source being measured. If this is not possible, stay at least 30 feet from structures.

All measurements should be made with the microphone at lease three feet above the ground, in relatively calm weather.

Introduction

Noise is a pollutant. While its physical and emotional effects are difficult to define quantitatively, the sound level itself can be measured.

Sound is an alteration of pressure that propagates through an elastic medium such as air and produces an auditory sensation.

Noise is any undesired sound.

Waves and sound pressure level

Sound travels in a wave motion through the air to our ears. An effective tool to demonstrate wave motion is a weight hanging from a spring. Picture the following diagram as a single weight and spring combination varying as time progresses along the horizontal axis.

Weight on a spring – Example of periodic motion

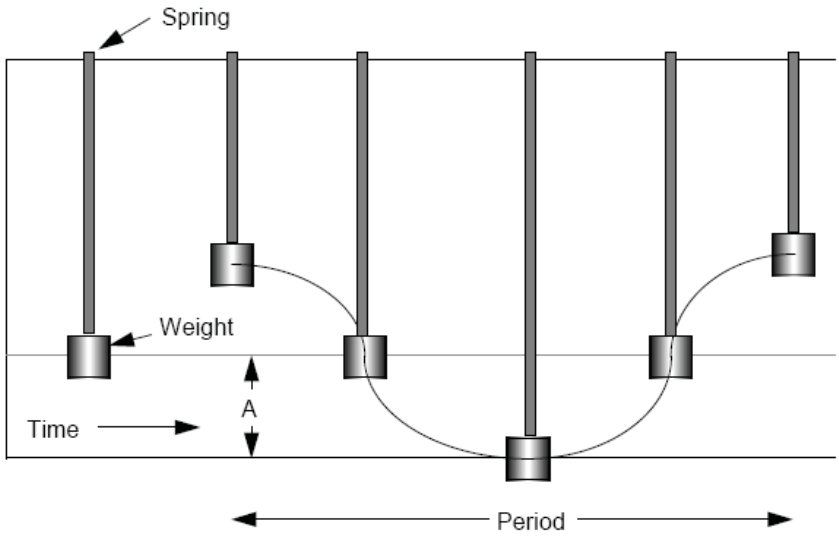


Figure 1

In Figure 1, the first position of the weight on the spring is at rest with no forces exerted upon the system. If the weight is raised above its point of rest and the progression of the weight moving down and up again is observed over a period of time, a sinusoidal wave form is produced. This example demonstrates the relationship between a linear motion, the weight bouncing on the spring, and its corresponding wave form.

The *amplitude* of the moving weight is denoted as A on the diagram and corresponds with the maximum displacement of the weight from its "at rest" position, or the peak of the wave form in the positive or negative direction. We perceive changes in amplitude as changes in loudness.

The *period* of the vibration is the amount of time taken to produce one complete cycle. The number of cycles per second defines the *frequency* of the periodic motion, denoted by the unit of *hertz*, or *Hz*. We perceive different frequencies as higher or lower pitched sounds.

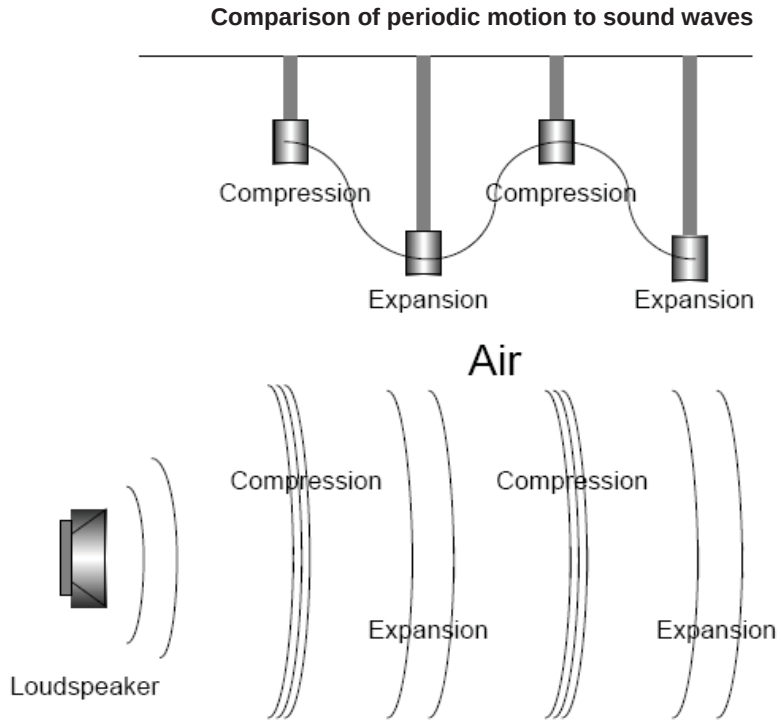


Figure 2

The graphical representation of sounds in Figure 2 is of *pure tones***,** which are sounds made up of a single frequency. A familiar example of a pure tone is the sound produced when a single key of a piano is pressed. For instance, the middle C key on a piano vibrates the associated wire at a rate of approximately 260 times per second or 260 Hertz. The vibration of the wire transfers its motion to the sound board of the piano, which then vibrates at the same frequency, causing the air adjacent to the sound board to form compression and expansion waves in the air emitting outward from the sound board. When received by the human ear, this is regarded as sound.

Most sounds are not pure tones but a mixture of tones of varying amplitude, frequency, and duration. The intensity of sound waves produce a sound pressure level, measured in a unit called the *decibel*, or *dB.* The decibel is a logarithmic measurement used to accommodate a numbering scheme that encompasses a large range of values. The logarithm is used because the human ear can detect sounds more than a million times quieter than a jet aircraft during take off.

Sound pressure level = 20 Log_{10} (Measured Sound Pressure / Reference Pressure)
Reference Pressure = 0.00002 Newton's / $(\text{meter})^2$

Decibel = The ratio between two quantities that are proportional to power. The unit of measurement for sound pressure levels, abbreviated dB.

Decibel levels of common noise sources

Many different properties affect the noise level of a specific source type. For example, three lawn mowers may have three different noise levels because of differences in each specific piece of equipment. Noise level also depends on the distance from the noise source and the attenuation of the surrounding environment.
Figure 3 provides a rough estimate of decibel levels of some common noise sources.

Decibel levels of common noise sources

Sound pressure level (dBA)	Noise source
140	Jet Engine (at 25 meters)
130	Jet Aircraft (at 100 meters)
120	Rock Concert
110	Pneumatic Chipper
100	Jackhammer (at 1 meter)
90	Chainsaw, Lawn Mower (at 1 meter)
80	Heavy Truck Traffic
70	Business Office, Vacuum Cleaner
60	Conversational Speech, Typical TV Volume
50	Library
40	Bedroom
30	Secluded Woods
20	Whisper

Figure 3

Using Decibel Measurements

Addition and subtraction of decibels is often necessary for estimating total noise levels or background noise. Because decibels are measured using a logarithmic scale, conventional linear mathematics cannot be used. The most convenient way to perform simple arithmetic functions involving logarithmic measurements is to use doubling rules. These rules provide an accurate estimate of the effect distance and multiple sources have on measured sound pressure level.

Sound propagation and sources

Sources of sound can be defined as *point* or *line* sources, based on the way sound pressure waves spread away from the source. Sound waves propagate from sources in a way similar to waves traveling away from a rock dropped in a pond. A *point* source, like a factory, emits sound that spreads out in a sphere. A *line* source, like a busy highway, emits sound that spreads out in a cylinder. Knowing the sources of sounds makes it possible to make assumptions about how the sound behaves.

Distance attenuation estimations

Over distance, sound attenuates, or is reduced in amplitude, and is perceived as the sound becoming quieter. This occurs as the sound travels outward to an increasingly larger sphere or cylinder, and the energy per unit of area decreases. These basic principles allow us to make generalized assumptions about sound.

When the distance is doubled from a *line* source, the sound level decreases three decibels.

Example: If a sound level is: 70 decibels at 50 feet it will be
67 decibels at 100 feet, and
64 decibels at 200 feet.

When the distance is doubled from a *point* source, the sound level decreases six decibels.

Example: If a sound level is: 95 decibels at 50 feet it will be
89 decibels at 100 feet, and
83 decibels at 200 feet.

Distance attenuation of noise levels from a point source

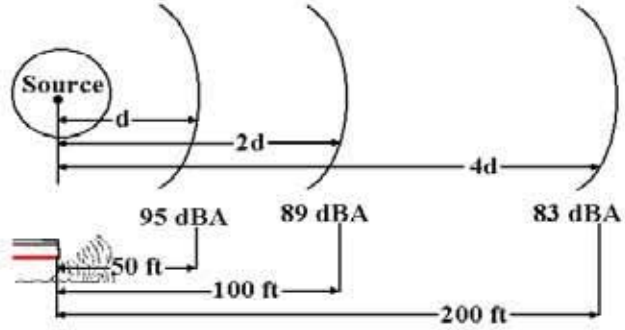


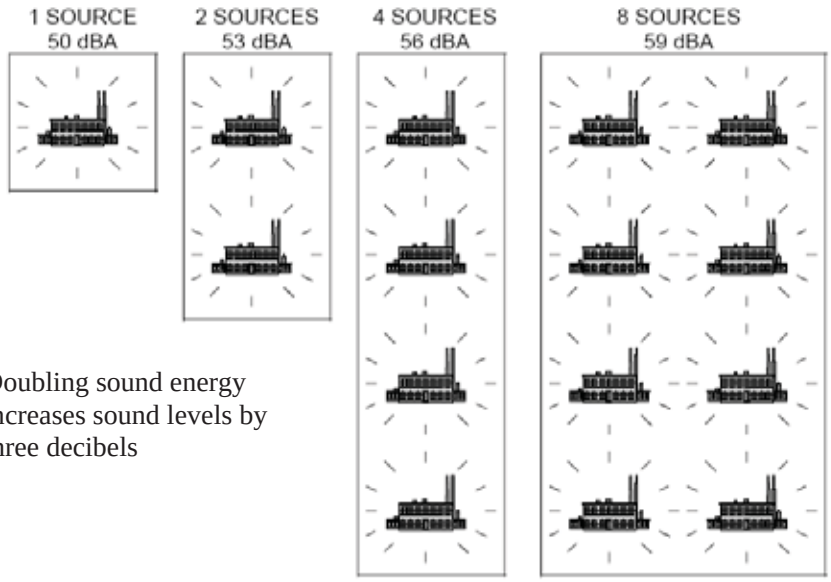
Figure 4

Addition and subtraction of decibel levels

In many situations pertaining to noise control and monitoring, it is very useful to be able to add and subtract noise levels. This can be done with principles similar to how sound attenuation over distance is estimated. It is important to note the characteristics of logarithmic addition or subtraction of decibel levels.

A doubling of sound energy yields an increase of three decibels. For example, each generator at a factory produces sound that is measured at 50 decibels, so running one generator would create sound measured at 50 dBA, turning on a second generator would increase sound by 3 dBA to 53 dBA, and doubling again to four generators would increase sound levels to 56 dBA. Figure 5 illustrates this principle.

Addition and subtraction of decibel levels



Doubling sound energy increases sound levels by three decibels

Figure 5

Background noise

Background, or ambient, noise is present in any environmental noise-monitoring situation. Background noise is considered to be all noise sources other than the noise source being monitored. This can include traffic, animals, machinery, voices, and other sounds.

Wind may be a major source of ambient noise. The MPCA's noise test procedures states that measurements should not be made when noise from wind or precipitation results in a difference between the background sound level and noise source being measured that is less than 10 dBA. In practice, this means that wind speeds must be below 11 mph, and rainy weather conditions should be avoided.

Background noise correction

Background noise could impact monitoring results. The background noise must be more than 10 decibels below the noise level of the source being monitored to have confidence in the accuracy of the measurement.

In certain instances, when a single noise source is analyzed along with other noise sources, correction factors can be used to isolate the noise source being monitored and calculate its individual noise level. This is done by measuring and recording the total noise level of all sources. Next, the noise source to be isolated is turned off and a noise level reading is taken with all the other existing noise sources in operation. Total noise level is then subtracted from the background noise level.

Background noise correction

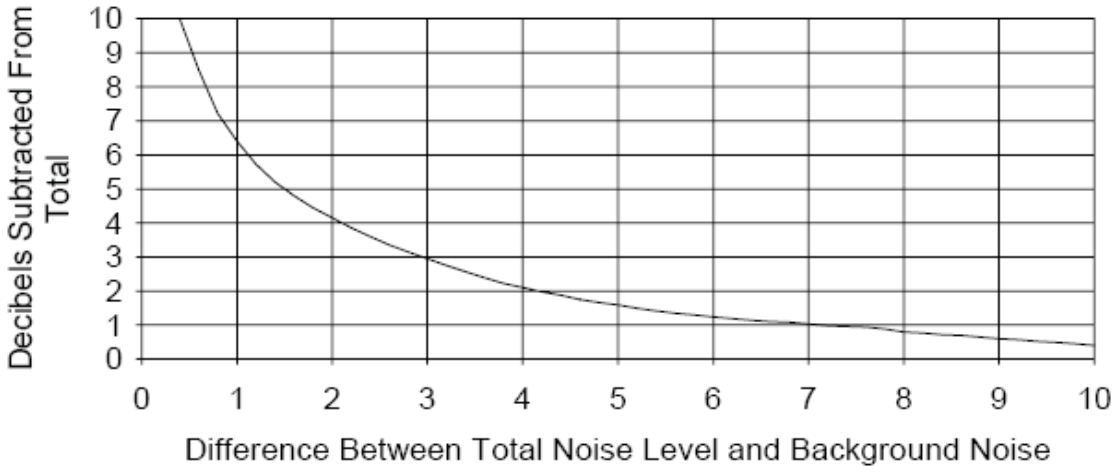


Figure 6

Figure 6 is a graph used to estimate the amount of background noise influencing a measurement, and the corresponding decibel level to be subtracted from the total measurement to determine the decibel level of the noise source being monitored.

For example, if the total noise level is 84 dBA, and then falls to 80 dBA when the source of interest is turned off, the difference of four decibels between the total noise level and background noise indicates that two decibels should be subtracted from the total. This means that an 82 dBA noise level can be attributed to the monitored source in the absence of background noise.

Human Perception of Sound

Sounds qualitative aspects that can be described with adjectives, and quantitative aspects that can be described with measurements. Sound can be perceived as pleasant or annoying, and as loudness, in terms of decibels.

Changes in loudness are described on a logarithmic scale because the human ear can hear such a wide variety of sound levels. The human ear can usually tell the difference when sound changes by 3 dBA, and a 5 dBA change is clearly noticeable. Because of the logarithmic scale, an increase of 10 dBA sounds twice as loud.

Change in decibel level and perceived change in loudness

± 1 dBA……..	Not Noticeable
± 3 dBA……..	Threshold of Perception
± 5 dBA……..	Noticeable Change
± 10 dBA……	Twice (Half) As Loud
± 20 dBA……	Four Times (One Fourth) As Loud

Figure 7

Compared to the example of addition or subtraction of sources, doubling sources yielded an increase of 3 dBA, which is a change that is just perceptible.

Weighting networks

Sound level meters used for monitoring can pick up sounds as a perfect computer, but the human ear is not so precise. The human ear cannot hear lower frequencies as well as higher frequencies.

Weighting networks are used in noise monitors to attenuate specific frequencies in the audio spectrum to attempt to duplicate the response of the human ear. The graph in Figure 8 represents the compensation of a C-weighting network, A-weighting network and the sensitivity of the ear. This illustration is useful in understanding how the ear is inefficient in the detection of lower frequencies and is very sensitive to higher frequencies.

The C-weighting network represents the actual sound pressure level that is received by the sound level meter, and does not noticeably vary in its amount of compensation throughout the audio spectrum. C-weighting is used during the calibration of sound level meters to ensure that the sound level displayed on the meter is invariant of the frequency of the calibrator.

The A-weighting network is used to duplicate the sensitivity of the human ear. At 100 Hertz, the A-weighting network filters out approximately 20 dB from the incoming signal before it is combined with the levels from the other frequency ranges to produce an A-weighted sound level.

Weighting networks

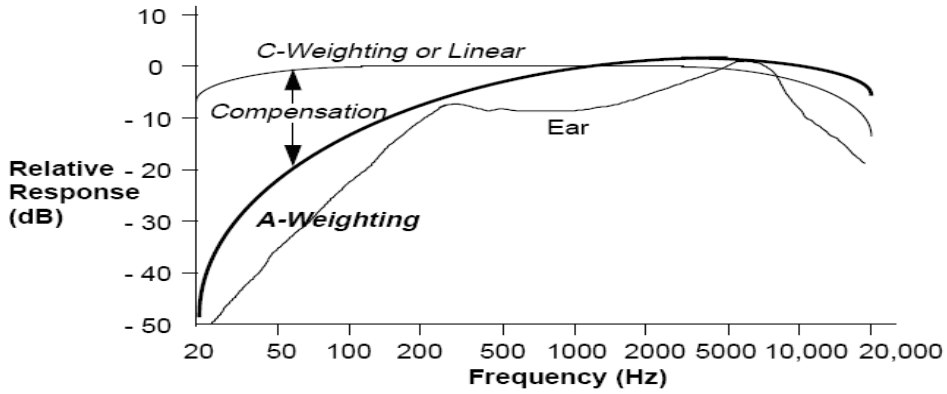


Figure 8

Measurement Procedures

This guide contains two measurement procedures. The general protocols remain the same, but your choice of procedure depends on the capabilities of your sound level meter (SLM). NTP-1 should be used if your SLM is capable of calculating monitoring results and NTP-2 should be used if your SLM only displays instantaneous readings.

Your sound level meter and microphone must comply with the specifications for ANSI S1.4-1983 Type 0, 1, 2, or S. You must also have a calibrator of a known frequency and sound level. Calibrators should be compared to a lab standard periodically.

Measurements should not be made when noise from wind or precipitation results in a difference between the background sound level and noise source being measured that is less than 10 dBA. In practice, this means that wind speeds must be below 11 mph, and rainy weather conditions should be avoided. Temperature and humidity should be within equipment specifications.

Properly choosing a monitoring location is an important consideration. Measurements should be made in an area of normal outdoor human activity, nearest to the noise source. The monitoring location may not necessarily be at the property line, such as if the property of the complainant is large and evidence of outdoor activity is limited to a backyard patio.

Another important part of site selection is the consideration of errors caused by reflecting objects. Figure 9 shows the effect on noise measurements of a reflective object such as a wall.

Errors caused by reflecting objects

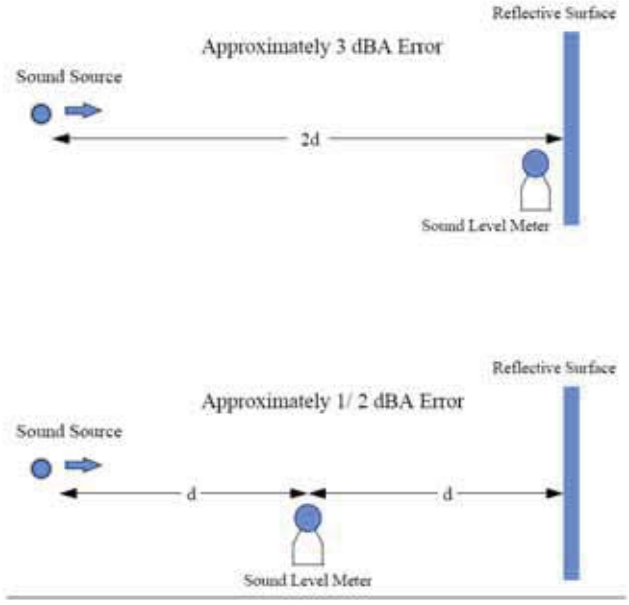


Figure 9

NTP-1 Measurement procedure for non-impulsive noise

The following test procedure has been approved by the Executive Director of the MPCA for the measurement of non-impulsive noise.

Instrumentation:

- a sound level meter and a microphone conforming to type 0, 1, 2, or S specifications under ANSI S1.4-1983
- a calibrator of known frequency and level
- a small screwdriver for sensitivity adjustment
- microphone windscreen
- noise survey form
- tripod (optional)

Meteorology:

- Measurements must not be made in sustained winds or in precipitation which results in a difference of less than 10 decibels between the background noise level and the noise source being measured
- Temperature and/or humidity conditions must be within the equipment manufacturer's specifications

Location:

- Measurements must be made at or within the applicable NAC at the point of human activity nearest the noise source.
- Measurements must be made outdoors.
- Measurements must be made at least three feet off the ground and away from natural or manmade structures which would prevent an accurate measurement (barriers, houses).

Survey Procedure:

- Monitoring must be conducted for at least a one hour time period.
- Calibration must be performed before and after the monitoring period. Adjustments should be made if necessary.
- Sound measuring devices must use the "A" weighting and FAST response characteristics.
- Background noise must be at least 10 decibels lower than the noise source being measured.
- A survey form must be completed containing date, time, location, noise source, wind speed/direction, temperature, humidity, equipment information (make, model, serial number), site sketch with the location of the noise source and measurement location (including appropriate distances), data and calibration information. A sample survey form is on the following pages.
- Follow your manufacturer instructions to obtain the L10 and L50 results.

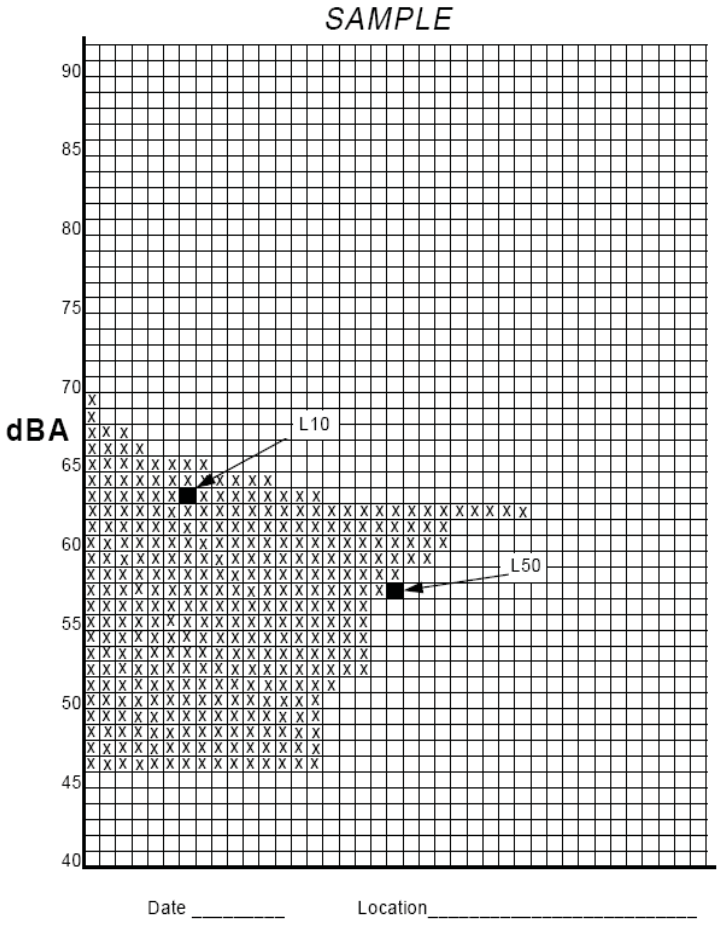
NTP-2 Manual measurement procedure for non-impulsive noise

The following test procedure has been approved by the Executive Director of the MPCA for the measurement of non-impulsive noise.

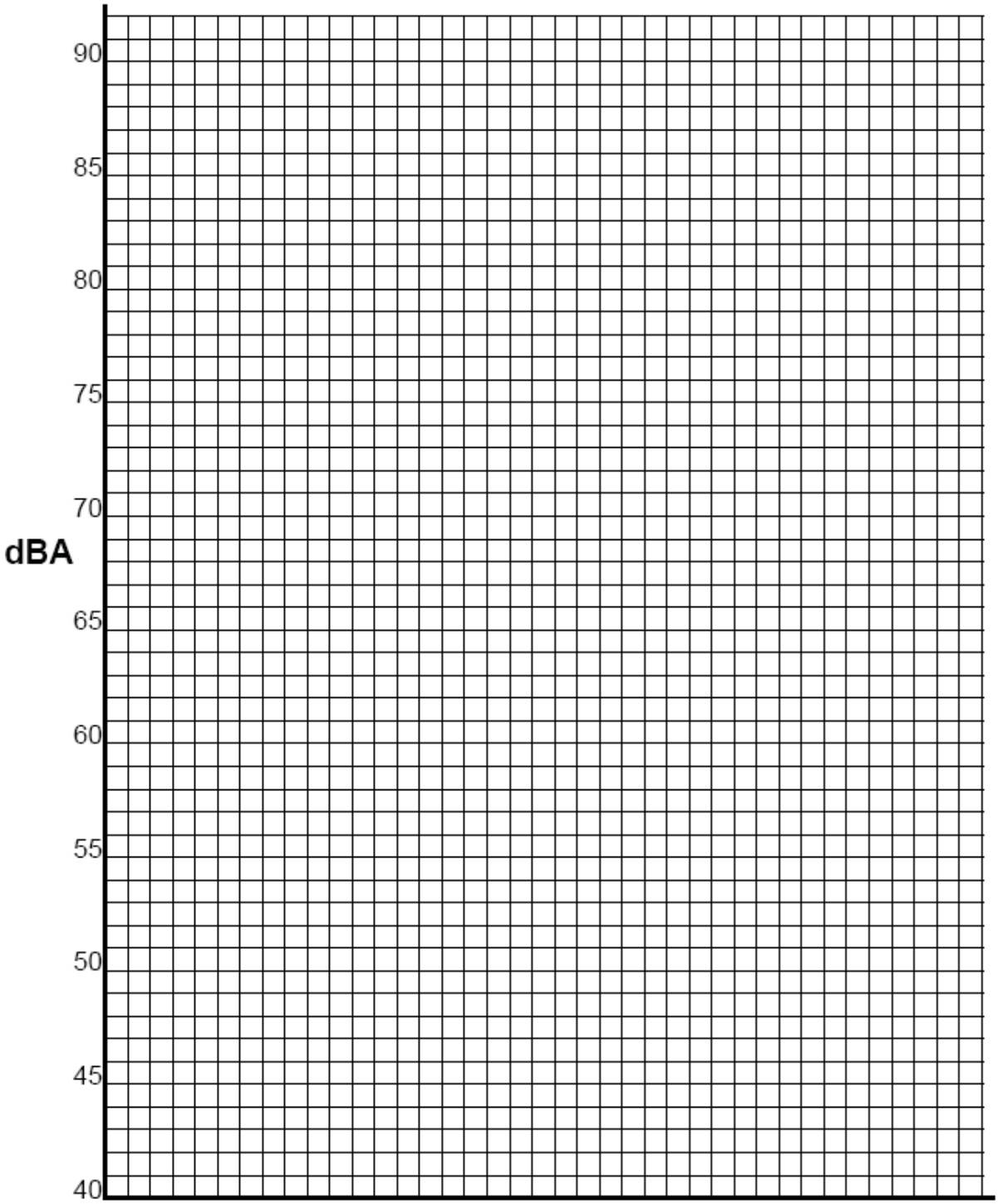
(Instrumentation, Meteorology, Location, and Survey Procedure Identical to NTP-1 Test Procedures)

Manual monitoring procedure:

- Using a hand-held sound level meter, take an instantaneous sound reading every 10 seconds and record on a sample sheet. A partner is very helpful.
- Continue taking sound readings for one hour, which will give you 360 individual readings. An example of a "sample sheet" is below.
- To determine the L10, take the 36th loudest (10 percent of 360 = 36) individual sound reading by counting from the loudest to the quietest on the "sample sheet" In the example on the next page, the L10 = 63 and is the 36th **X** from the top of the sheet.
- To determine the L50, take the 180th loudest (50 percent of 360 = 180) individual sound reading. In the example, the L50 = 57 and represents the 180th **X** from the top of the sheet.



Manual Monitoring Data Sheet



Date _____ Location_____

Noise survey

Investigator_____ Date_____

SLM Manufacturer and Model_____ Serial Number _____

Calibrator Manufacturer and Model _____

Calibrator Serial Number_____ Calibrator Frequency (Hz)_____

Initial Calibration (dBA)_____ Final Calibration (dBA) _____

Meteorological Conditions: Wind Speed_____ Direction_____ Temperature_____

Source_____

Monitor Location_____

Time Start_____ Time End_____

Results L10_____dBA L50_____dBA

Diagram *(Indicate noise source, receiver, microphone location, reflecting objects, obstructions, landmarks, and distances)*

Regulatory Agencies

Several agencies have noise regulations for different noise sources. Noise regulations are either source standards or receiver-based standards.

Department of Natural Resources (DNR) - The Minnesota DNR has source standards for snowmobiles, motorboats, personal watercraft and off-highway vehicles. For more information see: http://www.dnr.state.mn.us/index.html.

Federal Aviation Administration (FAA) - The FAA has source regulations for commercial jet engines. All commercial jet engines must meet noise emission criteria prior to being certified for flight.

Metropolitan Airport Commission (MAC) - The MAC is responsible for all noise issues related to the Minneapolis St. Paul International Airport and reliever airports. For more information see: http://www.macnoise.com/.

Minnesota Department of Transportation (Mn/DOT) – Mn/DOT is responsible for state highway noise mitigation. For more information see: http://www.dot.state.mn.us/environment/index.html.

Federal Highway Administration (FHWA) - The FHWA does not have actual noise standards, but has a 70 dBA L10guideline that is used to determine federal funding for noise abatement on highway projects.

Federal Railroad Administration (FRA) - Regulation of railroad related noise is the responsibility of the FRA. For more information see: http://www.fra.dot.gov/.

Housing and Urban Development (HUD) - HUD has noise regulations that establish acceptable noise zones for HUD housing projects.

Occupational Safety and Health Administration (OSHA) - OSHA has regulations to protect against hearing loss in the workplace. These are “dose standards” that restrict the amount of noise an employee receives over a period of time, such as eight hours.

Local Agency - A local governing agency, such as a city or county, has some responsibility for enforcing noise standards and may have an ordinance regulating noise levels.

Minnesota Pollution Control Agency (MPCA) - The MPCA has a receiver-based standard intended to limit noise levels and protect the health and welfare of the general public.

Minnesota Noise Pollution Statute and Rule

Minn. Stat. § 116.07 Powers and duties.

Subd. 2. Adoption of standards

The MPCA shall … also adopt standards describing the maximum levels of noise in terms of sound pressure level which may occur in the outdoor atmosphere, recognizing that due to variable factors no single standard of sound pressure is applicable to all areas of the state. Such standards shall give due consideration to such factors as the intensity of noises, the types of noises, the frequency with which noises recur, the time period for which noises continue, the times of day during which noises occur, and such other factors as could affect the extent to which noises may be injurious to human health or welfare, animal or plant life, or property, or could interfere unreasonably with the enjoyment of life or property.

In adopting standards, the MPCA shall give due recognition to the fact that the quantity or characteristics of noise or the duration of its presence in the outdoor atmosphere, which may cause noise pollution in one area of the state, may cause less or not cause any noise pollution in another area of the state, and it shall take into consideration in this connection such factors, including others which it may deem proper, as existing physical conditions, zoning classifications, topography, meteorological conditions and the fact that a standard which may be proper in an essentially residential area of the state, may not be proper as to a highly developed industrial area of the state. Such noise standards shall be premised upon scientific knowledge as well as effects based on technically substantiated criteria and commonly accepted practices.

No local governing unit shall set standards describing the maximum levels of sound pressure which are more stringent than those set by the MPCA.

Subd. 2a. Exemptions from standards

No standards adopted by any state agency for limiting levels of noise in terms of sound pressure which may occur in the outdoor atmosphere shall apply to:

A. segments of trunk highways constructed with federal interstate substitution money, provided that all reasonably available noise mitigation measures are employed to abate noise,
B. an existing or newly constructed segment of a highway, provided that all reasonably available noise mitigation measures, as approved by the commissioners of the Department of Transportation and MPCA, are employed to abate noise,
C. except for the cities of Minneapolis and St. Paul, an existing or newly constructed segment of a road, street, or highway under the jurisdiction of a road authority of a town, statutory or home rule charter city, or county, except for roadways for which full control of access has been acquired,
D. skeet, trap or shooting sports clubs, or
E. motor vehicle race events conducted at a facility specifically designed for that purpose that was in operation on or before July 1, 1996.

Nothing herein shall prohibit a local unit of government or a public corporation with the power to make rules for the government of its real property from regulating the location and operation of skeet, trap or shooting sports clubs, or motor vehicle race events conducted at a facility specifically designed for that purpose that was in operation on or before July 1, 1996.

Minn. Rules § 7030 Noise pollution

7030.0010 Incorporation by reference

For the purpose of chapter 7030, American National Standards Institute, Specification for Sound Level Meters, S1.4-1983 is incorporated by reference. This publication is available from the American National Standards Institute, 25 West 43rd Street 4th Floor, New York, N.Y. 10036 and can be found at: the offices of the MPCA

520 Lafayette Road North, St. Paul, Minnesota 55155; the Government Documents Section, Room 409, Wilson Library, University of Minnesota, 309 19th Avenue South, Minneapolis, Minnesota 55454; and the State of Minnesota Law Library, 25 Constitution Avenue, Saint Paul, Minnesota 55155. This document is not subject to frequent change.

The Federal Highway Administration publication, Sound Procedures for Measuring Highway Noise: Final Report, FHWA-DP-45-1R (August 1981) is incorporated by reference. This publication is available from the United States Department of Transportation, Federal Highway Administration, 1200 New Jersey Avenue S.E., Washington D.C. 20590 and can be found at: the offices of the MPCA, 520 Lafayette Road North, St. Paul, Minnesota 55155; the Government Documents Section, Room 409, Wilson Library, University of Minnesota, 309 19th Avenue South, Minneapolis, Minnesota 55454; and the State of Minnesota Law Library, 25 Constitution Avenue, Saint Paul, Minnesota 55155. This document is not subject to frequent change.

7030.0020 Definitions

Subpart 1. Application
The terms used in chapter 7030 have the meanings given them in this part.

Subp. 2. A-weighted
A-weighted means a specific weighting of the sound pressure level for the purpose of determining the human response to sound. The specific weighting characteristics and tolerances are those given in American National Standards Institute S1.4-1983, section 5.1.

Subp. 3. Daytime
Daytime means those hours from 7:00 a.m. to 10:00 p.m.

Subp. 4. dB(A)
dB(A) means a unit of sound level expressed in decibels (dB) and A-weighted.

Subp. 5. Decibel
Decibel means a unit of sound pressure level, abbreviated as dB.

Subp. 6. Impulsive noise
Impulsive noise means either a single sound pressure peak (with either a rise time less than 200 milliseconds or total duration less than 200 milliseconds) or multiple sound pressure peaks (with either rise times less than 200 milliseconds or total duration less than 200 milliseconds) spaced at least by 200 millisecond pauses.

Subp. 7. L10
L10 means the sound level, expressed in dB (A), which is exceeded 10 percent of the time for a one hour survey, as measured by test procedures approved by the commissioner.

Subp. 8. L50
L50 means the sound level, expressed in dB(A), which is exceeded 50 percent of the time for a one hour survey, as measured by test procedures approved by the commissioner.

Subp. 9. Municipality
Municipality means a county; a city; a town; a regional planning and development commission established under Minnesota Statutes, chapter 473; the metropolitan council; or other governmental subdivision of the state responsible by law for controlling or restricting land use within its jurisdiction.

Subp. 10. Nighttime
Nighttime means those hours from 10:00 p.m. to 7:00 a.m.

Subp. 11. Person
Person means any human being, any municipality or other governmental or political subdivision or other public department or agency, any public or private corporation, any partnership, firm, association, or other organization, any receiver, trustee, assignee, agency, legal entity, other than a court of law, or any legal representative of any of the foregoing, but does not include the agency.

Subp. 12. Sound pressure level
Sound pressure level, in decibels, means 20 times the logarithm to the base 10 of the ratio of the pressure to the reference pressure. The reference pressure shall be 20 micronewtons per square meter.

No person may violate the standards established in part 7030.0040, unless exempted by Minnesota Statutes, section 116.07, subdivision 2a. Any municipality having authority to regulate land use shall take all reasonable measures within its jurisdiction to prevent the establishment of land use activities listed in noise area classification (NAC) 1, 2, or 3 in any location where the standards established in part 7030.0040 will be violated immediately upon establishment of the land use.

7030.0030 Noise Control Requirement

No person may violate the standards established in part 7030.0040, unless exempted by Minnesota Statutes, section 116.07, subdivision 2a. Any municipality having authority to regulate land use shall take all reasonable measures within its jurisdiction to prevent the establishment of land use activities listed in noise area classification (NAC) 1, 2, or 3 in any location where the standards established in part 7030.0040 will be violated immediately upon establishment of the land use.

7030.0040 Noise standards

Subpart 1. Scope
These standards describe the limiting levels of sound established on the basis of present knowledge for the preservation of public health and welfare. These standards are consistent with speech, sleep, annoyance, and hearing conservation requirements for receivers within areas grouped according to land activities by the noise area classification (NAC) system established in part 7030.0050. However, these standards do not, by themselves, identify the limiting levels of impulsive noise needed for the preservation of public health and welfare. Noise standards in subpart 2 apply to all sources.

Subp. 2. Noise standards

Noise Area Classification	Daytime		Nighttime	
	L10	L50	L10	L50
1	65	60	55	50
2	70	65	70	65
3	80	75	80	75

7030.0050 Noise area classification

Subpart 1. Applicability
The noise area classification is based on the land use activity at the location of the receiver and determines the noise standards applicable to that land use activity unless an exception is applied under subpart 3.

Subp. 2. Noise area classifications
The noise area classifications and the activities included in each classification are listed below:

Noise Area Classification	Land Use Activities	
	Household Units (includes farm houses)	Transient lodging

1	Group quarters	Mobile home parks or courts
	Residential hotels	Other residential
	Cultural activities and nature exhibitions	Medical and other health services
	Correctional institutions	Educational services
	Religious activities	Motion picture production
	Entertainment assembly	Resorts and group camps
	Camping and picnicking areas (designated)	Other cultural, entertainment, and recreational activities.
2	Railroad terminals (passenger)	Bus passenger terminals (inter city)
	Railroad terminals (passenger and freight)	Bus passenger terminals (local)
	Rapid rail transit and street railway passenger terminals	Bus passenger terminals (inter city and local)
	Other motor vehicle transportation	Marine terminals (passenger)
	Airport and flying field terminals (passenger)	Marine terminals (passenger and freight)
	Airport and flying field terminals (passenger and freight)	Automobile parking
	Telegraph message centers	Transportation services and arrangements
	Wholesale trade	Retail trade -- apparel and accessories
	Retail trade -- building materials, hardware, and farm equipment	Retail trade -- automotive, marine craft, aircraft, and accessories
	Retail trade -- general merchandise	Retail trade -- furniture, home furnishings, and equipment
	Retail trade -- food	Retail trade -- eating and drinking
	Other retail trade	Finance, insurance, and real estate services
	Personal services	Repair services
	Business services Other professional services	Legal services Contract construction services
	Governmental services (except correctional institutions)	Miscellaneous services (except religious activities)
	Public assembly (except entertainment assembly and race tracks)	Amusements (except fairgrounds and amusement parks)
	Recreational activities (except designated camping and picnicking areas)	Parks.
3	Food and kindred products -- manufacturing	Textile mill products -- manufacturing
	Apparel and other finished products made from fabrics, leather, and similar materials -- manufacturing	Lumber and wood products (except furniture) -- manufacturing
	Furniture and fixtures -- manufacturing	Printing, publishing, and allied industries
	Paper and allied products -- manufacturing	Chemicals and allied products -- manufacturing
	Petroleum refining and related industries	Primary metal industries
	Rubber and miscellaneous plastic products -- manufacturing	Stone, clay, and glass products -- manufacturing
	Professional, scientific, and controlling instruments; photographic and optical goods; watches and clocks -- manufacturing	Railroad, rapid transit, and street railway transportation (except passenger terminals)
	Miscellaneous manufacturing (except motion picture production)	Fabricated metal products -- manufacturing
	Motor vehicle transportation (except passenger terminals)	Aircraft transportation (except passenger terminals)
	Marine craft transportation (except passenger and freight terminals)	Communication (except telegraph message centers)
	Highway and street right-of-way	Utilities

	Race tracks	Retail trade -- eating and drinking
	Fairgrounds and amusement parks	Agricultural
	Agricultural and related activities	Fishing activities and related services
	Other transportation, communication, and utilities (except transportation services and arrangements)	Forestry activities and related services (including commercial forest land, timber production, and other related activities)
	All other activities not otherwise listed.	
4	Undeveloped and unused land area (excluding non-commercial forest development)	Non commercial forest development
	Water areas	Vacant floor area
	Under construction	Other undeveloped land and water areas.

Subp. 3. Exceptions

The noise area classification for a land use may be changed in the following ways if the applicable conditions are met.

A. The daytime standards for noise area classification one shall be applied to noise area classification one during the nighttime if the land use activity does not include overnight lodging.

B. The standards for a building in a noise area classification two shall be applied to a building in a noise area classification one if the following conditions are met:
   1) the building is constructed in such a way that the exterior to interior sound level attenuation is at least 30 dB(A);
   2) the building has year-round climate control; and
   3) the building has no areas or accommodations that are intended for outdoor activities.

C. The standards for a building in a noise area classification three shall be applied to a building in a noise area classification one if the following conditions are met:
   1) the building is constructed in such a way that the exterior to interior sound level attenuation is at least 40 dB(A);
   2) the building has year-round climate control; and
   3) the building has no areas or accommodations that are intended for outdoor activities.

D. The standards for a building in a noise area classification three shall be applied to a building in a noise area classification two if the following conditions are met:
   1) the building is constructed in such a way that the exterior to interior sound level attenuation is at least 30 dB(A);
   2) the building has year-round climate control; and
   3) the building has no areas or accommodations that are intended for outdoor activities.

7030.0060 Measurement methodology

Subpart 1. Measurement location

Measurement of sound must be made at or within the applicable NAC at the point of human activity which is nearest to the noise source. All measurements shall be made outdoors.

Subp. 2. Equipment specifications

All sound level measuring devices must meet Type O, I, II, or S specifications under American National Standards Institute S1.4-1983.

Subp. 3. Calibration

All sound level measuring devices must, at a minimum, be externally field calibrated before and after monitoring using a calibration device of known frequency and sound pressure level.

Subp. 4. Measurement procedures

The following procedures must be used to obtain representative sound level measurements:

A. Measurements must be made at least three feet off the ground or surface and away from natural or artificial structures which would prevent an accurate measurement.

B. Measurements must be made using the A-weighting and fast response characteristics of the sound measuring device as specified in American National Standards Institute S1.4-1983.

C. Measurements must not be made in sustained winds or in precipitation which results in a difference of less than 10 decibels between the background noise level and the noise source being measured.

D. Measurements must be made using a microphone which is protected from ambient conditions which would prevent an accurate measurement.

Subp. 5. Data documentation

A summary sheet for all sound level measurements shall be completed and signed by the person making the measurements. At a minimum, the summary sheet shall include:

A. date
B. time
C. location
D. noise source
E. wind speed and direction
F. temperature
G. humidity
H. make, model, and serial number of measuring equipment
I. field calibration results
J. monitored levels
K. site sketch indicating noise source, measurement location, directions, distances, and obstructions

7030.0070 Sound attenuation measurement methodology

Subpart 1. Purpose

Sound level measurements made for assessing sound attenuation as specified in part 7030.0050, subpart 3, item B, C, or D, shall be made according to the requirements of this part.

Subp. 2. Equipment

The equipment shall meet the requirements specified in part 7030.0060, subpart 2.

Subp. 3. Calibration

The equipment must meet the calibration requirements specified in part 7030.0060, subpart 3.

Subp. 4. Measurement procedure

The measurement procedure described in 25 FHWA-DP-45-1R, section 8 must be used for determination of the sound attenuation.

Subp. 5. Equivalent methods

Methods equivalent to those described in subpart 4 may be used provided they are approved by the commissioner of the MPCA. The commissioner shall approve an alternative method if the commissioner finds that the method will produce representative data and results which are as reliable as the methods specified in subpart 4.

7030.0080 Variance

If, upon written application of the responsible person, the agency finds that by reason of exceptional circumstances strict conformity with any provisions of any noise rule would cause undue hardship, would be unreasonable, impractical, or not feasible under the circumstances, the agency may permit a variance upon the conditions and within the time limitations as it may prescribe for the prevention, control, or abatement of noise pollution in harmony with the intent of the state and any applicable federal laws.

MN R. 7030.1000 Motor vehicle noise limits

7030.1000 Definition

"Motor vehicle" means any self-propelled vehicle not operated exclusively upon railroad tracks and any vehicle propelled or drawn by a self-propelled vehicle and includes vehicles known as trackless trolleys which are propelled by electric power obtained from overhead trolley wires but not operated upon rails, except snowmobiles.

7030.1010 Prohibitions

Subpart 1. Operation of vehicle
No person shall operate either a motor vehicle or combination of vehicles of a type subject to registration pursuant to Minnesota Statutes, chapter 168 at any time or under any condition of grade, load, acceleration, or deceleration in such a manner as to exceed the noise limits contained herein for the category of motor vehicle and speed limits specified, when tested with a measurement procedure approved by the commissioner.

Subp. 2. Sale of vehicle
No person shall sell or offer for sale a new motor vehicle or combination of vehicles of a type subject to registration pursuant to Minnesota Statutes, chapter 168 which when maintained according to the manufacturer's specifications would exceed the noise limits contained herein for the category of motor vehicle and speed limits specified, when tested with a measurement procedure approved by the commissioner.

Subp. 3. Modification of vehicle
No person shall modify a motor vehicle or combination of vehicles of a type subject to registration pursuant to Minnesota Statutes, chapter 168 in a manner which will amplify or increase the noise emitted by the vehicle, above the noise limits contained herein for the category of motor vehicle and speed limits specified, when tested with a measurement procedure approved by the commissioner. No person shall operate a motor vehicle so modified.

Subp. 4. Sale of parts
No person shall sell or offer for sale replacement or additional parts for a motor vehicle or combination of vehicles of a type subject to registration pursuant to Minnesota Statutes, chapter 168 which when installed in the vehicle will amplify or increase the noise emitted by the vehicle, above the noise limits contained herein for the category of motor vehicle and speed limits specified, when tested with a measurement procedure approved by the commissioner. No person shall operate a motor vehicle incorporating such parts.

7030.1020 Scope

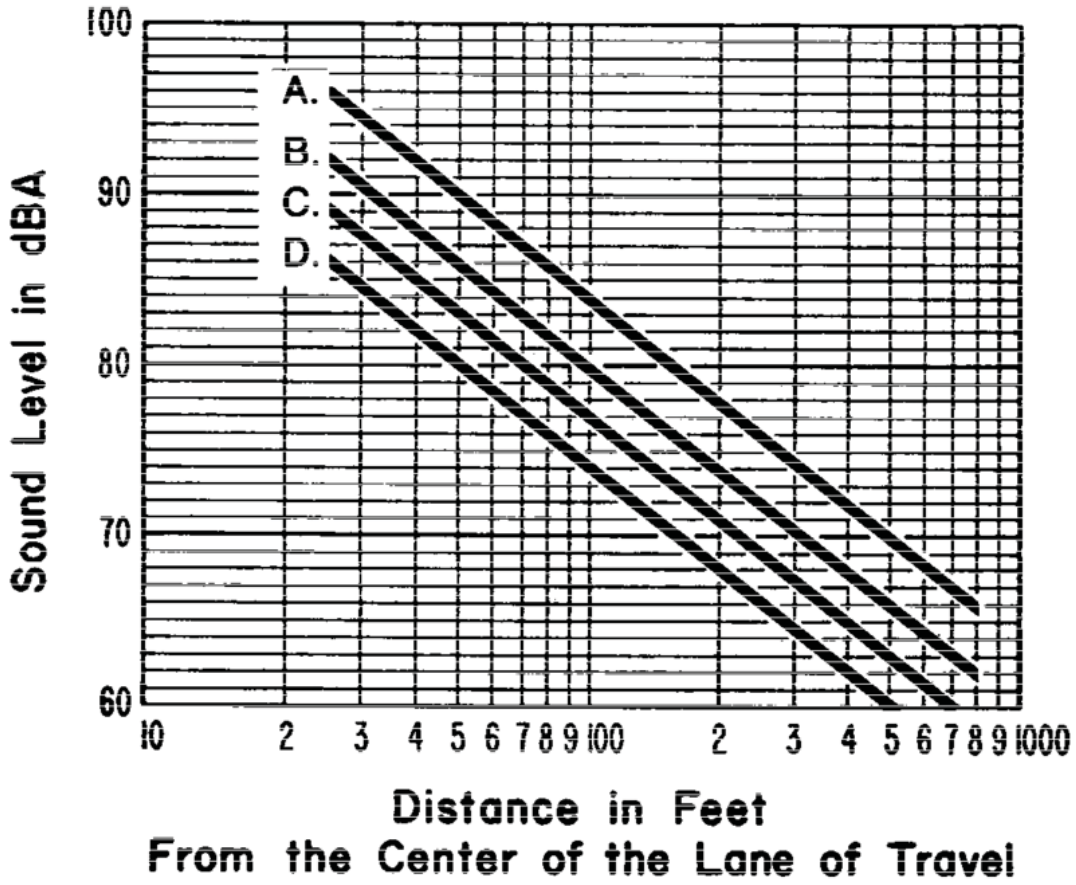
This chapter applies to the total noise from a vehicle or combination of vehicles of a type subject to registration pursuant to Minnesota Statutes, chapter 168 and shall not be construed as limiting or precluding the enforcement of any other provision of law relating to motor vehicle exhaust noise.

7030.1030 Exceptions

Vehicles under parts 7030.1050 and 7030.1060 are allowed to exceed the noise limits contained herein when performing acceleration maneuvers for safety purposes.

7030.1040 Noise limit for vehicles over 10,000 pounds

Motor vehicle noise limits for vehicles with a manufacturer's gross vehicle weight rating of more than 10,000 pounds and any combination of vehicles towed by such motor vehicle.



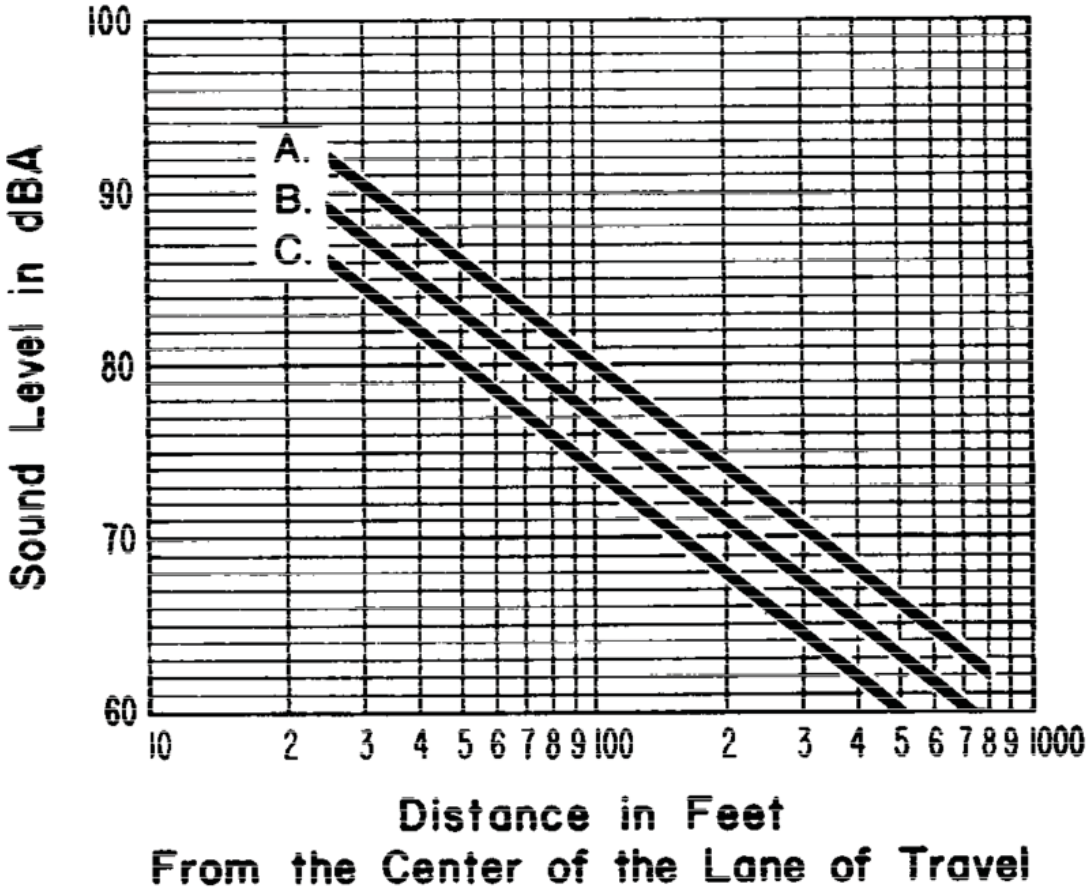
A. Speed limits greater than 35 mph.

B. Speed limits equal to or less than 35 mph and stationary run-up tests (for vehicles with governed engines). For stationary run-up tests on all-paved surfaces, add 2 dBA.

C. Speed limits equal to or less than 35 mph and stationary run-up tests (for vehicles with governed engines), for vehicles manufactured on or after January 1, 1978. For stationary run-up tests on all-paved surfaces, add 2 dBA.

D. Speed limits equal to or less than 35 mph and stationary run-up tests (for vehicles with governed engines), for vehicles manufactured on or after January 1, 1982. For stationary run-up tests on all-paved surfaces, add 2 dBA.

7030.1050 Motor vehicle noise limits for motorcycles.



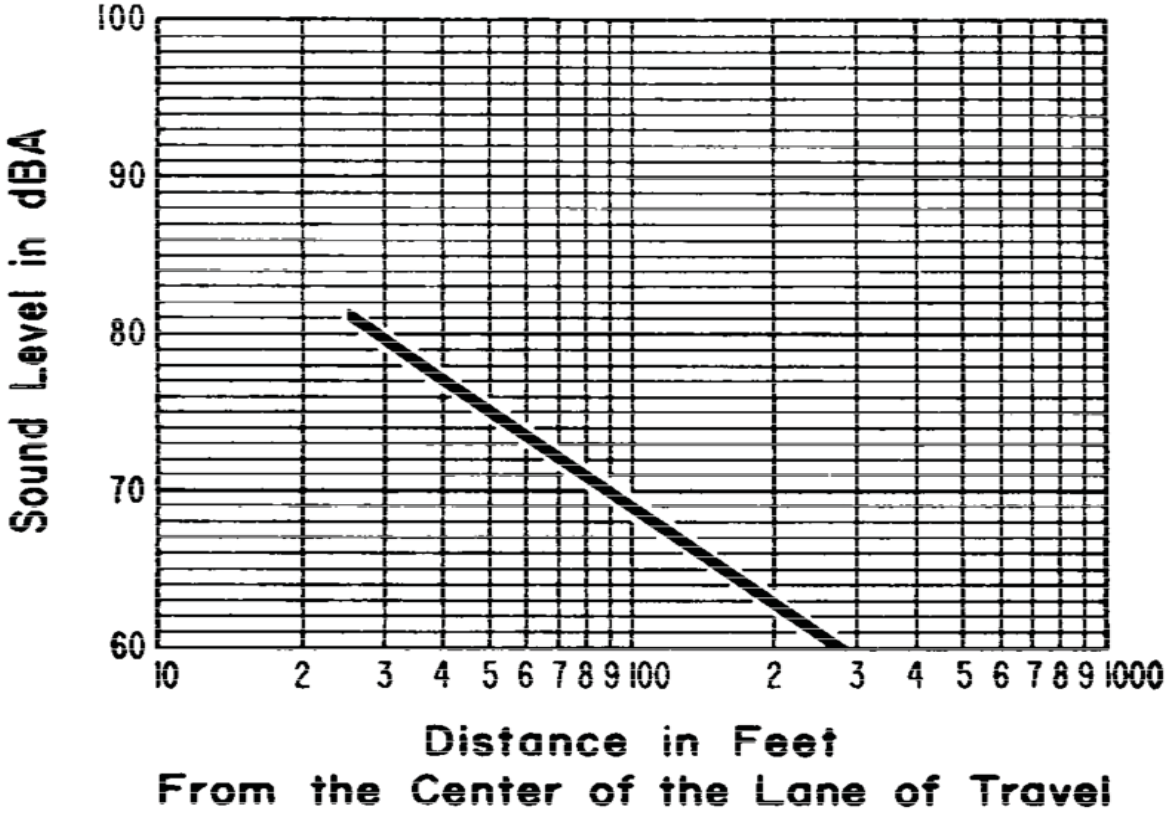
A. For vehicles manufactured before January 1, 1975.

B. Speed limits greater than 35 mph for vehicles manufactured on or after January 1, 1975.

C. Speed limits equal to or less than 35 mph for vehicles manufactured on or after January 1, 1975.

7030.1060 Noise limits for other vehicles.

Motor vehicle noise limits for any other motor vehicle not included under parts 7030.1040 and 7030.1050 and any combination of vehicles towed by such motor vehicle.



Minn. Stat. § 86B Motorboat noise limits

86B.321 Noise limits.

Subdivision 1. Operation in excess of noise limits prohibited
A person may not operate a motorboat under any condition of load, acceleration, or deceleration in a manner that exceeds the noise limits contained in subdivision 2.

Subd. 2. Noise limits

A. The noise limits for the total noise from the marine engine or motorboat may not exceed:
    1) for marine engines or motorboats manufactured before January 1, 1982, a noise level of 84 decibels on the A scale measured at a distance of 50 feet from the motorboat or equivalent noise levels at other distances as specified by the commissioner; and
    2) for marine engines or motorboats manufactured on or after January 1, 1982, a noise level of 82 decibels on the A scale measured at a distance of 50 feet from the motorboat or equivalent noise levels at other distances as specified by the commissioner.
B. The noise limits in paragraph (a) do not preclude enforcement of other laws relating to motorboat noise.

Subd. 3. Applicability
The provisions of this section do not apply to motorboats operating under a permit issued under section 86B.121 or a United States coast guard marine event permit in a regatta or race while on trial runs or while on official trials for speed records during the time and in the designated area authorized by the permit.

86B.521 Motorboat noise control

Subdivision 1. Exhaust muffling system required
A motor may not be used on a motorboat unless it is equipped with an efficient muffler, underwater exhaust, or other device that adequately muffles or suppresses the sound of the exhaust of the motor so as to prevent excessive or unusual noise. A motor may not be equipped with a cut-out.

Subd. 2. Sale of motor that exceeds noise limits prohibited
A person may not sell or offer for sale a new marine engine or motorboat that would exceed the noise limits contained in section 86B.321, subdivision 2, under a test procedure approved by the commissioner if the motor is maintained according to the manufacturer's specifications.

Subd. 3. Modification of engine to exceed noise limits prohibited

A. A person may not modify a marine engine or motorboat in a manner that will amplify or increase the noise emitted by the marine engine or motorboat above the noise limits contained in section 86B.321, subdivision 2, under a test procedure approved by the commissioner.
B. A person may not operate a motorboat with an engine modified to increase noise above the noise limits.

Subd. 4. Sale of parts that cause excessive noise

A. A person may not sell or offer for sale replacement or additional parts for a marine engine or motorboat which when installed in the marine engine or motorboat will amplify or increase the noise emitted by the marine engine or motorboat above the noise limits contained in section 86B.321, subdivision 2, under a test procedure approved by the commissioner.
B. A person may not operate a motorboat incorporating parts prohibited to be sold under paragraph (a).

Subd. 5. Applicability
The provisions of this section do not apply to motorboats operating under a permit issued under section 86B.121 or a United States Coast Guard marine event permit in a regatta, or race, while on trial runs, or while on official trials for speed records during the time and in the designated area authorized by the permit.

Minn. Stat. § 84.871 Snowmobile noise limits

84.871 Mufflers

Except as provided in this section, every snowmobile shall be equipped at all times with a muffler in good working order which blends the exhaust noise into the overall snowmobile noise and is in constant operation to prevent excessive or unusual noise. The exhaust system shall not emit or produce a sharp popping or crackling sound. This section does not apply to organized races or similar competitive events held on

A. private lands, with the permission of the owner, lessee, or custodian of the land;

B. public lands and water under the jurisdiction of the commissioner of natural resources, with the commissioner's permission; or

C. other public lands, with the consent of the public agency owning the land.

No person shall have for sale, sell, or offer for sale on any new snow-mobile any muffler that fails to comply with the specifications required by the rules of the commissioner after the effective date of the rules.

Minn. Rules § 6100.5700 Snowmobile noise limits

6100.5700 Required equipment

Subpart 5. Mufflers

Mufflers:

A. No person shall operate a snowmobile unless it is equipped with a muffler as required by law and these rules, except that snowmobiles may be operated in organized events as authorized by Minnesota Statutes, section 84.871, without such a muffler.

B. No snowmobile manufactured on or after June 30, 1970, and before February 1, 1972, for sale in Minnesota, except snowmobiles designed for competition purposes only, shall be sold, or offered for sale, unless it is equipped with a muffler that limits engine noise to not more than 86 decibels on the A scale at 50 feet.

C. No snowmobile manufactured on or after February 1, 1972, for sale in Minnesota - except snowmobiles designed for competition purposes only, shall be sold, or offered for sale, unless it is equipped with a muffler that limits engine noise to not more than 82 decibels on the A scale at 50 feet.

D. No snowmobile manufactured on or after April 1, 1975, except a snowmobile designed for competition purposes only, shall be sold, offered for sale, or operated in Minnesota unless it is so equipped and has been certified by the manufacturer to conform to a sound level limitation of not more than 78 decibels on the A scale at 50 feet as originally equipped.

E. In certifying that a new snowmobile complies with the noise limitation requirements of this rule, a manufacturer shall make such a certification based on measurements made in accordance with the SAE Recommended Practice J192 (a), as set forth in the Report of the Vehicle Sound Level Committee, as approved by the Society of Automotive Engineers September 1970 and revised November 1973.

F. No snowmobile shall be sold or offered for sale in Minnesota unless its maker has previously furnished the commissioner with a certificate of compliance certifying that all snowmobiles made by that maker meet or exceed the applicable noise level restrictions established by these rules. The certification of compliance shall be in the form of a "Snowmobile Safety Certification Committee" label conspicuously attached to the machine showing certification by the Snowmobile Safety and Certification Committee, Inc., or a label showing compliance with Snowmobile Safety Certification Committee standards accompanied by a letter containing test results of an evaluation of noise levels by a competent independent testing laboratory. Snowmobiles intended for competition purposes only shall be exempt from this part provided a separate placard identifying that such snowmobile is not so equipped is conspicuously and permanently affixed thereto.

G. Except for organized events as authorized by Minnesota Statutes, section 84.871, no snowmobile shall be modified by any person in any manner that shall amplify or otherwise increase total noise level above that emitted by the snowmobile as originally equipped, regardless of the date of manufacture.