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Environmental Noise Level Impact Assessment of Upstream and Pipeline Components of Proposed Queensland Curtis Liquified Natural Gas Project

conducted for

Q G C Limited

Report No: R09016/D2217/Rev.1/20.07.09

Revision No.	Date	Comment
0	21.03.09	Original report.
1	20.07.09	Report amended to include noise control measures and noise impact reduction detailed in David Moore & Associates Pty Ltd report R09053/D2217/REV.0/7.05.2009.

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EXECUTIVE SUMMARY

The proposed QGC Limited (QGC) gas pipeline from the Surat Basin to Port Curtis will involve sufficient upstream structures to supply a two train gas export pipeline delivering in the vicinity of 1360 TJ/d @ 5500 kPa to the LNG inlet flange located at Port Curtis. The potential upstream noise sources include:

- well drilling;
- construction;
- transportation to the site, as well as within the upstream area;
- field compressor stations comprising 8 screw compressors for each station and gas flaring;
- processing plants comprising a range of equipment with the primary noise source being 10 reciprocating compressors for each processing plant;
- oil lifts and hydra packs at the wells for some of the life of the well.

There is also the potential for vibration to be associated with these proposed upstream components, in particular the drill rigs and the gas compression facilities, as well as low frequency noise.
For the pipeline the assumed process will be:

1. vegetation clearing;
2. trenching;
3. pipe laying, which includes the welding together of the sections of pipe;
4. trench closure;
5. workers camp (mobile – moving with the pipeline); and
6. transportation, particularly trucks carrying pipe.

The current assumption is that for the upstream noise sources there would be a total of nine processing plants with twenty-seven field compressor stations feeding into these processing plants (three field compression stations for each processing plant). For the in-line compressor station it has been assumed that this would comprise six reciprocating compressors.

Location of the closest residences in the upstream area was provided by Mipela (GIS) Pty Ltd and the currently proposed location of the processing plants and field compression stations by QGC. With respect to the location of the closest residences the information was extracted from Google Earth Imagery with the following caveats:

- the data was not ground truthed and is subject to following inaccuracies:

    1. Captured receptors include all buildings/constructions and may not necessarily be occupied dwellings;

    2. In high density areas eg. Chinchilla/Miles townships, receptors were automatically placed within each property boundary;

    3. In irregular instances points were placed for each building grouped in the same area – majority of cases is just one point for grouped buildings.

Location of residences and compressor facilities was provided as longitude and latitude bearings, which was then converted to a suitable scale for the computer modelling. Computer noise modelling was conducted for the following scenarios:

- 8 screw compressors (one field compressor station) for receptors at nominated separation distances;
- 10 reciprocating compressors (one processing plant) for receptors at nominated separation distances;
- 1 processing plant and 3 field compressor stations for receptors at nominated separation distances;
- 9 processing plants and 27 field compressor stations for all of the closest residences;

- 6 reciprocating compressors for the midline compressor station for receptors at nominated separation distances;
- 1 Oil Lift for receptors at nominated separation distances;
- 1 Kundu hydra pack for receptors at nominated separation distances;
- 1 Weatherford hydra pack for receptors at nominated separation distances;
- 1 gas flare for receptors at nominated separation distances.

The above noise sources are steady state and, in accordance with the Environmental Protection Agency, the noise limit criteria are 'background plus allowance'. Further to this, for 'remote' rural areas the minimum background noise level to be applied during the night-time is 25 dB(A). The associated noise limits are:

- daytime (0700 to 1800 hours): 40 dB(A) $L_{A10,adj,T}$;
- evening (1800 to 2200 hours): 35 dB(A) $L_{A10,adj,T}$; and
- night-time (2200 to 0700 hours): 28 dB(A) $L_{A10,adj,T}$.

Ambient noise assessments have been previously conducted at three different locations, namely:

- adjacent the Warrego Highway (set back from the highway approximately 260 metres) approximately 8 km east of Miles;
- Kenya field, adjacent a residence to the west of the Kenya field compression station, approximately 2700 metres distant; and
- Berwyndale South field, adjacent a residence approximately 3400 metres from the field compression station.

At times existing ambient daytime noise levels could be at least 10 dB(A) less than the above noise limits. For a noise source to be audible it generally needs to be at least 3 dB(A) greater than the existing ambient noise. Generally a difference of approximately 3 dB(A) is just barely audible, a difference in noise level of 5 dB(A) clearly audible and an increase in noise level of 10 dB(A) twice as loud. Therefore, when the daytime ambient noise level is at its lowest and the noise from the compressor facilities is at the daytime noise limit of 40 dB(A), this noise level would be clearly audible and would sound at least twice as loud as the other ambient noise sources. For a difference in noise level of approximately 10 dB(A) the same level of audibility would equally apply for a noise source at the noise limit for the evening or night-time, when the other ambient noise sources are at their minimum.

Therefore compliance with the noise limits for the different time periods does not create inaudibility and, when the ambient noise levels are at their quietest, the noise of the compressor facilities (at the noise limit for each different time period) will sound about twice as loud as the ambient noise, for the complete 24-hour day.

All computer noise modelling was conducted for flat ground (no ground contours), for ground absorption factor of -0.5 and the following atmospheric conditions:

- temperature: 20^0C;
- humidity: 60%;
- wind: light breeze from the compressor/s to the receiver, which is worst case scenario for wind speed and direction.

The above atmospheric conditions, in particular wind speed and direction, provide noise levels at the receptors that represent the worst case scenario – that is, the highest likely noise levels at these receptors, as the wind direction that has been modelled is from the source to the receptor. In assessing noise impact it is accepted practice to assess, within reason, worst case scenario, and this is the position of the Environmental Protection Agency. However, the above does not account for daily or seasonal variation. Changes in temperature and humidity levels will not change the noise levels at the closest residences by the same magnitude as wind direction and speed and, for this reason, only average temperature and humidity values have been used.

Within the upstream area the current acoustic environment comprises primarily natural noises such as birds, insects and wind in the vegetation, as well as some noise associated with agricultural pursuits. In the rural areas there would generally be negligible traffic noise, but for those residences near the Warrego Highway and other main roads in the upstream area there would be some traffic noise, particularly during the daytime. For the residences within townships there would also be community noise, which could include, in addition to the natural noises, local traffic, airconditioning units, people noise and general property maintenance noise sources such as lawnmowers, blowers, trimmers, etc.

The location of the processing plants and field compression stations nominated in this report is not likely to exceed any of the noise limits in any of the towns such as Dalby, Chinchilla, Miles, etc, however, they will exceed the noise limits at a number of residences on rural properties.

As the compressor facilities will operate 24-hours per day the pertinent noise limit that should be complied with is the night-time limit of 28 dB(A). From the computer modelling, for a processing plant or a field compression station, this noise limit is exceeded for a radius of approximately 4000 metres. For one processing plant and three field compression stations this noise limit is exceeded for a radius of approximately 5000 metres.

For the upstream area, for a total of 9 processing plants and 27 field compression stations, the night-time noise limit only is exceeded at 215 residences, the night-time and evening noise limit is exceeded at a further 70 residences and the noise limits for the complete 24-hour day exceeded at a further 72 residences. For the computer modelled area, which included 'residences' numbered from 1 to 6718 but in fact only 1219 actual residential receptors within a 4000 metre buffer zone for the QCLHG Project, the noise limit exceedences are:

- 17.6% of the residences exceed the night-time noise limit only;
- 5.7 % of the residences exceed the evening and night-time noise limits; and
- 5.9 % of the residences exceed the noise limits for the complete 24-hour day.

Noise impact upon an individual can have a range of different effects, ranging from no effect to creating health issues such as sleep deprivation, irritability, etc. The effects of noise can be associated with both the wellbeing of an individual, as well as their lifestyle.

Whilst some of the rural community are most likely already experiencing some noise associated with the gas compression facilities in the area (both QGC and other companies), in general the rural community have not experienced these 'additional' noise sources previously. For some people just being able to hear the additional noise of the compressor facility could be sufficient enough for them to become annoyed, irritable and even suffer lack of sleep/disturbed sleep. Some of the residents may, over a period of time, adjust to the additional noise of the compressor facility, whilst others will not. Some residents could become increasingly agitated as the noise continues 24-hours per day, 7 days per week, and this could be exacerbated by the fact that the noise will be there for many years to come.

The selected noise limits are considered by the Environmental Protection Agency to be reasonable, both with respect to QGC and the surrounding residences, and have been applied in many situations in rural Queensland. However, as these noise limits will not provide inaudibility of the compressor facility noise, it is almost certain that there will be noise complaints, even if the noise limits are being complied with.

A range of potential noise control measures are available for the compressor facilities and well heads, and these include:

- noise source location – locate the noise sources as distant as possible from all residences;
- noise source/buy quiet – particularly for those noise sources closest to the surrounding residences, consider purchasing the quietest possible equipment;
- acoustic enclosure – complete. Purchase equipment with the manufacturer's acoustic enclosure with fully documented noise level reduction achieved by the enclosure. Ensure that the noise level reduction is achieved for all components of the compressor facility – engine, compressor, cooler and exhaust muffler;

- acoustic enclosure – partial. Purchase equipment with the manufacturer's acoustic enclosure with fully documented noise level reduction achieved by the enclosure;
- acoustic barriers – only applicable for controlling noise in one particular direction, could consist of portable screens for well head noise sources but would need to be a wall at least 4 metres high, with returns, for any of the compressor facilities;
- treatment at receptor – not a preferred option but it could be possible to provide noise control at the receptor. This would only be relevant inside the residence, and could include airconditioning, upgraded glazing, thermal insulation in the ceiling cavity.

Whilst not specifically a noise control measure, another option would be the purchase of properties in close proximity to noise sources, particularly those properties where the residences exceed the noise limits by a significant margin. In some circumstances this would occur as part of the project, when a property would be purchased for the purpose of locating infrastructure such as a processing plant on that property.

For different assumed source noise level reductions (10, 20, 30 and 40 dB(A)) the Table below details the distance from the noise source at which compliance with the nominated noise level will be achieved.

Approximate Distance from Noise Source for Compliance with Noise Limit				
Noise Source	Distance from Noise Source (m) for Noise Level to be Complied With			
	40 dB(A)	35 dB(A)	28 dB(A)	20 dB(A)
One Processing Plant:				
• no noise control	2000	2700	4000	6500
• 10 dB(A) noise control	1000	1400	2200	3600
• 20 dB(A) noise control	500	700	1200	2000
• 30 dB(A) noise control	200	300	600	1000
• 40 dB(A) noise control	0	200	300	500
One Field Compression Station:				
• no noise control	2100	2900	4300	7000
• 10 dB(A) noise control	1100	1500	2400	3800
• 20 dB(A) noise control	500	700	1200	2200
• 30 dB(A) noise control	200	300	600	1100
• 40 dB(A) noise control	0	200	300	500
One Processing Plant and Three Field Compression Stations:				
• no noise control	2400	3300	4900	8000
• 10 dB(A) noise control	1200	1800	2700	4400
• 20 dB(A) noise control	600	800	1400	2400
• 30 dB(A) noise control	300	400	700	1200
• 40 dB(A) noise control	0	200	300	600

It is not considered likely that there would be sufficient levels of vibration to exceed the criteria at any of the closest dwellings to the vibration sources.

Low frequency noise will be present in most noise sources, and is assessed in 1/3 octaves from 10 to 200 Hz. Source noise data in this frequency range was not available from either manufacturers or field data at the time of preparation of this document. Once this information is available low frequency

tonal components should be calculated, as well as low frequency noise inside the closest dwellings, and compared to the noise limits. It is the consultant's opinion that separation distance from noise sources to residences should result in compliance with the low frequency noise limits at these residences. For those residences which exceed one or more of the general (background plus allowance) noise limits there is an increased likelihood that the low frequency noise limits could also be exceeded.

Due to the short duration of the noise associated with the laying of the pipeline and any particular residence, noise from this activity is not likely to adversely impact upon any residents. Noise sources associated with pipeline activities will predominantly be dealt with by community consultation and, in some cases, directly with residential property owners.

Transportation noise needs to be considered relative to state and local controlled roads, as well as on private property. For private property most transportation would be during the daytime when all other ambient noise sources are at their maximum, thereby minimising potential noise impact from transportation. Internal roadways should be kept as remote from residences as possible, particularly those residences on adjoining properties. For state and council controlled roads, the greater the existing traffic volume and percentage heavy vehicles the less impact which is likely with vehicles associated with this project. Therefore it is not anticipated that there would be any noticeable increase in traffic noise levels from the Warrego Highway (or any other highways pertinent to the upstream or pipeline areas), but there could be increases of up to approximately 4 to 5 dB(A) on council controlled local roads. As this increase will occur predominantly during the daytime when all other ambient noise levels are at their greatest, overall transportation noise impact is not likely to be significant.

INTRODUCTION

QGC Limited (QGC) are proposing to construct a gas pipeline from the Surat Basin to Port Curtis and have contracted David Moore & Associates Pty Ltd to conduct desktop computer noise modelling for the associated upstream noise sources and the in-line compressor station. The upstream noise sources comprise:

- well drilling;
- construction;
- transportation to the site, as well as within the upstream area;
- field compressor stations comprising 8 screw compressors for each station and gas flaring;
- processing plants comprising a range of equipment with the primary noise source being 10 reciprocating compressors for each processing plant;
- oil lifts and hydra packs at the wells for some of the life of the well.

There is also the potential for vibration to be associated with these proposed upstream components, in particular the drill rigs and the gas compression facilities.

For the pipeline the assumed process will be:

7. vegetation clearing;
8. trenching;
9. pipe laying, which includes the welding together of the sections of pipe;
10. trench closure;
11. workers camp (mobile – moving with the pipeline); and
12. transportation, in particular trucks carrying piping.

It should be noted that currently the assumption is that for the upstream noise sources there would be a total of nine processing plants with twenty-seven field compressor stations feeding into these processing plants (three field compression stations for each processing plant). For the in-line compressor station it has been assumed that this would comprise six reciprocating compressors.

It is likely that the first stage of this project will involve sufficient upstream structures to supply a two train gas export pipeline delivering in the vicinity of 1360 TJ/d @ 5500 kPa to the LNG inlet flange located at Port Curtis.

The consultant has field measured data for the existing Torromont screw and reciprocating compressors operated by QGC, as well as the Oil Lift and two different types of hydra packs. This noise data has been used to best represent the noise of the proposed screw and reciprocating compressors, as well as the equipment at the wells. No noise data is available for a gas flare, but it has been assumed that the noise level of this activity will be 110 dB(A) @ 10 metres, the top of the flare at 30 metres high and the primary noise source being from the top of the flare.

The sound power levels for the compressors and well equipment (Oil lift and hydra packs) were determined in accordance with Australian Standard AS 1217.7-1985, *Acoustics – Determination of sound power levels of noise sources, Part 7, Survey Methods*.

Computer noise modelling was based on the Bruel & Kjaer Predictor software package, which models industrial noise sources in accordance with the algorithms detailed in ISO 9613.1 and 9613.2. International Standard ISO 9613.1 *Acoustics – Attenuation of sound during propagation outdoors – Part 1: Calculation of the absorption of sound by the atmosphere* and International Standard ISO 9613.2 *Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation*.

Computer noise modelling was conducted for each of the following:

- 8 screw compressors (one field compressor station);
- 10 reciprocating compressors (one processing plant);
- 1 processing plant and 3 field compressor stations;

- 9 processing plants and 27 field compressor stations;
- 6 reciprocating compressors for the midline compressor station;
- 1 Oil Lift;
- 1 Kundu hydra pack;
- 1 Weatherford hydra pack;
- 1 gas flare.

This report details the results of all of these computer generated noise levels with predicted noise level impact at nominated separation distances for all of the above scenarios, with the only exception being the 9 processing plants and 27 field compressor stations. For the 9 processing plants and 27 field compressor stations the computer modelling has been conducted over the entire area of the upstream area and includes all know residences and the likely noise impact upon these residences.

Location of the closest residences in the upstream area was provided by Mipela (GIS) Pty Ltd and the location of the processing plants and field compressor stations by QGC. This information was provided as longitude and latitude bearings, which was then converted to a suitable scale for the computer modelling. Figures 1 and 2 below have been provided by Mipela (GIS) Pty Ltd and indicate the location of all of the 'residences' and compressors which forms the basis of the computer modelling of the total upstream area contained in this report.

Ambient noise assessments have been previously conducted at three different locations, namely:

- adjacent the Warrego Highway (set back from the highway approximately 260 metres) approximately 8 km east of Miles;
- Kenya field, adjacent a residence to the west of the Kenya field compression station, approximately 270 metres distant; and
- Berwyndale South field, adjacent a residence approximately 3400 metres from the field compression station.

and the results of these assessments are detailed in this report.

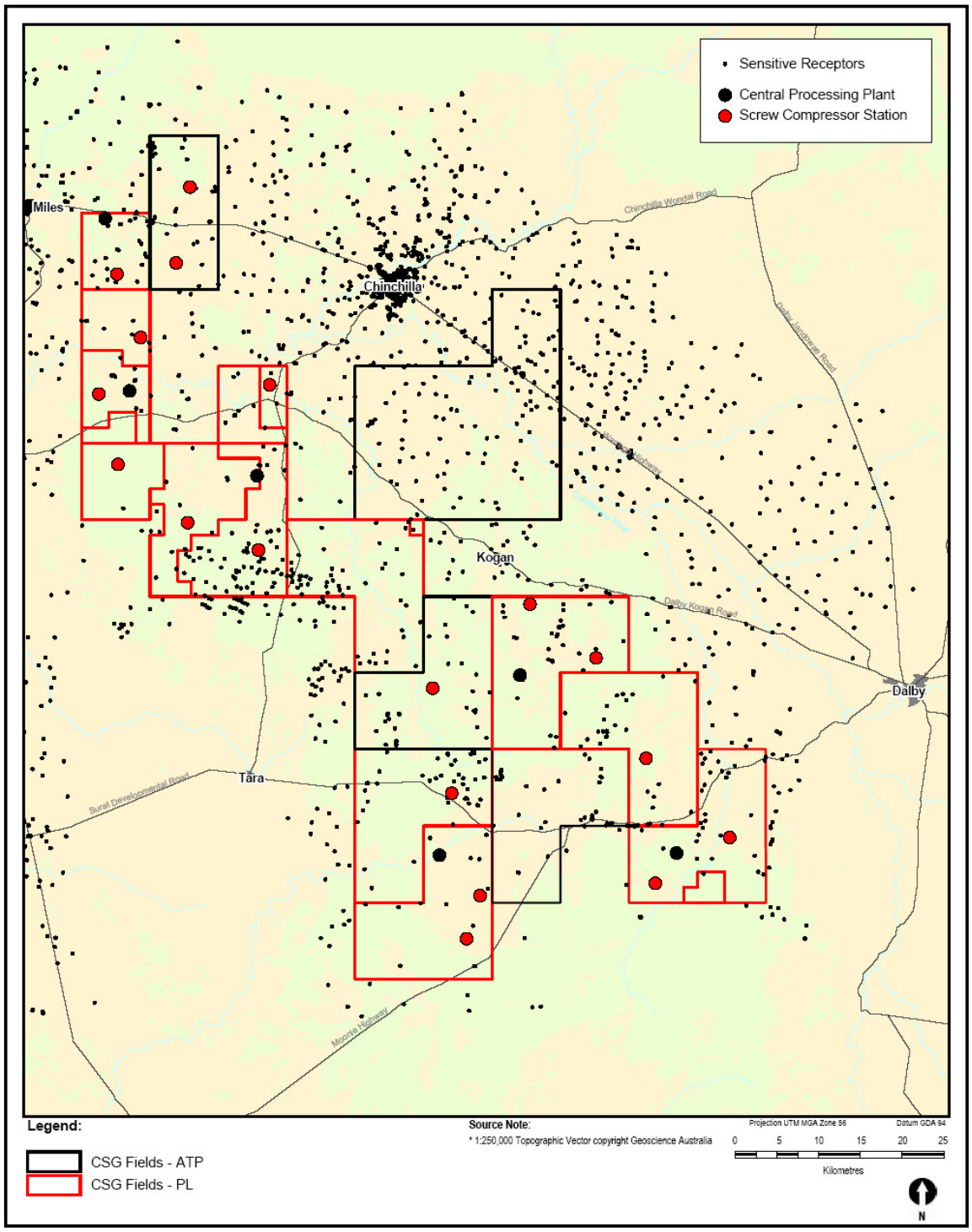

Figure 1
Location of 'Residences' and Compressors: Dalby to Miles Area

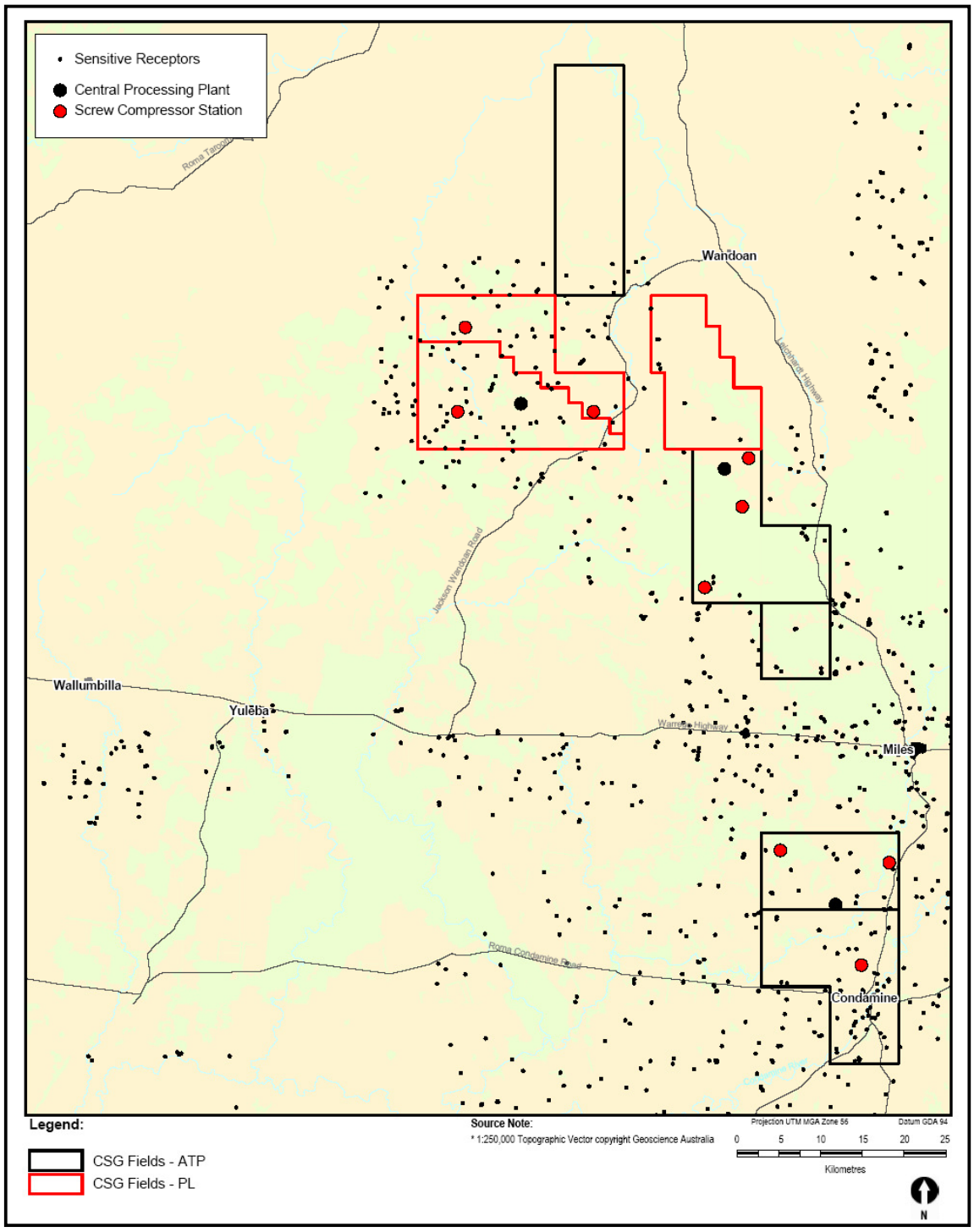

Figure 2
Location of 'Residences' and Compressors: Wandoan Area

CRITERIA

Noise Level Measurements

For the source noise levels already held by the consultant noise level measurements were conducted in accordance with the following:

- general requirements of the Queensland environmental protection legislation;
- Environmental Protection (Noise) Policy 2008;
- *Noise Measurement Manual*, Queensland Government – Environmental Protection Agency, 3rd Edition, March 2000;
- Australian Standard AS 1055.1-1997, *Acoustics – Description and Measurement of Environmental Noise,* Part 1, *General Procedures.*

Noise Limits

In accordance with the Environmental Protection Agency the relevant noise limits for steady state noise are:

- daytime: background + 5 dB(A)
- evening: background + 5 dB(A)
- night-time: background + 3 dB(A)

with the noise limit expressed as the $L_{Amax,adj,T}$, which is approximated by the $L_{A10,adj,T}$ – the A-weighted sound pressure level, adjusted for tonality and/or impulsiveness, and exceeded for 10% of the sample period T.

In accordance with the Environmental Protection Agency, for 'remote' rural areas the minimum background noise level to be applied during the night-time is 25 dB(A), with an associated noise limit of 25 + 3 = 28 dB(A). The associated daytime and evening background noise levels and noise limits would be:

- daytime: 35 (background) + 5 = 40 dB(A) noise limit from 0700 to 1800 hours;
- evening: 30 (background) + 5 = 35 dB(A) noise limit from 1800 to 2200 hours.

Therefore the noise limits adopted in this report are:

- daytime: 40 dB(A) $L_{A10,adj,T}$;
- evening: 35 dB(A) $L_{A10,adj,T}$;
- night-time: 28 dB(A) $L_{A10,adj,T}$.

refer below for results of existing ambient noise levels at three different locations within the upstream area.

AMBIENT NOISE LEVELS

The consultant has conducted ambient noise assessments for QGC at the following locations:

- adjacent the Warrego Highway (set back from the highway approximately 260 metres) approximately 8 km east of Miles;
- Kenya field, adjacent a residence to the west of the Kenya field compression station, approximately 2700 metres distant; and
- Berwyndale South field, adjacent a residence approximately 3400 metres from the field compression station.

The results of these ambient noise assessments have been included in this report to provide an indication of the possible range of ambient noise levels. It should be noted that the consultant has also conducted other ambient noise assessments in rural Queensland, where the ambient noise levels were below those measured with the upstream area, with night-time background noise levels regularly below 20 dB(A).

Adjacent Warrego Highway

The ambient noise levels for this location, which was approximately 8 km east of the township of Miles and set back approximately 260 metres from the highway (general setback distance for residences in this area), were conducted over a 7 day period in June 2007, from Monday 11th to Monday 18th June, 2007. The average ambient noise levels, including the 10th percentile background noise level, as described in the Environmental Protection Agency Draft Industrial Noise Guideline June 2002, is also included to provide an indication of how low the 'average' of the minimum background noise levels can be.

The average ambient noise levels at this location were:

- average L_{Aeq}
    - daytime: 50.8, 49.5, 47.1, 49.1, 48.7, 47.7, 47.7 Average = 48.6 dB(A)
    - evening: 49.1, 50.3, 48.7, 52.1, 51.6, 51.3, 48.2 Average = 50.1 dB(A)
    - night-time: 46.4, 49.1, 48.7, 48.8, 48.5, 45.9, 44.0 Average = 47.3 dB(A)
- average L_{A10}
    - daytime: 54.7, 53.3, 51.3, 53.0, 52.5, 51.5, 50.8 Average = 52.4 dB(A)
    - evening: 53.7, 55.1, 53.5, 56.9, 55.9, 54.8, 53.1 Average = 54.7 dB(A)
    - night-time: 49.7, 53.2, 52.0, 53.4, 52.5, 48.1, 47.9 Average = 50.9 dB(A)
- average L_{A90}
    - daytime: 40.8, 39.6, 34.4, 38.2, 34.8, 33.1, 34.9 Average = 36.5 dB(A)
    - evening: 25.6, 29.4, 28.3, 32.4, 33.1, 20.2, 24.8 Average = 27.6 dB(A)
    - night-time: 28.2, 26.6, 27.2, 29.0, 23.3, 19.0, 25.8 Average = 25.5 dB(A)
- average L_{A90} (tenth percentile)
    - daytime: 34.0, 32.1, 28.4, 32.5, 26.3, 27.3, 28.8 Average = 29.9 dB(A)
    - evening: 18.5, 21.0, 18.9, 18.9, 19.1, 18.1, 18.6 Average = 19.0 dB(A)
    - night-time: 17.4, 18.5, 17.9, 17.5, 17.7, 17.6, 18.6 Average = 17.9 dB(A)

Figure 3 is a graphical presentation of the ambient noise levels for the L_{Aeq}, L_{A10} and L_{A90} parameters.

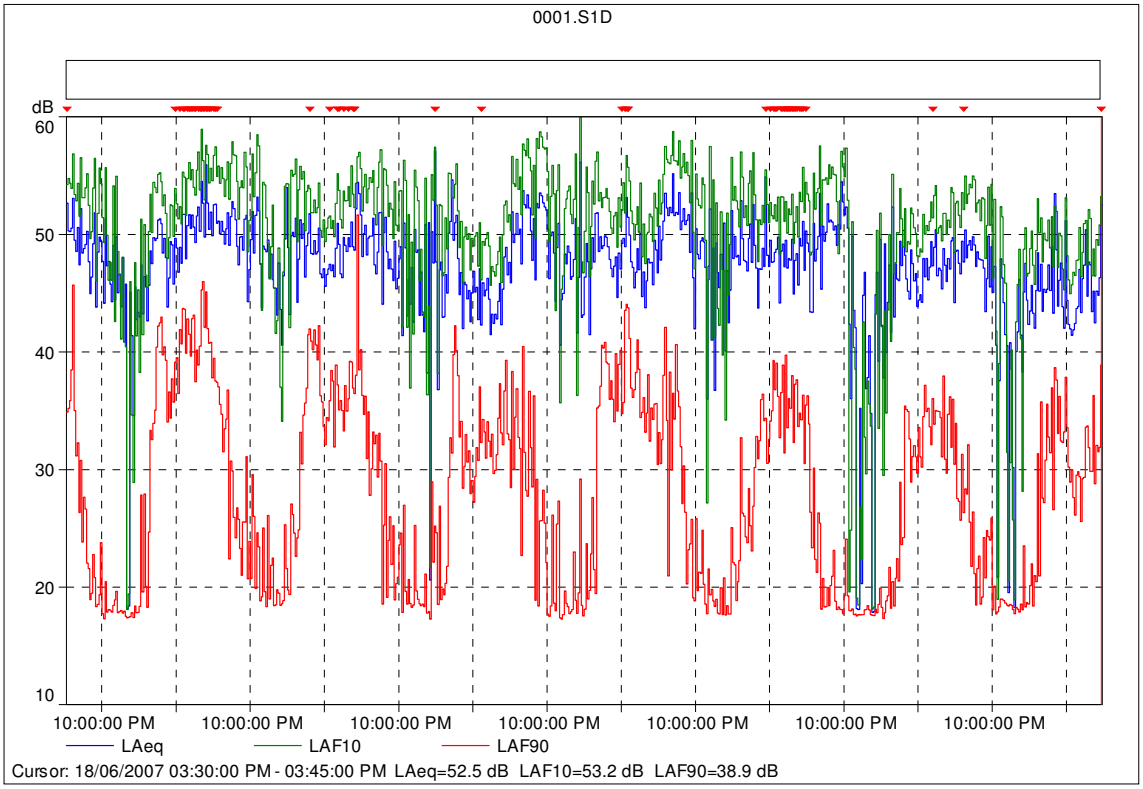

Figure 3
Graphical Presentation of Ambient Noise Levels, Warrego Highway Approx. 8 km East of Miles

Kenya Field

The ambient noise levels for this location, which was approximately 2700 metres west of the original Kenya field compression station (at such time that there was only one or two compressors operating some of the time), were conducted over a 7 day period in June 2007, from Monday 11th to Monday 18th June, 2007. The average ambient noise levels, including the 10th percentile background noise level, as described in the Environmental Protection Agency Draft Industrial Noise Guideline June 2002, is also included to provide an indication of how low the 'average' of the minimum background noise levels can be.

The average ambient noise levels at this location were:

- average L_{Aeq}
  - daytime: 49.0, 47.9, 44.8, 47.5, 45.0, 43.4, 44.7 Average = 46.0 dB(A)
  - evening: 24.0, 29.8, 26.6, 22.5, 26.1, 43.0, 29.3 Average = 28.7 dB(A)
  - night-time: 36.6, 40.6, 41.9, 36.5, 36.1, 33.7, 36.1 Average = 37.3 dB(A)
- average L_{A10}
  - daytime: 50.0, 50.6, 46.7, 50.7, 47.1, 45.8, 46.2 Average = 48.1 dB(A)
  - evening: 24.0, 31.3, 28.7, 23.6, 27.4, 42.9, 25.6 Average = 29.0 dB(A)
  - night-time: 40.0, 43.5, 45.7, 40.5, 39.3, 36.7, 37.7 Average = 40.4 dB(A)

- average L_{A90}
  - daytime: 36.5, 31.6, 28.0, 32.8, 34.0, 32.5, 30.6 Average = 32.2 dB(A)
  - evening: 20.5, 27.3, 24.0, 21.1, 22.4, 22.0, 21.2 Average = 22.6 dB(A)
  - night-time: 25.8, 32.0, 27.2, 24.6, 24.5, 24.6, 24.2 Average = 26.1 dB(A)

- average L_{A90} (10th percentile)
  - daytime: 28.0, 24.9, 21.9, 26.2, 22.9, 22.0, 23.1 Average = 24.1 dB(A)
  - evening: 17.8, 24.5, 21.7, 19.8, 20.1, 20.0, 18.7 Average = 20.4 dB(A)
  - night-time: 22.4, 27.8, 24.1, 21.9, 22.0, 21.1, 21.0 Average = 22.9 dB(A)

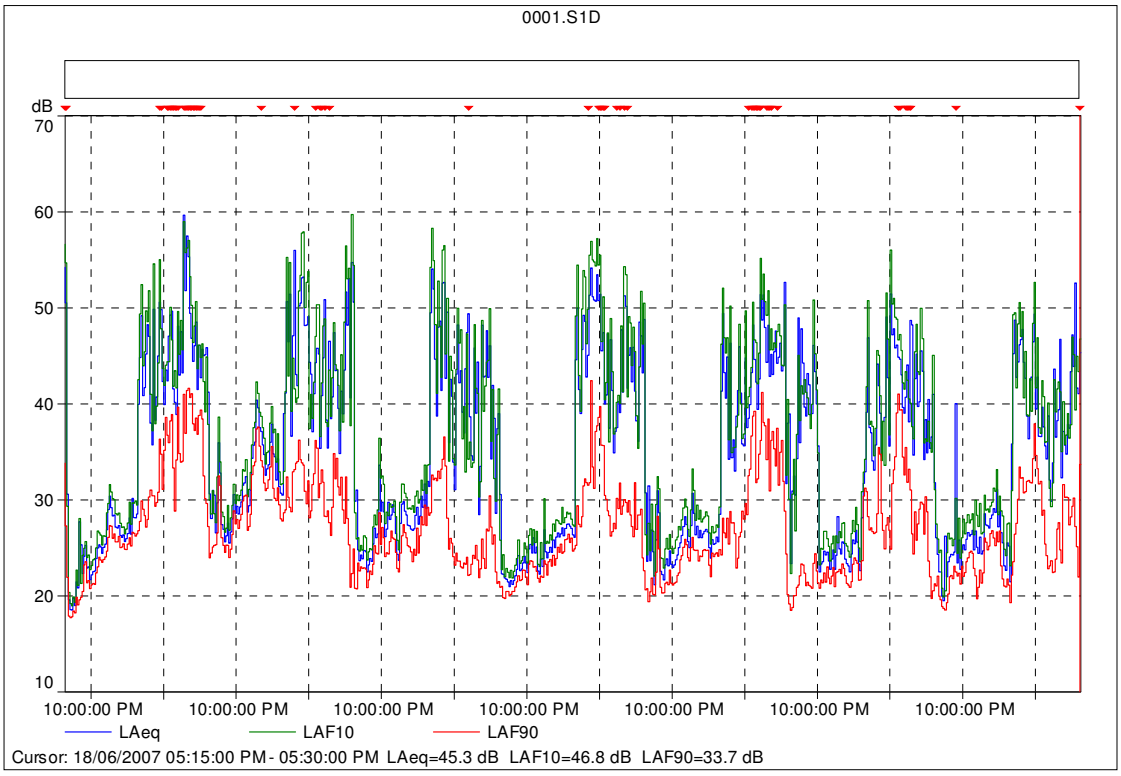

Figure 4
Graphical Presentation of Ambient Noise Levels, Kenya Field

Berwyndale South Field

The ambient noise levels for this location, which was approximately 3400 metres north-west of the Berwyndale South field compression station (at such time that there was approximately 6 compressors operating all of the time), were conducted over a 7 day period in March 2007, from Tuesday 6th to Tuesday 13th March, 2007.

The average ambient noise levels at this location were:

Average L_{Aeq}

- daytime: 49.0, 47.0, 47.4, 45.9, 56.6, 45.6, 52.0 Average = 49.0 dB(A)
- evening: 53.3, 47.3, 39.8, 44.2, 39.9, 39.0, 43.5 Average = 43.8 dB(A)
- night-time: 47.3, 40.5, 38.4, 41.8, 38.0, 43.3, 43.5 Average = 48.5 dB(A)

Average L_{A10}

- daytime: 52.0, 47.2, 48.0, 47.6, 56.2, 48.8, 53.5 Average = 50.4 dB(A)
- evening: 56.8, 48.8, 41.7, 44.3, 41.4, 40.4, 45.7 Average = 45.5 dB(A)
- night-time: 50.1, 42.3, 41.2, 44.1, 40.7, 43.8, 46.6 Average = 44.1 dB(A)

Average L_{A90}

- daytime: 41.1, 36.1, 37.4, 38.5, 41.0, 37.2, 42.8 Average = 39.1 dB(A)
- evening: 46.1, 41.9, 34.6, 39.2, 34.8, 36.1, 35.6 Average = 38.3 dB(A)
- night-time: 41.5, 36.3, 32.2, 35.3, 32.1, 38.0, 37.5 Average = 36.1 dB(A)

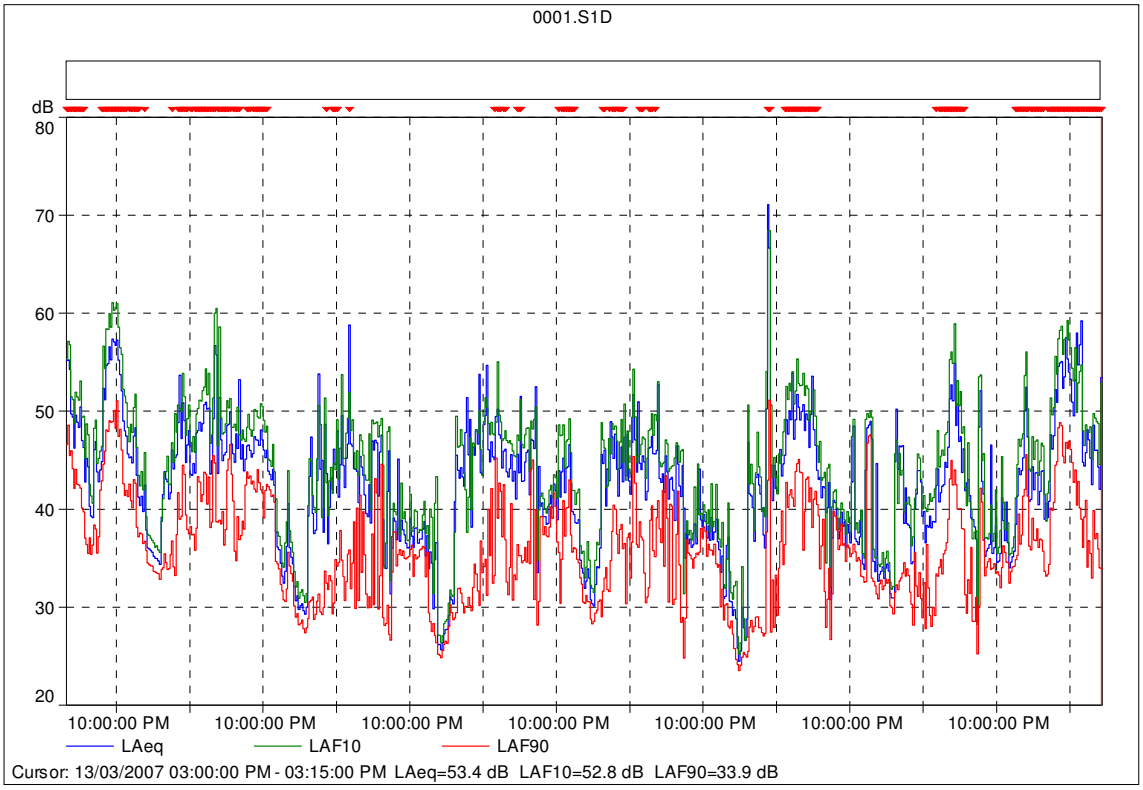

Figure 5
Graphical Presentation of Ambient Noise Levels, Berwyndale South Field

UPSTREAM NOISE SOURCES

Sound power levels were calculated in accordance with AS 1217.7-1985:

$$L_{WA} = (L_{pA} - K) + 10 \log_{10} (S \div S_O)$$

where L_{WA} = A-weighted sound power level;
L_{pA} = A-weighted sound pressure level averaged over the measurement surface;
S = area of the measurement surface, in m^2
S_O = 1 m^2
K = environmental correction to account for the influence of reflected sound, in dB.

Screw Compressor

For the Toromont screw compressor the table below details the sound power level for one screw compressor based on the results of the field noise level measurements, for the engine and compressor combined. The noise level of the cooler and the muffler have been excluded as, based on the field noise level measurements, the noise level of these two noise sources was at least 10 dB(A) less than the noise of the engine and the compressor, meaning that the noise of the cooler and muffler would add less than 0.5 dB(A) to the overall noise level. The total sound power level for one screw compressor (engine and compressor) is 122.7 dB(A).

Frequency (Hz)	31.5	63	125	250	500	1000	2000	4000	8000
Noise level SWL dB(A)	72.9	86.7	104.6	111.3	118.3	117.2	115.4	110.8	104.7

For eight screw compressors (one field compression station) the noise levels detailed in the Table above would be 9 dB greater for each frequency band.

Reciprocating Compressor

Sound power levels have also been determined for one Toromont reciprocating compressor in the processing plant and these are detailed in the table below. For one Toromont reciprocating compressor the table below details the sound power level based on the results of the field noise level measurements, for the engine and compressor combined. The noise level of the cooler and the muffler have been excluded as, based on the field noise level measurements, the noise level of these two noise sources was at least 10 dB(A) less than the noise of the engine and the compressor, meaning that the noise of the cooler and muffler would add less than 0.5 dB(A) to the overall noise level. The total sound power level for one reciprocating compressor (engine and compressor) is 121.1 dB(A).

Frequency (Hz)	31.5	63	125	250	500	1000	2000	4000	8000
Noise level SWL dB(A)	67.7	90.7	98.5	108.9	112.7	114.3	113.6	117.1	84.7

For ten reciprocating compressors – one processing plant – the noise levels detailed in the Table above would be 10 dB greater, for each frequency band.

For six reciprocating compressors – midline compression station – the noise levels detailed in the Table above would be 8 dB greater, for each frequency band.

Hydra Packs and Oil Lift

In addition to the above noise levels for the compressors, sound power levels have also determined for two different types of hydra packs and an oil lift, and these are detailed in the table below. The noise level for a Kudu Industries V8 has not been assessed, so it has been assumed to have the same noise level as the Kudu detailed below.

Frequency (Hz)	31.5	63	125	250	500	1000	2000	4000	8000
Kudu Industries GTA 5.9, 116hP @ 1800 rpm (5.9L Cummins engine, turbo charged)									
Noise level SWL dB	82.7	87.6	95.5	100.3	101.6	99.6	97.7	93.0	86.5
Noise level SWL dB(A)	45.7	63.0	80.4	92.3	97.7	99.6	98.9	93.9	85.1
Weatherford Model K3VL-80, s/n 6184841, @ 1600rpm									
Noise level SWL dB	92.0	100.7	113.4	102.8	102.1	101.0	99.0	96.1	91.0
Noise level SWL dB(A)	55.0	76.1	98.3	94.8	98.2	101.0	100.2	97.0	89.6
Oil Lift G5700									
Noise level SWL dB	95.6	93.1	110.5	101.1	94.8	94.0	93.8	89.6	83.3
Noise level SWL dB(A)	57.8	67.9	94.9	92.7	91.7	94.0	95.0	90.5	82.2

For the above hydra packs and oil lift the total sound power levels were:

- one Kudu Industries GTA 5.9, 116hP @ 1800 rpm (5.9L Cummins engine, turbo charged), 106.7 dB and 104.4 dB(A)SWL;
- one Weatherford Model K3VL-80, s/n 6184841, @ 1600rpm, 114.7 dB and 106.6 dB(A)SWL; and
- one Oil Lift G5700, 101.3 dB(A)SWL.

Refer Appendix A for details of the measurement equipment used to conduct the source noise levels.

PIPELINE NOISE SOURCES

Noise sources associated with the laying of the pipeline is likely to include:

1. camp, which will move with the progress of the pipeline. Noise sources will include vehicles, generator, exhaust fans, etc with the primary noise source being the generator.
2. raw material delivery, particularly pipe and pipe bedding material. The main noise source will be trucks and, if required, a crane to unload the pipes from the semi trailers.
3. initial clearing, presumably using a bulldozer.
4. trench digging using an excavator.
5. trench preparation for pipe laying – bedding material placed at the base of the trench using an excavator, with also an end loader or skid steer loader used to get the bedding material from the stockpile to the trench.
6. pipe laying using a crane or excavator as a crane, with the additional noise of welding and grinding and the associated power plants for this equipment.
7. backfilling of the trench using an excavator or skid steer loader, or possibly a small dozer.

COMPUTER MODELLED NOISE LEVELS

Atmospheric and Ground Conditions

All computer noise modelling was conducted for flat ground (no ground contours), for ground absorption factor of -0.5 and the following atmospheric conditions:

- temperature: 20^0C;
- humidity: 60%;
- wind: light breeze from the compressor/s to the receiver, which is worst case scenario for wind speed and direction.

The above atmospheric conditions, in particular wind speed and direction, provide noise levels at the receptors that represent the worst case scenario – that is, the highest likely noise levels at these receptors, as the wind direction that has been modelled is from the source to the receptor. If there was no wind then the actual noise levels would be less than those detailed in the following tables, and this reduction could be in the vicinity of 5 dB(A). For a wind in the opposite direction (from the receptor to the noise source) the noise levels detailed in the following tables could be up to 8 to 10 dB(A) less.

In assessing noise impact it is accepted practice to assess, within reason, worst case scenario, and this is the position of the Environmental Protection Agency. For this reason the computer model presents the source noise levels at the receptors for the worst case – wind direction from source to receptor, for a light to moderate wind speed.

However, it should be noted that 'worst case scenario' is more an overall average than accounting for daily and seasonal variations. Daily and seasonal variations (other than wind speed and direction – modelled as blowing from noise source to receptor) are not generally accounted for, with an average temperature of 20^0C and humidity of 60% applied. Changing of these parameters to allow for daily and seasonal variations would not significantly change the resultant noise level at the closest residences.

Reciprocating Compressors (One Processing Plant)

Computer noise modelling for ten reciprocating compressors (one processing plant) was conducted for an average source height of 2 metres, for flat ground for a ground absorption factor of -0.5 and the following atmospheric conditions:

- temperature: 20^0C;
- humidity: 60%;
- wind: light breeze from the compressor/s to the receiver.

Table 1 details the results of the modelling for the 10 reciprocating compressors.

With respect to Table 1 the black noise levels mean that all noise limits are complied with, green means that the night-time (28 dB(A)) noise limit only is exceeded, blue if the daytime and evening (35 dB(A)) noise limits are exceeded and red if the daytime (40 dB(A)), evening and night-time noise limits are exceeded.

Table 1
Noise Level of Ten Reciprocating Compressors at Nominated Distances

Distance (m)	Noise Level dB(A)	Distance (m)	Noise Level dB(A)
100	76.8	4100	27.9
200	69.2	4200	27.5
300	64.6	4300	27.1
400	61.3	4400	26.7
500	58.6	4500	26.3
600	56.4	4600	25.9
700	54.5	4700	25.5
800	52.8	4800	25.1
900	51.3	4900	24.8
1000	49.9	5000	24.4
1100	48.6	5500	22.8
1200	47.4	6000	21.3
1300	46.3	6500	19.9
1400	45.2	7000	18.7
1500	44.2	7500	17.6
1600	43.3	8000	16.6
1700	42.4	8500	15.6
1800	41.5	9000	14.7
1900	40.7	9500	13.9
2000	39.9	10000	13.2
2100	39.1	10500	12.4
2200	38.4	11000	11.8
2300	37.7	11500	11.1
2400	37.0	12000	10.5
2500	36.3	12500	10.0
2600	35.7	13000	9.4
2700	35.1	13500	8.9
2800	34.5	14000	8.4
2900	33.9	14500	8.0
3000	33.3	15000	7.5
3100	32.8	15500	7.1
3200	32.2	16000	6.7
3300	31.7	16500	6.3
3400	31.2	17000	5.9

Table 1 Noise Level of Ten Reciprocating Compressors at Nominated Distances			
Distance (m)	Noise Level dB(A)	Distance (m)	Noise Level dB(A)
3500	30.7	17500	5.5
3600	30.2	18000	5.1
3700	29.7	18500	4.8
3800	29.2	19000	4.4
3900	28.8	19500	4.1
4000	28.3	20000	3.8

The noise level of ten reciprocating compressors will comply with all of the noise limits for the complete 24-hour day at a minimum separation distance of approximately 4000 metres. Night-time only noise limits will be exceeded from a distance of approximately 2700 to 4000 metres from the plant, evening and night-time noise limits from approximately 2000 to 4000 metres from the plant and the noise limits for the complete 24-hour day will be exceeded closer than approximately 2000 metres from the plant.

Screw Compressors (One Field Compression Station)

Computer noise modelling for eight screw compressors – one field compression station – was conducted for flat ground (no ground contours), for an average source height of 2 metres, for flat ground for a ground absorption factor of -0.5 and the following atmospheric conditions:

- temperature: 20^0C;
- humidity: 60%;
- wind: light breeze from the compressor/s to the receiver.

Table 2 details the results of the modelling for 8 screw compressors.

With respect to Table 2 the black noise levels mean that all noise limits are complied with, green means that the night-time (28 dB(A)) noise limit only is exceeded, blue if the daytime and evening (35 dB(A)) noise limits are exceeded and red if the daytime (40 dB(A)), evening and night-time noise limits are exceeded.

Table 2 Noise Level of Eight Screw Compressors at Nominated Distances			
Distance (m)	Noise Level dB(A)	Distance (m)	Noise Level dB(A)
100	76.2	4100	29.0
200	69.2	4200	28.6
300	65.0	4300	28.2
400	61.9	4400	27.8
500	59.4	4500	27.4
600	57.2	4600	27.0
700	55.4	4700	26.6
800	53.7	4800	26.2

Table 2
Noise Level of Eight Screw Compressors at Nominated Distances

Distance (m)	Noise Level dB(A)	Distance (m)	Noise Level dB(A)
900	52.3	4900	25.9
1000	50.9	5000	25.5
1100	49.6	5500	23.8
1200	48.4	6000	22.3
1300	47.3	6500	21.0
1400	46.3	7000	19.7
1500	45.3	7500	18.6
1600	44.4	8000	17.5
1700	43.5	8500	16.5
1800	42.6	9000	15.6
1900	41.8	9500	14.7
2000	41.0	10000	13.9
2100	40.2	10500	13.2
2200	39.5	11000	12.5
2300	38.8	11500	11.8
2400	38.1	12000	11.1
2500	37.4	12500	10.5
2600	36.8	13000	9.9
2700	36.2	13500	9.3
2800	35.6	14000	8.8
2900	35.0	14500	8.2
3000	34.4	15000	7.7
3100	33.8	15500	7.2
3200	33.3	16000	6.7
3300	32.8	16500	6.3
3400	32.3	17000	5.8
3500	31.8	17500	5.4
3600	31.3	18000	4.9
3700	30.8	18500	4.5
3800	30.3	19000	4.1
3900	29.9	19500	3.7
4000	29.4	20000	3.3

The noise level of eight screw compressors will comply with all of the noise limits for the complete 24-hour day at a minimum separation distance of approximately 4300 metres. Night-time only noise limits will be exceeded from a distance of approximately 2900 to 4300 metres from the plant, evening and night-time noise limits from approximately 2100 to 4300 metres from the plant and the noise limits for the complete 24-hour day will be exceeded closer than approximately 2100 metres from the plant.

Combined Compressor Noise

Computer noise modelling for one processing plant (ten reciprocating compressors) and three field compression stations (eight screw compressors at each station) was conducted for flat ground (no ground contours), for an average source height of 2 metres, for flat ground for a ground absorption factor of -0.5 and the following atmospheric conditions:

- temperature: 20^0C;
- humidity: 60%;
- wind: light breeze from the compressor/s to the receiver.

For this computer model the processing plant was in the centre of the three field compression stations, with each field compression station 5000 m from the processing plant and 120^0 apart (that is, equi-spaced at a distance of 5000 m from the processing plant).

Table 3 details the results of the modelling for separation distances from the closest of the field compression stations to the receptor.

With respect to the Table the black noise levels mean that all noise limits are complied with, green means that the night-time noise limit only is exceeded, blue if the daytime and evening noise limits are exceeded and red if the daytime, evening and night-time noise limits are exceeded.

Table 3
Noise Level of One Processing Plant (8 Reciprocating Compressors) and Three Field Compression Stations (8 Screw Compressors at Each Station) at Nominated Distances

Distance (m)	Noise Level dB(A)	Distance (m)	Noise Level dB(A)
100	**77.6**	4100	**31.2**
200	**70.5**	4200	**30.8**
300	**66.3**	4300	**30.4**
400	**63.3**	4400	**30.0**
500	**60.9**	4500	**29.6**
600	**58.8**	4600	**29.2**
700	**57.0**	4700	**28.8**
800	**55.4**	4800	**28.4**
900	**54.0**	4900	**28.1**
1000	**52.7**	5000	27.7
1100	**51.4**	5500	26.0
1200	**50.3**	6000	24.5
1300	**49.2**	6500	23.1
1400	**48.2**	7000	21.9
1500	**17.2**	7500	20.8

Table 3
Noise Level of One Processing Plant (8 Reciprocating Compressors) and Three Field Compression Stations (8 Screw Compressors at Each Station) at Nominated Distances

Distance (m)	Noise Level dB(A)	Distance (m)	Noise Level dB(A)
1600	46.3	8000	19.7
1700	45.5	8500	18.8
1800	44.6	9000	17.9
1900	43.8	9500	17.1
2000	43.1	10000	16.4
2100	42.3	10500	15.7
2200	41.6	11000	15.0
2300	40.9	11500	14.4
2400	40.2	12000	13.8
2500	39.6	12500	13.3
2600	39.0	13000	12.7
2700	38.4	13500	12.2
2800	37.8	14000	11.7
2900	37.2	14500	11.3
3000	36.6	15000	10.8
3100	36.1	15500	10.4
3200	35.5	16000	9.9
3300	35.0	16500	9.5
3400	34.5	17000	9.1
3500	34.0	17500	8.7
3600	33.5	18000	8.3
3700	33.0	18500	8.0
3800	32.6	19000	7.6
3900	32.1	19500	7.2
4000	31.7	20000	6.9

The noise level of one processing plant and three field compression stations will comply with all of the noise limits for the complete 24-hour day at a minimum separation distance of approximately 4900 metres. Night-time only noise limits will be exceeded from a distance of approximately 3300 to 4900 metres from the plant, evening and night-time noise limits from approximately 2500 to 4000 metres from the plant and the noise limits for the complete 24-hour day will be exceeded closer than approximately 2500 metres from the plant.

Complete Upstream Area

Computer noise modelling of nine processing plants (ten reciprocating compressors at each of the processing plants) and twenty-seven field compression stations (eight screw compressors at each station) was conducted for flat ground (no ground contours), for an average source height of 2 metres, for flat ground for a ground absorption factor of -0.5 and the following atmospheric conditions:

- temperature: 20^0C;
- humidity: 60%;
- wind: light breeze from the compressor/s to the receiver.

Refer Figures 1 and 2 for the location of all of the residences and compressors included in this modelling.

For this computer model the processing plants and the field compression stations were located in accordance with preliminary information provided by QGC. Location of residences was provided by Mipela (GIS) Pty Ltd, with this information extracted from Google Earth Imagery over the upstream tenements and SPOT 10 2.5m resolution satellite imagery over the pipeline route. The location of the residences data was provided with the following caveats:

- the data was not ground truthed and is subject to following inaccuracies:

4. Captured receptors include all buildings/constructions and may not necessarily be occupied dwellings;

5. In high density areas eg. Chinchilla/Miles townships, receptors were automatically placed within each property boundary;

6. In irregular instances points were placed for each building grouped in the same area – majority of cases is just one point for grouped buildings.

All of the above data relating to plant and residence location was provided to David Moore & Associates Pty Ltd as latitude longitude bearings. These were then converted to points within the modelling area, with distances defined as metres. For the modelled area Table 4 details the results of the modelling for the nine processing plants and twenty-seven field compression stations at all residences, but only included in Table 4 are those residences where one or more of the noise limits are exceeded. With respect to the noise levels detailed in Table 4, green numbers indicate that only the night-time noise limit is exceeded (noise level of 28.5 to 35.4 dB(A)), blue numbers indicate that the evening and night-time noise limits are exceeded (noise level 35.5 to 40.4 dB(A)), and the red numbers that the noise limit is exceeded for all three time periods (noise level 40.5 dB(A) and greater).

Table 4
Noise Level of Nine Processing Plants (10 Reciprocating Compressors at Each Site) and Twenty-Seven Field Compression Stations (8 Screw Compressors at Each Station) at Closest 'Residences'

Residence Number	Noise Level dB(A)	Residence Number	Noise Level dB(A)
16	32.5	3141	35.3
24	35.5	3213	52.0
25	31.1	3267	41.3
26	51.2	3305	30.4
29	37.4	3387	31.0
30	32.5	3598	33.7
32	36.5	3666	30.0
33	35.0	3667	30.2

Table 4
Noise Level of Nine Processing Plants (10 Reciprocating Compressors at Each Site) and Twenty-Seven Field Compression Stations (8 Screw Compressors at Each Station) at Closest 'Residences'

Residence Number	Noise Level dB(A)	Residence Number	Noise Level dB(A)
34	35.1	3675	30.1
35	34.1	3683	30.5
37	33.0	3718	30.5
41	31.8	3727	30.4
62	29.4	3799	31.2
64	29.2	3812	32.5
66	42.8	3942	32.2
80	29.9	3945	31.9
85	34.1	3953	32.4
100	28.8	3957	32.9
105	33.9	3962	32.7
111	31.4	3970	32.8
134	73.8	4002	36.7
186	30.4	4020	30.6
194	49.3	4037	41.0
199	32.3	4043	34.9
223	30.9	4068	44.0
253	32.1	4079	35.9
263	32.1	4096	30.8
269	31.0	4106	31.1
273	33.9	4194	62.7
275	33.7	4197	30.9
278	34.5	4219	31.5
286	40.1	4265	35.1
287	30.2	4266	30.8
288	41.6	4295	32.1
289	51.5	4317	42.8
291	43.0	4325	37.5
293	43.9	4346	40.0
294	33.6	4359	36.1
295	44.5	4364	35.6
296	35.0	4368	31.7
297	44.7	4374	31.1
300	43.3	4384	40.9
306	41.9	4404	54.1
307	44.6	4408	29.3

Table 4
Noise Level of Nine Processing Plants (10 Reciprocating Compressors at Each Site) and Twenty-Seven Field Compression Stations (8 Screw Compressors at Each Station) at Closest 'Residences'

Residence Number	Noise Level dB(A)	Residence Number	Noise Level dB(A)
309	40.6	4427	32.0
312	31.0	4434	36.8
313	37.3	4444	30.5
314	34.3	4445	35.3
315	30.3	4448	30.7
316	50.1	4479	32.9
317	30.2	4481	32.5
322	54.4	4545	29.2
323	56.5	4547	29.2
324	30.6	4562	28.9
325	46.9	4584	37.8
331	39.8	4618	38.0
332	29.4	4686	44.7
333	29.8	4705	28.7
334	29.6	4707	52.4
336	30.3	4709	30.3
338	29.9	4710	29.2
341	30.6	4715	29.9
343	30.5	4718	39.0
344	30.5	4762	32.2
345	32.6	4776	49.5
346	31.3	4813	36.9
347	31.0	4819	35.7
348	33.8	4820	77.6
350	31.4	4829	36.7
351	31.4	4830	30.1
352	28.7	4835	35.7
358	31.5	4836	36.0
359	31.5	4839	33.5
360	28.7	4840	34.7
361	39.3	4841	48.8
362	30.9	4842	37.0
364	38.5	4844	40.8
369	30.7	4847	29.2
371	29.0	4849	28.8
375	36.0	4850	33.0

Table 4
Noise Level of Nine Processing Plants (10 Reciprocating Compressors at Each Site) and Twenty-Seven Field Compression Stations (8 Screw Compressors at Each Station) at Closest 'Residences'

Residence Number	Noise Level dB(A)	Residence Number	Noise Level dB(A)
376	29.2	4852	38.1
279	29.2	4853	33.5
383	33.9	4855	37.9
385	30.8	4857	33.0
388	34.4	4858	31.5
392	33.9	4859	30.3
394	35.6	4860	30.9
396	29.3	4861	30.3
397	29.3	4863	30.3
401	36.5	4864	30.3
404	33.6	4866	30.0
411	32.6	4867	30.0
460	34.1	4868	31.0
1643	28.6	4872	34.4
1654	29.6	4873	38.5
1667	28.9	4874	35.2
1685	31.6	4875	44.8
1701	30.9	4876	45.5
1721	35.4	4880	54.9
1726	35.2	4881	34.5
1727	31.1	4883	34.4
1765	35.9	4884	35.9
1766	38.3	4887	41.1
1780	37.7	4891	32.5
1796	40.0	5022	35.4
1819	29.5	5025	37.5
1838	47.9	5117	56.9
1839	40.6	5186	32.7
1843	49.8	5218	29.5
1844	33.7	5222	40.6
1849	29.7	5227	40.2
1853	32.6	5254	34.4
1860	41.5	5264	29.0
1861	37.7	5273	30.2
1865	51.3	6420	28.7
1879	32.9	6430	37.3

Table 4
Noise Level of Nine Processing Plants (10 Reciprocating Compressors at Each Site) and Twenty-Seven Field Compression Stations (8 Screw Compressors at Each Station) at Closest 'Residences'

Residence Number	Noise Level dB(A)	Residence Number	Noise Level dB(A)
1923	44.7	6445	30.1
1933	34.4	6455	40.5
1943	48.1	6456	38.4
1953	37.9	6459	30.7
1959	40.0	6460	31.2
1960	43.9	6462	34.6
1978	47.1	6463	55.4
1987	48.0	6464	30.9
2016	31.0	6465	55.2
2018	40.4	6466	56.7
2052	36.0	6467	49.8
2066	28.8	6468	57.1
2101	31.1	6469	40.1
2110	33.0	6470	34.5
2131	30.8	6471	45.5
2147	33.9	6472	35.0
2153	34.5	6473	34.2
2157	32.1	6474	60.6
2171	35.7	6475	34.6
2187	35.2	6479	36.5
2216	31.3	6545	30.5
2235	31.3	6548	38.7
2311	33.7	6554	38.0
2316	41.5	6577	32.9
2342	45.8	6584	31.9
2344	29.6	6597	34.0
2345	29.7	6599	35.5
2351	45.9	6606	33.4
2389	40.4	6608	29.8
2397	31.0	6613	29.3
2408	31.8	6616	31.4
2409	30.6	6617	29.7
2413	30.4	6619	32.4
2510	37.4	6626	32.2
2514	37.5	6629	30.1
2521	38.1	6630	29.1

Table 4
Noise Level of Nine Processing Plants (10 Reciprocating Compressors at Each Site) and Twenty-Seven Field Compression Stations (8 Screw Compressors at Each Station) at Closest 'Residences'

Residence Number	Noise Level dB(A)	Residence Number	Noise Level dB(A)
2529	40.6	6633	32.5
2534	39.6	6634	38.0
2582	35.5	6640	45.5
2634	30.7	6642	28.5
2642	31.5	6643	31.5
2665	47.5	6644	31.1
2701	37.0	6645	30.3
2748	35.5	6649	45.7
2749	31.6	6650	28.6
2752	29.7	6656	45.0
2754	28.6	6659	39.6
2768	28.8	6661	34.2
2783	32.6	6662	49.1
2812	34.9	6665	36.6
2817	28.9	6671	30.8
2833	38.1	6672	42.3
2845	35.4	6675	37.3
2955	45.4	6678	32.7
2956	44.0	6679	29.8
3026	36.7	6690	30.7
3033	40.1	6696	43.1
3042	39.9	6703	32.2
3051	39.3	6704	34.8
3052	39.6	6707	46.6
3091	43.6	6711	29.4
3119	37.4	6718	37.3
3140	49.5		

From Table 4 there are a total of 357 residences where one or more of the noise limits are exceeded. Just the night-time noise limit is exceeded at 215 residences, the night-time and evening noise limits at a further 70 residences and the noise limits for the complete 24-hour day at a further 72 residences.

Midline Compressor Station (Six Reciprocating Compressors)

Computer noise modelling for six reciprocating compressors (midline compressor station) was conducted for flat ground (no ground contours), for an average source height of 2 metres, for flat ground for a ground absorption factor of -0.5 and the following atmospheric conditions:

- temperature: 20^0C;
- humidity: 60%;
- wind: light breeze from the compressor/s to the receiver.

Table 5 details the results of the modelling for the 10 reciprocating compressors.

With respect to Table 5 the black noise levels mean that all noise limits are complied with, green means that the night-time (28 dB(A)) noise limit only is exceeded, blue if the daytime and evening (35 dB(A)) noise limits are exceeded and red if the daytime (40 dB(A)), evening and night-time noise limits are exceeded.

Table 5
Noise Level of Midline Compressor Station (Six Reciprocating Compressors) at Nominated Distances

Distance (m)	Noise Level dB(A)	Distance (m)	Noise Level dB(A)
100	**74.8**	4100	25.9
200	**67.2**	4200	25.5
300	**62.6**	4300	25.1
400	**59.3**	4400	24.7
500	**56.6**	4500	24.3
600	**54.4**	4600	23.9
700	**52.5**	4700	23.5
800	**50.8**	4800	23.1
900	**49.3**	4900	22.8
1000	**47.9**	5000	22.4
1100	**46.6**	5500	21.8
1200	**45.4**	6000	19.3
1300	**44.3**	6500	17.9
1400	**43.2**	7000	16.7
1500	**42.2**	7500	15.6
1600	**41.3**	8000	14.6
1700	**40.4**	8500	13.6
1800	**39.5**	9000	12.7
1900	**38.7**	9500	11.9
2000	**37.9**	10000	11.2
2100	**37.1**	10500	10.4
2200	**36.4**	11000	9.8
2300	**35.7**	11500	9.1

Table 5 Noise Level of Midline Compressor Station (Six Reciprocating Compressors) at Nominated Distances			
Distance (m)	Noise Level dB(A)	Distance (m)	Noise Level dB(A)
2400	**35.0**	12000	8.5
2500	**34.3**	12500	8.0
2600	**33.7**	13000	7.4
2700	**33.1**	13500	6.9
2800	**32.5**	14000	6.4
2900	**31.9**	14500	6.0
3000	**31.3**	15000	5.5
3100	**30.8**	15500	5.1
3200	**30.2**	16000	4.7
3300	**29.7**	16500	4.3
3400	**29.2**	17000	3.9
3500	**28.7**	17500	3.5
3600	28.2	18000	3.1
3700	27.7	18500	2.8
3800	27.2	19000	2.4
3900	26.8	19500	2.1
4000	26.3	20000	1.8

The noise level of six reciprocating compressors will comply with all of the noise limits for the complete 24-hour day at a minimum separation distance of approximately 3600 metres. Night-time only noise limits will be exceeded from a distance of approximately 2400 to 3600 metres from the plant, evening and night-time noise limits from approximately 1800 to 3600 metres from the plant and the noise limits for the complete 24-hour day will be exceeded closer than approximately 1800 metres from the plant.

Well Equipment

The results of computer noise modelling for an oil lift and two different types of hydra packs are detailed in Tables 6, 7 and 8 respectively. This computer modelling was conducted for flat ground (no ground contours), for an average source height of 1 metre, for flat ground for a ground absorption factor of -0.5 and the following atmospheric conditions:

- temperature: 20^0C;
- humidity: 60%;
- wind: light breeze from the oil lift or hydra packs to the receiver.

Table 6 details the results of the modelling for the oil lift and Tables 7 and 8 the results of the modelling for the two different hydra packs.

With respect to the Tables the black noise levels mean that all noise limits are complied with, green means that the Night-time noise limit only is exceeded, blue if the daytime and evening noise limits are exceeded and red if the daytime, evening and night-time noise limits are exceeded.

Table 6
Noise Level of One Oil Lift at Nominated Distances

Distance (m)	Noise Level dB(A)	Distance (m)	Noise Level dB(A)
100	**46.5**	4100	3.9
200	**39.5**	4200	3.6
300	**35.3**	4300	3.3
400	**32.1**	4400	3.0
500	**29.5**	4500	2.8
600	27.3	4600	2.5
700	25.4	4700	2.3
800	23.7	4800	2.0
900	22.2	4900	1.8
1000	20.9	5000	1.6
1100	19.7	5500	0.4
1200	18.6	6000	<0
1300	17.6	6500	<0
1400	16.7	7000	<0
1500	15.8	7500	<0
1600	15.1	8000	<0
1700	14.3	8500	<0
1800	13.6	9000	<0
1900	13.0	9500	<0
2000	12.3	10000	<0
2100	11.7	10500	<0
2200	11..2	11000	<0
2300	10.7	11500	<0
2400	10.1	12000	<0
2500	9.7	12500	<0
2600	9.2	13000	<0
2700	8.7	13500	<0
2800	8.3	14000	<0
2900	7.9	14500	<0
3000	7.5	15000	<0
3100	7.1	15500	<0
3200	6.7	16000	<0
3300	6.4	16500	<0
3400	6.0	17000	<0
3500	5.7	17500	<0
3600	5.4	18000	<0

Table 6 Noise Level of One Oil Lift at Nominated Distances			
Distance (m)	Noise Level dB(A)	Distance (m)	Noise Level dB(A)
3700	5.1	18500	<0
3800	4.7	19000	<0
3900	4.4	19500	<0
4000	4.1	20000	<0

The noise level of one oil lift will comply with all of the noise limits for the complete 24-hour day at a minimum separation distance of approximately 550 metres. Night-time only noise limits will be exceeded from a distance of approximately 300 to 550 metres from the plant, evening and night-time noise limits from approximately 200 to 550 metres from the plant and the noise limits for the complete 24-hour day will be exceeded closer than approximately 550 metres from the plant.

Table 7 Noise Level of One Kundu Hydra Pack at Nominated Distances			
Distance (m)	Noise Level dB(A)	Distance (m)	Noise Level dB(A)
100	**49.4**	4100	<0
200	**42.4**	4200	<0
300	**38.1**	4300	<0
400	**34.9**	4400	<0
500	**32.3**	4500	<0
600	**30.1**	4600	<0
700	**28.2**	4700	<0
800	26.5	4800	<0
900	24.9	4900	<0
1000	23.5	5000	<0
1100	22.2	5500	<0
1200	20.9	6000	<0
1300	19.7	6500	<0
1400	18.6	7000	<0
1500	17.6	7500	<0
1600	16.6	8000	<0
1700	15.6	8500	<0
1800	14.7	9000	<0
1900	13.8	9500	<0
2000	13.0	10000	<0
2100	12.1	10500	<0
2200	11.4	11000	<0
2300	10.6	11500	<0

Table 7 Noise Level of One Kundu Hydra Pack at Nominated Distances			
Distance (m)	Noise Level dB(A)	Distance (m)	Noise Level dB(A)
2400	9.8	12000	<0
2500	9.1	12500	<0
2600	8.4	13000	<0
2700	7.8	13500	<0
2800	7.1	14000	<0
2900	6.5	14500	<0
3000	5.8	15000	<0
3100	5.2	15500	<0
3200	4.6	16000	<0
3300	4.1	16500	<0
3400	3.5	17000	<0
3500	3.0	17500	<0
3600	2.4	18000	<0
3700	1.9	18500	<0
3800	1.4	19000	<0
3900	0.9	19500	<0
4000	0.4	20000	<0

The noise level of one kundu hydra pack will comply with all of the noise limits for the complete 24-hour day at a minimum separation distance of approximately 700 metres. Night-time only noise limits will be exceeded from a distance of approximately 400 to 700 metres from the plant, evening and night-time noise limits from approximately 250 to 700 metres from the plant and the noise limits for the complete 24-hour day will be exceeded closer than approximately 250 metres from the plant.

Table 8 Noise Level of One Weatherford Hydra Pack at Nominated Distances			
Distance (m)	Noise Level dB(A)	Distance (m)	Noise Level dB(A)
100	**51.8**	4100	7.5
200	**44.8**	4200	7.2
300	**40.5**	4300	6.9
400	**37.3**	4400	6.6
500	**34.7**	4500	6.4
600	**32.5**	4600	6.1
700	**30.6**	4700	5.8
800	**28.9**	4800	5.6
900	27.4	4900	5.3
1000	26.0	5000	5.1

Table 8
Noise Level of One Weatherford Hydra Pack at Nominated Distances

Distance (m)	Noise Level dB(A)	Distance (m)	Noise Level dB(A)
1100	24.8	5500	4.0
1200	23.6	6000	2.9
1300	22.6	6500	2.0
1400	21.6	7000	1.1
1500	20.7	7500	0.2
1600	19.8	8000	<0
1700	19.0	8500	<0
1800	18.2	9000	<0
1900	17.5	9500	<0
2000	16.8	10000	<0
2100	16.2	10500	<0
2200	15.5	11000	<0
2300	15.0	11500	<0
2400	14.4	12000	<0
2500	13.8	12500	<0
2600	13.3	13000	<0
2700	12.8	13500	<0
2800	12.4	14000	<0
2900	11.9	14500	<0
3000	11.4	15000	<0
3100	11.0	15500	<0
3200	10.6	16000	<0
3300	10.2	16500	<0
3400	9.9	17000	<0
3500	9.5	17500	<0
3600	9.1	18000	<0
3700	8.8	18500	<0
3800	8.4	19000	<0
3900	8.1	19500	<0
4000	7.8	20000	<0

The noise level of one weatherford hydra pack will comply with all of the noise limits for the complete 24-hour day at a minimum separation distance of approximately 850 metres. Night-time only noise limits will be exceeded from a distance of approximately 500 to 850 metres from the plant, evening and night-time noise limits from approximately 320 to 850 metres from the plant and the noise limits for the complete 24-hour day will be exceeded closer than approximately 320 metres from the plant.

Flare Noise

Noise data available for this potential noise source is only available as overall dB(A) sound pressure levels, namely:

- 860 Kg/Hr = 80 dB(A) @ 30 metres;
- 8600 Kg/Hr = 90 dB(A) @ 30 metres; and
- 76000 Kg/Hr = 109 dB(A) @ 30 metres.

Adopting 90 dB(A) @ 30 metres as the source noise level for the flare the sound power level would be approximately 131 dB(A). The assumed frequency spectrum for this noise source is detailed in the table below.

Frequency (Hz)	31.5	63	125	250	500	1000	2000	4000	8000
Noise level SWL dB(A)	100	110	115	120	120	125	125	125	120

Using the above source noise level at a height of 30 metres (assumed top of the flare stack) the results of the computer modelling are detailed in Table 9. This computer modelling was conducted for flat ground (no ground contours), for a source height of 30 metre, for flat ground for a ground absorption factor of -0.5 and the following atmospheric conditions:

- temperature: 20^0C;
- humidity: 60%;
- wind: light breeze from the oil lift or hydra packs to the receiver.

With respect to Table 9 the black noise levels mean that all noise limits are complied with, green means that the night-time noise limit only is exceeded, blue if the daytime and evening noise limits are exceeded and red if the daytime, evening and night-time noise limits are exceeded. It should be noted that these steady state source noise level limits have been assumed to be appropriate for the flare noise as it will continue for some time (not just flare for a couple of seconds, then stop).

Table 9
Noise Level of One Gas Flare Stack Venting at Nominated Distances

Distance (m)	Noise Level dB(A)	Distance (m)	Noise Level dB(A)
100	**79.7**	4100	**32.2**
200	**72.9**	4200	**31.9**
300	**68.7**	4300	**31.6**
400	**64.5**	4400	**31.3**
500	**61.2**	4500	**31.1**
600	**58.5**	4600	**30.8**
700	**56.3**	4700	**30.5**
800	**54.3**	4800	**30.2**
900	**52.6**	4900	**30.0**
1000	**51.2**	5000	**29.7**
1100	**49.9**	5500	**28.5**

Table 9
Noise Level of One Gas Flare Stack Venting at Nominated Distances

Distance (m)	Noise Level dB(A)	Distance (m)	Noise Level dB(A)
1200	48.8	6000	27.5
1300	47.7	6500	26.5
1400	46.8	7000	25.6
1500	45.8	7500	24.8
1600	45.0	8000	24.0
1700	44.1	8500	23.3
1800	43.3	9000	22.7
1900	42.6	9500	22.0
2000	41.9	10000	21.4
2100	41.2	10500	20.8
2200	40.6	11000	20.3
2300	40.0	11500	19.8
2400	39.4	12000	19.3
2500	38.8	12500	18.8
2600	38.3	13000	18.4
2700	37.8	13500	17.9
2800	37.3	14000	17.5
2900	36.8	14500	17.1
3000	36.4	15000	16.7
3100	35.9	15500	16.3
3200	35.5	16000	15.9
3300	35.1	16500	15.6
3400	34.7	17000	15.2
3500	34.3	17500	14.9
3600	33.9	18000	14.6
3700	33.6	18500	14.2
3800	33.2	19000	13.9
3900	32.9	19500	13.6
4000	32.6	20000	13.3

The noise level of one gas flare stack will comply with all of the noise limits for the complete 24-hour day at a minimum separation distance of approximately 5500 metres. Night-time only noise limits will be exceeded from a distance of approximately 3300 to 5500 metres from the plant, evening and night-time noise limits from approximately 2300 to 5500 metres from the plant and the noise limits for the complete 24-hour day will be exceeded closer than approximately 2300 metres from the plant.

NOISE IMPACT

Limits, Audibility and Impact

Within the upstream and pipeline areas the current acoustic environment comprises primarily natural noises such as birds, insects and wind in the vegetation, as well as some noise associated with agricultural pursuits. In the rural areas there would generally be negligible traffic noise, but for those residences near the Warrego Highway and other main roads in the upstream area there would be some traffic noise, particularly during the daytime. For the residences within townships there would also be community noise, which could include, in addition to the natural noises, local traffic, airconditioning units, people noise and general property maintenance noise sources such as lawnmowers, blowers, trimmers, etc.

The location of the processing plants and field compression stations, as detailed in Figures 1 and 2, is not likely to exceed any of the noise limits in any of the towns such as Dalby, Chinchilla, Miles, etc, however, for their current source noise level and location, they will exceed the noise limits at a number of residences on rural properties.

With respect to the noise limits and audibility of the noises associated with the processing plants and field compression stations in the upstream area, as well as the midline compressor station, existing ambient daytime noise levels can be as low as 25 to 30 dB(A), evening noise levels as low as 20 to 25 dB(A) and night-time noise levels can be less than 20 dB(A).

For a noise source to be audible it generally needs to be at least 3 dB(A) greater than the existing ambient noise. Generally a difference of approximately 3 dB(A) is just barely audible, an increase in noise level of 5 dB(A) clearly audible and an increase in noise level of 10 dB(A) twice as loud. Therefore, when the daytime ambient noise level is at its lowest and the noise from the compressor facilities is at the daytime noise limit of 40 dB(A), this noise level could be more than 10 dB(A) above all other ambient noise sources, making it clearly audible and sounding at least twice as loud as the other ambient noise sources. For a difference in noise level of approximately 10 dB(A) the same level of audibility would equally apply for a noise source at the noise limit for the evening or night-time, when the other ambient noise sources are at their minimum level (as detailed above).

Therefore compliance with the noise limits for the different time periods does not create inaudibility and, when the ambient noise levels are at their quietest, the noise of the compressor facilities (at the noise limit for each different time period) will sound about twice as loud as the ambient noise, for the complete 24-hour day.

Noise impact upon an individual can have a range of different effects, ranging from no effect to creating health issues such as sleep deprivation, irritability, etc. The effects of noise can be associated with both the wellbeing of an individual, as well as their lifestyle.

Whilst some of the rural community are most likely already experiencing some noise associated with the gas compression facilities in the area (both QGC and other companies), in general the rural community have not experienced these ‘additional’ noise sources previously. For some people just being able to hear the additional noise of the compressor facility could be sufficient enough for them to become annoyed, irritable and even suffer lack of sleep/disturbed sleep. Some of the residents may, over a period of time, adjust to the additional noise of the compressor facility, whilst others will not. Some residents could become increasingly agitated as the noise continues 24-hours per day, 7 days per week, and this could be exacerbated by the fact that the noise will be there for many years to come.

The selected noise limits are considered by the Environmental Protection Agency to be reasonable, both with respect to QGC and the surrounding residences, and have been applied in numerous situations in rural Queensland. However, as these noise limits will not provide inaudibility of the compressor facility noise, it is almost certain that there will be noise complaints, even if the noise limits are being complied with.

Upstream

From Table 4 there are a total of 357 residences where one or more of the noise limits are exceeded, with just the night-time noise limit exceeded at 215 residences (60%), the night-time and evening noise limit exceeded at 70 residences (20%) and the noise limits exceeded for the complete 24-hour day at 72 residences (20%).

A total of 5,732 'residences' were included in the computer modelling but of these there are only 1219 residential receptors within a 4000 metre buffer of the QCLNG Project, with the percentage of these residential receptors being exposed to noise levels in excess of the noise limits being:

- 17.6% exceed the night-time noise limit only;
- 5.7 % exceed the evening and night-time noise limits; and
- 5.9 % exceed the noise limits for the complete 24-hour day.

Pipeline

Noise associated with the laying of the pipeline is likely to include:

- camp, which will move with the progress of the pipeline. Noise sources will include vehicles, generator, exhaust fans, etc with the primary noise source being the generator.

- raw material delivery, particularly pipe and pipe bedding material. The main noise source will be trucks and, if required, a crane to unload the pipes from the semi trailers.

- initial clearing, presumably using a bulldozer.

- trench digging using an excavator.

- trench preparation for pipe laying – bedding material placed at the base of the trench using an excavator, with also an end loader or skid steer loader used to get the bedding material from the stockpile to the trench.

- pipe laying using a crane or excavator as a crane, with the additional noise of welding and grinding and the associated power plants for this equipment.

- backfilling of the trench using an excavator or skid steer loader, or possibly a small dozer.

Relative to any residential dwellings along the pipeline route the above noise sources will be transient, albeit that they are likely to occur intermittently during the whole 24-hour day. As the noise levels associated with the laying of the pipeline are transient, no specific consideration has been given to possible noise levels at the closest residences, noise impact and possible noise mitigation measures. Noise associated with the laying of the pipeline will predominantly be dealt with by community consultation and, in some circumstances, direct communication with individual property owners.

Transportation

There are two aspects of transportation noise which need to be considered:

- state and local Council controlled roads; and
- private property.

With the number of vehicles already using the Warrego Highway (and other highways pertinent to both the upstream and pipeline areas) and the current percentage heavy vehicles, transportation to and from the upstream area is not likely to have a significant effect on current Warrego Highway traffic

noise levels. This is based on the fact that for traffic noise to increase by 3 dB(A) the traffic volume (number of vehicles per day, 0600 hours to midnight) would have to double in this time period.

Noise level increase due to increases in percentage heavy vehicles is dependent upon speed. Assuming a speed limit of 100 kph the following increases in noise level for increased percentage heavy vehicles should be noted:

- heavy vehicle increase from 5 to 10%: noise level increase of 0.8 dB(A);
- heavy vehicle increase from 10 to 20%: noise level increase of 1.2 dB(A);
- heavy vehicle increase from 20 to 30%: noise level increase of 1.0 dB(A);
- heavy vehicle increase from 30 to 40%: noise level increase of 1.0 dB(A);
- heavy vehicle increase from 40 to 50%: noise level increase of 0.6 dB(A);
- heavy vehicle increase from 50 to 60%: noise level increase of 0.5 dB(A);
- heavy vehicle increase from 60 to 70%: noise level increase of 0.5 dB(A);
- heavy vehicle increase from 70 to 80%: noise level increase of 0.4 dB(A).

Therefore if current percentage heavy vehicles on the Warrego Highway was 20% and the project increased this to 40%, then the noise level would only increase by 2 dB(A).

However, with respect to local Council controlled roads, the percentage increase could be much greater. If, for example, the current percentage heavy vehicles was 10% and this increased to 80%, this would have an associated noise level increase of 5.2 dB(A).

Decreasing the speed from 100 to 80 kph would reduce noise levels by approximately 1.5 dB(A), dependent upon the percentage of heavy vehicles. Changing the surface of the road from gravel to bitumen would reduce the noise level, generally by approximately 2 dB(A).

An increase in the number of vehicles on a road will increase transportation noise levels at the residences closest to the road. This increase in noise level would only be expected to be minor with respect to the Warrego Highway, but the increase on lower traffic volume Council controlled roads could be up to 4 to 5 dB(A). The highest transportation noise levels will most likely occur during the construction phase of the project.

The highest transport activity will most likely be during the daytime and, therefore, this is when most of the transportation noise will occur. During the daytime the ambient noise levels are at their greatest and, therefore, this increase in transportation noise would not be perceived as great compared to if most of the transportation noise was to occur during the evening or night-time.

For vehicle movements on private property again most of these will be during the daytime. Internal roadways should be located as remote from neighbouring residences as possible and should be well maintained. As much as possible vehicle movements should be limited to daytime, particularly trucks and other heavy machinery.

Low Frequency

Low frequency noise (<200 Hz) is present in most of the noise sources associated with this project, particularly the screw and reciprocating gas compressors.

In accordance with the Environmental Protection Agency Noise Guideline "*Assessment of Low Frequency Noise*" low frequency noise is noise in the frequency range 10 to 200 Hz. Low frequency noise is assessed in 1/3 octave frequency bands from 8 to 200 Hz, dB linear and any tonal (annoying) components calculated and compared to the median hearing threshold levels.

If it is determined that the low frequency noise is non-annoying then noise impact is determined by converting the 1/3 octave noise levels to dB(A) levels, from 10 to 160 Hz, then summed. These noise levels must be relevant to inside a dwelling.

This summed level is called the $L_{pA,LF}$ and the limits for this parameter are:

- dwelling, evening and night: 20 dB(A) $L_{pA,LF}$;
- dwelling, day: 25 dB(A) $L_{pA,LF}$.

Source noise data expressed as 1/3 octaves from 10 to 200 Hz was not available from either the manufacturers or field noise assessments at the time of preparing this report.

Whilst low frequency noise is present in the noise sources associates with this project, both for the upstream area and the pipeline, it is the consultant's opinion that separation distance to most dwellings would result in compliance with the low frequency noise limits. For those dwellings which exceed one or more of the general noise limits there is an increased likelihood that inside these dwellings the low frequency noise limit could also be exceeded.

NOISE MITIGATION MEASURES

The results of the computer modelling detailed in this report is based on the likely location of residences ('likely' because the location of these residences was not ground proved) and, at the time of preparing this report, the most likely location of the processing plants and field compression stations. This computer modelling is also based on the worst case atmospheric conditions.

From the results of the computer modelling there are a number of residences (Table 4 refers) where the noise limits are exceeded, and for some of these residences the noise limits are exceeded for the complete 24-hour day.

Whilst it is not possible to provide, at this stage of the project, precise noise mitigation measures for each of the processing plants or field compression stations, it is possible to provide an overview of noise mitigation measures which could be applied. For a noise limit exceedence of up to approximately 10 dB(A) these noise mitigation measures would only need to relate to the engine and the compressor, but for noise limit exceedences greater than approximately 10 dB(A) the noise mitigation measures would need to relate the engine and compressor, as well as the cooling fans and muffler.

Noise mitigation measures could include:

1. Noise source location. For each of the potential noise sources – well head, field compression station and processing plant – locate these noise sources as remote as possible from residences. This noise mitigation measure should consider both the noise from the closest noise source to a particular residence, as well as the combined effect of multiple noise sources. Generally, for every doubling of separation distance from source to receiver, a further 6 dB(A) noise level reduction is achieved. For example, if a noise source was 400 metres from a residence and this separation distance was increased to 800 metres, then the noise level would reduce by approximately 6 dB(A). If the separation distance was doubled again to 1600 metres, then the total noise level reduction would be approximately 12 dB(A). Further attenuation could also be provided by ground absorption, but this is likely to be only an additional 1 or 2 dB(A).

2. Noise source/buy quiet. Some of the greatest potential noise level reduction can be achieved at the time of purchase. Particularly for those compressors in close proximity to adjoining residences the quietest possible compressor facility should be considered, but it needs to be considered as a total package. That is, for example, assuming the engine and the compressor have similar noise levels, buying a significantly quieter engine but not reducing the noise level of the compressor could result in a total noise level reduction of only 3 dB(A). The total noise level of the compressor facility – engine, compressor, cooling fans and muffler, must be considered and noise data from the manufacturer must be able to account for all of these noise sources, even if different manufacturer's are involved. The magnitude of noise level reduction achieved by purchasing a quieter noise source cannot be stated as there are too many variables, but a reduction in noise level of at least 10 dB(A) should be possible, and this could be even higher.

3. Acoustic enclosures – complete. Complete enclosing of the noise source – engine and compressor totally enclosed in a room, and quieter cooler and exhaust muffler, is a very effective noise control measure, provided there is adequate ventilation and the enclosure does not restrict the efficiency of the operation of the engine and compressor. These acoustic enclosures would generally be provided by the equipment manufacturer, and must be designed to meet the rigors of the location – summer temperatures above 40^0C must be taken into account. The equipment manufacturer should provide the data with respect to anticipated noise level reduction, and it should be possible to achieve a noise level reduction of at least 10 dB(A) and possibly as much as 20 dB(A).

4. Acoustic enclosures – partial. It is most likely that a partial enclosure would be with respect to the engine and compressor only, and could be in the form of, for example, a room over this part of the facility. As for the complete enclosure, the partial enclosure must provide adequate ventilation and not restrict the efficiency of the operation of the engine or compressor. These partial acoustic enclosures would generally be provided by the equipment manufacturer, and must be designed to meet the rigors of the location – summer temperatures above 40^0C must be taken into account. The equipment manufacturer should provide the data with respect to anticipated noise level reduction, and it should be possible to achieve a noise level reduction of 10 dB(A).

5. Acoustic barriers. All of the above potential noise mitigation measures are relative to residences in any direction from the compressor facility or well head. Acoustic barriers, however, are only effective for receptors in a given direction, and for receptors in the opposite direction care must be taken not to increase their noise exposure due to reflected noise off the inside surface of the barrier. For equipment at the well heads the acoustic barrier could be reasonably small and could even consist of moveable 'screens' – for example 1800 mm high metal frame with sheet metal external lining and 25 mm thick acoustic foam (with weather resistant film over) to the internal surface. These 'screens' could be placed around that side of the noise source which faces the closest residence, and could remain in place for the life of that noise source at that well head.

   For the compressor facilities any acoustic barrier would need to extend for the total side of the facility facing the closest residence, with returns at each end. It is likely that this barrier would need to be at least 4 metres high, lined externally with sheet metal or an even denser material, and internally lined with acoustic foam or similar, protected from the weather. In locating these acoustic barriers they provide the greatest noise level reduction close to the noise source – the closer the better – but they must also be located so that they do not restrict access to the compressor facility.

   Noise level reduction provided by an acoustic barrier would generally be in the vicinity of 5 to 8 dB(A) at the receptor.

6. Treatment at receptor. It could be possible to provide some level of acoustic treatment at the receptor. This could be treatment to the residence only, and could include airconditioning (so that the windows can be kept closed), upgraded windows (windows which provide a greater noise level reduction) and thermal insulation in the roof cavity. This acoustic treatment would only provide noise level reduction inside the residence and not any external living area, and would need to be considered on a house by house basis. It is not a recommended noise control measure, as it is 'off site' and something that QGC has no control over. It is also difficult to determine which residences warrant treatment, and which do not, and can create undue tension within the residential community.

Another option would be removal of a receptor by purchase of the property. This is not specifically a noise mitigation measure, but in some circumstances would occur as part of the project, when a property would be purchased for the purpose of locating infrastructure such as a processing plant on that property. This option could be particularly pertinent when the magnitude of noise limit exceedences is great and extends over the complete 24-hour day.

The above noise control measures should be considered for both existing residences as well as for the location of possible future residences, for the life of the project.

As a means of demonstrating the benefits of the above noise control measures further computer modelling has been conducted based on reduced source noise levels, Tables 10 to 21 refer.

Ten Reciprocating Compressors (Processing Plant)

For ten reciprocating compressors (one processing plant) Tables 10, 11, 12 and 13 detail the results of a source noise level reduction of 10, 20, 30 and 40 dB(A).

Table 10
Noise Level of Ten Reciprocating Compressors at Nominated Distances, 10 dB(A) Noise Control

Distance (m)	Noise Level dB(A)	Distance (m)	Noise Level dB(A)
100	66.8	2000	29.9
200	59.2	2100	29.1
300	54.6	2200	28.4
400	51.3	2300	27.7
500	48.6	2400	27.0
600	46.4	2500	26.3
700	44.5	2600	25.7
800	42.8	2700	25.1
900	41.3	2800	24.5
1000	39.9	2900	23.9
1100	38.6	3000	23.3
1200	37.4	3100	22.8
1300	36.3	3200	22.2
1400	35.2	3300	21.7
1500	34.2	3400	21.2
1600	33.3	3500	20.7
1700	32.4	3600	20.2
1800	31.5	3700	19.7
1900	30.7		

With 10 dB(A) of noise control measures applied to the processing plant the noise of the processing plant exceeds the daytime only noise limit (40 dB(A)) up to a radius of 1000 metres, the daytime and evening noise limit (35 dB(A)) up to a radius of 1400 metres and the daytime, evening and night-time noise limits (28 dB(A)) up to a radius of 2200 metres. To comply with a noise level of 20 dB(A) the radius from the processing plant would be 3600 metres.

Table 11 Noise Level of Ten Reciprocating Compressors at Nominated Distances, 20 dB(A) Noise Control			
Distance (m)	Noise Level dB(A)	Distance (m)	Noise Level dB(A)
100	56.8	1100	28.6
200	49.2	1200	27.4
300	44.6	1300	26.3
400	41.3	1400	25.2
500	38.6	1500	24.2
600	36.4	1600	23.3
700	34.5	1700	22.4
800	32.8	1800	21.5
900	31.3	1900	20.7
1000	29.9	2000	19.9

With 20 dB(A) of noise control measures applied to the processing plant the noise of the processing plant exceeds the daytime only noise limit (40 dB(A)) up to a radius of 500 metres, the daytime and evening noise limit (35 dB(A)) up to a radius of 700 metres and the daytime, evening and night-time noise limits (28 dB(A)) up to a radius of 1200 metres. To comply with a noise level of 20 dB(A) the radius from the processing plant would be 2000 metres.

Table 12 Noise Level of Ten Reciprocating Compressors at Nominated Distances, 30 dB(A) Noise Control			
Distance (m)	Noise Level dB(A)	Distance (m)	Noise Level dB(A)
100	46.8	600	26.4
200	39.2	700	24.5
300	34.6	800	22.8
400	31.3	900	21.3
500	28.6	1000	29.9

With 30 dB(A) of noise control measures applied to the processing plant the noise of the processing plant exceeds the daytime only noise limit (40 dB(A)) up to a radius of 200 metres, the daytime and evening noise limit (35 dB(A)) up to a radius of 300 metres and the daytime, evening and night-time noise limits (28 dB(A)) up to a radius of 600 metres. To comply with a noise level of 20 dB(A) the radius from the processing plant would be 1000 metres.

Table 13 Noise Level of Ten Reciprocating Compressors at Nominated Distances, 40 dB(A) Noise Control			
Distance (m)	Noise Level dB(A)	Distance (m)	Noise Level dB(A)
100	36.8	400	21.3
200	29.2	500	18.6
300	24.6		

With 40 dB(A) of noise control measures applied to the processing plant the noise of the processing plant does not exceed the daytime noise limit (40 dB(A)), exceeds the daytime and evening noise limit (35 dB(A)) up to a radius of 200 metres and the daytime, evening and night-time noise limits (28 dB(A)) up to a radius of 300 metres. To comply with a noise level of 20 dB(A) the radius from the processing plant would be 500 metres.

Eight Screw Compressors (Field Compression Station)

For eight screw compressors Tables 14, 15, 16 and 17 detail the results of a source noise level reduction of 10, 20, 30 and 40 dB(A).

Table 14 Noise Level of Eight Screw Compressors at Nominated Distances, 10 dB(A) Noise Control			
Distance (m)	Noise Level dB(A)	Distance (m)	Noise Level dB(A)
100	66.2	2000	31.0
200	59.2	2100	30.2
300	55.0	2200	29.5
400	51.9	2300	28.8
500	49.4	2400	28.1
600	47.2	2500	27.4
700	45.4	2600	26.8
800	43.7	2700	26.2
900	42.3	2800	25.6
1000	40.9	2900	25.0
1100	39.6	3000	24.4
1200	38.4	3100	23.8
1300	37.3	3200	23.3
1400	36.3	3300	22.8
1500	35.3	3400	22.3
1600	34.4	3500	21.8
1700	33.5	3600	21.3
1800	32.6	3700	20.8
1900	31.8	3800	20.3

With 10 dB(A) of noise control measures applied to the field compression station the noise of the field compression station exceeds the daytime only noise limit (40 dB(A)) up to a radius of 1100 metres, the daytime and evening noise limit (35 dB(A)) up to a radius of 1500 metres and the daytime, evening and night-time noise limits (28 dB(A)) up to a radius of 2400 metres. To comply with a noise level of 20 dB(A) the radius from the field compression station would be 3800 metres.

Table 15
Noise Level of Eight Screw Compressors at Nominated Distances, 20 dB(A) Noise Control

Distance (m)	Noise Level dB(A)	Distance (m)	Noise Level dB(A)
100	**56.2**	1200	**28.4**
200	**49.2**	1300	27.3
300	**45.0**	1400	26.3
400	**41.9**	1500	25.3
500	**39.4**	1600	24.4
600	**37.2**	1700	23.5
700	**35.4**	1800	22.6
800	**33.7**	1900	21.8
900	**32.3**	2000	21.0
1000	**30.9**	2100	20.2
1100	**29.6**	2200	19.5

With 20 dB(A) of noise control measures applied to the field compression station the noise of the field compression station exceeds the daytime only noise limit (40 dB(A)) up to a radius of 500 metres, the daytime and evening noise limit (35 dB(A)) up to a radius of 700 metres and the daytime, evening and night-time noise limits (28 dB(A)) up to a radius of 1200 metres. To comply with a noise level of 20 dB(A) the radius from the field compression station would be 2200 metres.

Table 16
Noise Level of Eight Screw Compressors at Nominated Distances, 30 dB(A) Noise Control

Distance (m)	Noise Level dB(A)	Distance (m)	Noise Level dB(A)
100	**46.2**	700	25.4
200	**39.2**	800	23.7
300	**35.0**	900	22.3
400	**31.9**	1000	20.9
500	**29.4**	1100	19.6
600	27.2		

With 30 dB(A) of noise control measures applied to the field compression station the noise of the field compression station exceeds the daytime only noise limit (40 dB(A)) up to a radius of 200 metres, the daytime and evening noise limit (35 dB(A)) up to a radius of 300 metres and the daytime, evening and night-time noise limits (28 dB(A)) up to a radius of 600 metres. To comply with a noise level of 20 dB(A) the radius from the field compression station would be 1100 metres.

Table 17 Noise Level of Eight Screw Compressors at Nominated Distances, 40 dB(A) Noise Control			
Distance (m)	Noise Level dB(A)	Distance (m)	Noise Level dB(A)
100	36.2	400	21.9
200	29.2	500	19.4
300	25.0		

With 40 dB(A) of noise control measures applied to the field compression station the noise of the field compression station does not exceed the daytime noise limit (40 dB(A)), exceeds the daytime and evening noise limit (35 dB(A)) up to a radius of 200 metres and the daytime, evening and night-time noise limits (28 dB(A)) up to a radius of 300 metres. To comply with a noise level of 20 dB(A) the radius from the field compression station would be 500 metres.

Combined Compressor Noise

For one processing plant (8 reciprocating compressors) and three field compression stations (8 screw compressors at each station) Tables 18, 19, 20 and 21 detail the results of a source noise level reduction of 10, 20, 30 and 40 dB(A).

Table 18 Noise Level of One Processing Plant (8 Reciprocating Compressors) and Three Field Compression Stations (8 Screw Compressors at Each Station) at Nominated Distances, 10 dB(A) Noise Control			
Distance (m)	Noise Level dB(A)	Distance (m)	Noise Level dB(A)
100	67.6	2300	30.9
200	60.5	2400	30.2
300	56.3	2500	29.6
400	53.3	2600	29.0
500	50.9	2700	28.4
600	48.8	2800	27.8
700	47.0	2900	27.2
800	45.4	3000	26.6
900	44.0	3100	26.1
1000	42.7	3200	25.5
1100	41.4	3300	25.0
1200	40.3	3400	24.5
1300	39.2	3500	24.0
1400	38.2	3600	23.5
1500	37.2	3700	23.0
1600	36.3	3800	22.6
1700	35.5	3900	22.1
1800	34.6	4000	21.7

Table 18
Noise Level of One Processing Plant (8 Reciprocating Compressors) and Three Field Compression Stations (8 Screw Compressors at Each Station) at Nominated Distances, 10 dB(A) Noise Control

Distance (m)	Noise Level dB(A)	Distance (m)	Noise Level dB(A)
1900	33.8	4100	21.2
2000	33.1	4200	20.8
2100	32.3	4300	20.4
2200	31.6	4400	20.0

With 10 dB(A) of noise control measures applied to the processing plant and three field compression stations the noise of these facilities adjacent the closest field compression station exceeds the daytime only noise limit (40 dB(A)) up to a radius of 1200 metres, the daytime and evening noise limit (35 dB(A)) up to a radius of 1800 metres and the daytime, evening and night-time noise limits (28 dB(A)) up to a radius of 2700 metres. To comply with a noise level of 20 dB(A) the radius from the field compression station would be 4400 metres.

Table 19
Noise Level of One Processing Plant (8 Reciprocating Compressors) and Three Field Compression Stations (8 Screw Compressors at Each Station) at Nominated Distances, 20 dB(A) Noise Control

Distance (m)	Noise Level dB(A)	Distance (m)	Noise Level dB(A)
100	57.6	1300	29.2
200	50.5	1400	28.2
300	46.3	1500	27.2
400	43.3	1600	26.3
500	40.9	1700	25.5
600	38.8	1800	34.6
700	37.0	1900	33.8
800	35.4	2000	33.1
900	34.0	2100	32.3
1000	32.7	2200	31.6
1100	31.4	2300	20.9
1200	30.3	2400	20.2

With 20 dB(A) of noise control measures applied to the processing plant and three field compression stations the noise of these facilities adjacent the closest field compression station exceeds the daytime only noise limit (40 dB(A)) up to a radius of 600 metres, the daytime and evening noise limit (35 dB(A)) up to a radius of 800 metres and the daytime, evening and night-time noise limits (28 dB(A)) up to a radius of 1400 metres. To comply with a noise level of 20 dB(A) the radius from the field compression station would be 2400 metres.

Table 20 Noise Level of One Processing Plant (8 Reciprocating Compressors) and Three Field Compression Stations (8 Screw Compressors at Each Station) at Nominated Distances, 30 dB(A) Noise Control			
Distance (m)	Noise Level dB(A)	Distance (m)	Noise Level dB(A)
100	**47.6**	700	27.0
200	**40.5**	800	25.4
300	**36.3**	900	24.0
400	**33.3**	1000	22.7
500	**30.9**	1100	21.4
600	**28.8**	1200	20.3

With 30 dB(A) of noise control measures applied to the processing plant and three field compression stations the noise of these facilities adjacent the closest field compression station exceeds the daytime only noise limit (40 dB(A)) up to a radius of 300 metres, the daytime and evening noise limit (35 dB(A)) up to a radius of 400 metres and the daytime, evening and night-time noise limits (28 dB(A)) up to a radius of 700 metres. To comply with a noise level of 20 dB(A) the radius from the field compression station would be 1200 metres.

Table 21 Noise Level of One Processing Plant (8 Reciprocating Compressors) and Three Field Compression Stations (8 Screw Compressors at Each Station) at Nominated Distances, 40 dB(A) Noise Control			
Distance (m)	Noise Level dB(A)	Distance (m)	Noise Level dB(A)
100	**37.6**	400	23.3
200	**30.5**	500	20.9
300	26.3	600	18.8

With 40 dB(A) of noise control measures applied to the processing plant and three field compression stations the noise of these facilities adjacent the closest field compression station exceeds the daytime only noise limit (40 dB(A)) is not exceeded, the daytime and evening noise limit (35 dB(A)) is exceeded by up to a radius of 200 metres and the daytime, evening and night-time noise limits (28 dB(A)) up to a radius of 300 metres. To comply with a noise level of 20 dB(A) the radius from the field compression station would be 600 metres.

VIBRATION

Vibration will be present in some of the plant and equipment associated with both the upstream area and the pipeline. However, vibration levels are not likely to be significant and are expected to comply with the nominated limits at even the closest dwellings. Therefore, no further consideration has been given to vibration.

Vibration limits are defines in Australian Standard 2670 – Evaluation of human exposure to whole-body vibration, Part 1 – General requirements (2001) and Part 2 – Continuous and shock-induced vibration in buildings (1990). Reference should also be made to the Environmental Protection Regulation 2008.

CONCLUSIONS

QGC Limited is proposing a gas pipeline from the Surat Basin to Port Curtis. To develop a level of appreciation of potential noise impact from a range of noise sources existing sound power level noise data for the Toromont reciprocating and screw compressors and gas well equipment (oil lift and hydra packs) have been computer modelled for a range of receptor locations. Noise of a gas flare has been estimated from supplied data (noise level of flare 90 dB(A) @ 30 metres for 8600 Kg/Hr).

Noise limits have been based on the assumption that all noise sources will be steady state, with the noise limits being:

- daytime (0700 to 1800 hours): 40 dB(A);
- evening (1800 to 2200 hours): 35 dB(A); and
- night-time (2200 to 0700 hours): 28 dB(A).

For one processing plant or one field compression station the area of noise level impact is in the vicinity of 2000 m for exceedence of the daytime, evening and night-time noise limits, 3000 m for exceedence of the evening and night-time noise limits and 4000 m for exceedence of the night-time noise limit. As these operate 24 hours per day the area of impact is approximately 4000 m around each facility.

For one processing plant and three field compression stations the noise impact radius increases to approximately 5000 m.

For the upstream area, for a total of 9 processing plants and 27 field compression stations, the night-time noise limit only of 28 dB(A) is exceeded at a total of 215 residences, the night-time and evening noise limits is excceded at a further 70 residences and the noise limits for the complete 24-hour day at a further 72 residences. These noise limit exceedences are for the current location of the noise sources, for the worst case atmospheric conditions and for residence locations which have not been ground proved. However, the computer modelling indicates that a number or residences will be noise impacted, and some of these will be significantly noise impacted with noise limits exceeded for the complete 24-hour day.

For the computer modelled area, which included a total of 5,732 residences, the percentage of these being exposed to noise levels in excess of the noise limits are:

- 17.6% exceed the night-time noise limit only;
- 5.7 % exceed the evening and night-time noise limits; and
- 5.9 % exceed the noise limits for the complete 24-hour day.

A range of potential noise control measures are available for the compressor facilities and well heads, and these include:

- noise source location – locate the noise sources as distant as possible from all residences;
- noise source/buy quiet – particularly for those noise sources closest to the surrounding residences, consider purchasing the quietest possible equipment;
- acoustic enclosure – complete. Purchase equipment with the manufacturer's acoustic enclosure with fully documented noise level reduction achieved by the enclosure. Ensure that the noise level reduction is achieved for all components of the compressor facility – engine, compressor, cooler and exhaust muffler;
- acoustic enclosure – partial. Purchase equipment with the manufacturer's acoustic enclosure with fully documented noise level reduction achieved by the enclosure;
- acoustic barriers – only applicable for controlling noise in one particular direction, could consist of portable screens for well head noise sources but would need to be a wall at least 4 metres high, with returns, for any of the compressor facilities;
- treatment at receptor – not a preferred option but it could be possible to provide noise control at the receptor. This would only be relevant inside the residence, and could include airconditioning, upgraded glazing, thermal insulation in the ceiling cavity.

Whilst not specifically a noise control measure, another option would be the purchase of properties in close proximity to noise sources, particularly those properties where the residences exceed the noise limits by a significant margin. In some circumstances this would occur as part of the project, when a property would be purchased for the purpose of locating infrastructure such as a processing plant on that property.

For different assumed source noise level reductions (10, 20, 30 and 40 dB(A)) Table 22 details the distance from the noise source at which compliance with the nominated noise level will be achieved.

Table 22
Approximate Distance from Noise Source for Compliance with Noise Limit

Noise Source	Distance from Noise Source (m) for Noise Level to be Complied With			
	40 dB(A)	35 dB(A)	28 dB(A)	20 dB(A)
One Processing Plant:				
• no noise control	2000	2700	4000	6500
• 10 dB(A) noise control	1000	1400	2200	3600
• 20 dB(A) noise control	500	700	1200	2000
• 30 dB(A) noise control	200	300	600	1000
• 40 dB(A) noise control	0	200	300	500
One Field Compression Station:				
• no noise control	2100	2900	4300	7000
• 10 dB(A) noise control	1100	1500	2400	3800
• 20 dB(A) noise control	500	700	1200	2200
• 30 dB(A) noise control	200	300	600	1100
• 40 dB(A) noise control	0	200	300	500
One Processing Plant and Three Field Compression Stations:				
• no noise control	2400	3300	4900	8000
• 10 dB(A) noise control	1200	1800	2700	4400
• 20 dB(A) noise control	600	800	1400	2400
• 30 dB(A) noise control	300	400	700	1200
• 40 dB(A) noise control	0	200	300	600

It is not considered likely that there would be sufficient levels of vibration to exceed the criteria at any of the closest dwellings to the vibration sources, for both the upstream area as well as the pipeline.

Low frequency noise will be present in most noise sources, and is assessed in 1/3 octaves from 10 to 200 Hz. Source noise data in this frequency range was not available from either manufacturers or field data at the time of preparation of this document. Once this information is available low frequency tonal components should be calculated, as well as low frequency noise inside the closest dwellings, and compared to the noise limits.

It is the consultant's opinion that separation distance from noise sources to residences should result in compliance with the low frequency noise limits at these residences. For those residences which

exceed one or more of the general (background plus allowance) noise limits there is an increased likelihood that the low frequency noise limits could also be exceeded.

Due to the short duration of the noise associated with the laying of the pipeline and any particular residence, noise from this activity is not likely to adversely impact upon any residents. Noise sources associated with pipeline activities will predominantly be dealt with by community consultation and, in some cases, directly with residential property owners.

Transportation noise needs to be considered relative to state and local controlled roads, as well as on private property.

For state and council controlled roads, the greater the existing traffic volume and percentage heavy vehicles the less impact which is likely with vehicles associated with this project. Therefore it is not anticipated that there would be any noticeable increase in traffic noise levels from the Warrego Highway (and any other highways pertinent to both the upstream and pipeline areas), but there could be increases of up to approximately 4 to 5 dB(A) on council controlled local roads. As this increase will occur predominantly during the daytime when all other ambient noise levels are at their greatest, overall transportation noise impact is not likely to be significant.

For private property most transportation would be during the daytime when all other ambient noise sources are at their maximum, thereby minimising potential noise impact from transportation. Internal roadways should be kept as remote from residences as possible, particularly those residences on adjoining properties.

APPENDIX A: NOISE MEASUREMENT EQUIPMENT FOR SOUND POWER LEVELS

Measurement Equipment

The following equipment was used to conduct the source noise level studies:

- Bruel and Kjaer Type 2260E Modular Precision Sound Analyzer – Observer – Serial No. 2497335, with Type BZ 7205 Sound Intensity Software and Sound Intensity Microphone Pair Type 4197, Serial No. 2464133;
- Bruel and Kjaer Type AO 0442 ten metre microphone extension cable; and
- Bruel and Kjaer Type 4297 Sound intensity Calibrator, Serial No. 2439820.

All of the above equipment is Type 1 in accordance with the requirements of Australian Standard AS 1259-1990, *Acoustics – Sound Level Meters*, as required by Australian Standard AS 1055.1-1997.

Measurement Equipment Settings

The above equipment was used with the following settings:

- Detector: RMS
- Time Weighting: FAST
- Frequency Weighting: A
- Sound Incidence: FRONTAL
- Microphone sensitivity: -26.7 dB
- Range: 10-90 dB.

Calibration

The sound level meter was calibrated to the required value of 93.8 dB at 1000 Hz immediately before and after the noise level measurements were conducted. At no time was an adjustment of more than ±0.5 dB required. This complies with the requirements of the Australian Standard.

Atmospheric Conditions

Throughout the ambient noise level study, atmospheric conditions were believed to have complied with the requirements of the Australian Standard for most of the time.