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Environmental Noise Impact Assessment
For The

Lindbergh SAGD Expansion Project

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Executive Summary

aci Acoustical Consultants Inc., of Edmonton AB, was retained by Pengrowth Energy Corporation (Pengrowth) to conduct an environmental noise impact assessment (NIA) for the proposed Lindbergh SAGD Expansion Project (the Project) in northeast Alberta in Townships 58 & 59 and Ranges 04 & 05, W4M. The purpose of the work was to conduct a site visit to measure the noise levels of current industrial noise sources within the area, to generate a computer noise model of the Project under Baseline Case, Application Case, and Planned Development Case conditions, and to compare the resultant sound levels to the Alberta Energy Regulator (AER) permissible sound level (PSL) guidelines (Directive 038 on Noise Control, 2007) and to the Alberta Utilities Commission (AUC) Rule 012 on Noise Control.

The results of the noise modeling indicated Baseline Case noise levels associated with Pilot Plant and the approved Phase 1 and the existing area noise sources (with the average ambient sound levels [ASLs] included) are below the AER Directive 038 and AUC Rule 012 PSLs at most of the area residential and theoretical 1,500 m receptors. For the four receptors with modeled Baseline Case noise levels in exceedance of the PSLs, the noise levels related to existing, non-Pengrowth, noise sources (i.e. the contribution from the Pengrowth Pilot Plant and Phase 1 is significantly less than from the other existing industrial noise sources). It is very important to note that these exceedances are based on noise modeling results and have not been confirmed with a comprehensive sound level (CSL) survey because Phase 1 is not yet operational. However, this is not the responsibility of Pengrowth since Pengrowth currently has no significant noise contribution at these locations and impacts associated with the Project at these locations are expected to be minor.

The Application Case noise levels associated with the Project (with the ASLs included) will be below the AER Directive 038 and AUC Rule 012 PSLs for all surrounding residential and theoretical 1,500 m receptors. The Project-only noise levels (i.e. no ASL) are projected to be more than 5 dBA below the PSL at all of the receptors.

As with the Baseline Case, the Planned Development Case noise levels associated with the existing noise sources and the Project noise sources (with the ASLs included) will be below the AER Directive 038 and AUC Rule 012 PSLs at most of the area residential and theoretical 1,500 m receptors. At the same four residential receptors and at 1,500 m regions to the south (relative to the Baseline Case), the noise levels are above the PSLs. Again, these exceedances are related to existing, non-Pengrowth, noise sources. The contributions from Pengrowth noise sources are significantly less than from the other existing industrial noise sources. In addition, the increase in noise levels at the four residential receptors and the theoretical 1,500 m regions to the south, relative to the Baseline Case, ranges from +0.0 to +0.1 dBA which is completely insignificant and will not be subjectively discernible.

Finally, the modeling results at some of the residential and theoretical 1,500 m receptor locations indicated C-weighted (dBC) sound levels will be less than 20 dB above the dBA sound levels. As specified in AER Directive 038 and AUC Rule 012, if the dBC – dBA sound levels are less than 20 dB, the noise is not considered to have a low frequency tonal component. At some of the residential and theoretical 1,500 m receptor locations, however, the dBC - dBA sound levels are greater than 20 dB. The reason for this is because of the large distances between the existing noise sources and the receptors. The mid-high frequency noises (which are the largest contributors to the dBA sound levels) are significantly more attenuated at these distances than the low frequency noises (which are the largest contributors to the dBC sound levels). In general, both the dBA and dBC sound levels are modeled to be low. Again, the contributions from the Pengrowth noise sources are significantly less than from the other existing industrial noise sources. The equipment at the well pads does not contain significant low frequency content and the distances between the Project CPFs and the receptors are several kilometres. As such, the likelihood of a low frequency noise complaint related to the Project is minimal. As a result, no additional noise mitigation is required.

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1.0 Introduction

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2.0 Project Location and Description

Currently, there is an existing Lindbergh SAGD Pilot Project (Pilot) operated by Pengrowth with a capacity of 200 m^3/day (1,258 bpd). Recently, Pengrowth received approval for the Lindbergh SAGD Project (Phase 1) with a capacity of 1,987 m^3/day (12,500 bpd) (EPEA Approval No. 1581-01-02, AER Approval No. 6410I). Phase 1 is anticipated to be operational by mid 2014. As such, it has been included in the Baseline Case noise model. Pengrowth is proposing to develop the Project (Pilot + Phase 1 + Phase 2) which will increase the total production to 4,770 m^3/day (30,000 bpd). Planned facilities for the Project include a number of well pads and well pairs, with associated infrastructure including roads, above ground gathering and distribution pipeline systems. The Project components for the CPF will be built within the existing Phase 1 CPF footprint, which will not increase in physical size. At the CPF, there will be equipment required for steam generation, water/oil separation, materials storage, pumping, and on-site utilities. At the well pads there will be equipment for pumping and piping.

The Project is located approximately 24 km south-southeast of Bonnyville, Alberta, within the County of St. Paul County No. 19 and Municipality of Bonnyville No. 87 and within Townships 58 & 59 and Ranges 04 & 05, W4M (Figure 1).

There are numerous other industrial noise sources within approximately 5 km of the proposed Project. These include:

- various well-sites with small internal combustion engines and surface pumps operated by Canadian Natural Resources Ltd (CNRL) and Bonavista Energy Ltd.;
- two small compressor stations operated by Bonavista Energy Ltd. (with internal combustion engines);
- two small compressor stations operated by AltaGas (with internal combustion engines); and
- a compressor station operated by Inter Pipeline (with electrically driven pumps).

The full list of existing sites with LSDs and noise producing equipment is provided in Appendix I. All of the locations were confirmed during site visits on June 13, 2011 and May 27, 2013.

Pengrowth has identified two development scenarios, the Initial Development footprint required to bring production up to the design capacity of 4,770 m^3/day (30,000 bpd) and the Future Development required to sustain production for the life of the Project. The noise impact assessment has considered the Initial and Future Development. The Project is expected to produce approximately 275 million barrels of bitumen over 25 years.

Area roads include Secondary Highway 657 which runs north-south through the middle of the Project. Information obtained by Alberta Transportation indicates that this road is considered heavily traveled[1] during the night-time. All other roads have a lesser volume of traffic and are not considered significant contributors to background noise levels.

There are no residential receptors within 3,000 m of Pilot Plant or the Project CPF noise sources. There are, however, several residential receptors will within 1,500 m of the Project well pads and a total of 51 residential receptors within approximately 2,000 m of the Project boundary. All 51 residential receptors have been included in the assessment. Residents beyond this distance were not included in the assessment because the noise modeling indicated that the impact from the Project at greater distances was negligible so there was no reason to evaluate at further distances.

[1] As per AER Directive 038 and AUC Rule 012, if a road has a traffic volume of 10 or more vehicles per hour, it is considered to be heavily traveled.

Topographically, the land surrounding the Project has regions with small hills and lower lying areas with bodies of water. There is a change in elevation of approximately 170 m from the lowest to the highest point within a 1.5 km radius surrounding the Project Area (delineated in Figure 1). Topographical mapping information for the entire area was incorporated into the model. The land is generally covered in trees, bush, grain crops, and field grasses throughout. As such, the vegetative sound absorption is significant.

3.0 Measurement & Modeling Methods

3.1. Baseline Noise Monitoring

Given the significant distance from the nearest resident to the closest proposed Pilot or Project noise sources, baseline noise monitoring was not conducted. This conforms with the requirements of the AER Directive 038 and AUC Rule 012.

3.2. Site Sound Level Measurements

As part of the study, site visits to the study area were conducted on June 13, 2011 and on May 27, 2013. During the site visits, existing noise sources were identified and sound level measurements were conducted to determine sound power levels for use in the computer noise model. Not all noise sources were measured. In most cases, the equipment was consistent from site to site. The only thing that changed was the quantity of each item. For example, some of the well sites had three internal combustion engines and three pumps, while others had a different number of engines and pumps. All, however, had the same engines and the same pumps. There were some engines that had additional noise mitigation, and those were measured separately. As such, the sound power levels used in the noise model accurately reflect the existing noise sources observed within the study area of approximately 2,000 m surrounding the Project boundary.

Sound level measurements were conducted using Brüel and Kjær Type 2250 and Type 2270 Precision Integrating Sound Level Meters. The distance from each noise source to the SLM was measured and the surrounding reflective conditions were noted. The sound pressure level data obtained was then used to determine the appropriate octave band sound power level data for the noise source. Refer to Appendix II for a detailed description of the measurement instrumentation used.

3.3. Computer Noise Modeling (General)

The computer noise modeling was conducted using the CADNA/A (version 4.3.143) software package. CADNA/A allows for the modeling of various noise sources such as road, rail, and stationary sources. Topographical features such as land contours, vegetation, and bodies of water and meteorological conditions such as temperature, relative humidity, wind-speed and wind-direction are considered in the assessment. The modeling methods utilized met or exceeded the requirements of the AER Directive 038 and AUC Rule 012.

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

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

Due to the large size of the study area and the density of vegetation within the study area, vegetative sound absorption was included in the model. A ground absorption coefficient of 0.6 was used along with a temperature of 10^{0}C and a relative humidity of 70%. Although there are trees in the area, they were not incorporated into the model. As a result, all sound level propagation calculations are considered a conservative representation of summertime conditions (as specified in AER Directive 038 and AUC Rule 012).

As part of the study, three noise modeling scenarios were conducted, including:

1) Baseline Case: This included all existing noise sources within approximately 2,500 m of the Project boundary as well as noise sources, buildings, and tanks associated with the Pilot and the approved Phase 1 Project.
2) Application Case: This included all noise sources, buildings, and tanks as well as all well pads associated with the Project without the existing surrounding noise sources.
3) Planned Development Case: This included all existing noise sources as well as the noise sources, buildings, and tanks and all well pads associated with the Project.

The computer noise modeling results were calculated in two ways. First, sound levels were calculated at the residential receptors within approximately 2,000 m of the Project boundary and at the theoretical 1,500 m receiver locations. Second, sound levels were calculated using a 50 m x 50 m receptor grid pattern within the entire study area. This provided color noise contours for easier visualization and evaluation of the results.

3.4. Noise Sources

Sound power levels for existing noise sources were determined based on sound level measurements conducted within the study area for specific noise producing items. The noise sources for the equipment associated with the Pilot Plant, Phase 1, and the Project are provided in Appendix I. The data were obtained from equipment specific information provided by Pengrowth and assessments carried out for other projects using similar operating equipment combined with aci in-house measurement information and calculations using methods presented in various texts. All sound power levels (PWLs) used in the modeling are considered conservative. In addition, the Project will not involve the use of all 51 well pads at the same time. There will be a few well pads to start and then new well pads will be brought on-line while the older ones are decommissioned. The exact sequencing of the well pads is unknown at this time. Therefore, for the noise assessment purposes, all of the well pads were assumed operational at the same time to provide a more conservative result and to account for every possible well-pad operational scenario.

All noise sources have been modeled as point sources at their appropriate heights[1]. Sound power levels for all noise sources were modeled using octave-band information. Buildings and tanks were included in the modeling calculations because of their ability to provide shielding as well as reflection for noise[2]. Refer to Appendix I for building and tank dimensions.

Finally, AER Directive 038 and AUC Rule 012 require the assessment to include background ambient noise levels in the model. As specified in AER Directive 038 and AUC Rule 012, in most rural areas of Alberta where there is an absence of industrial noise sources the average night-time ambient noise level is approximately 35 dBA. This is known as the average ambient sound level (ASL). The ASL is adjusted depending on the relative distance from the residential receptor to the nearest heavily traveled road or rail line and the population density. As it pertains to this study, there are three categories of ASL. These include:

- residential receptors greater than 500 m from heavily traveled road or rail line and with a population density of less than nine dwellings per quarter section of land (**ASL = 35 dBA**);
- residential receptors between 30 to 500 m from heavily traveled road or rail line and with a population density of less than nine dwellings per quarter section of land (**ASL = 40 dBA**); and
- residential receptors between 30 to 500 m from heavily traveled road or rail line and with a population density of between nine to 160 dwellings per quarter section of land (**ASL = 43 dBA**).

These ASL values were used as the ambient condition in the modeling with the various existing and Project related noise sources added.

3.5. Modeling Confidence

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

[1] The heights for many of the sources are generally slightly higher than actual. This makes the model more conservative
[2] Exterior building and tank walls were modeled with an absorption coefficient of 0.21 which is generally highly reflective.

4.0 Permissible Sound Levels

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

The documents which most directly relate to the Permissible Sound Levels (PSLs) for this NIA are the AER Directive 038 on Noise Control (2007) and the AUC Rule 012 on Noise Control (2013). AER Directive 038 and AUC Rule 012 set the PSLs at the receiver locations based on population density and relative distances to heavily traveled road and rail as shown in Table 1. In most instances, there is a Basic Sound Level (BSL) of 40 dBA for the night-time (night-time hours are 22:00 to 07:00) and 50 dBA for the day-time (day-time hours are 07:00 to 22:00) because the residential receptors are greater than 500 m from a heavily traveled road and have a population density less than nine dwellings per quarter section. For these residential receptors, the PSLs are a **PSL-Night of 40 dBA and a PSL-Day of 50 dBA**. Some residential receptors, however, are within 30 to 500 m of a heavily traveled road and have a population density of less than nine dwellings per quarter section, resulting in a **PSL-Night of 45 dBA and a PSL-Day of 55 dBA**. Further, some residential receptors are within 30 to 500 m of a heavily traveled road and have a population density between 9 to 160 dwellings per quarter section, resulting in a **PSL-Night of 48 dBA and a PSL-Day of 58 dBA**. Finally, AER Directive 038 and AUC Rule 012 specify that new or modified facilities must meet a PSL-Night of 40 dBA at 1,500 m from the facility fence-line if there are no closer dwellings. As such, the PSLs at a distance of 1,500 m from the Project boundary are an **PSL-Night of 40 dBA and a PSL-Day of 50 dBA.** Refer to Appendix V for a detailed determination of the permissible sound levels.

The PSLs provided are related to noise associated with activities and processes at the Project and are not related to vehicle traffic on nearby highways (or access roads). This includes all traffic related to the construction and operation of the Facility. Noises from traffic sources are not covered by any regulations or guidelines at the municipal, provincial, or federal levels. As such, an assessment of the noises related to vehicle traffic was not conducted. In addition, construction noise is not specifically regulated by AER Directive 038 or AUC Rule 012. However, construction noise mitigation recommendations are provided in Section 5.4.2.

Table 1. Basic Night-Time Sound Levels (as per AER Directive 038 and AUC Rule 012)

	Dwelling Density per Quarter Section of Land		
Proximity to Transportation	**1-8 Dwellings**	**9-160 Dwellings**	**>160 Dwellings**
Category 1	40 dBA	43 dBA	46 dBA
Category 2	45 dBA	48 dBA	51 dBA
Category 3	50 dBA	53 dBA	56 dBA

Category 1 Dwelling units more than 500 m from heavily travelled roads and/or rail lines and not subject to frequent aircraft flyovers

Category 2 Dwelling units more than 30 m but less than 500 m from heavily travelled roads and/or rail lines and not subject to frequent aircraft flyovers

Category 3 Dwelling units less than 30 m from heavily travelled roads and/or rail lines and not subject to frequent aircraft flyovers

5.0 Results and Discussion

5.1. Baseline Case Results

The results of the Baseline Case noise modeling are presented in Tables 2a and 2b for the residential and theoretical 1,500 m receptors, respectively, and illustrated in Figure 2. The modeled noise levels at most of the residential and theoretical 1,500 m receptor locations are under the PSLs with the existing noise sources and the Pilot Plant and the approved Phase 1 combined with the ASLs. At four of the residential receptors (R-13, R-39, R-40, R-41) and at 1,500 m regions to the south, the noise levels are above the PSLs. These exceedances are related to existing, non-Pengrowth, noise sources. For all of the residents, the contribution from the Pengrowth Pilot Plant and Phase 1 is significantly less than from the other existing industrial noise sources. It is very important to note that these exceedances are based on noise modeling results and have not been confirmed with a comprehensive sound level (CSL) survey because Phase 1 is not yet operational. However, this is not the responsibility of Pengrowth since Pengrowth currently has no significant noise contribution at these locations and, as will be illustrated in the Planned Development Case results, is not projected to have any significant impact at these locations.

In addition to the broadband A-weighted (dBA) sound levels, the modeling results at many of the residential and theoretical 1,500 m receptor locations indicated C-weighted (dBC) sound levels will be less than 20 dB above the dBA sound levels, as shown in Tables 2a and 2b. As specified in AER Directive 038 and AUC Rule 012, if the dBC – dBA sound levels are less than 20 dB, the noise is not considered to have a low frequency tonal component. At some of the residential and theoretical 1,500 m receptor locations, however, the dBC - dBA sound levels are greater than 20 dB. The reason for this is because of the large distances between the existing noise sources and the receptors. The mid-high frequency noises (which are the largest contributors to the dBA sound levels) are significantly more attenuated at these distances than the low frequency noises (which are the largest contributors to the dBC sound levels). In general, both the dBA and dBC sound levels are modeled to be low and the dBA sound levels are all below the PSLs. Again, the contribution from the Pengrowth Pilot Plant and Phase 1 is significantly less than from the other existing industrial noise sources.

Table 2a. Baseline Case Modeled Sound Levels at Residential Receptor Locations

Receptor	ASL-Night (dBA)	Baseline Case L_{eq}Night (dBA)	ASL + Baseline Case L_{eq}Night (dBA)	PSL-Night (dBA)	Compliant		Baseline Case L_{eq}Night (dBC)	dBC - dBA	Tonal
R-01	35.0	34.2	37.6	40.0	YES		49.7	15.5	NO
R-02	35.0	34.7	37.9	40.0	YES		53.3	18.6	NO
R-03	35.0	34.6	37.8	40.0	YES		53.2	18.6	NO
R-04	35.0	32.4	36.9	40.0	YES		50.5	18.1	NO
R-05	35.0	32.2	36.8	40.0	YES		50.4	18.2	NO
R-06	35.0	31.8	36.7	40.0	YES		50.2	18.4	NO
R-07	35.0	37.4	39.4	40.0	YES		53.1	15.7	NO
R-08	35.0	31.2	36.5	40.0	YES		46.8	15.6	NO
R-09	35.0	31.6	36.6	40.0	YES		47.4	15.8	NO
R-10	35.0	31.2	36.5	40.0	YES		45.2	14.0	NO
R-11	35.0	31.5	36.6	40.0	YES		45.3	13.8	NO
R-12	35.0	37.7	39.6	40.0	YES		50.6	12.9	NO
R-13	35.0	42.7	43.4	40.0	NO		54.6	11.9	NO
R-14	35.0	31.4	36.6	40.0	YES		44.8	13.4	NO
R-15	35.0	34.5	37.8	40.0	YES		49.6	15.1	NO
R-16	35.0	32.4	36.9	40.0	YES		48.2	15.8	NO
R-17	35.0	28.4	35.9	40.0	YES		42.9	14.5	NO
R-18	35.0	29.2	36.0	40.0	YES		45.8	16.6	NO
R-19	35.0	31.2	36.5	40.0	YES		47.1	15.9	NO
R-20	35.0	20.1	35.1	40.0	YES		39.6	19.5	NO
R-21	35.0	22.4	35.2	40.0	YES		41.3	18.9	NO
R-22	35.0	23.1	35.3	40.0	YES		45.3	22.2	POSSIBLE
R-23	35.0	27.1	35.7	40.0	YES		49.5	22.4	POSSIBLE
R-24	35.0	32.0	36.8	40.0	YES		59.4	27.4	POSSIBLE
R-25	35.0	22.2	35.2	40.0	YES		43.3	21.1	POSSIBLE
R-26	35.0	20.7	35.2	45.0	YES		41.4	20.7	POSSIBLE
R-27	35.0	20.9	35.2	45.0	YES		41.7	20.8	POSSIBLE
R-28	35.0	20.3	35.1	45.0	YES		40.1	19.8	NO
R-29	35.0	20.7	35.2	45.0	YES		39.0	18.3	NO
R-30	35.0	20.1	35.1	45.0	YES		37.9	17.8	NO
R-31	35.0	18.6	35.1	48.0	YES		36.9	18.3	NO
R-32	35.0	19.4	35.1	45.0	YES		37.3	17.9	NO
R-33	35.0	16.2	35.1	43.0	YES		35.1	18.9	NO
R-34	35.0	18.1	35.1	48.0	YES		35.7	17.6	NO
R-35	35.0	22.8	35.3	45.0	YES		39.2	16.4	NO
R-36	35.0	20.8	35.2	45.0	YES		37.0	16.2	NO
R-37	35.0	23.6	35.3	40.0	YES		39.0	15.4	NO
R-38	35.0	34.3	37.7	40.0	YES		46.2	11.9	NO
R-39	35.0	40.6	41.7	40.0	NO		48.7	8.1	NO
R-40	35.0	44.8	45.2	40.0	NO		55.0	10.2	NO
R-41	35.0	48.0	48.2	40.0	NO		57.9	9.9	NO
R-42	35.0	29.5	36.1	40.0	YES		42.1	12.6	NO
R-43	35.0	32.3	36.9	40.0	YES		43.8	11.5	NO
R-44	35.0	28.7	35.9	40.0	YES		50.3	21.6	POSSIBLE
R-45	35.0	26.3	35.5	40.0	YES		43.0	16.7	NO
R-46	35.0	25.9	35.5	40.0	YES		43.1	17.2	NO
R-47	35.0	24.6	35.4	40.0	YES		44.7	20.1	POSSIBLE
R-48	35.0	25.0	35.4	40.0	YES		46.4	21.4	POSSIBLE
R-49	35.0	27.3	35.7	40.0	YES		50.7	23.4	POSSIBLE
R-50	35.0	26.7	35.6	40.0	YES		46.9	20.2	POSSIBLE
R-51	35.0	29.1	36.0	40.0	YES		56.8	27.7	POSSIBLE

Table 2b. Baseline Case Modeled Sound Levels at Theoretical 1,500 m Receptor Locations

Receptor	ASL-Night (dBA)	Baseline Case L_{eq}Night (dBA)	ASL + Baseline Case L_{eq}Night (dBA)	PSL-Night (dBA)	Compliant		Baseline Case L_{eq}Night (dBC)	dBC - dBA	Tonal
r-01	35.0	19.3	35.1	40.0	YES		35.4	16.1	NO
r-02	35.0	20.4	35.1	40.0	YES		36.3	15.9	NO
r-03	35.0	20.2	35.1	40.0	YES		36.2	16.0	NO
r-04	35.0	16.7	35.1	40.0	YES		34.4	17.7	NO
r-05	35.0	12.8	35.0	40.0	YES		32.7	19.9	NO
r-06	35.0	9.4	35.0	40.0	YES		31.2	21.8	POSSIBLE
r-07	35.0	6.5	35.0	40.0	YES		29.8	23.3	POSSIBLE
r-08	35.0	4.6	35.0	40.0	YES		28.9	24.3	POSSIBLE
r-09	35.0	4.5	35.0	40.0	YES		29.2	24.7	POSSIBLE
r-10	35.0	4.6	35.0	40.0	YES		29.6	25.0	POSSIBLE
r-11	35.0	4.5	35.0	40.0	YES		30.0	25.5	POSSIBLE
r-12	35.0	3.9	35.0	40.0	YES		29.9	26.0	POSSIBLE
r-13	35.0	0.0	35.0	40.0	YES		29.1	29.1	POSSIBLE
r-14	35.0	0.0	35.0	40.0	YES		28.6	28.6	POSSIBLE
r-15	35.0	9.0	35.0	40.0	YES		30.6	21.6	POSSIBLE
r-16	35.0	7.9	35.0	40.0	YES		24.5	16.6	NO
r-17	35.0	16.4	35.1	40.0	YES		34.2	17.8	NO
r-18	35.0	21.7	35.2	40.0	YES		41.7	20.0	POSSIBLE
r-19	35.0	24.2	35.3	40.0	YES		41.4	17.2	NO
r-20	35.0	29.0	36.0	40.0	YES		46.8	17.8	NO
r-21	35.0	28.6	35.9	40.0	YES		45.7	17.1	NO
r-22	35.0	27.6	35.7	40.0	YES		43.6	16.0	NO
r-23	35.0	26.9	35.6	40.0	YES		43.0	16.1	NO
r-24	35.0	26.1	35.5	40.0	YES		42.2	16.1	NO
r-25	35.0	25.2	35.4	40.0	YES		41.3	16.1	NO
r-26	35.0	25.8	35.5	40.0	YES		41.7	15.9	NO
r-27	35.0	29.5	36.1	40.0	YES		46.9	17.4	NO
r-28	35.0	32.0	36.8	40.0	YES		45.1	13.1	NO
r-29	35.0	40.2	41.3	40.0	NO		52.3	12.1	NO
r-30	35.0	36.1	38.6	40.0	YES		50.1	14.0	NO
r-31	35.0	34.5	37.8	40.0	YES		49.5	15.0	NO
r-32	35.0	32.2	36.8	40.0	YES		46.3	14.1	NO
r-33	35.0	39.0	40.5	40.0	NO		49.6	10.6	NO
r-34	35.0	28.1	35.8	40.0	YES		43.8	15.7	NO
r-35	35.0	30.0	36.2	40.0	YES		50.4	20.4	POSSIBLE
r-36	35.0	31.2	36.5	40.0	YES		52.2	21.0	POSSIBLE
r-37	35.0	32.6	37.0	40.0	YES		50.4	17.8	NO
r-38	35.0	36.8	39.0	40.0	YES		57.7	20.9	POSSIBLE
r-39	35.0	28.9	36.0	40.0	YES		48.7	19.8	NO
r-40	35.0	25.5	35.5	40.0	YES		43.5	18.0	NO
r-41	35.0	24.8	35.4	40.0	YES		44.3	19.5	NO
r-42	35.0	25.0	35.4	40.0	YES		43.2	18.2	NO
r-43	35.0	21.9	35.2	40.0	YES		40.8	18.9	NO
r-44	35.0	19.4	35.1	40.0	YES		39.1	19.7	NO
r-45	35.0	17.9	35.1	40.0	YES		38.3	20.4	POSSIBLE
r-46	35.0	18.0	35.1	40.0	YES		38.6	20.6	POSSIBLE
r-47	35.0	20.1	35.1	40.0	YES		42.1	22.0	POSSIBLE
r-48	35.0	16.3	35.1	40.0	YES		37.6	21.3	POSSIBLE
r-49	35.0	13.9	35.0	40.0	YES		34.3	20.4	POSSIBLE
r-50	35.0	14.6	35.0	40.0	YES		33.7	19.1	NO

5.2. Application Case Results

The results of the Application Case noise modeling are presented in Tables 3a and 3b for the residential and theoretical 1,500 m receptors, respectively, and are illustrated in Figure 3. The modeled noise levels at the residential and theoretical 1,500 m receptor locations are under the PSLs with the Project noise combined with the ASLs. In addition, the Project-only noise levels (i.e. no average ambient sound level) are more than 5 dBA below the PSLs at all of the residential and theoretical 1,500 m receptors, providing for a large margin of safety for the noise modeling results.

In addition to the broadband A-weighted (dBA) sound levels, the modeling results at some of the residential and theoretical 1,500 m receptor locations indicated C-weighted (dBC) sound levels will be less than 20 dB above the dBA sound levels, as shown in Tables 3a and 3b. As specified in AER Directive 038 and AUC Rule 012, if the dBC – dBA sound levels are less than 20 dB, the noise is not considered to have a low frequency tonal component. At many of the residential and theoretical 1,500 m receptor locations, however, the dBC - dBA sound levels are greater than 20 dB. The reason for this is because of the large distances between the existing noise sources and the receptors. The mid-high frequency noises (which are the largest contributors to the dBA sound levels) are significantly more attenuated at these distances than the low frequency noises (which are the largest contributors to the dBC sound levels). In general, both the dBA and dBC sound levels are modeled to be low and the dBA sound levels are all well below the PSLs. The equipment at the well pads does not contain significant low frequency noise and the distances between the Project CPFs and the receptors are several kilometers. As such, the likelihood of a low frequency noise complaint related to Project operations is minimal.

Table 3a. Application Case Modeled Sound Levels at Residential Receptors

Receptor	ASL-Night (dBA)	Application Case L_{eq}Night (dBA)	ASL + Application Case L_{eq}Night (dBA)	PSL-Night (dBA)	Compliant		Application Case L_{eq}Night (dBC)	dBC - dBA	Tonal
R-01	35.0	32.0	36.8	40.0	YES		50.1	18.1	NO
R-02	35.0	33.5	37.3	40.0	YES		52.0	18.5	NO
R-03	35.0	33.0	37.1	40.0	YES		51.8	18.8	NO
R-04	35.0	30.5	36.3	40.0	YES		49.6	19.1	NO
R-05	35.0	31.6	36.6	40.0	YES		49.9	18.3	NO
R-06	35.0	29.3	36.0	40.0	YES		49.0	19.7	NO
R-07	35.0	30.5	36.3	40.0	YES		50.1	19.6	NO
R-08	35.0	25.6	35.5	40.0	YES		46.1	20.5	POSSIBLE
R-09	35.0	23.6	35.3	40.0	YES		43.1	19.5	NO
R-10	35.0	22.4	35.2	40.0	YES		41.8	19.4	NO
R-11	35.0	22.3	35.2	40.0	YES		42.0	19.7	NO
R-12	35.0	22.0	35.2	40.0	YES		44.9	22.9	POSSIBLE
R-13	35.0	25.2	35.4	40.0	YES		47.1	21.9	POSSIBLE
R-14	35.0	20.6	35.2	40.0	YES		40.6	20.0	POSSIBLE
R-15	35.0	22.0	35.2	40.0	YES		43.3	21.3	POSSIBLE
R-16	35.0	21.3	35.2	40.0	YES		42.8	21.5	POSSIBLE
R-17	35.0	19.6	35.1	40.0	YES		39.9	20.3	POSSIBLE
R-18	35.0	21.9	35.2	40.0	YES		42.8	20.9	POSSIBLE
R-19	35.0	23.5	35.3	40.0	YES		43.2	19.7	NO
R-20	35.0	21.4	35.2	40.0	YES		41.3	19.9	NO
R-21	35.0	23.1	35.3	40.0	YES		42.4	19.3	NO
R-22	35.0	20.1	35.1	40.0	YES		40.6	20.5	POSSIBLE
R-23	35.0	22.1	35.2	40.0	YES		44.2	22.1	POSSIBLE
R-24	35.0	22.9	35.3	40.0	YES		44.6	21.7	POSSIBLE
R-25	35.0	19.3	35.1	40.0	YES		39.8	20.5	POSSIBLE
R-26	35.0	19.2	35.1	45.0	YES		39.7	20.5	POSSIBLE
R-27	35.0	19.2	35.1	45.0	YES		41.1	21.9	POSSIBLE
R-28	35.0	13.8	35.0	45.0	YES		34.8	21.0	POSSIBLE
R-29	35.0	2.3	35.0	45.0	YES		23.0	20.7	POSSIBLE
R-30	35.0	1.8	35.0	45.0	YES		22.5	20.7	POSSIBLE
R-31	35.0	1.0	35.0	48.0	YES		22.0	21.0	POSSIBLE
R-32	35.0	1.3	35.0	45.0	YES		22.1	20.8	POSSIBLE
R-33	35.0	0.0	35.0	43.0	YES		20.8	20.8	POSSIBLE
R-34	35.0	0.7	35.0	48.0	YES		21.7	21.0	POSSIBLE
R-35	35.0	1.5	35.0	45.0	YES		22.2	20.7	POSSIBLE
R-36	35.0	1.1	35.0	45.0	YES		21.9	20.8	POSSIBLE
R-37	35.0	3.3	35.0	40.0	YES		23.5	20.2	POSSIBLE
R-38	35.0	8.0	35.0	40.0	YES		26.3	18.3	NO
R-39	35.0	8.0	35.0	40.0	YES		26.3	18.3	NO
R-40	35.0	8.3	35.0	40.0	YES		26.5	18.2	NO
R-41	35.0	8.3	35.0	40.0	YES		26.5	18.2	NO
R-42	35.0	5.4	35.0	40.0	YES		24.8	19.4	NO
R-43	35.0	6.1	35.0	40.0	YES		25.2	19.1	NO
R-44	35.0	6.6	35.0	40.0	YES		29.6	23.0	POSSIBLE
R-45	35.0	5.7	35.0	40.0	YES		25.3	19.6	NO
R-46	35.0	5.7	35.0	40.0	YES		25.4	19.7	NO
R-47	35.0	18.5	35.1	40.0	YES		39.3	20.8	POSSIBLE
R-48	35.0	21.3	35.2	40.0	YES		43.9	22.6	POSSIBLE
R-49	35.0	21.3	35.2	40.0	YES		43.9	22.6	POSSIBLE
R-50	35.0	21.4	35.2	40.0	YES		43.9	22.5	POSSIBLE
R-51	35.0	21.4	35.2	40.0	YES		43.9	22.5	POSSIBLE

Table 3b. Application Case Modeled Sound Levels at Theoretical 1,500 m Receptors

Receptor	ASL-Night (dBA)	Application Case L_{eq}Night (dBA)	ASL + Application Case L_{eq}Night (dBA)	PSL-Night (dBA)	Compliant		Application Case L_{eq}Night (dBC)	dBC - dBA	Tonal
r-01	35.0	1.5	35.0	40.0	YES		22.2	20.7	POSSIBLE
r-02	35.0	4.7	35.0	40.0	YES		24.2	19.5	NO
r-03	35.0	8.4	35.0	40.0	YES		26.5	18.1	NO
r-04	35.0	12.0	35.0	40.0	YES		28.9	16.9	NO
r-05	35.0	13.6	35.0	40.0	YES		30.1	16.5	NO
r-06	35.0	13.5	35.0	40.0	YES		30.0	16.5	NO
r-07	35.0	12.4	35.0	40.0	YES		29.1	16.7	NO
r-08	35.0	10.8	35.0	40.0	YES		28.0	17.2	NO
r-09	35.0	12.3	35.0	40.0	YES		30.0	17.7	NO
r-10	35.0	14.0	35.0	40.0	YES		35.1	21.1	POSSIBLE
r-11	35.0	13.3	35.0	40.0	YES		34.5	21.2	POSSIBLE
r-12	35.0	10.5	35.0	40.0	YES		32.8	22.3	POSSIBLE
r-13	35.0	6.6	35.0	40.0	YES		28.0	21.4	POSSIBLE
r-14	35.0	3.2	35.0	40.0	YES		23.6	20.4	POSSIBLE
r-15	35.0	0.8	35.0	40.0	YES		22.1	21.3	POSSIBLE
r-16	35.0	0.0	35.0	40.0	YES		20.4	20.4	POSSIBLE
r-17	35.0	0.4	35.0	40.0	YES		21.6	21.2	POSSIBLE
r-18	35.0	22.8	35.3	40.0	YES		45.4	22.6	POSSIBLE
r-19	35.0	22.8	35.3	40.0	YES		42.3	19.5	NO
r-20	35.0	27.4	35.7	40.0	YES		48.0	20.6	POSSIBLE
r-21	35.0	27.5	35.7	40.0	YES		47.5	20.0	POSSIBLE
r-22	35.0	24.9	35.4	40.0	YES		43.7	18.8	NO
r-23	35.0	23.6	35.3	40.0	YES		42.7	19.1	NO
r-24	35.0	22.0	35.2	40.0	YES		41.5	19.5	NO
r-25	35.0	19.8	35.1	40.0	YES		40.1	20.3	POSSIBLE
r-26	35.0	19.6	35.1	40.0	YES		40.7	21.1	POSSIBLE
r-27	35.0	20.5	35.2	40.0	YES		42.0	21.5	POSSIBLE
r-28	35.0	20.4	35.1	40.0	YES		40.5	20.1	POSSIBLE
r-29	35.0	22.9	35.3	40.0	YES		44.5	21.6	POSSIBLE
r-30	35.0	22.2	35.2	40.0	YES		43.2	21.0	POSSIBLE
r-31	35.0	22.6	35.2	40.0	YES		44.8	22.2	POSSIBLE
r-32	35.0	20.4	35.1	40.0	YES		40.5	20.1	POSSIBLE
r-33	35.0	21.5	35.2	40.0	YES		44.6	23.1	POSSIBLE
r-34	35.0	22.2	35.2	40.0	YES		43.8	21.6	POSSIBLE
r-35	35.0	25.7	35.5	40.0	YES		48.3	22.6	POSSIBLE
r-36	35.0	27.7	35.7	40.0	YES		49.5	21.8	POSSIBLE
r-37	35.0	28.5	35.9	40.0	YES		49.6	21.1	POSSIBLE
r-38	35.0	28.7	35.9	40.0	YES		48.8	20.1	POSSIBLE
r-39	35.0	30.7	36.4	40.0	YES		51.7	21.0	POSSIBLE
r-40	35.0	26.7	35.6	40.0	YES		45.1	18.4	NO
r-41	35.0	26.7	35.6	40.0	YES		47.0	20.3	POSSIBLE
r-42	35.0	26.4	35.6	40.0	YES		44.8	18.4	NO
r-43	35.0	23.0	35.3	40.0	YES		42.5	19.5	NO
r-44	35.0	20.8	35.2	40.0	YES		40.8	20.0	POSSIBLE
r-45	35.0	20.0	35.1	40.0	YES		40.3	20.3	POSSIBLE
r-46	35.0	19.5	35.1	40.0	YES		39.9	20.4	POSSIBLE
r-47	35.0	20.7	35.2	40.0	YES		42.8	22.1	POSSIBLE
r-48	35.0	0.0	35.0	40.0	YES		20.0	20.0	POSSIBLE
r-49	35.0	0.0	35.0	40.0	YES		19.2	19.2	NO
r-50	35.0	0.0	35.0	40.0	YES		19.9	19.9	NO

5.3. Planned Development Case Results

The results of the Planned Development Case noise modeling are presented in Tables 4a and 4b for the residential and theoretical 1,500 m receptors, respectively, and illustrated in Figure 4. As with the Baseline Case, the modeled noise levels at most of the residential and theoretical 1,500 m receptor locations are under the PSLs with the existing noise sources and the Project combined with the ASLs. At the same four residential receptors (R-13, R-39, R-40, R-41) and at 1,500 m regions to the south, the noise levels are above the PSLs. Again, these exceedances are related to existing, non-Pengrowth noise sources. The contributions from Pengrowth noise sources are significantly less than from the other existing industrial noise sources. This is clearly indicated in the order-ranked noise source contribution from the existing and Pengrowth noise sources at the four residential, presented in Appendix VI. In addition, the increase in noise levels at these four residential receptors and the theoretical 1,500 m regions to the south, relative to the Baseline Case, ranges from +0.0 to +0.1 dBA which is completely insignificant and will not be subjectively discernible.

In addition to the broadband A-weighted (dBA) sound levels, the modeling results at many of the residential and theoretical 1,500 m receptor locations indicated C-weighted (dBC) sound levels will be less than 20 dB above the dBA sound levels, as shown in Tables 4a and 4b. As specified in AER Directive 038 and AUC Rule 012, if the dBC – dBA sound levels are less than 20 dB, the noise is not considered to have a low frequency tonal component. At some of the residential and theoretical 1,500 m receptor locations, however, the dBC - dBA sound levels are greater than 20 dB. The reason for this is because of the large distances between the existing noise sources and the receptors. The mid-high frequency noises (which are the largest contributors to the dBA sound levels) are significantly more attenuated at these distances than the low frequency noises (which are the largest contributors to the dBC sound levels). In general, both the dBA and dBC sound levels are modeled to be low. Again, the contributions from the Pengrowth noise sources are significantly less than from the other existing industrial noise sources. The equipment at the well pads does not contain significant low frequency content and the distances between the Project CPFs and the receptors are several kilometers. As such, the likelihood of a low frequency noise complaint related to Project operations is minimal.

Table 4a. Planned Development Case Modeled Sound Levels at Residential Receptors

Receptor	ASL-Night (dBA)	Planned Development Case L_{eq}Night (dBA)	ASL + Planned Development Case L_{eq}Night (dBA)	PSL-Night (dBA)	Compliant		Planned Development Case L_{eq}Night (dBC)	dBC - dBA	Tonal
R-01	35.0	36.0	38.5	40.0	YES		52.2	16.2	NO
R-02	35.0	36.9	39.1	40.0	YES		55.2	18.3	NO
R-03	35.0	36.6	38.9	40.0	YES		55.0	18.4	NO
R-04	35.0	34.3	37.7	40.0	YES		52.4	18.1	NO
R-05	35.0	34.7	37.9	40.0	YES		52.4	17.7	NO
R-06	35.0	33.5	37.3	40.0	YES		51.9	18.4	NO
R-07	35.0	38.1	39.8	40.0	YES		54.3	16.2	NO
R-08	35.0	32.0	36.8	40.0	YES		48.7	16.7	NO
R-09	35.0	32.1	36.8	40.0	YES		48.4	16.3	NO
R-10	35.0	31.6	36.6	40.0	YES		46.4	14.8	NO
R-11	35.0	31.8	36.7	40.0	YES		46.5	14.7	NO
R-12	35.0	37.8	39.6	40.0	YES		51.2	13.4	NO
R-13	35.0	42.8	43.5	40.0	NO		55.1	12.3	NO
R-14	35.0	31.6	36.6	40.0	YES		45.8	14.2	NO
R-15	35.0	34.6	37.8	40.0	YES		49.8	15.2	NO
R-16	35.0	32.6	37.0	40.0	YES		48.5	15.9	NO
R-17	35.0	28.8	35.9	40.0	YES		44.1	15.3	NO
R-18	35.0	29.6	36.1	40.0	YES		46.6	17.0	NO
R-19	35.0	31.6	36.6	40.0	YES		48.1	16.5	NO
R-20	35.0	23.0	35.3	40.0	YES		42.6	19.6	NO
R-21	35.0	25.1	35.4	40.0	YES		44.0	18.9	NO
R-22	35.0	24.5	35.4	40.0	YES		46.2	21.7	POSSIBLE
R-23	35.0	27.9	35.8	40.0	YES		50.2	22.3	POSSIBLE
R-24	35.0	32.4	36.9	40.0	YES		54.5	22.1	POSSIBLE
R-25	35.0	23.6	35.3	40.0	YES		44.4	20.8	POSSIBLE
R-26	35.0	22.5	35.2	45.0	YES		43.0	20.5	POSSIBLE
R-27	35.0	22.5	35.2	45.0	YES		43.5	21.0	POSSIBLE
R-28	35.0	20.9	35.2	45.0	YES		40.7	19.8	NO
R-29	35.0	20.8	35.2	45.0	YES		39.1	18.3	NO
R-30	35.0	20.1	35.1	45.0	YES		38.1	18.0	NO
R-31	35.0	18.7	35.1	48.0	YES		37.0	18.3	NO
R-32	35.0	19.5	35.1	45.0	YES		37.4	17.9	NO
R-33	35.0	16.3	35.1	43.0	YES		35.3	19.0	NO
R-34	35.0	18.2	35.1	48.0	YES		35.9	17.7	NO
R-35	35.0	22.9	35.3	45.0	YES		39.3	16.4	NO
R-36	35.0	20.8	35.2	45.0	YES		37.2	16.4	NO
R-37	35.0	23.6	35.3	40.0	YES		39.2	15.6	NO
R-38	35.0	34.3	37.7	40.0	YES		46.3	12.0	NO
R-39	35.0	40.6	41.7	40.0	NO		48.8	8.2	NO
R-40	35.0	44.8	45.2	40.0	NO		55.0	10.2	NO
R-41	35.0	48.0	48.2	40.0	NO		57.9	9.9	NO
R-42	35.0	29.6	36.1	40.0	YES		42.2	12.6	NO
R-43	35.0	32.3	36.9	40.0	YES		43.9	11.6	NO
R-44	35.0	28.8	35.9	40.0	YES		50.3	21.5	POSSIBLE
R-45	35.0	26.3	35.5	40.0	YES		43.1	16.8	NO
R-46	35.0	25.9	35.5	40.0	YES		43.2	17.3	NO
R-47	35.0	25.3	35.4	40.0	YES		45.5	20.2	POSSIBLE
R-48	35.0	26.2	35.5	40.0	YES		47.8	21.6	POSSIBLE
R-49	35.0	28.0	35.8	40.0	YES		51.3	23.3	POSSIBLE
R-50	35.0	27.5	35.7	40.0	YES		48.1	20.6	POSSIBLE
R-51	35.0	29.6	36.1	40.0	YES		56.9	27.3	POSSIBLE

Table 4b. Planned Development Case Modeled Sound Levels at Theoretical 1,500 m Receptors

Receptor	ASL-Night (dBA)	Planned Development Case L_{eq}Night (dBA)	ASL + Planned Development Case L_{eq}Night (dBA)	PSL-Night (dBA)	Compliant		Planned Development Case L_{eq}Night (dBC)	dBC - dBA	Tonal
r-01	35.0	19.4	35.1	40.0	YES		35.6	16.2	NO
r-02	35.0	20.5	35.2	40.0	YES		36.6	16.1	NO
r-03	35.0	20.5	35.2	40.0	YES		36.6	16.1	NO
r-04	35.0	18.0	35.1	40.0	YES		35.5	17.5	NO
r-05	35.0	16.2	35.1	40.0	YES		34.6	18.4	NO
r-06	35.0	14.9	35.0	40.0	YES		33.7	18.8	NO
r-07	35.0	13.4	35.0	40.0	YES		32.5	19.1	NO
r-08	35.0	11.8	35.0	40.0	YES		31.5	19.7	NO
r-09	35.0	13.0	35.0	40.0	YES		32.6	19.6	NO
r-10	35.0	14.5	35.0	40.0	YES		36.2	21.7	POSSIBLE
r-11	35.0	13.8	35.0	40.0	YES		35.8	22.0	POSSIBLE
r-12	35.0	11.4	35.0	40.0	YES		34.6	23.2	POSSIBLE
r-13	35.0	7.2	35.0	40.0	YES		31.6	24.4	POSSIBLE
r-14	35.0	4.2	35.0	40.0	YES		29.8	25.6	POSSIBLE
r-15	35.0	9.6	35.0	40.0	YES		31.2	21.6	POSSIBLE
r-16	35.0	8.4	35.0	40.0	YES		25.9	17.5	NO
r-17	35.0	16.5	35.1	40.0	YES		34.4	17.9	NO
r-18	35.0	24.6	35.4	40.0	YES		46.0	21.4	POSSIBLE
r-19	35.0	26.0	35.5	40.0	YES		44.0	18.0	NO
r-20	35.0	30.8	36.4	40.0	YES		49.5	18.7	NO
r-21	35.0	30.5	36.3	40.0	YES		48.7	18.2	NO
r-22	35.0	29.0	36.0	40.0	YES		45.8	16.8	NO
r-23	35.0	28.1	35.8	40.0	YES		45.0	16.9	NO
r-24	35.0	27.1	35.7	40.0	YES		44.1	17.0	NO
r-25	35.0	26.0	35.5	40.0	YES		43.0	17.0	NO
r-26	35.0	26.4	35.6	40.0	YES		43.4	17.0	NO
r-27	35.0	29.8	36.1	40.0	YES		47.4	17.6	NO
r-28	35.0	32.2	36.8	40.0	YES		46.0	13.8	NO
r-29	35.0	40.2	41.3	40.0	NO		52.7	12.5	NO
r-30	35.0	36.2	38.7	40.0	YES		50.3	14.1	NO
r-31	35.0	34.7	37.9	40.0	YES		50.1	15.4	NO
r-32	35.0	32.4	36.9	40.0	YES		47.0	14.6	NO
r-33	35.0	39.0	40.5	40.0	NO		50.3	11.3	NO
r-34	35.0	28.8	35.9	40.0	YES		46.0	17.2	NO
r-35	35.0	31.0	36.5	40.0	YES		51.9	20.9	POSSIBLE
r-36	35.0	32.4	36.9	40.0	YES		53.6	21.2	POSSIBLE
r-37	35.0	33.6	37.4	40.0	YES		52.2	18.6	NO
r-38	35.0	37.3	39.3	40.0	YES		58.1	20.8	POSSIBLE
r-39	35.0	32.3	36.9	40.0	YES		52.6	20.3	POSSIBLE
r-40	35.0	28.5	35.9	40.0	YES		46.4	17.9	NO
r-41	35.0	28.0	35.8	40.0	YES		47.8	19.8	NO
r-42	35.0	28.0	35.8	40.0	YES		46.1	18.1	NO
r-43	35.0	24.8	35.4	40.0	YES		43.8	19.0	NO
r-44	35.0	22.4	35.2	40.0	YES		42.1	19.7	NO
r-45	35.0	21.3	35.2	40.0	YES		41.4	20.1	POSSIBLE
r-46	35.0	21.0	35.2	40.0	YES		41.4	20.4	POSSIBLE
r-47	35.0	22.7	35.2	40.0	YES		44.5	21.8	POSSIBLE
r-48	35.0	16.4	35.1	40.0	YES		37.6	21.2	POSSIBLE
r-49	35.0	14.0	35.0	40.0	YES		34.4	20.4	POSSIBLE
r-50	35.0	14.7	35.0	40.0	YES		33.8	19.1	NO

5.4. Noise Mitigation Measures

5.4.1. Operation Noise

The results of the noise modeling indicated that no specific additional noise mitigation measures are required for the Project equipment.

5.4.2. Construction Noise

Although there are no specific construction noise level limits detailed by AER Directive 038 and AUC Rule 012, there are general recommendations for construction noise mitigation. This includes all activities associated with construction of the facility, well pads (including drilling), borrow pits, etc. The document states:

> "*While Directive 038 is not applicable to construction noise, licensees should attempt to take the following reasonable mitigating measures to reduce the impact on nearby dwellings of construction noise from new facilities or modifications to existing facilities. Licensees should:*
>
> - *Conduct construction activity between the hours of 07:00 and 22:00 to reduce the potential impact of construction noise;*
> - *Advise nearby residents of significant noise-causing activities and schedule these events to reduce disruption to them;*
> - *Ensure all internal combustion engines are fitted with appropriate muffler systems; and*
> - *Take advantage of acoustical screening from existing on-site buildings to shield dwellings from construction equipment noise.*
>
> *Should a valid complaint be made during construction, the licensee is expected to respond expeditiously and take appropriate action to ensure that the issue has been managed responsibly.*"

6.0 Conclusion

The results of the noise modeling indicated Baseline Case noise levels associated with the Pilot and the approved Phase 1 and the existing area noise sources (with the average ambient sound levels [ASLs] included) are below the AER Directive 038 and AUC Rule 012 PSLs at most of the area residential and theoretical 1,500 m receptors. For the four receptors with modeled Baseline Case noise levels in exceedance of the PSLs, the noise levels related to existing, non-Pengrowth, noise sources (i.e. the contribution from the Pengrowth Pilot and Phase 1 is significantly less than from the other existing industrial noise sources). It is very important to note that these exceedances are based on noise modeling results and have not been confirmed with a comprehensive sound level (CSL) survey because Phase 1 is not yet operational. However, this is not the responsibility of Pengrowth since Pengrowth currently has no significant noise contribution at these locations and impacts associated with the Project at these locations are expected to be minor.

The Application Case noise levels associated with the Project (with the ASLs included) will be below the AER Directive 038 and AUC Rule 012 PSLs for all surrounding residential and theoretical 1,500 m receptors. The Project-only noise levels (i.e. no ASL) are projected to be more than 5 dBA below the PSL at all of the receptors.

As with the Baseline Case, the Planned Development Case noise levels associated with the existing noise sources and the Project noise sources (with the ASLs included) will be below the AER Directive 038 and AUC Rule 012 PSLs at most of the area residential and theoretical 1,500 m receptors. At the same four residential receptors and at 1,500 m regions to the south (relative to the Baseline Case), the noise levels are above the PSLs. Again, these exceedances are related to existing, non-Pengrowth, noise sources. The contributions from Pengrowth noise sources are significantly less than from the other existing industrial noise sources. In addition, the increase in noise levels at the four residential receptors and the theoretical 1,500 m regions to the south, relative to the Baseline Case, ranges from +0.0 to +0.1 dBA which is completely insignificant and will not be subjectively discernible.

Finally, the modeling results at some of the residential and theoretical 1,500 m receptor locations indicated C-weighted (dBC) sound levels will be less than 20 dB above the dBA sound levels. As specified in AER Directive 038 and AUC Rule 012, if the dBC – dBA sound levels are less than 20 dB, the noise is not considered to have a low frequency tonal component. At some of the residential and theoretical 1,500 m receptor locations, however, the dBC - dBA sound levels are greater than 20 dB.

The reason for this is because of the large distances between the existing noise sources and the receptors. The mid-high frequency noises (which are the largest contributors to the dBA sound levels) are significantly more attenuated at these distances than the low frequency noises (which are the largest contributors to the dBC sound levels). In general, both the dBA and dBC sound levels are modeled to be low. Again, the contributions from the Pengrowth noise sources are significantly less than from the other existing industrial noise sources. The equipment at the well pads does not contain significant low frequency content and the distances between the Project CPFs and the receptors are several kilometers. As such, the likelihood of a low frequency noise complaint related to Project operations is minimal. As a result, no additional noise mitigation is required.

A short form (AER form) noise impact assessment is presented in Appendix VII.

7.0 References

- Alberta Energy Regulator (AER), *Directive 038 on Noise Control, 2007*, Calgary, Alberta.
- Alberta Utilities Commission (AUC), *Rule 012 on Noise Control*, 2013, Calgary, Alberta.
- International Organization for Standardization (ISO), *Standard 1996-1, Acoustics – Description, measurement and assessment of environmental noise – Part 1: Basic quantities and assessment procedures, 2003*, Geneva Switzerland.
- International Organization for Standardization (ISO), *Standard 9613-1, Acoustics – Attenuation of sound during propagation outdoors – Part 1: Calculation of absorption of sound by the atmosphere, 1993*, Geneva Switzerland.
- International Organization for Standardization (ISO), *Standard 9613-2, Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation, 1996*, Geneva Switzerland.

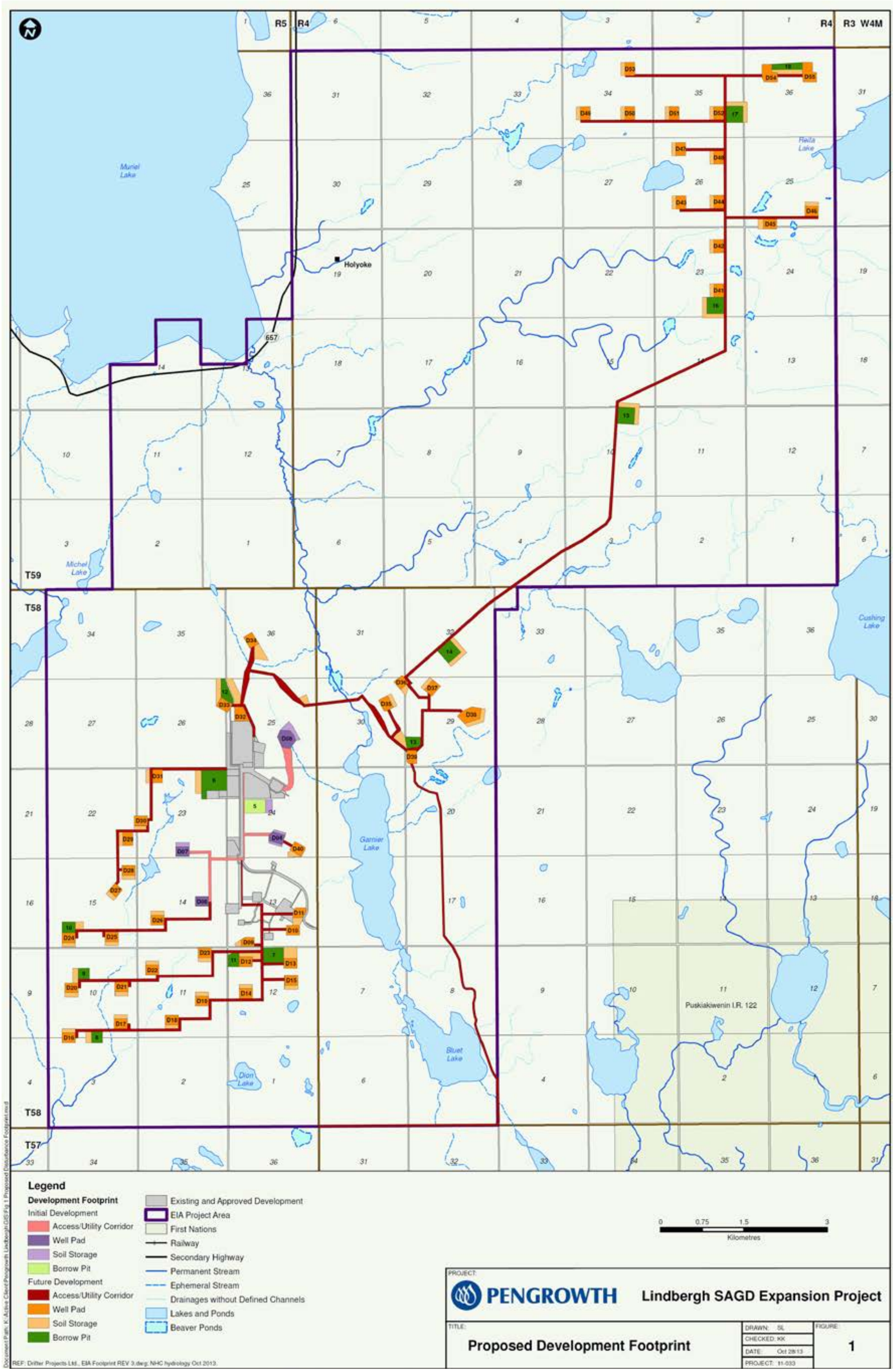

Figure 1. Study Area

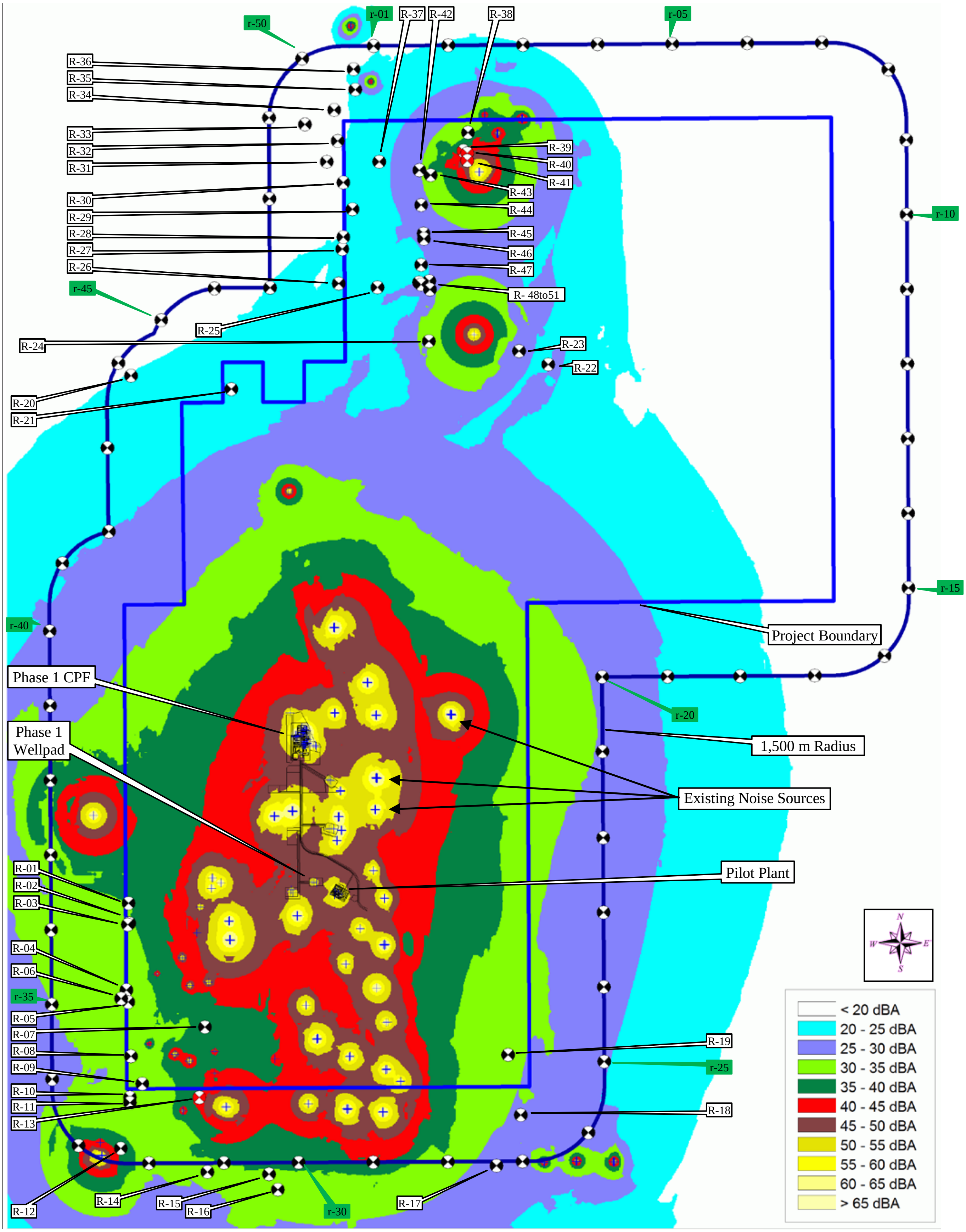

Figure 2. Baseline Case Modeled Night-time Noise Levels (Without ASL)

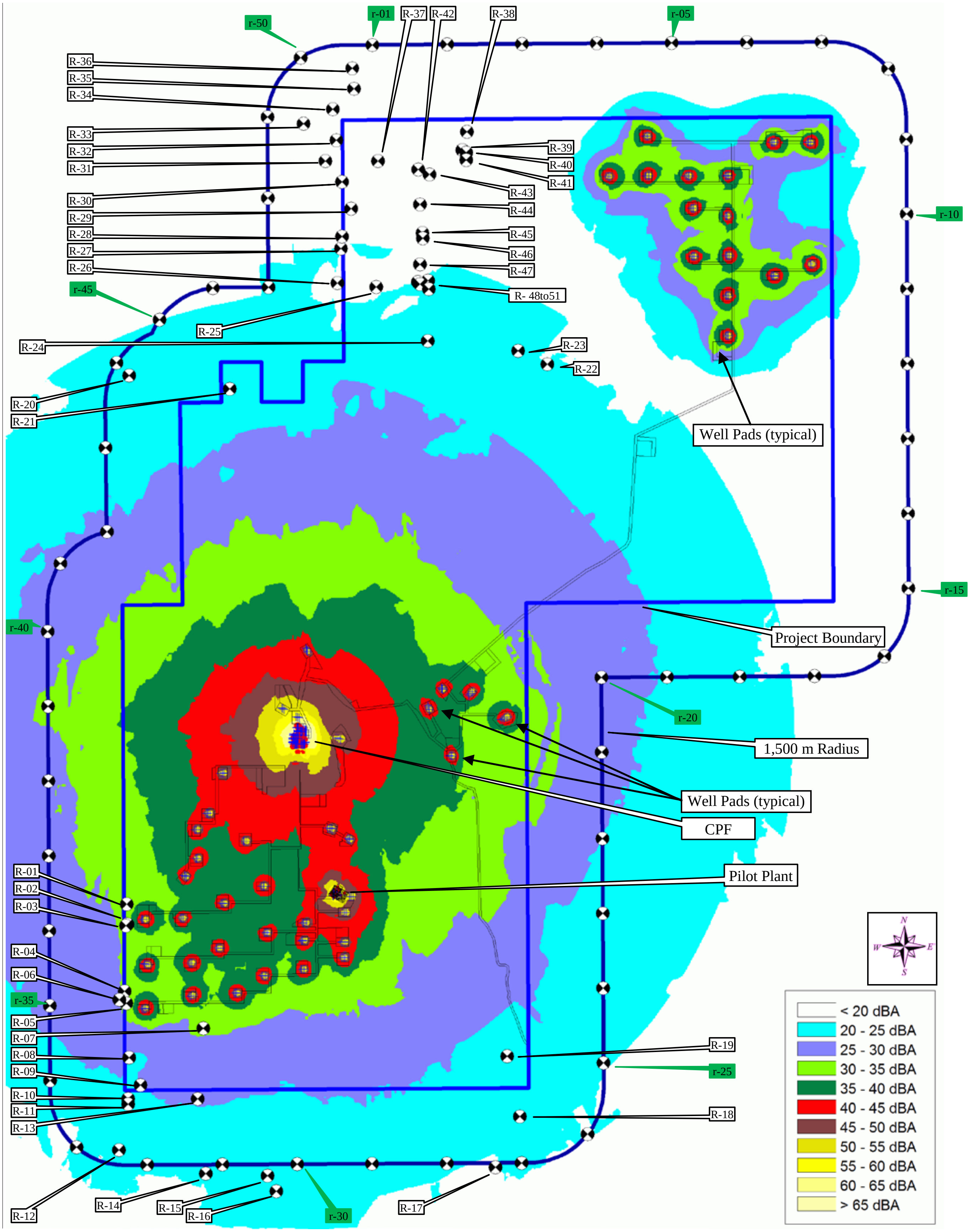

Figure 3. Application Case Modeled Night-time Noise Levels (Without ASL)

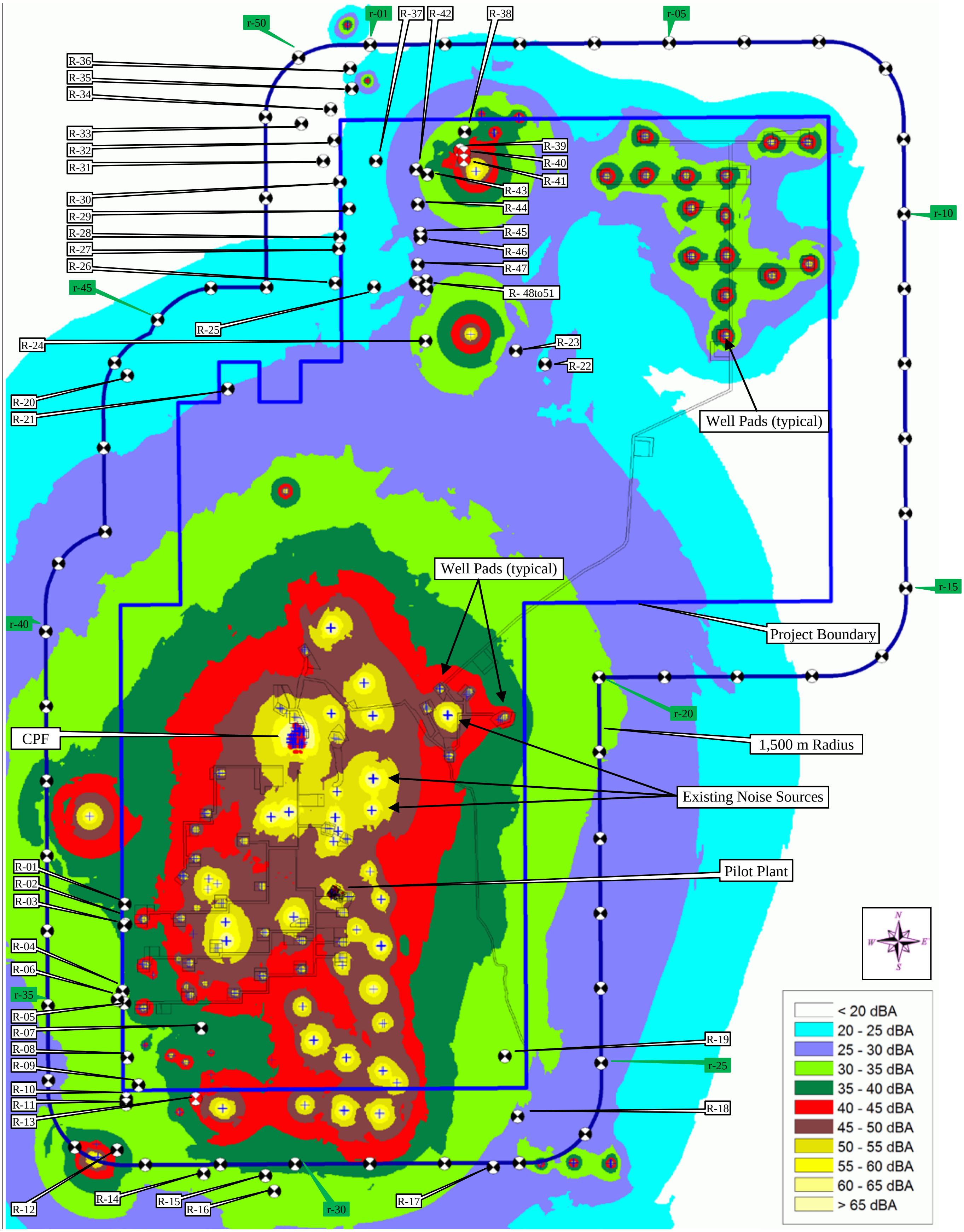

Figure 4. Planned Development Case Modeled Night-time Noise Levels (Without ASL)

Appendix I NOISE MODELING PARAMETERS

Existing Well Site and Compressor Site Equipment and Locations

Site Description	Company	LSD	Equipment
Well-Site	CNRL	02-24-58-05-W4M	Small Engines Without Mitigation + Surface Pumps (x2)
Well-Site	CNRL	02/02-24-58-05-W4M	Small Engines Without Mitigation + Surface Pumps (x3)
Well-Site	CNRL	07-24-58-05-W4M	Small Engines Without Mitigation + Surface Pumps (x5)
Well-Site	CNRL	10-24-58-05-W4M	Small Engines Without Mitigation + Surface Pumps (x2)
Bear Hill Booster Compressor	Bonavista	12-25-58-05-W4M	Compressor in Building With Aerial Cooler
Well-Site	CNRL	08-23-58-05-W4M	Small Engines Without Mitigation + Surface Pumps (x4)
Well-Site	CNRL	05-24-58-05-W4M	Small Engines Without Mitigation + Surface Pumps (x6)
Well-Site	CNRL	05-18-58-04-W4M	Small Engines Without Mitigation + Surface Pumps (x2)
Well-Site	CNRL	12-18-58-04-W4M	Small Engines Without Mitigation + Surface Pumps (x1)
Well-Site	CNRL	13-19-58-04-W4M	Small Engines Without Mitigation + Surface Pumps (x7)
Well-Site	CNRL	05-19-58-04-W4M	Small Engines Without Mitigation + Surface Pumps (x4)
Well-Site	CNRL	10-36-58-04-W4M	Small Engines Without Mitigation + Surface Pumps (x6)
Brittney Booster Compressor	Bonavista	06-12-59-05-W4M	Compressor in Building With Aerial Cooler
Well-Site	Bonavista	10-25-58-05-W4M	Small Engines Without Mitigation + Surface Pumps (x2)
Well-Site	Bonavista	12-30-58-04-W4M	Small Engines Without Mitigation + Surface Pumps (x4)
Well-Site	Bonavista	04-31-58-04-W4M	Small Engines Without Mitigation + Surface Pumps (x4)
Well-Site	CNRL	12-29-58-04-W4M	Small Engines Without Mitigation + Surface Pumps (x6)
Well-Site	CNRL	06-12-58-05-W4M	Small Engines Without Mitigation + Surface Pumps (x1)
Well-Site	CNRL	04-13-58-05-W4M	Small Engines Without Mitigation + Surface Pumps (x4)
Well-Site	CNRL	04-12-58-05-W4M	Small Engines Without Mitigation + Surface Pumps (x1)
Well-Site	CNRL	14-11-58-05-W4M	Small Engines Without Mitigation + Surface Pumps (x6)
Well-Site	CNRL	03B-14-58-05-W4M	Small Engines Without Mitigation + Surface Pumps (x3)
Well-Site	CNRL	08-15-58-05-W4M	Small Engines With Mitigation + Surface Pumps (x3)
Well-Site	CNRL	12B-14-58-05-W4M	Small Engines Without Mitigation + Surface Pumps (x1)
Well-Site	CNRL	12-14-58-05-W4M	Small Engines Without Mitigation + Surface Pumps (x1)
Well-Site	CNRL	05C-14-58-05-W4M	Small Engines Without Mitigation + Surface Pumps (x1)
Well-Site	CNRL	16-10-58-05-W4M	Small Engines With Mitigation + Surface Pumps (x1)
Well-Site	CNRL	05-11-58-05-W4M	Small Engines With Mitigation + Surface Pumps (x3)
Well-Site	CNRL	01-10-58-05-W4M	Small Engines With Mitigation + Surface Pumps (x3)
Well-Site	CNRL	10-10-58-05-W4M	Small Engines With Mitigation + Surface Pumps (x3)
Well-Site	CNRL	05-10-58-05-W4M	Small Engines With Mitigation + Surface Pumps (x1)
Well-Site	CNRL	08-02-58-05-W4M	Small Engines With Mitigation + Surface Pumps (x1)
Well-Site	CNRL	05-02-58-05-W4M	Small Engines With Mitigation + Surface Pumps (x1)
Well-Site	CNRL	04-02-58-05-W4M	Small Engines With Mitigation + Surface Pumps (x1)
Well-Site	CNRL	07-03-58-05-W4M	Small Engines With Mitigation + Surface Pumps (x3)
Well-Site	CNRL	08-03-58-05-W4M	Small Engines With Mitigation + Surface Pumps (x3)
Well-Site	CNRL	10-12-58-05-W4M	Small Engines Without Mitigation + Surface Pumps (x1)
Well-Site	CNRL	12-07-58-04-W4M	Small Engines Without Mitigation + Surface Pumps (x4)
Well-Site	CNRL	13-06-58-04-W4M	Small Engines Without Mitigation + Surface Pumps (x1)
Lindbergh Compressor Station	Interpipe	04-07-58-04-W4M	Electric Motors + Pumps Inside Building
Well-Site	CNRL	04-06-58-04-W4M	Small Engines Without Mitigation + Surface Pumps (x2)
Well-Site	CNRL	03-06-58-04-W4M	Small Engines Without Mitigation + Surface Pumps (x1)
Well-Site	CNRL	12-31-57-04-W4M	Small Engines With Mitigation + Surface Pumps (x3)
Well-Site	CNRL	08-01-58-05-W4M	Small Engines Without Mitigation + Surface Pumps (x2)
Well-Site	CNRL	11-01-58-05-W4M	Small Engines With Mitigation + Surface Pumps (x3)
Well-Site	CNRL	09-36-57-05-W4M	Small Engines With Mitigation + Surface Pumps (x3)
Well-Site	CNRL	14-36-57-05-W4M	Small Engines Without Mitigation + Surface Pumps (x1)
Well-Site	CNRL	11-35-57-05-W4M	Small Engines Without Mitigation + Surface Pumps (x2)
Well-Site	CNRL	13-34-57-05-W4M	Surface Pumps (x2)
Well-Site	CNRL	1a-33-57-05-W4M	Small Engines Without Mitigation (x2) + Surface Pumps (x1)
Well-Site	CNRL	7a-33-57-05-W4M	Small Engines Without Mitigation + Surface Pumps (x1)
Well-Site	CNRL	14b-03-58-05-W4M	Small Engines With Mitigation + Surface Pumps (x1)
Compressor Station	AltaGas	07-21-58-05-W4M	Compressor in Building With Aerial Cooler
Well-Site	CNRL	04-33-57-04-W4M	Small Engines With Mitigation + Surface Pumps (x3)
Well-Site	CNRL	02-33-57-04-W4M	Small Engines With Mitigation + Surface Pumps (x5)
Well-Site	CNRL	04-34-57-04-W4M	Small Engines With Mitigation + Surface Pumps (x7)
Compressor Station	AltaGas	07-20-59-04-W4M	Compressor in Building With Aerial Cooler
Well-Site	CNRL	07-32-59-04-W4M	Small Engines Without Mitigation (x2) + Surface Pumps (x1)
Well-Site	CNRL	01-05-60-04-W4M	Small Engines With Mitigation + Surface Pumps (x2)
Well-Site	CNRL	16-32-59-04-W4M	Small Engines With Mitigation + Surface Pumps (x7)
Well-Site	CNRL	04-04-60-04-W4M	Small Engines With Mitigation + Surface Pumps (x8)
Well-Site	CNRL	11-06-60-04-W4M	Small Engines With Mitigation + Surface Pumps (x1)
Well-Site	CNRL	04-07-60-04-W4M	Small Engines With Mitigation + Surface Pumps (x2)

Existing Noise Source Sound Power Levels (Re 10^{-12} Watts)

Description	dBA	31.5 Hz	63 HZ	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
Wellsite Engine (Typical)	107.4	102.9	107.4	113.2	103.4	105.3	102.8	98.2	93.4	86.1
Wellsite Pump (Typical)	85.6	96.4	87.6	82.8	82.1	75.5	75.3	77.1	82.1	69.9
Bonavista 12-25-58-05-W4M Compressor	97.6	99.6	97.1	95.4	90.7	93.9	94.9	88.0	84.2	80.6
Bonavista 06-12-59-05-W4M Compressor	95.0	98.0	98.7	95.4	90.1	89.8	90.6	88.8	82.9	80.3
3-Engine Wellsite With Mitigation (Typical)	93.6	96.8	98.7	96.2	93.3	85.2	87.2	87.5	85.4	76.1
1-Engine Wellsite With Mitigation (Typical)	84.0	88.9	91.9	88.4	83.9	78.6	77.3	77.9	73.1	64.1
Interpipe 04-07-58-04-W4M Compressor Station	110.8	98.8	99.2	101.1	115.3	104.2	106.7	100.0	84.3	74.0
AltaGas Lindbergh Comp. 07-21-58-05-W4M	110.2	119.4	123.6	118.0	110.3	105.2	105.6	100.2	94.0	85.4
AltaGas Muriel Lake Comp. 07-20-59-04-W4M	103.9	127.0	109.2	108.5	101.8	102.2	98.9	94.2	88.4	83.4

Project (Phase 1 + 2) Noise Source Broadband Sound Power Levels (Re 10^{-12} Watts, un-mitigated)

ID TAG	Description	Location	Height (m)	Model/Type	Rating (kW)	# Units	Equipment Sound Power Level (dBA)	Building Attenuation (dBA)	Overall Sound Power Level (dBA)
P-336	Produced Water Injection pump	01-002	2	Centrifugal	149.0	1	104.3	18.8	**85.5**
P-703 A/B/C	HP BFW Pumps	01-002	2	Centrifugal	597.0	3	110.9	18.8	**92.1**
P-304	Wash Water Pump	01-003	2	Centrifugal	22.0	1	101.8	18.8	**83.0**
P-337	SAC Regen Waste Injection Pump	01-006	2	Centrifugal	149.0	1	104.3	18.8	**85.5**
P-801 A/B/C	Primary Glycol Pumps	01-008	2	Centrifugal	149.0	3	109.1	18.8	**90.3**
H-943	Utility Boiler Stack	01-011	10	Heater	450 BHP	1	96.3	0.0	**96.3**
K-943	Utility Boiler Blower	01-011	3	Blower Fan	15.0	1	100.6	0.0	**100.6**
P-627 A/B	Concentrator Distillate Pumps	02-001	2	Centrifugal	11.0	2	103.9	18.8	**85.1**
P-635	Evaporator Drain Pump	02-001	2	Centrifugal	11.0	1	100.9	18.8	**82.1**
P-602 A/B/C	Evaporator Feed Pumps	02-001	2	Centrifugal	22.0	3	106.6	18.8	**87.8**
P-607 A/B/C	Evaporator Distillate Pumps	02-001	2	Centrifugal	45.0	3	107.5	18.8	**88.7**
P-624	Concentrator Recirculation Pump	02-001	2	Centrifugal	75.0	1	103.4	18.8	**84.6**
P-604/14	Evaporator Recirculation Pump	02-001	2	Centrifugal	447.0	2	108.8	18.8	**90.0**
K-625	Concentrator Vapour Compressor #1	02-001	2	Reciprocating	485.0	1	117.8	22.6	**95.2**
K-630	Concentrator Vapour Compressor #2	02-001	2	Reciprocating	485.0	1	117.8	22.6	**95.2**
K-605	Vapour Compressor #1	02-001	2	Reciprocating	3952.0	1	126.9	22.6	**104.3**
K-615	Vapour Compressor #2	02-001	2	Reciprocating	3952.0	1	126.9	22.6	**104.3**
P-793 A/B	Blowdown Recycle Pumps	03-001	2	Centrifugal	15.0	2	104.3	18.8	**85.5**
H-712	Boiler #1 Stack	03-001	36	Heater	95541.0	1	101.2	0.0	**101.2**
K-712	Combustion Air Blower #1	03-001	5	Blower Fan	597.0	1	115.0	0.0	**115.0**
H-722	Boiler #2 Stack	03-001	36	Heater	95541.0	1	101.2	0.0	**101.2**
K-722	Combustion Air Blower #2	03-001	5	Blower Fan	597.0	1	115.0	0.0	**115.0**
K-907 A/B	Instrument Air Compressors	03-003	2	Reciprocating	93.0	2	113.6	22.6	**91.0**
K-731	Gas Turbine #1 Inlet	04-001	5	Gas Turbine	N/A	1	104.3	0.0	**104.3**
	Gas Turbine #1 Exhaust	04-001	25	Gas Turbine	N/A	1	104.8	0.0	**104.8**
	Gas Turbine #1 Casing	04-001	3	Gas Turbine	N/A	1	107.7	16.8	**90.9**
	Generator #1	04-001	3	Generator	7500.0	1	112.4	17.7	**94.7**
	HRSG #1 Casing	04-001	3	HRSG	N/A	1	107.7	16.8	**90.9**
	Turbine #1 Lube Oil Cooler	04-001	3	Axial Fan	N/A	1	103.1	0.0	**103.1**
K-741	Gas Turbine #1 Inlet	04-001	5	Gas Turbine	N/A	1	104.3	0.0	**104.3**
	Gas Turbine #1 Exhaust	04-001	25	Gas Turbine	N/A	1	104.8	0.0	**104.8**
	Gas Turbine #1 Casing	04-001	3	Gas Turbine	N/A	1	107.7	16.8	**90.9**
	Generator #1	04-001	3	Generator	7500.0	1	112.4	17.7	**94.7**
	HRSG #1 Casing	04-001	3	HRSG	N/A	1	107.7	16.8	**90.9**
	Turbine #1 Lube Oil Cooler	04-001	3	Axial Fan	N/A	1	103.1	0.0	**103.1**
K-206	High Pressure Assist Gas Compressor	05-012	2	Reciprocating	186.0	1	113.6	22.6	**91.0**
P-414	Slop Water Pump	06-001	2	Centrifugal	11.0	1	100.9	18.8	**82.1**
P-408	Slop Oil Pump	06-001	2	Centrifugal	15.0	1	101.3	18.8	**82.5**
P-410	Production Tank Recycle Pump	06-001	2	Centrifugal	30.0	1	102.2	18.8	**83.4**
P-411	Sales Oil Tank Recycle Pump	06-001	2	Centrifugal	30.0	1	102.2	18.8	**83.4**
P-412	Off-Spec Oil Tank Recycle Pump	06-001	2	Centrifugal	30.0	1	102.2	18.8	**83.4**
P-406 A/B	Diluent Pumps	06-001	2	Centrifugal	37.0	2	105.5	18.8	**86.7**

Project (Phase 1 + 2) Noise Source Broadband Sound Power Levels (Re 10^{-12} Watts, un-mitigated) Cont.

ID TAG	Description	Location	Height (m)	Model/Type	Rating (kW)	# Units	Equipment Sound Power Level (dBA)	Building Attenuation (dBA)	Overall Sound Power Level (dBA)
P-416 A/B	Sales Oil Truck Loading Pump	06-001	2	Centrifugal	37.0	2	105.5	18.8	**86.7**
P-330 A/B	De-oiled Water Pumps	06-001	2	Centrifugal	75.0	2	106.4	18.8	**87.6**
P-326	ORF Backwash Pump	06-001	2	Centrifugal	75.0	1	103.4	18.8	**84.6**
P-310 A/B	De-oiling Booster Pump	06-001	2	Centrifugal	93.0	2	106.7	18.8	**87.9**
P-312	1st Stage De-oiling Booster Pump	06-001	2	Centrifugal	93.0	1	103.7	18.8	**84.9**
P-314	2nd Stage De-oiling Booster Pump	06-001	2	Centrifugal	93.0	1	103.7	18.8	**84.9**
P-316	3rd Stage De-oiling Booster Pump	06-001	2	Centrifugal	93.0	1	103.7	18.8	**84.9**
P-320 A/B	ORF Feed Pump	06-001	2	Centrifugal	112.0	2	107.0	18.8	**88.2**
P-222 A/B	VRU Pumps	06-001	2	Centrifugal	261.0	2	108.1	18.8	**89.3**
P-811 A/B	Secondary Glycol Pumps	06-012	2	Centrifugal	112.0	2	107.0	18.8	**88.2**
E-818	VRU Aerial Cooler Fans	06-013	5	Aerial Cooler	30.0	2	106.0	0.0	**106.0**
P-701 A/B/C	BFW Booster Pumps	08-001	2	Centrifugal	149.0	3	109.1	18.8	**90.3**
E-805 A	Primary Cooling Glycol Aerial Cooler Fans	Outside	5	Aerial Cooler	37.0	3	108.5	0.0	**108.5**
E-805 B	Primary Cooling Glycol Aerial Cooler Fans	Outside	5	Aerial Cooler	37.0	3	108.5	0.0	**108.5**
E-805 C	Primary Cooling Glycol Aerial Cooler Fans	Outside	5	Aerial Cooler	37.0	3	108.5	0.0	**108.5**
E-805 D	Primary Cooling Glycol Aerial Cooler Fans	Outside	5	Aerial Cooler	37.0	3	108.5	0.0	**108.5**
E-805 E	Primary Cooling Glycol Aerial Cooler Fans	Outside	5	Aerial Cooler	37.0	3	108.5	0.0	**108.5**
E-805 F	Primary Cooling Glycol Aerial Cooler Fans	Outside	5	Aerial Cooler	37.0	3	108.5	0.0	**108.5**
E-815 A	Produced Water Cooling Glycol Aerial Cooler Fans	Outside	5	Aerial Cooler	37.0	2	106.8	0.0	**106.8**
E-815 B	Produced Water Cooling Glycol Aerial Cooler Fans	Outside	5	Aerial Cooler	37.0	2	106.8	0.0	**106.8**
P-8101 A/B/C	Primary Cooling Glycol Pumps	01-008	2	Centrifugal	224.0	3	109.6	18.8	**90.8**
P-5103	Source Water SAC Backwash Pump	08-001	2	Centrifugal	11.0	1	100.9	18.8	**82.1**
P-3118 A/B	Froth Oil Pumps	08-001	2	Centrifugal	11.0	2	103.9	18.8	**85.1**
P-5101 A/B	Raw Water Pumps	08-001	2	Centrifugal	11.0	2	103.9	18.8	**85.1**
P-5107 A/B	Soft Water Pumps	08-001	2	Centrifugal	11.0	2	103.9	18.8	**85.1**
P-3139 A/B	Produced Water SAC Regen Pumps	08-001	2	Centrifugal	11.0	2	103.9	18.8	**85.1**
H-9143	Utility Boiler Stack	08-001	10	Heater	450 BHP	1	96.3	0.0	**96.3**
K-9143	Utility Boiler Blower	08-001	3	Blower Fan	22.0	1	101.9	0.0	**101.9**
P-3104	Wash Water Pump	08-001	2	Centrifugal	22.0	1	101.8	18.8	**83.0**
P-5111 A/B	SAC Regen Pump	08-001	2	Centrifugal	37.0	2	105.5	18.8	**86.7**
P-7101 A/B/C/D	BFW Booster Pumps	08-001	2	Centrifugal	224.0	4	110.9	18.8	**92.1**
P-3137	SAC Regen Waste Injection Pump	08-001	2	Centrifugal	224.0	1	104.9	18.8	**86.1**
P-3136	Produced Water Injection pump	08-001	2	Centrifugal	336.0	1	105.4	18.8	**86.6**
P-7103 A/B/C/D	HP BFW Pumps	08-001	2	Centrifugal	895.0	4	112.7	18.8	**93.9**
P-6102 A/B/C/D	Evaporator Feed Pumps	08-003	2	Centrifugal	37.0	4	108.5	18.8	**89.7**
P-6107 A/B/C/D	Distillate Pumps	08-003	2	Centrifugal	75.0	4	109.4	18.8	**90.6**
P-6104/114/124	Evaporator Recirculation Pumps	08-003	2	Centrifugal	447.0	3	110.5	18.8	**91.7**
K-6105	Vapour Compressor #1	08-003	2	Reciprocating	3729.0	1	126.6	22.6	**104.0**
K-6115	Vapour Compressor #2	08-003	2	Reciprocating	3729.0	1	126.6	22.6	**104.0**
K-6125	Vapour Compressor #3	08-003	2	Reciprocating	3729.0	1	126.6	22.6	**104.0**
K-2106	High Pressure Assist Gas Compressor	09-001	2	Reciprocating	261.0	1	115.1	22.6	**92.5**
	Boiler #1 Stack	10-001	36	Heater	95541.0	1	101.2	0.0	**101.2**
	Combustion Air Blower #1	10-001	5	Blower Fan	895.0	1	116.7	0.0	**116.7**
	Boiler #2 Stack	10-001	36	Heater	95541.0	1	101.2	0.0	**101.2**
	Combustion Air Blower #2	10-001	5	Blower Fan	895.0	1	116.7	0.0	**116.7**
	Boiler #3 Stack	10-001	36	Heater	95541.0	1	101.2	0.0	**101.2**
	Combustion Air Blower #3	10-001	5	Blower Fan	895.0	1	116.7	0.0	**116.7**
	Gas Turbine #1 Inlet	10-002	5	Gas Turbine	N/A	1	104.3	0.0	**104.3**
	Gas Turbine #1 Exhaust	10-002	25	Gas Turbine	N/A	1	104.8	0.0	**104.8**
	Gas Turbine #1 Casing	10-002	3	Gas Turbine	N/A	1	107.7	16.8	**90.9**

Project (Phase 1 + 2) Noise Source Broadband Sound Power Levels (Re 10^{-12} Watts, un-mitigated) Cont.

ID TAG	Description	Location	Height (m)	Model/Type	Rating (kW)	# Units	Equipment Sound Power Level (dBA)	Building Attenuation (dBA)	Overall Sound Power Level (dBA)
	Generator #1	10-002	3	Generator	7500.0	1	112.4	17.7	**94.7**
	HRSG #1 Casing	10-002	3	HRSG	N/A	1	107.7	16.8	**90.9**
	Turbine #1 Lube Oil Cooler	10-002	3	Axial Fan	N/A	1	103.1	0.0	**103.1**
	Gas Turbine #1 Inlet	10-002	5	Gas Turbine	N/A	1	104.3	0.0	**104.3**
	Gas Turbine #1 Exhaust	10-002	25	Gas Turbine	N/A	1	104.8	0.0	**104.8**
	Gas Turbine #1 Casing	10-002	3	Gas Turbine	N/A	1	107.7	16.8	**90.9**
	Generator #1	10-002	3	Generator	7500.0	1	112.4	17.7	**94.7**
	HRSG #1 Casing	10-002	3	HRSG	N/A	1	107.7	16.8	**90.9**
	Turbine #1 Lube Oil Cooler	10-002	3	Axial Fan	N/A	1	103.1	0.0	**103.1**
	Gas Turbine #1 Inlet	10-002	5	Gas Turbine	N/A	1	104.3	0.0	**104.3**
	Gas Turbine #1 Exhaust	10-002	25	Gas Turbine	N/A	1	104.8	0.0	**104.8**
	Gas Turbine #1 Casing	10-002	3	Gas Turbine	N/A	1	107.7	16.8	**90.9**
	Generator #1	10-002	3	Generator	7500.0	1	112.4	17.7	**94.7**
	HRSG #1 Casing	10-002	3	HRSG	N/A	1	107.7	16.8	**90.9**
	Turbine #1 Lube Oil Cooler	10-002	3	Axial Fan	N/A	1	103.1	0.0	**103.1**
P-4118	Vent Accumulator Pump	11-001	2	Centrifugal	11.0	1	100.9	18.8	**82.1**
P-3128	Produced Water Disposal Booster Pump	11-001	2	Centrifugal	11.0	1	100.9	18.8	**82.1**
P-3138 A/B	Produced Water SAC Regen Dilution Pumps	11-001	2	Centrifugal	11.0	2	103.9	18.8	**85.1**
P-4114	Slop Water Pump	11-001	2	Centrifugal	11.0	1	100.9	18.8	**82.1**
P-4108	Slop Oil Pump	11-001	2	Centrifugal	15.0	1	101.3	18.8	**82.5**
P-4112	Off-Spec Oil Tank Recycle Pump	11-001	2	Centrifugal	30.0	1	102.2	18.8	**83.4**
P-4110	Production Tank Recycle Pump	11-001	2	Centrifugal	30.0	1	102.2	18.8	**83.4**
P-4111	Sales Oil Tank Recycle Pump	11-001	2	Centrifugal	30.0	1	102.2	18.8	**83.4**
P-4106 A/B	Diluent Pumps	11-001	2	Centrifugal	56.0	2	106.1	18.8	**87.3**
P-4116 A/B	Sales Oil Truck Loading Pump	11-001	2	Centrifugal	56.0	2	106.1	18.8	**87.3**
P-3110 A/B	De-oiling Booster Pump	11-001	2	Centrifugal	93.0	2	106.7	18.8	**87.9**
P-3130 A/B	De-oiled Water Pumps	11-001	2	Centrifugal	112.0	2	107.0	18.8	**88.2**
P-3126	ORF Backwash Pump	11-001	2	Centrifugal	112.0	1	103.9	18.8	**85.1**
P-3112	1st Stage De-oiling Booster Pump	11-001	2	Centrifugal	149.0	1	104.3	18.8	**85.5**
P-3114	2nd Stage De-oiling Booster Pump	11-001	2	Centrifugal	149.0	1	104.3	18.8	**85.5**
P-3116	3rd Stage De-oiling Booster Pump	11-001	2	Centrifugal	149.0	1	104.3	18.8	**85.5**
P-3120 A/B	ORF Feed Pump	11-001	2	Centrifugal	186.0	2	107.6	18.8	**88.8**
P-2122 A/B	VRU Pumps	11-001	2	Centrifugal	373.0	2	108.5	18.8	**89.7**
P-8111 A/B	Secondary Cooling Glycol Pumps	11-002	2	Centrifugal	186.0	2	107.6	18.8	**88.8**
E-8118	Secondary Cooling Glycol Aerial Cooler Fans	Outside	5	Aerial Cooler	45.0	2	107.4	0.0	**107.4**
E-8105 A	Primary Cooling Glycol Aerial Cooler Fans	Outside	5	Aerial Cooler	56.0	3	110.0	0.0	**110.0**
E-8105 B	Primary Cooling Glycol Aerial Cooler Fans	Outside	5	Aerial Cooler	56.0	3	110.0	0.0	**110.0**
E-8105 C	Primary Cooling Glycol Aerial Cooler Fans	Outside	5	Aerial Cooler	56.0	3	110.0	0.0	**110.0**
E-8105 D	Primary Cooling Glycol Aerial Cooler Fans	Outside	5	Aerial Cooler	56.0	3	110.0	0.0	**110.0**
E-8105 E	Primary Cooling Glycol Aerial Cooler Fans	Outside	5	Aerial Cooler	56.0	3	110.0	0.0	**110.0**
E-8105 F	Primary Cooling Glycol Aerial Cooler Fans	Outside	5	Aerial Cooler	56.0	3	110.0	0.0	**110.0**
E-8105 G	Primary Cooling Glycol Aerial Cooler Fans	Outside	5	Aerial Cooler	56.0	3	110.0	0.0	**110.0**
E-8105 H	Primary Cooling Glycol Aerial Cooler Fans	Outside	5	Aerial Cooler	56.0	3	110.0	0.0	**110.0**
E-8115 A	Produced Water Cooling Glycol Aerial Cooler Fans	Outside	5	Aerial Cooler	56.0	2	108.2	0.0	**108.2**
E-8115 B	Produced Water Cooling Glycol Aerial Cooler Fans	Outside	5	Aerial Cooler	56.0	2	108.2	0.0	**108.2**
E-8115 C	Produced Water Cooling Glycol Aerial Cooler Fans	Outside	5	Aerial Cooler	56.0	2	108.2	0.0	**108.2**
12P-992 A/B	Wellpad Seal Flush Pumps	Wellpad (typical)	1	Centrifugal	4.0	2	102.6	18.8	**83.8**
12K-932 A/B	Wellpad Instrument Air Compressors	Wellpad (typical)	1	Reciprocating	30.0	2	108.7	22.6	**86.1**
12P-111 A/B	Wellpad Emulsion Pumps	Wellpad (typical)	1	Centrifugal	112.0	2	107.0	18.8	**88.2**
	wellpad piping	Wellpad (typical)	1	Piping / Valves	N/A	1	95.5	0.0	**95.5**

Project (Phase 1 + 2) Noise Source Octave Band Sound Power Levels (Re 10^{-12} Watts, un-mitigated)

Description	31.5 Hz	63 HZ	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
Produced Water Injection pump	96.5	97.5	98.5	99.5	98.5	100.5	97.5	93.5	87.5
HP BFW Pumps	103.1	104.1	105.1	106.1	105.1	107.1	104.1	100.1	94.1
Wash Water Pump	94.0	95.0	96.0	97.0	96.0	98.0	95.0	91.0	85.0
SAC Regen Waste Injection Pump	96.5	97.5	98.5	99.5	98.5	100.5	97.5	93.5	87.5
Primary Glycol Pumps	101.3	102.3	103.3	104.3	103.3	105.3	102.3	98.3	92.3
Utility Boiler Stack	99.6	99.6	98.6	96.6	93.6	90.6	87.6	84.6	81.6
Utility Boiler Blower	101.4	104.4	104.4	101.4	98.4	94.4	91.4	88.4	80.4
Concentrator Distillate Pumps	96.1	97.1	98.1	99.1	98.1	100.1	97.1	93.1	87.1
Evaporator Drain Pump	93.1	94.1	95.1	96.1	95.1	97.1	94.1	90.1	84.1
Evaporator Feed Pumps	98.8	99.8	100.8	101.8	100.8	102.8	99.8	95.8	89.8
Evaporator Distillate Pumps	99.7	100.7	101.7	102.7	101.7	103.7	100.7	96.7	90.7
Concentrator Recirculation Pump	95.6	96.6	97.6	98.6	97.6	99.6	96.6	92.6	86.6
Evaporator Recirculation Pump	101.0	102.0	103.0	104.0	103.0	105.0	102.0	98.0	92.0
Concentrator Vapour Compressor #1	107.9	103.9	108.9	107.9	105.9	108.9	113.9	110.9	103.9
Concentrator Vapour Compressor #2	107.9	103.9	108.9	107.9	105.9	108.9	113.9	110.9	103.9
Vapour Compressor #1	117.0	113.0	118.0	117.0	115.0	118.0	123.0	120.0	113.0
Vapour Compressor #2	117.0	113.0	118.0	117.0	115.0	118.0	123.0	120.0	113.0
Blowdown Recycle Pumps	96.5	97.5	98.5	99.5	98.5	100.5	97.5	93.5	87.5
Boiler #1 Stack	109.7	108.7	103.7	97.7	96.7	94.7	92.7	92.7	92.7
Combustion Air Blower #1	115.8	118.8	118.8	115.8	112.8	108.8	105.8	102.8	94.8
Boiler #2 Stack	109.7	108.7	103.7	97.7	96.7	94.7	92.7	92.7	92.7
Combustion Air Blower #2	115.8	118.8	118.8	115.8	112.8	108.8	105.8	102.8	94.8
Instrument Air Compressors	103.7	99.7	104.7	103.7	101.7	104.7	109.7	106.7	99.7
Gas Turbine #1 Inlet	110.5	113.5	113.5	111.5	92.5	60.5	58.5	78.5	67.5
Gas Turbine #1 Exhaust	123.5	123.5	114.5	107.5	101.5	91.5	87.5	85.5	84.5
Gas Turbine #1 Casing	118.5	111.5	108.5	105.5	103.5	102.5	100.5	97.5	92.5
Generator #1	105.2	108.2	109.2	109.2	109.2	107.2	105.2	102.2	97.2
HRSG #1 Casing	118.5	111.5	108.5	105.5	103.5	102.5	100.5	97.5	92.5
Turbine #1 Lube Oil Cooler	107.5	114.5	111.5	104.5	99.5	96.5	92.5	88.5	83.5
Gas Turbine #1 Inlet	110.5	113.5	113.5	111.5	92.5	60.5	58.5	78.5	67.5
Gas Turbine #1 Exhaust	123.5	123.5	114.5	107.5	101.5	91.5	87.5	85.5	84.5
Gas Turbine #1 Casing	118.5	111.5	108.5	105.5	103.5	102.5	100.5	97.5	92.5
Generator #1	105.2	108.2	109.2	109.2	109.2	107.2	105.2	102.2	97.2
HRSG #1 Casing	118.5	111.5	108.5	105.5	103.5	102.5	100.5	97.5	92.5
Turbine #1 Lube Oil Cooler	107.5	114.5	111.5	104.5	99.5	96.5	92.5	88.5	83.5
High Pressure Assist Gas Compressor	103.7	99.7	104.7	103.7	101.7	104.7	109.7	106.7	99.7
Slop Water Pump	93.1	94.1	95.1	96.1	95.1	97.1	94.1	90.1	84.1
Slop Oil Pump	93.5	94.5	95.5	96.5	95.5	97.5	94.5	90.5	84.5
Production Tank Recycle Pump	94.4	95.4	96.4	97.4	96.4	98.4	95.4	91.4	85.4
Sales Oil Tank Recycle Pump	94.4	95.4	96.4	97.4	96.4	98.4	95.4	91.4	85.4
Off-Spec Oil Tank Recycle Pump	94.4	95.4	96.4	97.4	96.4	98.4	95.4	91.4	85.4
Diluent Pumps	97.7	98.7	99.7	100.7	99.7	101.7	98.7	94.7	88.7

Project (Phase 1 + 2) Noise Source Octave Band Sound Power Levels (Re 10^{-12} Watts, un-mitigated) Cont.

Description	31.5 Hz	63 HZ	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
Sales Oil Truck Loading Pump	97.7	98.7	99.7	100.7	99.7	101.7	98.7	94.7	88.7
De-oiled Water Pumps	98.6	99.6	100.6	101.6	100.6	102.6	99.6	95.6	89.6
ORF Backwash Pump	95.6	96.6	97.6	98.6	97.6	99.6	96.6	92.6	86.6
De-oiling Booster Pump	98.9	99.9	100.9	101.9	100.9	102.9	99.9	95.9	89.9
1st Stage De-oiling Booster Pump	95.9	96.9	97.9	98.9	97.9	99.9	96.9	92.9	86.9
2nd Stage De-oiling Booster Pump	95.9	96.9	97.9	98.9	97.9	99.9	96.9	92.9	86.9
3rd Stage De-oiling Booster Pump	95.9	96.9	97.9	98.9	97.9	99.9	96.9	92.9	86.9
ORF Feed Pump	99.2	100.2	101.2	102.2	101.2	103.2	100.2	96.2	90.2
VRU Pumps	100.3	101.3	102.3	103.3	102.3	104.3	101.3	97.3	91.3
Secondary Glycol Pumps	99.2	100.2	101.2	102.2	101.2	103.2	100.2	96.2	90.2
VRU Aerial Cooler Fans	106.8	109.8	109.8	106.8	103.8	99.8	96.8	93.8	85.8
BFW Booster Pumps	101.3	102.3	103.3	104.3	103.3	105.3	102.3	98.3	92.3
Primary Cooling Glycol Aerial Cooler Fans	109.3	112.3	112.3	109.3	106.3	102.3	99.3	96.3	88.3
Primary Cooling Glycol Aerial Cooler Fans	109.3	112.3	112.3	109.3	106.3	102.3	99.3	96.3	88.3
Primary Cooling Glycol Aerial Cooler Fans	109.3	112.3	112.3	109.3	106.3	102.3	99.3	96.3	88.3
Primary Cooling Glycol Aerial Cooler Fans	109.3	112.3	112.3	109.3	106.3	102.3	99.3	96.3	88.3
Primary Cooling Glycol Aerial Cooler Fans	109.3	112.3	112.3	109.3	106.3	102.3	99.3	96.3	88.3
Primary Cooling Glycol Aerial Cooler Fans	109.3	112.3	112.3	109.3	106.3	102.3	99.3	96.3	88.3
Produced Water Cooling Glycol Aerial Cooler Fans	107.6	110.6	110.6	107.6	104.6	100.6	97.6	94.6	86.6
Produced Water Cooling Glycol Aerial Cooler Fans	107.6	110.6	110.6	107.6	104.6	100.6	97.6	94.6	86.6
Primary Cooling Glycol Pumps	101.8	102.8	103.8	104.8	103.8	105.8	102.8	98.8	92.8
Source Water SAC Backwash Pump	93.1	94.1	95.1	96.1	95.1	97.1	94.1	90.1	84.1
Froth Oil Pumps	96.1	97.1	98.1	99.1	98.1	100.1	97.1	93.1	87.1
Raw Water Pumps	96.1	97.1	98.1	99.1	98.1	100.1	97.1	93.1	87.1
Soft Water Pumps	96.1	97.1	98.1	99.1	98.1	100.1	97.1	93.1	87.1
Produced Water SAC Regen Pumps	96.1	97.1	98.1	99.1	98.1	100.1	97.1	93.1	87.1
Utility Boiler Stack	99.6	99.6	98.6	96.6	93.6	90.6	87.6	84.6	81.6
Utility Boiler Blower	102.7	105.7	105.7	102.7	99.7	95.7	92.7	89.7	81.7
Wash Water Pump	94.0	95.0	96.0	97.0	96.0	98.0	95.0	91.0	85.0
SAC Regen Pump	97.7	98.7	99.7	100.7	99.7	101.7	98.7	94.7	88.7
BFW Booster Pumps	103.1	104.1	105.1	106.1	105.1	107.1	104.1	100.1	94.1
SAC Regen Waste Injection Pump	97.1	98.1	99.1	100.1	99.1	101.1	98.1	94.1	88.1
Produced Water Injection pump	97.6	98.6	99.6	100.6	99.6	101.6	98.6	94.6	88.6
HP BFW Pumps	104.9	105.9	106.9	107.9	106.9	108.9	105.9	101.9	95.9
Evaporator Feed Pumps	100.7	101.7	102.7	103.7	102.7	104.7	101.7	97.7	91.7
Distillate Pumps	101.6	102.6	103.6	104.6	103.6	105.6	102.6	98.6	92.6
Evaporator Recirculation Pumps	102.7	103.7	104.7	105.7	104.7	106.7	103.7	99.7	93.7
Vapour Compressor #1	116.7	112.7	117.7	116.7	114.7	117.7	122.7	119.7	112.7
Vapour Compressor #2	116.7	112.7	117.7	116.7	114.7	117.7	122.7	119.7	112.7
Vapour Compressor #3	116.7	112.7	117.7	116.7	114.7	117.7	122.7	119.7	112.7
High Pressure Assist Gas Compressor	105.2	101.2	106.2	105.2	103.2	106.2	111.2	108.2	101.2
Boiler #1 Stack	109.7	108.7	103.7	97.7	96.7	94.7	92.7	92.7	92.7
Combustion Air Blower #1	117.5	120.5	120.5	117.5	114.5	110.5	107.5	104.5	96.5
Boiler #2 Stack	109.7	108.7	103.7	97.7	96.7	94.7	92.7	92.7	92.7
Combustion Air Blower #2	117.5	120.5	120.5	117.5	114.5	110.5	107.5	104.5	96.5
Boiler #3 Stack	109.7	108.7	103.7	97.7	96.7	94.7	92.7	92.7	92.7
Combustion Air Blower #3	117.5	120.5	120.5	117.5	114.5	110.5	107.5	104.5	96.5
Gas Turbine #1 Inlet	110.5	113.5	113.5	111.5	92.5	60.5	58.5	78.5	67.5
Gas Turbine #1 Exhaust	123.5	123.5	114.5	107.5	101.5	91.5	87.5	85.5	84.5
Gas Turbine #1 Casing	118.5	111.5	108.5	105.5	103.5	102.5	100.5	97.5	92.5

Project (Phase 1 + 2) Noise Source Octave Band Sound Power Levels (Re 10^{-12} Watts, un-mitigated) Cont.

Description	31.5 Hz	63 HZ	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
Generator #1	105.2	108.2	109.2	109.2	109.2	107.2	105.2	102.2	97.2
HRSG #1 Casing	118.5	111.5	108.5	105.5	103.5	102.5	100.5	97.5	92.5
Turbine #1 Lube Oil Cooler	107.5	114.5	111.5	104.5	99.5	96.5	92.5	88.5	83.5
Gas Turbine #1 Inlet	110.5	113.5	113.5	111.5	92.5	60.5	58.5	78.5	67.5
Gas Turbine #1 Exhaust	123.5	123.5	114.5	107.5	101.5	91.5	87.5	85.5	84.5
Gas Turbine #1 Casing	118.5	111.5	108.5	105.5	103.5	102.5	100.5	97.5	92.5
Generator #1	105.2	108.2	109.2	109.2	109.2	107.2	105.2	102.2	97.2
HRSG #1 Casing	118.5	111.5	108.5	105.5	103.5	102.5	100.5	97.5	92.5
Turbine #1 Lube Oil Cooler	107.5	114.5	111.5	104.5	99.5	96.5	92.5	88.5	83.5
Gas Turbine #1 Inlet	110.5	113.5	113.5	111.5	92.5	60.5	58.5	78.5	67.5
Gas Turbine #1 Exhaust	123.5	123.5	114.5	107.5	101.5	91.5	87.5	85.5	84.5
Gas Turbine #1 Casing	118.5	111.5	108.5	105.5	103.5	102.5	100.5	97.5	92.5
Generator #1	105.2	108.2	109.2	109.2	109.2	107.2	105.2	102.2	97.2
HRSG #1 Casing	118.5	111.5	108.5	105.5	103.5	102.5	100.5	97.5	92.5
Turbine #1 Lube Oil Cooler	107.5	114.5	111.5	104.5	99.5	96.5	92.5	88.5	83.5
Vent Accumulator Pump	93.1	94.1	95.1	96.1	95.1	97.1	94.1	90.1	84.1
Produced Water Disposal Booster Pump	93.1	94.1	95.1	96.1	95.1	97.1	94.1	90.1	84.1
Produced Water SAC Regen Dilution Pumps	96.1	97.1	98.1	99.1	98.1	100.1	97.1	93.1	87.1
Slop Water Pump	93.1	94.1	95.1	96.1	95.1	97.1	94.1	90.1	84.1
Slop Oil Pump	93.5	94.5	95.5	96.5	95.5	97.5	94.5	90.5	84.5
Off-Spec Oil Tank Recycle Pump	94.4	95.4	96.4	97.4	96.4	98.4	95.4	91.4	85.4
Production Tank Recycle Pump	94.4	95.4	96.4	97.4	96.4	98.4	95.4	91.4	85.4
Sales Oil Tank Recycle Pump	94.4	95.4	96.4	97.4	96.4	98.4	95.4	91.4	85.4
Diluent Pumps	98.3	99.3	100.3	101.3	100.3	102.3	99.3	95.3	89.3
Sales Oil Truck Loading Pump	98.3	99.3	100.3	101.3	100.3	102.3	99.3	95.3	89.3
De-oiling Booster Pump	98.9	99.9	100.9	101.9	100.9	102.9	99.9	95.9	89.9
De-oiled Water Pumps	99.2	100.2	101.2	102.2	101.2	103.2	100.2	96.2	90.2
ORF Backwash Pump	96.1	97.1	98.1	99.1	98.1	100.1	97.1	93.1	87.1
1st Stage De-oiling Booster Pump	96.5	97.5	98.5	99.5	98.5	100.5	97.5	93.5	87.5
2nd Stage De-oiling Booster Pump	96.5	97.5	98.5	99.5	98.5	100.5	97.5	93.5	87.5
3rd Stage De-oiling Booster Pump	96.5	97.5	98.5	99.5	98.5	100.5	97.5	93.5	87.5
ORF Feed Pump	99.8	100.8	101.8	102.8	101.8	103.8	100.8	96.8	90.8
VRU Pumps	100.7	101.7	102.7	103.7	102.7	104.7	101.7	97.7	91.7
Secondary Cooling Glycol Pumps	99.8	100.8	101.8	102.8	101.8	103.8	100.8	96.8	90.8
Secondary Cooling Glycol Aerial Cooler Fans	108.2	111.2	111.2	108.2	105.2	101.2	98.2	95.2	87.2
Primary Cooling Glycol Aerial Cooler Fans	110.8	113.8	113.8	110.8	107.8	103.8	100.8	97.8	89.8
Primary Cooling Glycol Aerial Cooler Fans	110.8	113.8	113.8	110.8	107.8	103.8	100.8	97.8	89.8
Primary Cooling Glycol Aerial Cooler Fans	110.8	113.8	113.8	110.8	107.8	103.8	100.8	97.8	89.8
Primary Cooling Glycol Aerial Cooler Fans	110.8	113.8	113.8	110.8	107.8	103.8	100.8	97.8	89.8
Primary Cooling Glycol Aerial Cooler Fans	110.8	113.8	113.8	110.8	107.8	103.8	100.8	97.8	89.8
Primary Cooling Glycol Aerial Cooler Fans	110.8	113.8	113.8	110.8	107.8	103.8	100.8	97.8	89.8
Primary Cooling Glycol Aerial Cooler Fans	110.8	113.8	113.8	110.8	107.8	103.8	100.8	97.8	89.8
Primary Cooling Glycol Aerial Cooler Fans	110.8	113.8	113.8	110.8	107.8	103.8	100.8	97.8	89.8
Produced Water Cooling Glycol Aerial Cooler Fans	109.0	112.0	112.0	109.0	106.0	102.0	99.0	96.0	88.0
Produced Water Cooling Glycol Aerial Cooler Fans	109.0	112.0	112.0	109.0	106.0	102.0	99.0	96.0	88.0
Produced Water Cooling Glycol Aerial Cooler Fans	109.0	112.0	112.0	109.0	106.0	102.0	99.0	96.0	88.0
Wellpad Seal Flush Pumps	94.8	95.8	96.8	97.8	96.8	98.8	95.8	91.8	85.8
Wellpad Instrument Air Compressors	98.8	94.8	99.8	98.8	96.8	99.8	104.8	101.8	94.8
Wellpad Emulsion Pumps	99.2	100.2	101.2	102.2	101.2	103.2	100.2	96.2	90.2
wellpad piping	101.0	100.0	94.0	92.0	91.0	90.0	88.0	87.0	82.0

Pilot Plant Noise Source Broadband Sound Power Levels (Re 10^{-12} Watts, un-mitigated)

ID TAG	Description	Location	Height (m)	Model/Type	Rating (kW)	# Units	Equipment Sound Power Level (dBA)	Building Attenuation (dBA)	Overall Sound Power Level (dBA)
P-216	Water Injection Pumps	Water Treatment Bldg	2	Centrifugal	111.9	2	107.0	18.8	**88.2**
P-217	Heat Medium Circulation Pump	Utility Bldg	2	Centrifugal	22.4	1	101.8	18.8	**83.0**
P-218	Cooling Medium Circulation Pump	Utility Bldg	2	Centrifugal	56.0	2	106.1	18.8	**87.3**
P-219	Disposal Water Charge Pump	Process Bldg	2	Centrifugal	14.9	1	101.3	18.8	**82.5**
P-226	Wash Water Pump	Process Bldg	2	Centrifugal	56.0	1	103.0	18.8	**84.2**
P-320	Raw Water Feed Pumps	Source Water Pond Pump Skid	2	Centrifugal	44.8	2	105.8	18.8	**87.0**
P-501	BFW HP Pumps	Steam Generator Bldg	2	Centrifugal	298.4	1	105.2	18.8	**86.4**
P-502	BFW HP Pumps	Steam Generator Bldg	2	Centrifugal	298.4	1	105.2	18.8	**86.4**
BL-510	Steam Generator #1 Blower	Steam Generator Bldg	3	Blower Fan	44.8	1	104.4	0.0	**104.4**
BL-520	Steam Generator #2 Blower	Steam Generator Bldg	3	Blower Fan	44.8	1	104.4	0.0	**104.4**
EA-215	Cooling Medium Aerial Coolers	Outside near Utility Bldg	5	Aerial Coolers	29.8	2	106.0	0.0	**106.0**
EA-555	Cooling Medium Aerial Coolers	Outside near Utility Bldg	5	Aerial Coolers	29.8	2	106.0	0.0	**106.0**
B-204	Heat Medium Boiler Stack	Utility Bldg	7.4	Heater	280 BHP	1	95.5	0.0	**95.5**
B-204B	Heat Medium Boiler Stack	Utility Bldg	7.4	Heater	280 BHP	1	95.5	0.0	**95.5**
BL510	Steam Generator #1 Stack	Steam Generator Bldg	14	Heater	1500 BHP	1	98.4	0.0	**98.4**
BL520	Steam Generator #2 Stack	Steam Generator Bldg	14	Heater	1500 BHP	1	98.4	0.0	**98.4**
K-106	Air Compressors	Utility Bldg	2	Reciprocating	3.7	2	99.6	22.6	**77.0**
K-202	VRU Compressor	Process Bldg	2	Reciprocating	18.7	1	103.6	22.6	**81.0**

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

Description	31.5 Hz	63 HZ	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
Water Injection Pumps	99.2	100.2	101.2	102.2	101.2	103.2	100.2	96.2	90.2
Heat Medium Circulation Pump	94.0	95.0	96.0	97.0	96.0	98.0	95.0	91.0	85.0
Cooling Medium Circulation Pump	98.3	99.3	100.3	101.3	100.3	102.3	99.3	95.3	89.3
Disposal Water Charge Pump	93.5	94.5	95.5	96.5	95.5	97.5	94.5	90.5	84.5
Wash Water Pump	95.2	96.2	97.2	98.2	97.2	99.2	96.2	92.2	86.2
Raw Water Feed Pumps	98.0	99.0	100.0	101.0	100.0	102.0	99.0	95.0	89.0
BFW HP Pumps	97.4	98.4	99.4	100.4	99.4	101.4	98.4	94.4	88.4
BFW HP Pumps	97.4	98.4	99.4	100.4	99.4	101.4	98.4	94.4	88.4
Steam Generator #1 Blower	105.2	108.2	108.2	105.2	102.2	98.2	95.2	92.2	84.2
Steam Generator #2 Blower	105.2	108.2	108.2	105.2	102.2	98.2	95.2	92.2	84.2
Cooling Medium Aerial Coolers	106.8	109.8	109.8	106.8	103.8	99.8	96.8	93.8	85.8
Cooling Medium Aerial Coolers	106.8	109.8	109.8	106.8	103.8	99.8	96.8	93.8	85.8
Heat Medium Boiler Stack	98.8	98.8	97.8	95.8	92.8	89.8	86.8	83.8	80.8
Heat Medium Boiler Stack	98.8	98.8	97.8	95.8	92.8	89.8	86.8	83.8	80.8
Steam Generator #1 Stack	101.7	101.7	100.7	98.7	95.7	92.7	89.7	86.7	83.7
Steam Generator #2 Stack	101.7	101.7	100.7	98.7	95.7	92.7	89.7	86.7	83.7
Air Compressors	89.7	85.7	90.7	89.7	87.7	90.7	95.7	92.7	85.7
VRU Compressor	93.7	89.7	94.7	93.7	91.7	94.7	99.7	96.7	89.7

Phase 1 Noise Source Broadband Sound Power Levels (Re 10^{-12} Watts, un-mitigated)

ID TAG	Description	Location	Height (m)	Model/Type	Rating (kW)	# Units	Equipment Sound Power Level (dBA)	Building Attenuation (dBA)	Overall Sound Power Level (dBA)
P-302	Surge Tank Skim Pump	Tank Building	2	Centrifugal	26.1	1	102.1	18.8	**83.3**
P-303	ORF Feed Tank Skim Pump	Tank Building	2	Centrifugal	26.1	1	102.1	18.8	**83.3**
P-304	Wash Water Pump	Tank Building	2	Centrifugal	44.8	1	102.8	18.8	**84.0**
P-306	Desand Skim Pump	Tank Building	2	Centrifugal	26.1	1	102.1	18.8	**83.3**
P-310	De-Oiling Feed Pumps	Tank Building	2	Centrifugal	37.3	2	105.5	18.8	**86.7**
P-312	2nd Stage De-Oiling Pump	Tank Building	2	Centrifugal	37.3	1	102.5	18.8	**83.7**
P-314	3rd Stage De-Oiling Pump	Tank Building	2	Centrifugal	37.3	1	102.5	18.8	**83.7**
P-316	De-Oiling Transfer Pumps	Tank Building	2	Centrifugal	37.3	2	105.5	18.8	**86.7**
P-318	Froth Oil Pump	Tank Building	2	Centrifugal	26.1	1	102.1	18.8	**83.3**
P-320	ORF Feed Pumps	Tank Building	2	Centrifugal	67.1	2	106.3	18.8	**87.5**
P-326	ORF Backwash Pump	Tank Building	2	Centrifugal	67.1	1	103.3	18.8	**84.5**
P-327	De-Oiled Water Tank Skim Pump	Tank Building	2	Centrifugal	26.1	1	102.1	18.8	**83.3**
P-330	De-Oiled Water Pumps	Tank Building	2	Centrifugal	56.0	2	106.1	18.8	**87.3**
P-335	Disposal SAC Regen Waste Booster Pump	Source Water Building	2	Centrifugal	149.2	1	104.3	18.8	**85.5**
P-336	Produced Water Injection Pump	Source Water Building	2	Centrifugal	149.2	1	104.3	18.8	**85.5**
P-337	SAC Regen Waste Injection Pump	Source Water Building	2	Centrifugal	149.2	1	104.3	18.8	**85.5**
P-406	Diluent Pumps	Tank Building	2	Centrifugal	44.8	2	105.8	18.8	**87.0**
P-408	Slop Oil Pump	Tank Building	2	Centrifugal	26.1	1	102.1	18.8	**83.3**
P-410	Production Oil Tank Recycle Pump	Tank Building	2	Centrifugal	26.1	1	102.1	18.8	**83.3**
P-411	Sales Oil Tank Recycle Pump	Tank Building	2	Centrifugal	26.1	1	102.1	18.8	**83.3**
P-412	Off-Spec Oil Tank Recycle Pump	Tank Building	2	Centrifugal	26.1	1	102.1	18.8	**83.3**
P-414	Slop Water Pump	Tank Building	2	Centrifugal	26.1	1	102.1	18.8	**83.3**
P-501	Raw Water Pumps	Source Water Building	2	Centrifugal	22.4	2	104.9	18.8	**86.1**
P-503	SAC Backwash Pump	Source Water Building	2	Centrifugal	22.4	1	101.8	18.8	**83.0**
P-507	Soft Water Pumps	Source Water Building	2	Centrifugal	22.4	2	104.9	18.8	**86.1**
P-508	Utility Water Pumps	Source Water Building	2	Centrifugal	22.4	2	104.9	18.8	**86.1**
P-511	SAC Regen Pump	Source Water Building	2	Centrifugal	22.4	1	101.8	18.8	**83.0**
P-602	Evaporator Feed Pump	Evaporator Building	2	Centrifugal	59.7	1	103.1	18.8	**84.3**
P-606	Distillate Pump	Evaporator Building	2	Centrifugal	111.9	1	103.9	18.8	**85.1**
P-607	Evaporator Recirculation Pump	Evaporator Building	2	Centrifugal	671.4	1	106.3	18.8	**87.5**
P-612	Evaporator Feed Pump	Evaporator Building	2	Centrifugal	59.7	1	103.1	18.8	**84.3**
P-616	Distillate Pump	Evaporator Building	2	Centrifugal	111.9	1	103.9	18.8	**85.1**
P-617	Evaporator Recirculation Pump	Evaporator Building	2	Centrifugal	671.4	1	106.3	18.8	**87.5**
P-623	Vent Condenser Slop Pumps	Evaporator Building	2	Centrifugal	14.9	2	104.3	18.8	**85.5**
P-626	Seal Water Pumps	Evaporator Building	2	Centrifugal	7.5	2	103.4	18.8	**84.6**
P-701	BFW Booster Pumps	Source Water Building	2	Centrifugal	186.5	3	109.4	18.8	**90.6**
P-702	Utility BFW Pumps	Source Water Building	2	Centrifugal	4.5	2	102.8	18.8	**84.0**
P-703	HP BFW Pumps	Steam Generator Building	2	Centrifugal	559.5	3	110.8	18.8	**92.0**
P-793	Blowdown Recycle Pumps	Steam Generator Building	2	Centrifugal	22.4	2	104.9	18.8	**86.1**
P-795	Condensate Pump	Steam Silencer Building	2	Centrifugal	2.2	1	98.8	18.8	**80.0**
P-801	Primary Cooling Glycol Pumps	Primary Cooling Glycol Building	2	Centrifugal	186.5	3	109.4	18.8	**90.6**
P-811	Secondary Cooling Glycol Pumps	Secondary Cooling Glycol Building	2	Centrifugal	186.5	2	107.6	18.8	**88.8**

Phase 1 Noise Source Broadband Sound Power Levels (Re 10^{-12} Watts, un-mitigated) Cont.

ID TAG	Description	Location	Height (m)	Model/Type	Rating (kW)	# Units	Equipment Sound Power Level (dBA)	Building Attenuation (dBA)	Overall Sound Power Level (dBA)
P-803	Primary Cooling Glycol Make-Up Pump	Primary Cooling Glycol Building	2	Centrifugal	2.2	1	98.8	18.8	**80.0**
P-902	Flare Knock Out Drum Pumps	HP Flare KO Building	2	Centrifugal	2.2	2	101.9	18.8	**83.1**
P-905	Truck Flare Knock Out Drum Pump	LP Flare KO Building	2	Centrifugal	2.2	1	98.8	18.8	**80.0**
K-206	High Pressure Assist Gas Compressor	Fuel Gas Compressor Building	2	Reciprocating	186.5	1	113.6	22.6	**91.0**
K-222	VRU Compressors	Tank Building	2	Reciprocating	149.2	2	115.6	22.6	**93.0**
K-604	Vapour Compressor	Evaporator Building	2	Reciprocating	2611.0	1	125.1	22.6	**102.5**
K-614	Vapour Compressor	Evaporator Building	2	Reciprocating	2611.0	1	125.1	22.6	**102.5**
K-712	Combustion Air Blower	Steam Generator Building	2	Blower Fan	559.5	1	109.7	0.0	**109.7**
K-722	Combustion Air Blower	Steam Generator Building	2	Blower Fan	559.5	1	109.7	0.0	**109.7**
K-907	Instrument Air Compressors	Instrument Air Building	2	Reciprocating	74.6	2	112.6	22.6	**90.0**
K-943	Utility Boiler Blower	Source Water Building	2	Blower Fan	14.9	1	100.6	0.0	**100.6**
H-710	Steam Generator Stacks	Steam Generator Building	36	Heater	96713.0	1	101.3	0.0	**101.3**
H-720	Steam Generator Stacks	Steam Generator Building	36	Heater	96713.0	1	101.3	0.0	**101.3**
K-731	Gas Turbine #1 Inlet	CoGen Building	5	Gas Turbine	N/A	1	104.3	0.0	**104.3**
H-730	Gas Turbine #1 HRSG Exhaust Stack	CoGen Building	25	Gas Turbine	N/A	1	104.8	0.0	**104.8**
K-731	Gas Turbine #1 Casing	CoGen Building	3	Gas Turbine	N/A	1	107.7	16.8	**90.9**
K-731	Generator #1	CoGen Building	3	Generator	7500.0	1	112.4	17.7	**94.7**
H-730	HRSG #1 Casing	CoGen Building	3	HRSG	N/A	1	107.7	16.8	**90.9**
	Turbine #1 Lube Oil Cooler	CoGen Building	3	Axial Fan	N/A	1	103.1	0.0	**103.1**
K-741	Gas Turbine #2 Inlet	CoGen Building	5	Gas Turbine	N/A	1	104.3	0.0	**104.3**
H-740	Gas Turbine #2 HRSG Exhaust Stack	CoGen Building	25	Gas Turbine	N/A	1	104.8	0.0	**104.8**
K-741	Gas Turbine #2 Casing	CoGen Building	3	Gas Turbine	N/A	1	107.7	16.8	**90.9**
K-741	Generator #2	CoGen Building	3	Generator	7500.0	1	112.4	17.7	**94.7**
H-740	HRSG #2 Casing	CoGen Building	3	HRSG	N/A	1	107.7	16.8	**90.9**
	Turbine #2 Lube Oil Cooler	CoGen Building	3	Axial Fan	N/A	1	103.1	0.0	**103.1**
H-942	Utility Steam Boiler	Source Water Building	10	Heater	380 BHP	1	96.0	0.0	**96.0**
EM-805	Primary Cooling Glycol Aerial Coolers	Glycol Cooler Area	2.5	Aerial Coolers	44.8	3	109.2	0.0	**109.2**
EM-805	Primary Cooling Glycol Aerial Coolers	Glycol Cooler Area	2.5	Aerial Coolers	44.8	3	109.2	0.0	**109.2**
EM-805	Primary Cooling Glycol Aerial Coolers	Glycol Cooler Area	2.5	Aerial Coolers	44.8	3	109.2	0.0	**109.2**
EM-805	Primary Cooling Glycol Aerial Coolers	Glycol Cooler Area	2.5	Aerial Coolers	44.8	3	109.2	0.0	**109.2**
EM-815	Secondary Cooling Glycol Aerial Coolers	Glycol Cooler Area	2.5	Aerial Coolers	44.8	3	109.2	0.0	**109.2**
EM-815	Secondary Cooling Glycol Aerial Coolers	Glycol Cooler Area	2.5	Aerial Coolers	44.8	3	109.2	0.0	**109.2**
EM-815	Secondary Cooling Glycol Aerial Coolers	Glycol Cooler Area	2.5	Aerial Coolers	44.8	3	109.2	0.0	**109.2**
	Wellpad Emulsion Pump	Pad 1	2	Centrifugal	187.0	2	107.6	18.8	**88.8**
	I/A Compressors	Pad 1	2	Reciprocating	38.0	2	109.7	22.6	**87.1**
	wellpad piping	Pad 1	2	Piping / Valves	N/A	1	95.5	0.0	**95.5**
	Wellpad Emulsion Pump	Pad 2	2	Centrifugal	187.0	2	107.6	18.8	**88.8**
	I/A Compressors	Pad 2	2	Reciprocating	38.0	2	109.7	22.6	**87.1**
	wellpad piping	Pad 2	2	Piping / Valves	N/A	1	95.5	0.0	**95.5**
	Wellpad Emulsion Pump	Pad 3	2	Centrifugal	187.0	2	107.6	18.8	**88.8**
	I/A Compressors	Pad 3	2	Reciprocating	38.0	2	109.7	22.6	**87.1**
	wellpad piping	Pad 3	2	Piping / Valves	N/A	1	95.5	0.0	**95.5**
	Wellpad Emulsion Pump	Pad 4	2	Centrifugal	187.0	2	107.6	18.8	**88.8**
	I/A Compressors	Pad 4	2	Reciprocating	38.0	2	109.7	22.6	**87.1**
	wellpad piping	Pad 4	2	Piping / Valves	N/A	1	95.5	0.0	**95.5**
	Wellpad Emulsion Pump	Pad 5	2	Centrifugal	187.0	2	107.6	18.8	**88.8**
	I/A Compressors	Pad 5	2	Reciprocating	38.0	2	109.7	22.6	**87.1**
	wellpad piping	Pad 5	2	Piping / Valves	N/A	1	95.5	0.0	**95.5**

Phase 1 Noise Source Octave Band Sound Power Levels (Re 10^{-12} Watts, un-mitigated)

Description	31.5 Hz	63 HZ	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
Surge Tank Skim Pump	94.3	95.3	96.3	97.3	96.3	98.3	95.3	91.3	85.3
ORF Feed Tank Skim Pump	94.3	95.3	96.3	97.3	96.3	98.3	95.3	91.3	85.3
Wash Water Pump	95.0	96.0	97.0	98.0	97.0	99.0	96.0	92.0	86.0
Desand Skim Pump	94.3	95.3	96.3	97.3	96.3	98.3	95.3	91.3	85.3
De-Oiling Feed Pumps	97.7	98.7	99.7	100.7	99.7	101.7	98.7	94.7	88.7
2nd Stage De-Oiling Pump	94.7	95.7	96.7	97.7	96.7	98.7	95.7	91.7	85.7
3rd Stage De-Oiling Pump	94.7	95.7	96.7	97.7	96.7	98.7	95.7	91.7	85.7
De-Oiling Transfer Pumps	97.7	98.7	99.7	100.7	99.7	101.7	98.7	94.7	88.7
Froth Oil Pump	94.3	95.3	96.3	97.3	96.3	98.3	95.3	91.3	85.3
ORF Feed Pumps	98.5	99.5	100.5	101.5	100.5	102.5	99.5	95.5	89.5
ORF Backwash Pump	95.5	96.5	97.5	98.5	97.5	99.5	96.5	92.5	86.5
De-Oiled Water Tank Skim Pump	94.3	95.3	96.3	97.3	96.3	98.3	95.3	91.3	85.3
De-Oiled Water Pumps	98.3	99.3	100.3	101.3	100.3	102.3	99.3	95.3	89.3
Disposal SAC Regen Waste Booster Pump	96.5	97.5	98.5	99.5	98.5	100.5	97.5	93.5	87.5
Produced Water Injection Pump	96.5	97.5	98.5	99.5	98.5	100.5	97.5	93.5	87.5
SAC Regen Waste Injection Pump	96.5	97.5	98.5	99.5	98.5	100.5	97.5	93.5	87.5
Diluent Pumps	98.0	99.0	100.0	101.0	100.0	102.0	99.0	95.0	89.0
Slop Oil Pump	94.3	95.3	96.3	97.3	96.3	98.3	95.3	91.3	85.3
Production Oil Tank Recycle Pump	94.3	95.3	96.3	97.3	96.3	98.3	95.3	91.3	85.3
Sales Oil Tank Recycle Pump	94.3	95.3	96.3	97.3	96.3	98.3	95.3	91.3	85.3
Off-Spec Oil Tank Recycle Pump	94.3	95.3	96.3	97.3	96.3	98.3	95.3	91.3	85.3
Slop Water Pump	94.3	95.3	96.3	97.3	96.3	98.3	95.3	91.3	85.3
Raw Water Pumps	97.1	98.1	99.1	100.1	99.1	101.1	98.1	94.1	88.1
SAC Backwash Pump	94.0	95.0	96.0	97.0	96.0	98.0	95.0	91.0	85.0
Soft Water Pumps	97.1	98.1	99.1	100.1	99.1	101.1	98.1	94.1	88.1
Utility Water Pumps	97.1	98.1	99.1	100.1	99.1	101.1	98.1	94.1	88.1
SAC Regen Pump	94.0	95.0	96.0	97.0	96.0	98.0	95.0	91.0	85.0
Evaporator Feed Pump	95.3	96.3	97.3	98.3	97.3	99.3	96.3	92.3	86.3
Distillate Pump	96.1	97.1	98.1	99.1	98.1	100.1	97.1	93.1	87.1
Evaporator Recirculation Pump	98.5	99.5	100.5	101.5	100.5	102.5	99.5	95.5	89.5
Evaporator Feed Pump	95.3	96.3	97.3	98.3	97.3	99.3	96.3	92.3	86.3
Distillate Pump	96.1	97.1	98.1	99.1	98.1	100.1	97.1	93.1	87.1
Evaporator Recirculation Pump	98.5	99.5	100.5	101.5	100.5	102.5	99.5	95.5	89.5
Vent Condenser Slop Pumps	96.5	97.5	98.5	99.5	98.5	100.5	97.5	93.5	87.5
Seal Water Pumps	95.6	96.6	97.6	98.6	97.6	99.6	96.6	92.6	86.6
BFW Booster Pumps	101.6	102.6	103.6	104.6	103.6	105.6	102.6	98.6	92.6
Utility BFW Pumps	95.0	96.0	97.0	98.0	97.0	99.0	96.0	92.0	86.0
HP BFW Pumps	103.0	104.0	105.0	106.0	105.0	107.0	104.0	100.0	94.0
Blowdown Recycle Pumps	97.1	98.1	99.1	100.1	99.1	101.1	98.1	94.1	88.1
Condensate Pump	91.0	92.0	93.0	94.0	93.0	95.0	92.0	88.0	82.0
Primary Cooling Glycol Pumps	101.6	102.6	103.6	104.6	103.6	105.6	102.6	98.6	92.6
Secondary Cooling Glycol Pumps	99.8	100.8	101.8	102.8	101.8	103.8	100.8	96.8	90.8

Phase 1 Noise Source Octave Band Sound Power Levels (Re 10^{-12} Watts, un-mitigated) Cont.

Description	31.5 Hz	63 HZ	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
Primary Cooling Glycol Make-Up Pump	91.0	92.0	93.0	94.0	93.0	95.0	92.0	88.0	82.0
Flare Knock Out Drum Pumps	94.1	95.1	96.1	97.1	96.1	98.1	95.1	91.1	85.1
Truck Flare Knock Out Drum Pump	91.0	92.0	93.0	94.0	93.0	95.0	92.0	88.0	82.0
High Pressure Assist Gas Compressor	103.7	99.7	104.7	103.7	101.7	104.7	109.7	106.7	99.7
VRU Compressors	105.7	101.7	106.7	105.7	103.7	106.7	111.7	108.7	101.7
Vapour Compressor	115.2	111.2	116.2	115.2	113.2	116.2	121.2	118.2	111.2
Vapour Compressor	115.2	111.2	116.2	115.2	113.2	116.2	121.2	118.2	111.2
Combustion Air Blower	110.5	113.5	113.5	110.5	107.5	103.5	100.5	97.5	89.5
Combustion Air Blower	110.5	113.5	113.5	110.5	107.5	103.5	100.5	97.5	89.5
Instrument Air Compressors	102.7	98.7	103.7	102.7	100.7	103.7	108.7	105.7	98.7
Utility Boiler Blower	101.4	104.4	104.4	101.4	98.4	94.4	91.4	88.4	80.4
Steam Generator Stacks	109.8	108.8	103.8	97.8	96.8	94.8	92.8	92.8	92.8
Steam Generator Stacks	109.8	108.8	103.8	97.8	96.8	94.8	92.8	92.8	92.8
Gas Turbine #1 Inlet	110.5	113.5	113.5	111.5	92.5	60.5	58.5	78.5	67.5
Gas Turbine #1 HRSG Exhaust Stack	123.5	123.5	114.5	107.5	101.5	91.5	87.5	85.5	84.5
Gas Turbine #1 Casing	118.5	111.5	108.5	105.5	103.5	102.5	100.5	97.5	92.5
Generator #1	105.2	108.2	109.2	109.2	109.2	107.2	105.2	102.2	97.2
HRSG #1 Casing	118.5	111.5	108.5	105.5	103.5	102.5	100.5	97.5	92.5
Turbine #1 Lube Oil Cooler	107.5	114.5	111.5	104.5	99.5	96.5	92.5	88.5	83.5
Gas Turbine #2 Inlet	110.5	113.5	113.5	111.5	92.5	60.5	58.5	78.5	67.5
Gas Turbine #2 HRSG Exhaust Stack	123.5	123.5	114.5	107.5	101.5	91.5	87.5	85.5	84.5
Gas Turbine #2 Casing	118.5	111.5	108.5	105.5	103.5	102.5	100.5	97.5	92.5
Generator #2	105.2	108.2	109.2	109.2	109.2	107.2	105.2	102.2	97.2
HRSG #2 Casing	118.5	111.5	108.5	105.5	103.5	102.5	100.5	97.5	92.5
Turbine #2 Lube Oil Cooler	107.5	114.5	111.5	104.5	99.5	96.5	92.5	88.5	83.5
Utility Steam Boiler	99.3	99.3	98.3	96.3	93.3	90.3	87.3	84.3	81.3
Primary Cooling Glycol Aerial Coolers	110.0	113.0	113.0	110.0	107.0	103.0	100.0	97.0	89.0
Primary Cooling Glycol Aerial Coolers	110.0	113.0	113.0	110.0	107.0	103.0	100.0	97.0	89.0
Primary Cooling Glycol Aerial Coolers	110.0	113.0	113.0	110.0	107.0	103.0	100.0	97.0	89.0
Primary Cooling Glycol Aerial Coolers	110.0	113.0	113.0	110.0	107.0	103.0	100.0	97.0	89.0
Secondary Cooling Glycol Aerial Coolers	110.0	113.0	113.0	110.0	107.0	103.0	100.0	97.0	89.0
Secondary Cooling Glycol Aerial Coolers	110.0	113.0	113.0	110.0	107.0	103.0	100.0	97.0	89.0
Secondary Cooling Glycol Aerial Coolers	110.0	113.0	113.0	110.0	107.0	103.0	100.0	97.0	89.0
Wellpad Emulsion Pump	99.8	100.8	101.8	102.8	101.8	103.8	100.8	96.8	90.8
I/A Compressors	99.8	95.8	100.8	99.8	97.8	100.8	105.8	102.8	95.8
wellpad piping	101.0	100.0	94.0	92.0	91.0	90.0	88.0	87.0	82.0
Wellpad Emulsion Pump	99.8	100.8	101.8	102.8	101.8	103.8	100.8	96.8	90.8
I/A Compressors	99.8	95.8	100.8	99.8	97.8	100.8	105.8	102.8	95.8
wellpad piping	101.0	100.0	94.0	92.0	91.0	90.0	88.0	87.0	82.0
Wellpad Emulsion Pump	99.8	100.8	101.8	102.8	101.8	103.8	100.8	96.8	90.8
I/A Compressors	99.8	95.8	100.8	99.8	97.8	100.8	105.8	102.8	95.8
wellpad piping	101.0	100.0	94.0	92.0	91.0	90.0	88.0	87.0	82.0
Wellpad Emulsion Pump	99.8	100.8	101.8	102.8	101.8	103.8	100.8	96.8	90.8
I/A Compressors	99.8	95.8	100.8	99.8	97.8	100.8	105.8	102.8	95.8
wellpad piping	101.0	100.0	94.0	92.0	91.0	90.0	88.0	87.0	82.0
Wellpad Emulsion Pump	99.8	100.8	101.8	102.8	101.8	103.8	100.8	96.8	90.8
I/A Compressors	99.8	95.8	100.8	99.8	97.8	100.8	105.8	102.8	95.8
wellpad piping	101.0	100.0	94.0	92.0	91.0	90.0	88.0	87.0	82.0

Project (Phase 1 + 2) Building Dimensions

Tag	Building Name	Length (m)	Width (m)	Height (m)
01-002	Source/Raw Water Pump Skid	10.8	5.0	3.0
01-003	Soft/Utility Water Pump Skid	12.0	5.0	3.0
01-004	BFW Booster Pump Skid	8.4	7.0	3.0
01-006	PW/SAC Regen Waste Inj. Pump Skid	7.0	5.0	3.0
01-008	Primary Glycol Building	23.4	7.0	3.0
01-009	HP Flare KO Building	12.0	5.5	3.2
01-010	Source Water SAC Vessel Skid	7.0	4.0	3.0
01-011	Utility Steam Boiler Skid	7.0	4.0	3.0
01-012	HP Flare KO Building	12.0	5.5	3.2
02-001	Evaporator Building	51.8	25.9	11.4
02-002	MCC-02-002	23.0	7.3	3.0
02-003	MCC-02-003	23.0	7.3	3.0
03-001	Steam Generator Building	51.0	43.0	11.2
03-003	Instrument Air Building	7.4	3.7	3.0
03-004	Utility Lab	9.0	3.0	3.0
04-001	Cogen Building	33.5	28.0	11.4
04-002	MCC-04-002	23.0	7.3	3.0
04-003	MCC-04-003	23.0	7.3	3.0
05-001	Inlet Building	37.5	23.2	12.0
05-008	Clean Oil/Glycol Exchanger Building	24.0	7.0	5.1
05-009	Fuel Gas Building	14.8	6.4	5.3
05-010	Steam Silencer Building	4.7	2.4	3.0
05-012	Assist Gas Compressor Building	15.0	10.0	3.0
05-013	Process Lab	9.0	3.0	6.4
05-014	FWKO/Treater Control Building	31.0	23.8	6.4
05-017	Treater 104 Building	26.0	5.0	6.4
06-001	Tank Building	96.3	32.5	11.0
06-012	Secondary Glycol Building	17.4	7.5	3.0
06-013	MCC-06-013	23.0	7.3	3.0
07-001	LP Flare KO Building	9.0	6.0	3.2
07-007	Office Building	38.1	24.3	3.0
07-008	Warehouse	24.3	12.0	3.0
07-009	Truck Loading Office Building	5.0	5.0	3.0
08-001	Source Water Building	43.5	25.0	7.6
08-002	Crystallizer Building	23.0	27.0	7.6
08-003	Evaporator Building	27.0	51.1	11.4
08-004	Instrument Air Building	3.7	7.4	3.0
09-001	Inlet Building	28.0	34.0	12.0
09-002	Fuel Gas Building	12.0	20.0	5.3
09-003	Clean Oil/Glycol Exchanger Building	15.7	23.6	5.1
09-005	FWKO/Treater Control Building	26.9	30.0	6.4
09-008	Treater Building	28.0	6.0	6.4
10-001	Steam Generator Building	75.0	43.0	11.2
10-002	Cogen Building	42.0	33.5	11.4
10-003	MCC	23.0	7.3	3.0
11-001	Tank Building	102.0	35.0	11.0
11-002	Secondary Glycol Building	7.5	4.3	3.0

Pilot Plant Building Dimensions

Building Name	Length (m)	Width (m)	Height (m)
Water Treatment Building	32.0	15.0	5.5
Process Building	43.0	15.0	6.1
Utility Building	18.4	8.5	3.5
Fuel Gas Building	7.4	3.7	3.6
Maintenance & Admin Building	24.5	16.6	4.1
Warehouse Building	23.1	7.3	7.1
Source Water Pump Skid	5.0	4.0	3.9
Test Separator Building	18.0	7.3	6.4
Steam Generator Building	28.4	22.7	6.5
Flare KO Building	3.2	1.8	2.2
MCC Building	10.8	6.1	3.6
Meter Skid	1.0	2.0	2.1

Phase 1 Building Dimensions

Building Name	Length (m)	Width (m)	Height (m)
001 Tank Building	80.5	26.0	9.1
002 Steam Generator Building	34.0	32.6	11.2
003 CoGen Building	35.5	22.0	11.4
004 Inlet Building	34.0	21.1	7.6
005 FWKO/Treater Building	31.0	23.8	6.4
006 Fuel Gas Building	18.0	7.0	3.0
007 Fuel Gas Compressor Building	15.0	10.0	3.0
008 Evaporator Building	35.0	27.0	11.4
009 Source Water Building	30.0	20.0	7.6
010 Primary Cooling Glycol Building	20.0	8.8	3.0
011 Secondary Cooling Glycol Building	20.0	8.7	3.0
012 Office Building	17.0	16.0	3.0
013 Warehouse	27.5	16.0	3.0
014 Dewatering/Exchanger Building	20.0	13.0	3.0
015 Steam Silencer Building	10.0	7.0	3.0
016 Instrument Air Building	7.4	3.7	3.0
017 HP Flare KO Building	11.0	7.0	3.2
018 LP Flare KO Building	9.0	6.0	3.2
019 Truck Loading Office	5.0	5.0	3.0
020 MCC Building A	23.0	7.3	3.0
021 MCC Building B	23.0	7.3	3.0
022 MCC Building C	23.0	7.3	3.0
023 MCC Building D	23.0	7.3	3.0
024 MCC Building E	23.0	7.3	3.0
033 Process Lab Building	9.0	3.0	3.0
034 Utility Lab Building	9.0	3.0	3.0

Building Sound Attenuation

	31.5 Hz	63 HZ	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
Building Attenuation (dB)	3	6	9	12	15	20	25	30	30

Project (Phase 1 + 2) Tank Dimensions

ID TAG	Tank Name	Radius (m)	Height (m)
T-300	Produced Water Surge Tank	7.3	9.8
T-301	ORF Feed Tank	10.2	9.8
T-305	Desand Tank	3.6	9.8
T-311	1st Stage De-Oiling Tank	2.7	9.8
T-313	2nd Stage De-Oiling Tank	2.7	9.8
T-315	3rd Stage De-Oiling Tank	2.7	9.8
T-317	Froth Oil Tank	0.9	2.4
T-325	De-Oiling Water Tank	7.3	9.8
T-333	Brine Tank	1.8	5.5
T-334	SAC Regen Waste Tank	1.9	9.8
T-400	Sales Oil Tank	10.2	9.8
T-401	Sales Oil Tank	10.2	9.8
T-402	Off-Spec Oil Tank	7.3	9.8
T-403	Slop Oil Tank	3.6	9.8
T-404	Slop Oil Tank	3.6	9.8
T-405	Diluent Tank	7.3	9.8
T-500	Raw Water Tank	3.6	9.8
T-506	Soft Water Tank	3.6	9.8
T-510	Source Water Brine Tank	1.2	4.6
T-620	Evaporator Waste Tank	3.6	9.8
T-700	Boiler Feedwater Tank	10.2	9.8
T-792	Blowdown Tank	3.6	9.8
T-806	Primary Glycol Storage Tank	1.9	3.0
T-807	Primary Glycol Pop Tank	1.2	1.5
T-816	Secondary Glycol Storage Tank	1.9	3.0
T-817	Secondary Glycol Pop Tank	1.2	1.5
T-920	Floor Drain Tank Tank	2.4	4.9
T-3100	Produced Water Surge Tank	10.2	9.8
T-3101	ORF Feed Tank	10.2	9.8
T-3105	Desand Tank	3.6	9.8
T-3125	Deoiled Water Tank	10.2	9.8
T-4100	Sales Oil Tank	10.2	9.8
T-4101	Sales Oil Tank	10.2	9.8
T-4102	Off-Spec Oil Tank	10.2	9.8
T-4103	Slop Oil Tank	3.6	9.8
T-4104	Slop Oil Tank	3.6	9.8
T-4105	Diluent Tank	10.2	9.8
T-5100	Raw Water Tank	3.6	9.8
T-5106	Soft Water Tank	3.6	9.8
T-6120	Evaporator Waste Tank	3.6	9.8
T-7100	Boiler Feedwater Tank	10.2	9.8

Pilot Plant Tank Dimensions

ID TAG	Tank Name	Radius (m)	Height (m)
T-300	Raw Water Tank	5.1	9.8
T-302	Boiler Feed Water Tank	5.1	9.8
T-310	Softener Waste Tank	2.6	3.7
T-411	Production Sales Tank #1	3.6	7.9
T-412	Production Sales Tank #2	3.6	7.9
T-420	Off-Spec Oil Tank	3.6	7.9
T-430	Slop Oil Tank	2.6	7.3
T-440	Diluent Tank	2.6	7.3
T-450	Produced Water Skim Tank	3.6	9.8
T-460	Produced Water Storage Tank	3.6	9.8
T-470	Desand Tank	2.4	7.3
T-561	Blowdown Vent Tank	2.3	7.3
T-790	Pop Tank	2.4	7.3
T-795	Floor Drain Tank	2.1	3.6
T-890	Glycol Storage Tank	1.2	1.8

Phase 1 Tank Dimensions

ID TAG	Tank Name	Radius (m)	Height (m)
T-300	Produced Water Surge Tank	7.3	9.8
T-301	ORF Feed Tank	10.2	9.8
T-305	Desand Tank	3.6	9.8
T-311	1st Stage De-Oiling Tank	2.5	9.1
T-313	2nd Stage De-Oiling Tank	2.5	9.1
T-315	3rd Stage De-Oiling Tank	2.5	9.1
T-317	Froth Oil Tank	1.5	4.6
T-325	De-Oiling Water Tank	7.3	9.8
T-334	Disposal Water Tank	1.9	9.8
T-400	Sales Oil Tank	10.2	9.8
T-401	Sales Oil Tank	10.2	9.8
T-402	Off-Spec Oil Tank	7.3	9.8
T-403	Slop Oil Tank	3.6	9.8
T-404	Slop Oil Tank	3.6	9.8
T-405	Diluent Tank	7.3	9.8
T-500	Raw Water Tank	3.6	9.8
T-506	Soft Water Tank	3.6	9.8
T-620	Evaporator Waste Tank	3.6	9.8
T-700	Boiler Feedwater Tank	10.2	9.8
T-792	Blowdown Tank	3.6	9.8
T-806	Primary Glycol Storage Tank	1.9	3.0
T-816	Secondary Glycol Storage Tank	1.9	3.0
T-920	Floor Drain Tank Tank	2.4	4.9

General Noise Modeling Parameters

Parameter	Value
Modeling Software	CADNA/A (Version 4.3.143)
Standard Followed	ISO 9613-2
Ground Sound Absorption Coefficient	0.6
Wind Speed	1 - 5 m/s (3.6 - 18 km/hr)
Wind Direction	Downwind from all sources to all receptors
Temperature	10 °C
Humidity	70%
Topography	Used Digital Terrain Model Contours Provided by Client

Appendix II MEASUREMENT EQUIPMENT USED

The sound level measurement equipment used consisted of Brüel and Kjær Type 2250 and Type 2270 Precision Integrating Sound Level Meters on a tripod with a windscreen. The systems acquired data for a minimum of 30-second L_{eq} samples using 1/3 octave band frequency analysis and overall A-weighted and C-weighted sound levels. The sound level meter conforms to Type 1, ANSI S1.4, ANSI S1.43, IEC 61672-1, IEC 60651, IEC 60804 and DIN 45657. The 1/3 octave filters conform to S1.11 – Type 0-C, and IEC 61260 – Class 0. The calibrator conforms to IEC 942 and ANSI S1.40. For the measurements conducted on June, 2011, the Type 2250 sound level meter, pre-amplifier and microphone were certified on November 2, 2009 and the calibrator (type B&K 4231) was certified on November 4, 2010. For the measurements conducted on May, 2013, the Type 2270 sound level meter, pre-amplifier and microphone were certified on December 11, 2012 and the calibrator (type B&K 4231) was certified on October 1, 2012. All instrumentation was calibrated by a NIST NVLAP Accredited Calibration Laboratory for all requirements of ISO 17025: 1999 and relevant requirements of ISO 9002:1994, ISO 9001:2000 and ANSI/NCSL Z540: 1994 Part 1. All measurement methods and instrumentation conform to the requirements of the AER Directive 038. Refer to the next section in the Appendix for a detailed description of the various acoustical descriptive terms used.

SLM Calibration Certificate From June, 2011 Measurements

Scantek, Inc.
CALIBRATION LABORATORY
ISO 17025: 2005, ANSI/NCSL Z540:1994 Part 1
and relevant requirements of ISO 9002: 1994
ACCREDITED by NVLAP
(an ILAC and APLAC signatory)

NVLAP®
NVLAP Lab Code: 200625-0

Calibration Certificate No.20669

Instrument:	**Sound Level Meter**	*Date Calibrated:*	**11/2/2009**	
Model:	**2250**	*Status:*	**Received**	**Sent**
Manufacturer:	**Brüel and Kjær**	*In tolerance:*	**X**	**X**
Serial number:	**2600498**	*Out of tolerance:*		
Tested with:	**Microphone 4189 s/n 2595637** **Preamplifier ZC0032 s/n 6434**	*See comments:*		
		Contains non-accredited tests: __Yes _X_ No		
Type (class):	**1**	*Calibration service:* __ Basic _X_ Standard		
Customer:	**Acoustical Consultants Inc.**	*Address:*	**Suite 107, 9920-63 Ave** **Edmonton, Alberta** **CANADA T6E 0G9**	
Tel/Fax:	**780-414-6373/ -6376**			

Tested in accordance with the following procedures and standards:
Calibration of Sound Level Meters, Scantek Inc., 06/07/2005
SLM & Dosimeters – Acoustical Tests, Scantek Inc., 06/15/2005

Instrumentation used for calibration: Nor-1504 Norsonic Test System:

Instrument - Manufacturer	Description	S/N	Cal. Date	Traceability evidence Cal. Lab / Accreditation	Cal. Due
483B-Norsonic	SME Cal Unit	25747	Jan 2, 2009	Scantek, Inc./NVLAP	Jan 2, 2010
DS-360-SRS	Function Generator	61646	Nov 19, 2007	Davis Inotek / A2LA	Nov 19, 2009
34401A-Agilent Technologies	Digital Multimeter	MY41022043	Nov 13, 2008	Transcat / NVLAP	Nov 13, 2009
DPI 141-Druck	Pressure Indicator	790/00-04	Nov 21, 2008	Transcat / NVLAP	Nov 21, 2010
HMP233-Vaisala Oyj	Humidity & Temp. Transmitter	V3820001	May 7, 2008	Vaisala / A2LA	Nov 7, 2009
PC Program 1019 Norsonic	Calibration software	v.46	Validated Dec 2006	-	-
1253-Norsonic	Calibrator	25726	Jan 2, 2009	Scantek, Inc./NVLAP	Jan 2, 2010

Instrumentation and test results are traceable to SI (International System of Units) through standards maintained by NIST (USA) and NPL (UK).

Environmental conditions:

Temperature (°C)	Barometric pressure (kPa)	Relative Humidity (%)
22.9 °C	100.926 kPa	40.3 %RH

Calibrated by	Valentin Buzduga	**Checked by**	Mariana Buzduga
Signature	[signature]	Signature	[signature]
Date	11/02/2009	Date	11/3/2009

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Microphone Calibration Certificate From June, 2011 Measurements

Scantek, Inc.
CALIBRATION LABORATORY
ISO 17025: 2005, ANSI/NCSL Z540: 1994 Part 1
and relevant requirements of ISO 9002: 1994
ACCREDITED by NVLAP
(an ILAC and APLAC signatory)

NVLAP®
NVLAP Lab Code: 200625-0

Calibration Certificate No.20670

Instrument: **Microphone**
Model: **4189**
Manufacturer: **Brüel & Kjær**
Serial number: **2595637**

Date Calibrated: **11/2/2009**

Status:	**Received**	**Sent**
In tolerance:	X	X
Out of tolerance:		
See comments:		

Contains non-accredited tests: __Yes _X_ No

Customer: **Acoustical Consultants Inc.**
Tel/Fax: **780-414-6373/ -6376**

Address: **Suite 107, 9920-63 Ave**
Edmonton, Alberta
CANADA T6E 0G9

Tested in accordance with the following procedures and standards:
Procedure for Calibration of Measurement Microphones, Scantek Inc., 06/15/2005

Instrumentation used for calibration: N-1504 Norsonic Test System:

Instrument - Manufacturer	Description	S/N	Cal. Date	Traceability evidence Cal. Lab / Accreditation	Cal. Due
483B-Norsonic	SME Cal Unit	25747	Jan 2, 2009	Scantek, Inc./NVLAP	Jan 2, 2010
DS-360-SRS	Function Generator	61646	Nov 19, 2007	Davis Inotek / A2LA	Nov 19, 2009
34401A-Agilent Technologies	Digital Multimeter	MY41022043	Nov 13, 2008	Transcat / NVLAP	Nov 13, 2009
DPI 141-Druck	Pressure Indicator	790/00-04	Nov 21, 2008	Transcat / NVLAP	Nov 21, 2010
HMP233-Vaisala Oyj	Humidity & Temp. Transmitter	V3820001	May 7, 2008	Vaisala / A2LA	Nov 7, 2009
PC Program 1017 Norsonic	Calibration software	v.46	Validated Feb 2006	-	-
1253-Norsonic	Calibrator	28326	Feb 16, 2009	Scantek, Inc. / NVLAP	Feb 16, 2010
1203-Norsonic	Preamplifier	14051	Jan 2, 2009	Scantek, Inc./ NVLAP	Jan 2, 2010
4180-Bruel&Kjaer	Microphone	2246115	Mar 7, 2008	NPL (UK) / UKAS	Mar 7, 2010

Instrumentation and test results are traceable to SI - BIPM through standards maintained by NPL (UK) and NIST (USA)

Calibrated by	Valentin Buzduga	Checked by	Mariana Buzduga
Signature	[signature]	Signature	[signature]
Date	11/02/2009	Date	11/3/2009

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Calibrator Calibration Certificate From June, 2011 Measurements

Scantek, Inc.
CALIBRATION LABORATORY

ISO 17025: 2005, ANSI/NCSL Z540:1994 Part 1 and relevant requirements of ISO 9002:1994 ACCREDITED by NVLAP (an ILAC and APLAC signatory)

NVLAP®

NVLAP Lab Code: 200625-0

Calibration Certificate No.22807

Instrument: **Acoustical Calibrator**
Model: **4231**
Manufacturer: **Brüel and Kjær**
Serial number: **2594693**
Class (IEC 60942): **1**
Barometer type:
Barometer s/n:

Date Calibrated: **11/4/2010** *Cal Due:*

Status:	Received	Sent
In tolerance:	X	X
Out of tolerance:		
See comments:		

Contains non-accredited tests: __Yes _X_ No

Customer: **Acoustical Consultants Inc.**
Tel/Fax: **780-414-6373 / 780-414-6376**

Address: **5031 - 210 Street**
Edmonton, Alberta
CANADA T6M 0A8

Tested in accordance with the following procedures and standards:
Calibration of Acoustical Calibrators, Scantek Inc., 06/06/2005

Instrumentation used for calibration: Nor-1504 Norsonic Test System:

Instrument - Manufacturer	Description	S/N	Cal. Date	Traceability evidence Cal. Lab / Accreditation	Cal. Due
483B-Norsonic	SME Cal Unit	25747	Dec 24, 2009	Scantek, Inc./ NVLAP	Dec 24, 2010
DS-360-SRS	Function Generator	61646	Nov 13, 2009	ACR Env. / A2LA	Nov 13, 2011
34401A-Agilent Technologies	Digital Multimeter	MY41022043	Nov 12, 2009	ACR Env. / A2LA	Nov 12, 2010
DPI 141-Druck	Pressure Indicator	790/00-04	Nov 21, 2008	Transcat / NVLAP	Nov 21, 2010
8903A-HP	Audio Analyzer	2514A05691	Jan 2, 2008	Transcat/ NVLAP	Jan 2, 2011
HMP233-Vaisala Oyj	Humidity & Temp. Transmitter	V3820001	Nov 25, 2009	ACR Env./ A2LA	May 25, 2011
PC Program 1018 Norsonic	Calibration software	v.5.0	Validated July 2009	-	
1253-Norsonic	Calibrator	28326	Dec 7, 2009	Scantek, Inc./ NVLAP	Dec 7, 2010
1203-Norsonic	Preamplifier	14059	Jan 4, 2010	Scantek, Inc./ NVLAP	Jan 4, 2011
4180-Brüel&Kjær	Microphone	2246115	Dec 14, 2009	NPL (UK) / UKAS	Dec 14, 2011

Instrumentation and test results are traceable to SI (International System of Units) through standards maintained by NIST (USA) and NPL (UK)

Calibrated by	Valentin Buzduga	Checked by	Mariana Buzduga
Signature	[signature]	Signature	[signature]
Date	11/04/2010	Date	11/5/2010

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SLM and Microphone Calibration Certificate From May, 2013 Measurements

MANUFACTURER'S CERTIFICATE OF CONFORMANCE

We certify that Brüel & Kjær **-2270--D00-** Serial No. **3002730** has been tested and passed all production tests, confirming compliance with the manufacturer's published specification at the date of the test.

The final test has been performed using calibrated equipment, traceable to National or International Standards or by ratio measurements.

Brüel & Kjær is certified under ISO 9001:2008 assuring that all test data is retained on file and is available for inspection upon request.

Nærum 11-dec-2012

Torben Bjørn
Vice President, Operations

Please note that this document is not a calibration certificate.
For information on our calibration services please contact your nearest Brüel & Kjær office.

HEADQUARTERS: Brüel & Kjær Sound & Vibration Measurement A/S · DK-2850 Nærum · Denmark
Telephone: +45 7741 2000 · Fax: +45 4580 1405 · www.bksv.com · info@bksv.com
Local representatives and service organisations worldwide

Brüel & Kjær

Prepolarized Free-field 1/2" Microphone Type 4189

Brüel & Kjær Calibration Chart

Serial No: 2850741

Open-circuit Sensitivity*, S_0:	-26.0	dB re 1V/Pa
Equivalent to:	49.8	mV/Pa
Uncertainty, 95 % confidence level	0.2	dB
Capacitance:	14.1	pF
Valid At:		
Temperature:	23	°C
Ambient Static Pressure:	101.3	kPa
Relative Humidity:	50	%
Frequency:	251.2	Hz
Polarization Voltage, external:	0	V

Sensitivity Traceable To:
DPLA: Danish Primary Laboratory of Acoustics
NIST: National Institute of Standards and Technology, USA

IEC 61094-4: Type WS 2 F

Environmental Calibration Conditions:
99.7 kPa 22 °C 47 % RH

Procedure: 704215 **Date:** 26. Nov. 2012 **Signature:** AK

$^*K_0 = -26 - S_0$ Example: $K_0 = -26 - (-26.2) = +0.2$ dB

Calibrator Calibration Certificate From May, 2013 Measurements

Scantek, Inc.
CALIBRATION LABORATORY
ISO 17025: 2005, ANSI/NCSL Z540:1994 Part 1 ACCREDITED
by NVLAP (an ILAC and APLAC signatory)

NVLAP®
NVLAP Lab Code: 200625-0

Calibration Certificate No.27290

Instrument: **Acoustical Calibrator**
Model: **4231**
Manufacturer: **Brüel and Kjær**
Serial number: **2594693**
Class (IEC 60942): **1**
Barometer type:
Barometer s/n:

Date Calibrated: **10/1/2012** *Cal Due:*

Status:	Received	Sent
In tolerance:	X	X
Out of tolerance:		
See comments:		

Contains non-accredited tests: __Yes _X_ No

Customer: **ACI Acoustical Consultants Inc.**
Tel/Fax: **780-414-6373 / -6376**
Address: **5031 - 210 Street, Edmonton Alberta, CANADA T6M 0A8**

Tested in accordance with the following procedures and standards:
Calibration of Acoustical Calibrators, Scantek Inc., Rev. 10/1/2010

Instrumentation used for calibration: Nor-1504 Norsonic Test System:

Instrument - Manufacturer	Description	S/N	Cal. Date	Traceability evidence Cal. Lab / Accreditation	Cal. Due
483B-Norsonic	SME Cal Unit	25747	Jul 2, 2012	Scantek, Inc./ NVLAP	Jul 2, 2013
DS-360-SRS	Function Generator	61646	Nov 16, 2011	ACR Env./ A2LA	Nov 16, 2013
34401A-Agilent Technologies	Digital Voltmeter	MY41022043	Dec 9, 2011	ACR Env. / A2LA	Dec 9, 2012
DPI 141-Druck	Pressure Indicator	790/00-04	Dec 13, 2010	ACR Env./ A2LA	Dec 13, 2012
HMP233-Vaisala Oyj	Humidity & Temp. Transmitter	V3820001	Sep 6, 2012	ACR Env./ A2LA	Mar 6, 2014
8903A-HP	Audio Analyzer	2514A05691	Dec 1, 2010	ACR Env./ A2LA	Dec 1, 2013
PC Program 1018 Norsonic	Calibration software	v.5.2	Validated March 2011	Scantek, Inc.	-
4134-Brüel&Kjær	Microphone	456005	Mar 23, 2012	Scantek, Inc. / NVLAP	Mar 23, 2013
1203-Norsonic	Preamplifier	14059	Jan 3, 2012	Scantek, Inc./ NVLAP	Jan 3, 2013

Instrumentation and test results are traceable to SI (International System of Units) through standards maintained by NIST (USA) and NPL (UK)

Calibrated by:	Valentin Buzduga	Authorized signatory:	Mariana Buzduga
Signature	[signature]	Signature	[signature]
Date	10/01/2012	Date	10/2/2012

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Appendix III THE ASSESSMENT OF ENVIRONMENTAL NOISE (GENERAL)

Sound Pressure Level

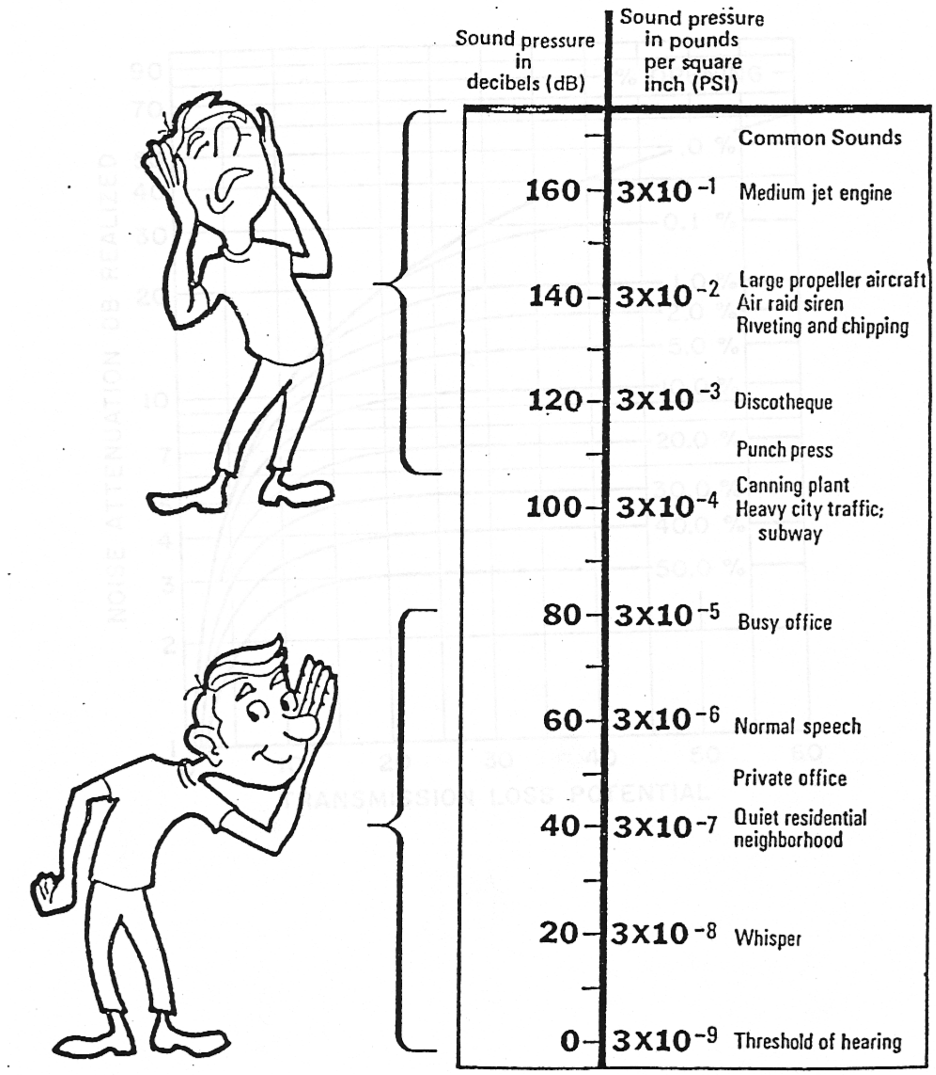
Sound pressure is initially measured in Pascal's (Pa). Humans can hear several orders of magnitude in sound pressure levels, so a more convenient scale is used. This scale is known as the decibel (dB) scale, named after Alexander Graham Bell (telephone guy). It is a base 10 logarithmic scale. When we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

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

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

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

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


Sound pressure in decibels (dB)
Sound pressure in pounds per square inch (PSI)
Common Sounds
160 3X10 -1 Medium jet engine
140 3X10 -2 Large propeller aircraft
Air raid siren
Riveting and chipping
120 3X10 -3 Discotheque
Punch press
Canning plant
100 3X10 -4 Heavy city traffic; subway
80 3X10 -5 Busy office
60 3X10 -6 Normal speech
Private office
40 3X10 -7 Quiet residential neighborhood
20 3X10 -8 Whisper
0 3X10 -9 Threshold of hearing

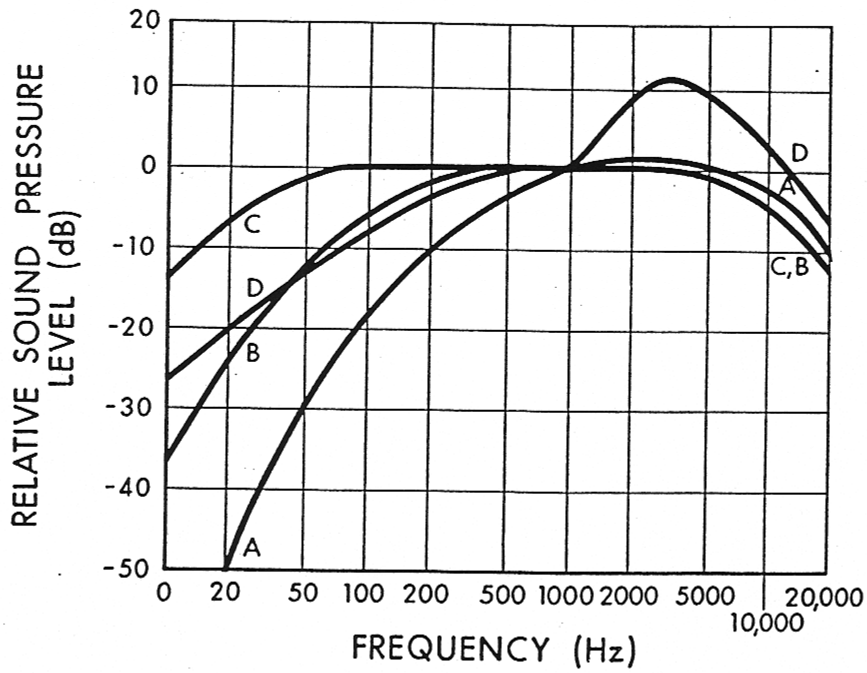
Frequency

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

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

Lower Band Limit	Whole Octave Center Frequency	Upper Band Limit	Lower Band Limit	1/3 Octave Center Frequency	Upper Band Limit
11	**16**	22	14.1	**16**	17.8
			17.8	**20**	22.4
			22.4	**25**	28.2
22	**31.5**	44	28.2	**31.5**	35.5
			35.5	**40**	44.7
			44.7	**50**	56.2
44	**63**	88	56.2	**63**	70.8
			70.8	**80**	89.1
			89.1	**100**	112
88	**125**	177	112	**125**	141
			141	**160**	178
			178	**200**	224
177	**250**	355	224	**250**	282
			282	**315**	355
			355	**400**	447
355	**500**	710	447	**500**	562
			562	**630**	708
			708	**800**	891
710	**1000**	1420	891	**1000**	1122
			1122	**1250**	1413
			1413	**1600**	1778
1420	**2000**	2840	1778	**2000**	2239
			2239	**2500**	2818
			2818	**3150**	3548
2840	**4000**	5680	3548	**4000**	4467
			4467	**5000**	5623
			5623	**6300**	7079
5680	**8000**	11360	7079	**8000**	8913
			8913	**10000**	11220
			11220	**12500**	14130
11360	**16000**	22720	14130	**16000**	17780
			17780	**20000**	22390

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



Combination of Sounds

When combining multiple sound sources the general equation is:

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

Examples:

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

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

Sound Level Measurements

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

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

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

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

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

Statistical Descriptor

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

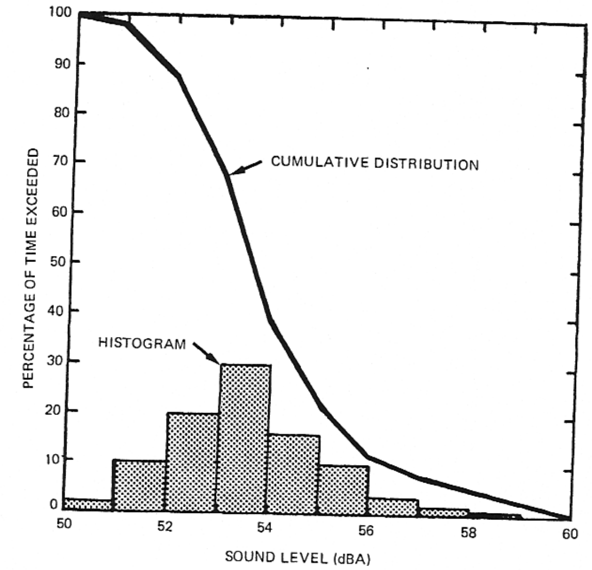


Figure 16.6 Statistically processed community noise showing histogram and cumulative distribution of A weighted sound levels.

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

The most common statistical descriptors are:

L_{min} - minimum sound level measured
L_{01} - sound level that was exceeded only 1% of the time
L_{10} - sound level that was exceeded only 10% of the time.
- Good measure of intermittent or intrusive noise
- Good measure of Traffic Noise

L_{50} - sound level that was exceeded 50% of the time (arithmetic average)
- Good to compare to L_{eq} to determine steadiness of noise

L_{90} - sound level that was exceeded 90% of the time
- Good indicator of typical “ambient” noise levels

L_{99} - sound level that was exceeded 99% of the time
L_{max} - maximum sound level measured

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

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

Sound Propagation

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

Point Source

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

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

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

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

Examples (note no atmospheric absorption):

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

Line Source

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

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

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

Examples (note no atmospheric absorption):

- A line source measuring 50 dB at 100 m will be 47 dB at 200 m.
- A line source measuring 50 dB at 100 m will be 45 dB at 300 m.
- A line source measuring 50 dB at 100 m will be 34 dB at 400 m.
- A line source measuring 50 dB at 100 m will be 40 dB at 1000 m.

Atmospheric Absorption

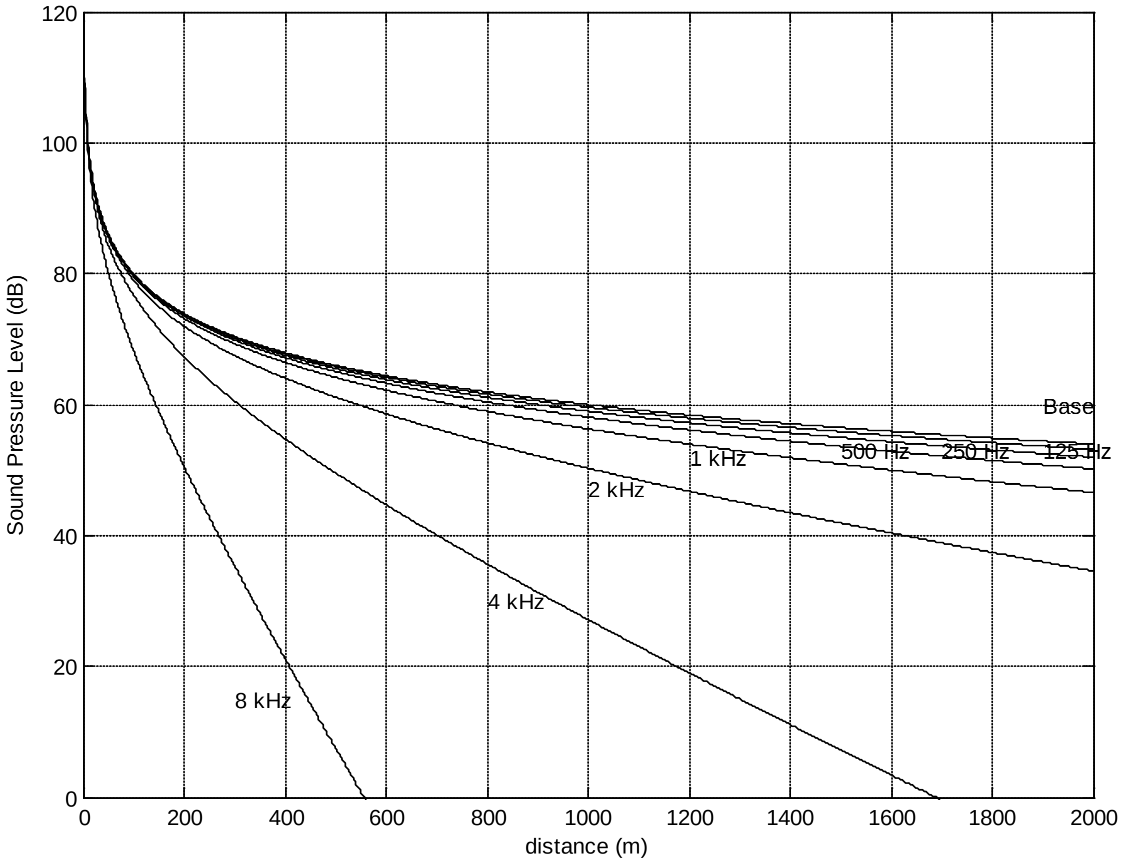
As sound transmits through a medium, there is an attenuation (or dissipation of acoustic energy) which can be attributed to three mechanisms:

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

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

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

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



Atmospheric Absorption at 10^{o}C and 70% RH

Meteorological Effects

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

Wind

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

Temperature

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

Rain

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

Summary

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

Topographical Effects

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

Topography

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

Grass

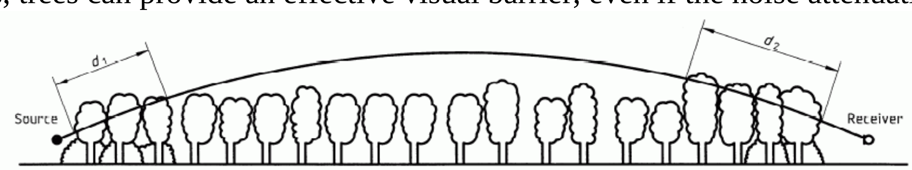
- Can be an effective absorber due to large area covered.
- Only effective at low height above ground. Does not affect sound transmitted direct from source to receiver if there is line of sight.
- Typically less absorption than atmospheric absorption when there is line of sight.
- Approximate rule of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

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

Where: A_g is the absorption amount

Trees

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



NOTE — $d_f = d_1 + d_2$

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

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

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

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

Tree/Foliage attenuation from ISO 9613-2:1996

Bodies of Water

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

Snow

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

Appendix IV SOUND LEVELS OF FAMILIAR NOISE SOURCES

Used with Permission Obtained from AER Directive 038 (January, 2007)

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

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

SOUND LEVELS GENERATED BY COMMON APPLIANCES

Used with Permission Obtained from AER Directive 038 (January, 2007)

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

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

Appendix V PERMISSIBLE SOUND LEVEL DETERMINATION

Permissible Sound Levels at Residential Receptors Greater Than 500 m From a Heavily Traveled Road and With a Population Density Less Than 9 Per Quarter Section and Theoretical 1,500 m Receptors

Basic Sound Level

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

Time of Day Adjustment

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

Class A Adjustments

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

Class B Adjustments

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

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

Permissible Sound Levels at Residential Receptors Less Than 500 m From a Heavily Traveled Road and With a Population Density Less Than 9 Per Quarter Section

Basic Sound Level

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

Time of Day Adjustment

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

Class A Adjustments

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

Class B Adjustments

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

	Night-Time	Day-Time
Total Permissible Sound Level (PSL) [dBA]	45	55

Traffic information obtained from the Alberta Transportation website indicates an average annual daily total AADT of 1000 vehicles per day on Secondary Highway 657 which equates to approximately 11 vehicles per hour during the night-time which exceeds the minimum AER requirement of 10 vehicles per hour for the road to be considered heavily travelled.

Permissible Sound Levels at Residential Receptors Less Than 500 m From a Heavily Traveled Road and With a Population Density Between 9 - 160 Per Quarter Section

Basic Sound Level

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

Time of Day Adjustment

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

Class A Adjustments

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

Class B Adjustments

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

	Night-Time	Day-Time
Total Permissible Sound Level (PSL) [dBA]	48	58

Traffic information obtained from the Alberta Transportation website indicates an average annual daily total AADT of 1000 vehicles per day on Secondary Highway 657 which equates to approximately 11 vehicles per hour during the night-time which exceeds the minimum AER requirement of 10 vehicles per hour for the road to be considered heavily travelled.

Appendix VI PLANNED DEVELOPMENT CASE NOISE SOURCE ORDER-RANKING

Residential R-13

Noise Source	Location	dBA		31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
CNRL 11-35-57-05-W4M CNRL_Engine	Existing	39.3		42.3	46.8	45.1	31.2	36.1	36.5	29	11.2
CNRL 11-35-57-05-W4M CNRL_Engine	Existing	39		42.1	46.6	44.8	31	35.9	36.2	28.6	10.6
CNRL 14-36-57-05-W4M CNRL_Engine	Existing	22.7		30.9	35.2	30.6	17.8	21.3	18.9	1.6	-53.8
CNRL 11-01-58-05-W4M CNRL_Engine	Existing	20.2		29.3	33.6	28.9	15.8	18.9	15.7	-4.2	-69.8
CNRL 11-01-58-05-W4M CNRL_Engine	Existing	20.2		29.3	33.6	28.9	15.8	18.9	15.7	-4.3	-69.8
CNRL 11-01-58-05-W4M CNRL_Engine	Existing	20.1		29.3	33.5	28.8	15.7	18.8	15.6	-4.4	-70.2
CNRL 04-12-58-05-W4M CNRL_Engine	Existing	19.1		28.7	32.9	28.2	15	17.9	14.3	-6.8	-76.9
AltaGas Lindbergh Comp. 07-21-58-05-W4M	Existing	17.5		38.4	42.1	25.9	15	6.3	-1.2	-42.5	-100
CNRL 1a-33-57-05-W4M CNRL_Engine	Existing	17.4		19.8	23.9	28.9	17.2	16.4	8.8	-11.1	-70.8
CNRL 14-11-58-05-W4M CNRL_Engine	Existing	17.2		27.5	31.8	26.9	13.4	16	11.8	-11.7	-100
CNRL 14-11-58-05-W4M CNRL_Engine	Existing	17.2		27.5	31.8	26.9	13.4	16	11.8	-11.7	-100
CNRL 14-11-58-05-W4M CNRL_Engine	Existing	17.2		27.6	31.8	26.9	13.4	16	11.8	-11.7	-100
CNRL 14-11-58-05-W4M CNRL_Engine	Existing	17.2		27.6	31.8	26.9	13.4	16	11.8	-11.7	-100
CNRL 14-11-58-05-W4M CNRL_Engine	Existing	17.2		27.6	31.8	26.9	13.4	16	11.8	-11.7	-100
CNRL 14-11-58-05-W4M CNRL_Engine	Existing	17.2		27.6	31.8	26.9	13.4	16	11.8	-11.7	-100
CNRL 1a-33-57-05-W4M CNRL_Engine	Existing	17.2		19.8	23.9	28.8	17	16	8.3	-11.9	-71.6
CNRL 08-03-58-05-W4M Well_Built_3	Existing	16.2		23.4	25.3	22.6	18.4	10.6	11.4	7.5	-11.3
CNRL 03B-14-58-05-W4M CNRL_Engine	Existing	15.6		26.6	30.8	25.8	12.1	14.3	9.5	-16.2	-100
CNRL 03B-14-58-05-W4M CNRL_Engine	Existing	15.6		26.6	30.8	25.8	12.1	14.3	9.5	-16.2	-100
CNRL 03B-14-58-05-W4M CNRL_Engine	Existing	15.6		26.6	30.8	25.8	12.1	14.3	9.5	-16.2	-100
CNRL 09-36-57-05-W4M CNRL_Engine	Existing	15.4		17.6	21.9	26.8	14.4	14.5	7	-15.1	-87.8
CNRL 09-36-57-05-W4M CNRL_Engine	Existing	15.3		17.6	21.8	26.8	14.4	14.4	6.9	-15.3	-88.3
CNRL 09-36-57-05-W4M CNRL_Engine	Existing	15.2		17.5	21.8	26.7	14.3	14.3	6.8	-15.6	-100
CNRL 04-02-58-05-W4M Well_Built_1	Existing	15		28.1	31	19.9	11.4	9.1	10.7	8.3	-9.9
Interpipe 04-07-58-04-W4M Compressor Station	Existing	15		10.5	10.5	11.2	22.7	7.9	3.2	-28.6	-100
CNRL 08-01-58-05-W4M CNRL_Engine	Existing	14.6		17.2	21.4	26.3	13.8	13.7	5.8	-17.5	-100
CNRL 08-01-58-05-W4M CNRL_Engine	Existing	14.6		17.1	21.3	26.2	13.8	13.6	5.7	-17.7	-100
CNRL 04-13-58-05-W4M CNRL_Engine	Existing	13.5		25.4	29.5	24.3	10.3	12	6.2	-22.7	-100
CNRL 04-13-58-05-W4M CNRL_Engine	Existing	13.5		25.4	29.5	24.3	10.3	12	6.2	-22.8	-100
CNRL 04-13-58-05-W4M CNRL_Engine	Existing	13.5		25.4	29.5	24.3	10.3	12	6.2	-22.8	-100
CNRL 04-13-58-05-W4M CNRL_Engine	Existing	13.4		25.3	29.5	24.3	10.3	12	6.2	-22.8	-100
CNRL 11-35-57-05-W4M Pump	Existing	13.4		35.7	26.9	14.5	9.8	6.2	8.8	7.7	-0.4
CNRL 05C-14-58-05-W4M CNRL_Engine	Existing	13.2		25.2	29.3	24.2	10.1	11.8	5.8	-23.5	-100
CNRL 11-35-57-05-W4M Pump	Existing	13.1		35.5	26.6	14.2	9.5	5.9	8.5	7.3	-1.2
CNRL 13-34-57-05-W4M Pump	Existing	13.1		28.2	19.4	14.5	12.5	6.9	6.5	6.9	4.9
CNRL 07-03-58-05-W4M Well_Built_3	Existing	12.9		21.1	22.9	20.1	15.8	7.6	7.9	2.2	-22.8
CNRL 12-14-58-05-W4M CNRL_Engine	Existing	12.8		25	29.1	23.9	9.7	11.3	5.1	-25	-100
CNRL 13-34-57-05-W4M Pump	Existing	12.7		27.9	19.1	14.3	12.3	6.6	6.1	6.4	4.3
CNRL 12B-14-58-05-W4M CNRL_Engine	Existing	12.5		24.8	28.9	23.7	9.5	10.9	4.6	-26	-100
CNRL 12-31-57-04-W4M CNRL_Engine	Existing	12.4		15.7	19.8	24.6	11.8	11.1	2.2	-24.5	-100
CNRL 12-31-57-04-W4M CNRL_Engine	Existing	12.3		15.6	19.8	24.5	11.7	11	2.1	-24.7	-100
CNRL 12-31-57-04-W4M CNRL_Engine	Existing	12.3		15.6	19.8	24.5	11.7	11	2.1	-24.8	-100
CNRL 04-06-58-04-W4M CNRL_Engine	Existing	12		15.5	19.6	24.3	11.5	10.7	1.7	-25.6	-100
CNRL 04-06-58-04-W4M CNRL_Engine	Existing	12		15.4	19.6	24.3	11.4	10.6	1.6	-25.8	-100
Combustion Air Blower #1	Project	12		24	26.3	24.1	16.4	6.8	-10.2	-58.3	-100
Combustion Air Blower #2	Project	12		24	26.3	24.2	16.4	6.8	-10.2	-58.3	-100
Combustion Air Blower #3	Project	12		24	26.3	24.2	16.4	6.8	-10.2	-58.2	-100
CNRL 10-12-58-05-W4M CNRL_Engine	Existing	11.4		15	19.2	23.8	10.8	9.9	0.6	-27.8	-100
Cooling Medium Aerial Coolers	Pilot	11.2		27.7	30.2	19.9	14.4	8.8	-1.1	-33.4	-100
Cooling Medium Aerial Coolers	Pilot	11.2		27.7	30.2	19.9	14.4	8.8	-1.1	-33.4	-100

Notes:

- Octave band sound levels are linear (i.e. not A-weighted)
- Only those noise sources which result in a contribution greater than 0.0 dBA at the receptor are shown

Residential R-13 (Cont.)

Noise Source	Location	dBA		31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
CNRL 13-06-58-04-W4M CNRL_Engine	Existing	11.1		14.9	19	23.6	10.6	9.6	0.1	-28.7	-100
CNRL 03-06-58-04-W4M CNRL_Engine	Existing	11.1		14.9	19	23.6	10.6	9.6	0.1	-28.8	-100
Gas Turbine #1 Exhaust	Project	10.8		34.8	34.1	22	9.3	-2.1	-24.4	-73.3	-100
Gas Turbine #1 Exhaust	Project	10.8		34.8	34.1	22	9.3	-2.1	-24.3	-73.3	-100
Gas Turbine #1 Exhaust	Project	10.8		34.8	34.1	22	9.3	-2.1	-24.3	-73.3	-100
Gas Turbine #1 Exhaust	Project	10.7		34.7	34.1	22	9.2	-2.2	-24.6	-73.8	-100
Gas Turbine #1 Exhaust	Project	10.7		34.7	34.1	22	9.2	-2.2	-24.5	-73.7	-100
Combustion Air Blower #1	Project	10.2		22.2	24.5	22.3	14.6	4.9	-12.1	-60.4	-100
Combustion Air Blower #2	Project	10.2		22.2	24.5	22.4	14.6	4.9	-12.1	-60.4	-100
CNRL 16-12-58-05-W4M CNRL_Engine	Existing	9.1		13.6	17.7	22.1	8.7	7.1	-3.5	-36.1	-100
CNRL 05-02-58-05-W4M Well_Built_1	Existing	9		23.8	26.8	13.8	6.7	4	4.9	0.1	-27
CNRL 12-07-58-04-W4M CNRL_Engine	Existing	8.7		13.3	17.4	21.8	8.3	6.6	-4.2	-37.6	-100
CNRL 12-07-58-04-W4M CNRL_Engine	Existing	8.7		13.3	17.4	21.8	8.3	6.6	-4.2	-37.7	-100
CNRL 12-07-58-04-W4M CNRL_Engine	Existing	8.7		13.3	17.4	21.8	8.3	6.6	-4.2	-37.7	-100
CNRL 12-07-58-04-W4M CNRL_Engine	Existing	8.7		13.3	17.4	21.8	8.3	6.6	-4.2	-100.2	-100
Gas Turbine #1 Inlet	Project	8.6		27.8	30.1	19	12.9	-10.9	-53.2	-100.2	-100
Gas Turbine #1 Inlet	Project	8.6		27.8	30.1	19	12.9	-10.9	-53.2	-100.2	-100
CNRL 08-23-58-05-W4M CNRL_Engine	Existing	8.3		22.3	26.3	20.6	5.5	5.8	-3	-42.2	-100
CNRL 08-23-58-05-W4M CNRL_Engine	Existing	8.3		22.3	26.3	20.6	5.5	5.8	-3	-42.2	-100
CNRL 08-23-58-05-W4M CNRL_Engine	Existing	8.3		22.3	26.3	20.6	5.5	5.8	-3	-42.2	-100
CNRL 08-23-58-05-W4M CNRL_Engine	Existing	8.3		22.3	26.3	20.6	5.5	5.8	-3	-42.2	-100
CNRL 02-24-58-05-W4M CNRL_Engine	Existing	8.2		22.3	26.3	20.6	5.5	5.8	-3	-42.3	-100
CNRL 02-24-58-05-W4M CNRL_Engine	Existing	8.2		22.3	26.3	20.6	5.5	5.7	-3	-42.3	-100
CNRL 05-24-58-05-W4M CNRL_Engine	Existing	7.8		22	26	20.3	5	5.1	-4	-44.4	-100
CNRL 05-24-58-05-W4M CNRL_Engine	Existing	7.8		22	26	20.3	5	5.1	-4	-44.5	-100
CNRL 05-24-58-05-W4M CNRL_Engine	Existing	7.8		22	26	20.3	5	5.1	-4	-44.4	-100
CNRL 05-24-58-05-W4M CNRL_Engine	Existing	7.8		22	26	20.3	5	5.1	-4	-44.4	-100
CNRL 05-24-58-05-W4M CNRL_Engine	Existing	7.8		22	26	20.3	5	5.1	-4	-44.4	-100
CNRL 05-24-58-05-W4M CNRL_Engine	Existing	7.8		22	26	20.3	5	5.1	-4	-44.4	-100
CNRL 02/02-24-58-05-W4M CNRL_Engine	Existing	7.7		22	25.9	20.2	5	5	-4.2	-44.8	-100
CNRL 02/02-24-58-05-W4M CNRL_Engine	Existing	7.7		22	25.9	20.2	5	5	-4.2	-44.8	-100
CNRL 02/02-24-58-05-W4M CNRL_Engine	Existing	7.7		22	25.9	20.2	5	5	-4.2	-44.8	-100
Produced Water Cooling Glycol Aerial Cooler Fans	Project	7.6		26.3	28.6	17.6	10.5	2.7	-11.5	-58.6	-100
Produced Water Cooling Glycol Aerial Cooler Fans	Project	7.6		26.3	28.6	17.6	10.5	2.7	-11.5	-58.5	-100
CNRL 07-24-58-05-W4M CNRL_Engine	Existing	7.2		21.7	25.6	19.8	4.4	4.3	-5.3	-47.1	-100
CNRL 07-24-58-05-W4M CNRL_Engine	Existing	7.2		21.7	25.6	19.8	4.4	4.3	-5.3	-47.1	-100
CNRL 07-24-58-05-W4M CNRL_Engine	Existing	7.2		21.7	25.6	19.8	4.4	4.3	-5.3	-47.1	-100
CNRL 07-24-58-05-W4M CNRL_Engine	Existing	7.2		21.7	25.6	19.8	4.4	4.3	-5.3	-47.2	-100
CNRL 07-24-58-05-W4M CNRL_Engine	Existing	7.2		21.7	25.6	19.8	4.4	4.3	-5.3	-47.2	-100
CNRL 05-18-58-04-W4M CNRL_Engine	Existing	6.9		12.2	16.2	20.5	6.5	4.3	-7.7	-45	-100
CNRL 05-18-58-04-W4M CNRL_Engine	Existing	6.9		12.2	16.2	20.5	6.5	4.3	-7.7	-45	-100
Turbine #1 Lube Oil Cooler	Project	6.8		24.8	31.1	16.6	4.2	-4	-17.2	-65.5	-100
Turbine #1 Lube Oil Cooler	Project	6.8		24.8	31.1	16.6	4.2	-4	-17.2	-65.5	-100
Secondary Cooling Glycol Aerial Cooler Fans	Project	6.8		25.5	27.9	16.8	9.7	1.9	-12.3	-59.4	-100
CNRL 12-18-58-04-W4M CNRL_Engine	Existing	6.2		11.8	15.8	19.9	5.8	3.3	-9.1	-48.2	-100
Produced Water Cooling Glycol Aerial Cooler Fans	Project	6.1		16.1	19	17.6	10.5	2.8	-13.4	-60.8	-100
Steam Generator #1 Blower	Pilot	5.8		15.4	17.9	16.5	10.4	3	-9.6	-42.4	-100
Steam Generator #2 Blower	Pilot	5.8		15.4	17.9	16.5	10.4	3	-9.5	-42.1	-100
Gas Turbine #1 Inlet	Project	5.1		17.1	19.5	17.4	10.8	-14.5	-58.8	-100.2	-100
wellpad piping	Project	5.1		18.8	17.6	11	5.9	3.7	0.3	-14.2	-63.3
wellpad piping	Project	5.1		27.1	25.9	9	2.9	0.1	1.1	-15.6	-79.5
wellpad piping	Project	5		18.8	17.6	11	5.8	3.6	0.2	-14.4	-63.7
Primary Cooling Glycol Aerial Cooler Fans	Project	4.9		17	19.3	17.1	9.3	-0.5	-17.8	-66.9	-100
Primary Cooling Glycol Aerial Cooler Fans	Project	4.9		17	19.4	17.1	9.3	-0.5	-17.8	-66.9	-100

Notes:

- Octave band sound levels are linear (i.e. not A-weighted)
- Only those noise sources which result in a contribution greater than 0.0 dBA at the receptor are shown

Residential R-13 (Cont.)

Noise Source	Location	dBA		31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
Primary Cooling Glycol Aerial Cooler Fans	Project	4.9		17	19.4	17.1	9.3	-0.5	-17.8	-66.9	-100
Primary Cooling Glycol Aerial Cooler Fans	Project	4.9		17	19.4	17.1	9.3	-0.5	-17.8	-66.9	-100
Primary Cooling Glycol Aerial Cooler Fans	Project	4.9		17	19.4	17.1	9.3	-0.5	-17.8	-66.8	-100
Primary Cooling Glycol Aerial Cooler Fans	Project	4.9		17	19.4	17.1	9.3	-0.5	-17.8	-66.8	-100
Primary Cooling Glycol Aerial Cooler Fans	Project	4.9		17	19.4	17.1	9.3	-0.5	-17.8	-66.8	-100
Primary Cooling Glycol Aerial Cooler Fans	Project	4.9		17	19.4	17.1	9.3	-0.5	-17.7	-66.8	-100
wellpad piping	Project	4.7		26.9	25.6	8.7	2.6	-0.3	0.5	-16.7	-82.5
wellpad piping	Project	4.5		26.7	25.5	8.5	2.3	-0.5	0.2	-17.4	-84.4
wellpad piping	Project	4		18.1	16.9	10.2	5	2.6	-1.1	-16.7	-69.9
CNRL 10-24-58-05-W4M CNRL_Engine	Existing	3.8		10.3	14.2	18	3.3	-0.1	-14.3	-59.6	-100
CNRL 10-24-58-05-W4M CNRL_Engine	Existing	3.8		10.3	14.2	18	3.3	-0.1	-14.4	-59.6	-100
CNRL 05-19-58-04-W4M CNRL_Engine	Existing	3.8		10.3	14.2	18	3.3	-0.1	-14.3	-59.6	-100
CNRL 05-19-58-04-W4M CNRL_Engine	Existing	3.8		10.3	14.2	18	3.3	-0.1	-14.3	-59.6	-100
CNRL 05-19-58-04-W4M CNRL_Engine	Existing	3.8		10.3	14.2	18	3.3	-0.1	-14.4	-59.6	-100
CNRL 05-19-58-04-W4M CNRL_Engine	Existing	3.8		10.3	14.2	18	3.3	-0.1	-14.4	-59.6	-100
wellpad piping	Project	3.6		26.1	24.9	7.8	1.6	-1.5	-1.1	-19.8	-100
Primary Cooling Glycol Aerial Cooler Fans	Project	3.4		15.6	17.9	15.6	7.8	-2	-19.4	-68.6	-100
Primary Cooling Glycol Aerial Cooler Fans	Project	3.4		15.6	17.9	15.6	7.8	-2	-19.4	-68.6	-100
Primary Cooling Glycol Aerial Cooler Fans	Project	3.4		15.6	17.9	15.7	7.8	-2	-19.3	-68.6	-100
Primary Cooling Glycol Aerial Cooler Fans	Project	3.4		15.6	17.9	15.7	7.8	-2	-19.3	-68.6	-100
Primary Cooling Glycol Aerial Cooler Fans	Project	3.4		15.6	17.9	15.7	7.8	-2	-19.3	-68.6	-100
Primary Cooling Glycol Aerial Cooler Fans	Project	3.4		15.6	17.9	15.7	7.8	-2	-19.3	-68.6	-100
CNRL 01-10-58-05-W4M Well_Built_3	Existing	3.1		13.9	15.6	12.5	7.4	-1.9	-3.8	-16.9	-70.9
CNRL 13-19-58-04-W4M CNRL_Engine	Existing	2.7		9.6	13.4	17.1	2	-1.9	-17.1	-65.7	-100
CNRL 13-19-58-04-W4M CNRL_Engine	Existing	2.7		9.6	13.4	17.1	2	-1.9	-17.1	-65.7	-100
CNRL 13-19-58-04-W4M CNRL_Engine	Existing	2.7		9.6	13.4	17.1	2	-1.9	-17.1	-65.7	-100
CNRL 13-19-58-04-W4M CNRL_Engine	Existing	2.7		9.6	13.4	17.1	2	-1.9	-17.1	-65.7	-100
CNRL 13-19-58-04-W4M CNRL_Engine	Existing	2.7		9.6	13.4	17.1	2	-1.9	-17.1	-65.7	-100
CNRL 13-19-58-04-W4M CNRL_Engine	Existing	2.7		9.6	13.4	17.1	2	-1.9	-17.1	-65.7	-100
CNRL 13-19-58-04-W4M CNRL_Engine	Existing	2.7		9.6	13.4	17.1	2	-1.9	-17.1	-65.8	-100
CNRL 05-11-58-05-W4M Well_Built_3	Existing	2.7		13.7	15.4	12.2	7.1	-2.3	-4.3	-17.8	-73.3
Steam Generator #2 Stack	Pilot	2.7		15.5	16.2	12.8	6.7	0.5	-10.4	-43.2	-100
Steam Generator #1 Stack	Pilot	2.6		13.2	14.8	12.8	6.7	0.5	-10.4	-43.2	-100
wellpad piping	Project	2.2		25.3	24	6.9	0.4	-2.9	-3.1	-23.6	-100
CNRL 08-02-58-05-W4M Well_Built_1	Existing	2.1		19	21.9	8.2	1	-2.3	-2.7	-11.9	-56.2
Produced Water Cooling Glycol Aerial Cooler Fans	Project	2.1		14.1	16.4	14.3	6.5	-3.1	-20	-67.8	-100
Produced Water Cooling Glycol Aerial Cooler Fans	Project	2.1		14.1	16.4	14.3	6.5	-3.1	-20	-67.8	-100
Turbine #1 Lube Oil Cooler	Project	1.7		14.1	20.4	15.3	3.6	-7.9	-23.7	-72.1	-100
VRU Aerial Cooler Fans	Project	1.4		13.4	15.7	13.5	5.8	-3.8	-20.7	-68.6	-100
wellpad piping	Project	1.2		24.7	23.3	6.1	-0.5	-4	-4.6	-26.7	-100
Bonavista 10-25-58-05-W4M Engine	Existing	1.1		8.6	12.4	15.8	0.2	-4.5	-21.1	-74.9	-100
Bonavista 10-25-58-05-W4M Engine	Existing	1.1		8.6	12.4	15.8	0.2	-4.5	-21.1	-74.9	-100
wellpad piping	Project	1.1		24.6	23.3	6.1	-0.5	-4.1	-4.7	-26.9	-100
Turbine #1 Lube Oil Cooler	Project	0.9		13.8	20	14.5	2.3	-10.3	-27.7	-78.9	-100
Wellpad Emulsion Pumps	Project	0.8		14	11.8	9.2	4.1	-1.1	-6.5	-26.9	-83.6
Bonavista 12-30-58-04-W4M Engine	Existing	0.7		8.3	12.1	15.4	-0.4	-5.3	-22.4	-77.8	-100
Bonavista 12-30-58-04-W4M Engine	Existing	0.7		8.3	12.1	15.4	-0.4	-5.3	-22.4	-77.7	-100
Bonavista 12-30-58-04-W4M Engine	Existing	0.7		8.3	12.1	15.4	-0.4	-5.3	-22.4	-77.8	-100
Bonavista 12-30-58-04-W4M Engine	Existing	0.7		8.3	12.1	15.4	-0.4	-5.3	-22.4	-77.8	-100
wellpad piping	Project	0.7		24.4	23	5.8	-0.9	-4.6	-5.4	-28.2	-100
Wellpad Emulsion Pumps	Project	0.6		13.9	11.7	9.1	3.9	-1.3	-6.7	-27.3	-84.9
wellpad piping	Project	0.4		24.2	22.8	5.5	-1.2	-5	-5.9	-29.3	-100
CNRL 10-10-58-05-W4M Well_Built_3	Existing	0.3		11.9	13.6	10.3	4.9	-4.9	-7.7	-24.2	-100
Turbine #1 Lube Oil Cooler	Project	0.1		13.7	19.7	13.8	1	-12.2	-30.3	-82.2	-100

Notes:

- Octave band sound levels are linear (i.e. not A-weighted)
- Only those noise sources which result in a contribution greater than 0.0 dBA at the receptor are shown

Residential R-39

Noise Source	Location	dBA		31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
CNRL 07-32-59-04-W4M CNRL_Engine	Existing	37.7		32.8	37.3	43.1	31.8	35.5	34.2	27.8	10.8
CNRL 07-32-59-04-W4M CNRL_Engine	Existing	37.4		32.7	37.2	43	31.7	35.4	33.8	27.6	10.6
CNRL 07-32-59-04-W4M Pump	Existing	11.7		26.1	17.4	12.6	10.4	5.5	6.2	6.4	-0.9
AltaGas Muriel Lake Comp. 07-20-59-04-W4M	Existing	9.6		39.8	21.6	19.9	10.8	7.9	-1.7	-28.7	-100
CNRL 16-32-59-04-W4M Well_Built_1	Existing	7.8		15.6	18.5	14.9	9	4.2	2.1	-0.7	-20.2
CNRL 16-32-59-04-W4M Well_Built_1	Existing	7.8		15.5	18.5	14.8	8.9	4.2	2.1	-0.8	-20.4
CNRL 16-32-59-04-W4M Well_Built_1	Existing	7.7		15.5	18.4	14.8	8.9	4.1	2	-0.8	-20.6
CNRL 16-32-59-04-W4M Well_Built_1	Existing	7.7		15.4	18.4	14.7	8.8	4.1	2	-0.9	-20.7
CNRL 16-32-59-04-W4M Well_Built_1	Existing	7.6		15.4	18.4	14.7	8.8	4.1	1.9	-0.9	-20.9
CNRL 16-32-59-04-W4M Well_Built_1	Existing	7.6		15.4	18.3	14.7	8.8	4	1.9	-1	-21
CNRL 16-32-59-04-W4M Well_Built_1	Existing	7.5		15.3	18.3	14.6	8.7	4	1.8	-1.1	-21.1
CNRL 01-05-60-04-W4M Well_Built_1	Existing	6.1		14.6	17.6	13.8	8	2.9	0.2	-4	-27.7
CNRL 01-05-60-04-W4M Well_Built_1	Existing	6.1		14.6	17.5	13.8	8	2.8	0.2	-4	-27.7
CNRL 04-04-60-04-W4M Well_Built_1	Existing	5.1		21.1	24	10.5	3.5	0.5	0.8	-6.1	-41.7
CNRL 04-04-60-04-W4M Well_Built_1	Existing	5.1		21.1	24	10.5	3.5	0.5	0.7	-6.2	-41.8
CNRL 04-04-60-04-W4M Well_Built_1	Existing	5.1		21.1	24	10.5	3.5	0.5	0.7	-6.2	-41.9
CNRL 04-04-60-04-W4M Well_Built_1	Existing	5.1		21.1	24	10.4	3.5	0.5	0.7	-6.3	-42
CNRL 04-04-60-04-W4M Well_Built_1	Existing	5		21.1	24	10.4	3.4	0.5	0.7	-6.3	-42.1
CNRL 04-04-60-04-W4M Well_Built_1	Existing	5		21.1	23.9	10.4	3.4	0.4	0.6	-6.4	-42.2
CNRL 04-04-60-04-W4M Well_Built_1	Existing	5		21	23.9	10.4	3.4	0.4	0.6	-6.4	-42.3
CNRL 04-04-60-04-W4M Well_Built_1	Existing	5		21	23.9	10.4	3.4	0.4	0.6	-6.4	-42.4
wellpad piping	Project	0.1		15.6	14.3	7.5	1.8	-1.2	-6.3	-26.3	-100

Notes:

- Octave band sound levels are linear (i.e. not A-weighted)
- Only those noise sources which result in a contribution greater than 0.0 dBA at the receptor are shown

Residential R-40

Noise Source	Location	dBA		31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
CNRL 07-32-59-04-W4M CNRL_Engine	Existing	41.9		44.3	48.7	48	33.3	38.3	38.9	32.1	17.1
CNRL 07-32-59-04-W4M CNRL_Engine	Existing	41.8		44.2	48.7	47.9	33.3	38.3	38.8	32	16.9
CNRL 07-32-59-04-W4M Pump	Existing	16.3		37.6	28.8	17.4	11.9	8.4	11.2	10.8	5.4
AltaGas Muriel Lake Comp. 07-20-59-04-W4M	Existing	9.8		39.9	21.7	20	11	8.1	-1.4	-28	-100
CNRL 16-32-59-04-W4M Well_Built_1	Existing	9.1		16.1	19	15.4	9.5	5.1	3.4	2.2	-18.5
CNRL 16-32-59-04-W4M Well_Built_1	Existing	9.1		16	19	15.4	9.4	5	3.4	2.2	-18.6
CNRL 16-32-59-04-W4M Well_Built_1	Existing	9.1		16	18.9	15.3	9.4	5	3.3	2.2	-18.8
CNRL 16-32-59-04-W4M Well_Built_1	Existing	9		15.9	18.9	15.3	9.3	4.9	3.3	2.1	-18.9
CNRL 16-32-59-04-W4M Well_Built_1	Existing	9		15.9	18.9	15.2	9.3	4.9	3.2	2.1	-19.1
CNRL 16-32-59-04-W4M Well_Built_1	Existing	9		15.9	18.8	15.2	9.3	4.9	3.2	2.1	-19.2
CNRL 16-32-59-04-W4M Well_Built_1	Existing	8.9		15.8	18.8	15.2	9.2	4.8	3.2	2.1	-19.3
CNRL 01-05-60-04-W4M Well_Built_1	Existing	6		14.5	17.5	13.7	7.9	2.7	0.1	-4.2	-28.2
CNRL 01-05-60-04-W4M Well_Built_1	Existing	6		14.5	17.4	13.7	7.9	2.7	0	-4.2	-28.2
CNRL 04-04-60-04-W4M Well_Built_1	Existing	5.5		21.4	24.3	10.8	3.8	0.9	1.2	-5.5	-40.1
CNRL 04-04-60-04-W4M Well_Built_1	Existing	5.5		21.4	24.3	10.8	3.8	0.8	1.1	-5.6	-40.3
CNRL 04-04-60-04-W4M Well_Built_1	Existing	5.5		21.4	24.3	10.8	3.8	0.8	1.1	-5.6	-40.3
CNRL 04-04-60-04-W4M Well_Built_1	Existing	5.4		21.3	24.2	10.7	3.7	0.8	1.1	-5.6	-40.5
CNRL 04-04-60-04-W4M Well_Built_1	Existing	5.4		21.3	24.2	10.7	3.7	0.8	1.1	-5.7	-40.5
CNRL 04-04-60-04-W4M Well_Built_1	Existing	5.4		21.3	24.2	10.7	3.7	0.8	1	-5.7	-40.7
CNRL 04-04-60-04-W4M Well_Built_1	Existing	5.4		21.3	24.2	10.7	3.7	0.7	1	-5.7	-40.7
CNRL 04-04-60-04-W4M Well_Built_1	Existing	5.3		21.3	24.2	10.7	3.7	0.7	1	-5.8	-40.9
wellpad piping	Project	0.5		15.8	14.6	7.7	2.1	-0.8	-5.7	-25.2	-100

Notes:

- Octave band sound levels are linear (i.e. not A-weighted)

- Only those noise sources which result in a contribution greater than 0.0 dBA at the receptor are shown

Residential R-41

Noise Source	Location	dBA		31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
CNRL 07-32-59-04-W4M CNRL_Engine	Existing	45		46.7	51.2	51.6	36.1	41.2	42	35.9	23.6
CNRL 07-32-59-04-W4M CNRL_Engine	Existing	44.9		46.6	51.1	51.4	35.9	41	41.8	35.7	23.3
CNRL 07-32-59-04-W4M Pump	Existing	19.9		40	31.1	20.8	14.5	11.1	14.1	14.4	11.7
AltaGas Muriel Lake Comp. 07-20-59-04-W4M	Existing	10.3		40.3	22.1	20.4	11.5	8.8	-0.5	-26.2	-100
CNRL 16-32-59-04-W4M Well_Built_1	Existing	6.7		15	17.9	14.2	8.4	3.3	0.8	-3.1	-25.6
CNRL 16-32-59-04-W4M Well_Built_1	Existing	6.6		14.9	17.9	14.2	8.3	3.3	0.7	-3.1	-25.8
CNRL 16-32-59-04-W4M Well_Built_1	Existing	6.6		14.9	17.9	14.1	8.3	3.2	0.7	-3.2	-25.9
CNRL 16-32-59-04-W4M Well_Built_1	Existing	6.5		14.9	17.8	14.1	8.3	3.2	0.7	-3.3	-26.1
CNRL 16-32-59-04-W4M Well_Built_1	Existing	6.5		14.9	17.8	14.1	8.2	3.2	0.6	-3.3	-26.2
CNRL 16-32-59-04-W4M Well_Built_1	Existing	6.4		14.8	17.8	14	8.2	3.1	0.6	-3.4	-26.3
CNRL 16-32-59-04-W4M Well_Built_1	Existing	6.4		14.8	17.7	14	8.2	3.1	0.5	-3.4	-26.4
CNRL 04-04-60-04-W4M Well_Built_1	Existing	4.7		20.9	23.7	10.2	3.2	0.2	0.3	-6.9	-43.5
CNRL 04-04-60-04-W4M Well_Built_1	Existing	4.7		20.8	23.7	10.2	3.2	0.1	0.3	-6.9	-43.6
CNRL 04-04-60-04-W4M Well_Built_1	Existing	4.7		20.8	23.7	10.2	3.2	0.1	0.3	-6.9	-43.6
CNRL 04-04-60-04-W4M Well_Built_1	Existing	4.7		20.8	23.7	10.1	3.1	0.1	0.2	-7	-43.8
CNRL 04-04-60-04-W4M Well_Built_1	Existing	4.6		20.8	23.7	10.1	3.1	0.1	0.2	-7	-43.8
CNRL 04-04-60-04-W4M Well_Built_1	Existing	4.6		20.8	23.7	10.1	3.1	0.1	0.2	-7.1	-44
CNRL 04-04-60-04-W4M Well_Built_1	Existing	4.6		20.8	23.6	10.1	3.1	0.1	0.2	-7.1	-44
CNRL 04-04-60-04-W4M Well_Built_1	Existing	4.6		20.7	23.6	10.1	3.1	0	0.1	-7.1	-44.2
CNRL 01-05-60-04-W4M Well_Built_1	Existing	4.2		13.2	16.1	12.4	6.5	1.1	-1.9	-7.3	-34.8
CNRL 01-05-60-04-W4M Well_Built_1	Existing	4.2		13.2	16.1	12.3	6.4	1	-2	-7.3	-34.9
wellpad piping	Project	0.6		15.9	14.7	7.8	2.2	-0.7	-5.6	-24.9	-100

Notes:

- Octave band sound levels are linear (i.e. not A-weighted)
- Only those noise sources which result in a contribution greater than 0.0 dBA at the receptor are shown

Appendix VII NOISE IMPACT ASSESSMENT

Licensee: **Pengrowth Energy Corporation**

Facility name: **Lindbergh SAGD Expansion Project**

Type: **Steam Assisted Gravity Drainage**

Legal location: **Townships 58 & 59, Ranges 04 & 05, W4M**

Contact: **Steve De Maio** Telephone: **(403) 233-0224**

1. Permissible Sound Level (PSL) Determination (*Directive 038,* Section 2)

(Note that the PSL for a pre-1988 facility undergoing modifications may be the sound pressure level (SPL) that currently exists at the residence if no complaint exists and the current SPL exceeds the calculated PSL from Section 2.1.)

Complete the following for the nearest or most impacted residence(s):

Distance from facility	Direction from facility	BSL (dBA)	Daytime adjustment (dBA)	Class A adjustment (dBA)	Class B adjustment (dBA)	Nighttime PSL (dBA)	Daytime PSL(dBA)
Within Project Boundary	Within Project Boundary	40	10	0	0	40	50

2. Sound Source Identification

For the new and existing equipment, identify major sources of noise from the facility, their associated sound power level (PWL) or sound pressure level (SPL), the distance (far or free field) at which it was calculated or measured, and whether the sound data are from vendors, field measurement, theoretical estimates, etc.

New Equipment	Predicted OR Measured X PWL (dBA) X PWL (dBA) X SPL (dBA) X SPL (dBA)	Data source	Distance calculated or measured (m)
Listed in Appendix I		**Measurements / Calculations**	

Existing Equipment/Facility	Predicted OR Measured X PWL (dBA) X PWL (dBA) X SPL (dBA) X SPL (dBA)	Data source	Distance calculated or measured (m)
Listed in Appendix I		**Measurements / Calculations**	

3. Operating Conditions

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

Equipment assumed to be operating at all times at maximum capacity

4. Modelling Parameters

If modelling was conducted, identify the parameters used (see Section 3.5.1):

Ground absorption 0.6, Temperature 10^{0}C, Relative Humitidy 70%, all receptors downwind, Following ISO 9613

5. Predicted Sound Level/Compliance Determination

Identify the predicted overall (cumulative) sound level at the nearest or most impacted residence. Typically, only the nighttime sound level is necessary, as levels do not often change from daytime to nighttime. However, if there are differences between day and night operations, both levels must be calculated.

Predicted sound level to the nearest or most impacted residence from new facility (including any existing facilities):

Application Case

Modeled L_{eq}-Night = **33.5 dBA,** ASL = **35.0 dBA**, Overall L_{eq}-Night = **37.3 dBA,** PSL-Night: **40 dBA**

Is the predicted sound level less than the permissible sound level? **YES** If **YES**, go to number 7

6. Compliance Determination/Attenuation Measures

(a) If 5 is **NO**, identify the noise attenuation measures the licensee is committing to:

Predicted sound level to the nearest or most impacted residence from the facility (**with** noise attenuation measures):

N/A

Is the predicted sound level less than the permissible sound level? **YES** If **YES**, go to number 7

(b) If 6 (a) is **NO** or the licensee is not committing to any noise attenuation measures, the facility is not in compliance. If further attenuation measures are not practical, provide the reasons why the measures proposed to reduce the impacts are not practical.

Note: If 6 (a) is NO, the Noise Impact Assessment must be included with the application filed as non-routine.

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

Advising nearby residents of significant noise sources and appropriately scheduling
Mufflers on all internal combustion engines
Taking advantage of acoustical screening

8. Analyst's Name : **Steven Bilawchuk, M.Sc., P.Eng.**

Company: **ACI Acoustical Consultants Inc.**

Title: **Director**

Telephone: **(780) 414-6373** Date: **December 06, 2013**