6.10 Noise and Vibration

6.10.1 Introduction

The following section provides a summary of the noise and vibration assessment findings, including a description of the existing environmental values, assessment of potential noise impacts and recommended mitigation measures in accordance with the ToR requirements for the EIS. Further details are provided in Appendix U1.

6.10.2 Methodology

The noise and vibration assessment considered the potential noise and vibration impacts associated with the construction and operational phases of the CSG fields development and included:

- A description of the existing acoustic and vibration environment surrounding the proposed CSG fields;
- An overview of applicable construction and operational noise and vibration goals based on relevant legislation and EPA guidelines;
- Noise and vibration modelling to predict the potential impacts at sensitive receptors during the construction and operational phases of CSG fields development;
  - Noise modelling was carried out using SoundPLAN (Version 6.4) utilising the CONCAWE prediction methodology. The computer model calculates noise emission levels and considers source sound power level (SWL) (compressor ~ 123 dBA; well heads ~ 90 dBA), location, distance attenuation, ground absorption, air absorption, shielding attenuation, and meteorological conditions including wind effects;
- An overview of possible mitigation measures which could be incorporated into the CSG fields development program to minimise potential impacts; and
- Traffic vibration impacts were assessed on the basis that heavy trucks passing over normal (smooth) road surfaces generate relatively low vibration levels, typically ranging from 0.01 mm/s to 0.2 mm/s at the footings of buildings located 10 m to 20 m from a roadway. Depending on the roadway surface, very large surface irregularities can cause levels up to 5 to 10 times higher than that of smooth road surfaces.

Traffic noise predictions associated with new CSG fields roads were modelled using the Calculation of Road Traffic Noise (CoRTN) prediction technique recommended by the Department of Main Roads (DMR) Code of Practice. The model accounts for traffic volumes, composition, vehicle speed and road surface (usually dense graded asphalt - DGA). It is likely that new roads will be required throughout the CSG fields to service the gas wells and compressor sites and will be either gravel or a chip seal road surface. In this instance the predicted road traffic noise levels will be typically 5 to 7 dBA higher than for a DGA road surface.

Cumulative road noise was assessed based on anticipated traffic movements associated with construction and operation workers as a percentage of existing road traffic. Further assessment of cumulative noise impacts associated with project related transport is considered in Section 4.

A full description of the CSG fields development program used as the basis for the assessment is provided in Section 3.6.

6.10.3 Regulatory Framework

6.10.3.1 Noise

The relevant Queensland legislation for construction and operational noise and vibration control is provided by the *Environmental Protection Act 1994* (EP Act). The EP Act aims to protect Queensland's

environment while allowing for development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends (being ecologically sustainable development).

In establishing construction and operational noise level goals the following legislative or guideline documents were reviewed:

- *EP Act;*
- *Environment Protection (Noise) Policy 1997*; and
- EcoAccess Guidelines;
  - Planning for Noise Control Guideline (EPA 2004) and
  - Assessment of Low Frequency Noise (Draft).

The *Environmental Protection (Noise) Policy 2008* (Qld) (EPP (Noise)) aims to achieve the object of the EP Act in relation to the noise environment by identifying environmental values to be enhanced or protected, stating acoustic quality objectives for enhancing or protecting environmental values and providing a framework for making consistent, equitable and informed decisions about the acoustic environment. Legislative amendments to the EPP Noise that took effect on 1 January 2009 were considered during preparation of this EIS.

Construction Criteria

The EPP (Noise) does not include construction noise limits, with noise impacts minimised by limiting the hours of operation to:

- Monday - Saturday: 6:30 am to 6:30 pm.

The adopted project noise and vibration criteria for the construction phase are described in Table 6.10.1.

Table 6.10.1 Summary of Construction Criteria

Construction Noise		Vibration		
Monday to Saturday (6:30am to 6:30pm)	Monday to Saturday (6:30pm to 6:30am); Sundays and Public Holidays	Structural Damage (mm/s)	Human Comfort (mm/s)	
			Day	Night
No limit	50 dBA L_{Amax}	12.5	0.3 - 0.6	0.2

Operational Noise Criteria

All operational noise emissions were assessed in accordance with the EPA *EcoAccess Guideline: Planning for Noise Control* guideline (EPA 2004) which considers:

- Background noise creep criteria;
- Planning noise levels criteria;
- Short term intrusive criteria;
- Sleep disturbance noise criteria; and
- Low frequency noise criteria.

Background Noise Creep Criteria

The background noise creep criteria aim to prevent an incremental increase in background noise from all noise sources. Where existing noise levels approach the recommended Rating Background Level (RBL), criteria must be adjusted to prevent background creep. The RBLs for each sensitive receptor were

determined from ambient noise monitoring (refer Table 6.10.2) conducted at each sensitive receptor. The background creep criteria were then developed from the RBL in accordance with the EPA (2004) *EcoAccess Guidelines: Planning for Noise Control* and are presented in Table 6.10.2.

A full description of the methodology used to derive the adopted criteria for the CSG fields is provided in Appendix U1.

The most significant continuous noise sources associated with the CSG fields were assessed against the applicable background noise creep criteria. Refer Appendix U1 for further details.

Planning Noise Level Criteria

Maximum Planning Noise Levels (PNLs) for various noise area categories are also recommended within EPA (2004): *EcoAccess Guidelines: Planning for Noise Control*. Where existing noise levels in an area approach the maximum PNL, the noise level from any new source must be controlled to preserve the amenity of the area. To achieve this, the EPA (2004) guideline recommends modifications be made to the maximum PNL depending on the existing noise levels (based on measured maximum LAeq (1hour) noise levels (see Table 6.10.2).

Short Term Intrusive Noise Criteria

The short term intrusive noise criteria (SNL) are based on the existing measured RBL with the addition of 3 dBA (refer Table 6.10.2) as per EPA (2004) guideline. The SNL noise criteria are in terms of the LAeq (1hr) noise level.

In very rural areas (where minimum LA90 is lower than 25 dBA) it may be possible for the (LAeq) SNL to be calculated to a lower noise level than the recommended background creep level (LA90) due to the 25 dBA threshold nominated for background creep in the EPA guideline. It is considered to be appropriate to set the SNL (LAeq level) higher than the background creep level (min LA90), therefore background creep + 3dBA has been adopted for the SNL in these instances.

Sleep Disturbance Noise Criteria

EPA (2004) guideline recommends that in order to achieve a good night of sleep, internal noise levels should not exceed:

- L_{Amax} of 45dBA > 10-15 times per night.

The project adopted the sleep disturbance noise criteria of 50 dBA, which assumes a conservative 5 dBA attenuation from the building facade (refer Appendix U1 for further detail). The sleep disturbance noise criteria are shown in Table 6.10.1 (construction noise) and Table 6.10.2 (operational noise).

Low Frequency Noise Criteria

The potential for low frequency noise in the range of 20 Hz to 200 Hz was assessed in accordance with *EcoAccess Guideline: Assessment of Low Frequency Noise*. The adopted project criteria for low frequency noise are provided in Table 6.10.2 and are based on the guideline limit of 20 LpA,LF (dBA) and a conservative estimate of 3 dBA attenuation from building façades (for low frequency noise).

Table 6.10.2 Project Noise Criteria

Noise Assessment Location	Background Noise Creep Criteria LA90(1hour) (dBA)			Design Criteria[1] LAeq(1hour) (dBA)			Sleep disturbance[2] LAmax (dBA)			Low Frequency Criteria[2] LpA,LF (dBA)		
	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night
Gas & Pipeline 1	37	25	25	40	37	31	N/A	N/A	50	28	23	23
Gas & Pipeline 2	28	25	25	28	28	28	N/A	N/A	50	28	23	23
Gas & Pipeline 3	29	25	25	28	28	28	N/A	N/A	50	28	23	23
Gas & Pipeline 4	32	25	25	30	28	28	N/A	N/A	50	28	23	23
Gas & Pipeline 5	26	25	25	28	28	28	N/A	N/A	50	28	23	23
Gas & Pipeline 9	33	25	25	33	32	32	N/A	N/A	50	28	23	23

Note 1: Design criterion is the most stringent of the Planning Noise Level (PNL) and Specific Noise Level (SNL) (as defined in *EPA (2004)*).
2: Sleep disturbance and low frequency criteria have been adjusted to represent outdoor levels.

Environmental Protection (Noise) Policy 2008

A summary of the applicable noise criteria contained in the EPP (Noise) 2008 (as in force from 1 January 2009) is provided below.

Section 10 of the EPP (Noise) 2008 states the following with respect to controlling background creep:

> *"To the extent that it is reasonable to do so, noise from an activity must not be-*
>
> *(a) for noise that is continuous noise measured by $L_{A90,T}$ – more than nil dB(A) greater than the existing acoustic environment measured by $L_{A90,T}$; or*
>
> *(b) for noise that varies over time measured by $L_{Aeq,adj,T}$ – more than 5 dB(A) greater than the existing acoustic environment measured by $L_{A90,T}$."*

It is considered that for continuous noise emissions (such as that from the compressor stations in the CSG fields) the background creep noise criteria as determined using the EPA's EcoAccess Planning for Noise Control Guideline would generally result in more stringent noise limits than the EPP (Noise) 2008 limit of "background + 0 dBA". The exception to this would be in areas where the existing background noise levels are below the 25 dBA threshold nominated in the EPA's EcoAccess Planning for Noise Control Guideline, as no such threshold level is nominated in the EPP (Noise) 2008.

The time varying background creep noise criteria described above is considered to be similar to the LAeq(1 hour) SNL noise criteria from the EPA's EcoAccess Planning for Noise Control Guideline which applies an existing measured RBL with the addition of 3dBA.

The EPP (Noise) 2008 includes acoustic quality objectives for noise sensitive receptors which are to be considered in the assessment process. It is intended that the acoustic quality objectives be progressively achieved as part of achieving the purpose of the EPP (Noise) 2008 over the long term. The acoustic quality objectives for residential dwellings as described in the EPP (Noise) 2008 are summarised below in Table 6.10.3.

Table 6.10.3 Acoustic Quality Objective EPP (Noise) 2008

Sensitive Receptor	Time of Day	Acoustic Quality Objectives (measured at receptor) dB(A)			Environmental Value
		LAeq,adj,1hr	LA10,adj,1hr	LA1,adj,1hr	
Dwelling (for outdoors)	Daytime and evening	50	55	65	Health and wellbeing
Dwelling (for indoors)	Daytime and evening	35	40	45	Health and wellbeing
	Night time	30	35	40	Health and wellbeing

In general, the acoustic quality objectives in the EPP (Noise) 2008 are lower than (or equal to in some instances) the 55 dBA objective in the EPP (Noise) 1997.

The acoustic quality objects in the EPP (Noise) 2008 do not apply for transport activities (road, rail, aircraft and ports). Transport activities associated with a specific facility will be assessed via other limits relevant to the transport mode (e.g. Main Roads' Road Traffic Noise Management Code of Practice).

6.10.3.2 Vibration

Activities associated with the construction and operation of the CSG fields were assessed for each of the following impacts:

- Human comfort;
- Structural damage;
- Safe vibration levels for common services; and
- Effects of vibration on building contents.

The key requirements for human comfort and structural damage are provided below with all guidelines provided in full in Appendix U1.

Human Comfort

Guidelines for the assessment of potential human disturbance inside buildings and structures are provided by the British Standard BS 6472 *"Evaluation of Human Exposure to Vibration in Buildings (1 Hz to 80 Hz)"* (1992).

The relevant peak vibration levels (below which probability of 'adverse comment' is low) for different building occupancy types are shown in Table 6.10.4.

Table 6.10.4 Building Occupancy Vibration Guidelines (BS 6472)

Type of Space Occupancy	Time of Day	Satisfactory Peak Vibration Levels in mm/s Over the Frequency Range 8 Hz to 80 Hz			
		Continuous Vibration		Impulsive Vibration with up to 3 Occurrences per Day	
		Vertical	Horizontal	Vertical	Horizontal
Critical working areas (e.g. some hospital operating theatres, some precision laboratories, etc)	Day Night	0.14 0.14	0.4 0.4	0.14 0.14	0.4 0.4
Residential	Day Night	0.3 to 0.6 0.2	0.8 to 1.6 0.6	8.4 to 12.6 2.8	24 to 36 8
Offices	Day Night	0.6 0.6	1.6 1.6	18 18	51 51
Workshops	Day Night	1.2 1.2	3.2 3.2	18 18	51 51

Note : The vibration guideline levels in Table 6.10.4 may need to be reduced by up to 50 % for continuous vibration sources.

Structural Damage

Guidelines for the assessment of potential for building damage caused by ground vibration are contained in the *British Standard 7385* (1993). The guideline vibration values below which there is a minimal risk of cosmetic damage to residential buildings and industrial buildings for transient vibration are shown in Table 6.10.5.

Further information on vibration guidelines is provided in Appendix U1.

Table 6.10.5 Vibration Guide Values for Cosmetic Damage (BS 7385)

Line	Type of Building	Peak Component Particle Velocity in Frequency Range of Predominant Pulse	
		4 Hz to 15 Hz	15 Hz and above
1	Reinforced or framed structures Industrial and heavy commercial buildings	50 mm/s at 4 Hz and above	
2	Non-reinforced or light framed structures Residential or light commercial type buildings	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above

Note: The vibration guideline levels in Table 6.10.5 may need to be reduced by up to 50 % for continuous vibration sources

6.10.3.3 Road Traffic Noise Criteria

Traffic noise criteria applicable to the project are established in the *Queensland Environmental Protection (Noise) Policy 1997* and the *Road Traffic Noise Management: Code of Practice* (Queensland Main Roads, January 2000).

Different criteria apply depending on whether the road is new or existing. The road traffic noise criteria applicable for the assessment of noise from vehicle movements associated with the project are summarised below in Table 6.10.6.

Table 6.10.6 Road Traffic Noise Criteria

Road Type		Criteria
State	Existing Road	68 dBA L_{A10} (18 hour) and ≤ 2 dBA change in existing L_{A10} (18 hour)
	New Road	63 dBA L_{A10} (18 hour)
Other public road	Existing Road	63 dBA L_{A10} (18 hour) and ≤ 2 dBA change in existing L_{A10} (18 hour)
	New Road	63 dBA L_{A10} (18 hour)

6.10.4 Existing Environmental Values

6.10.4.1 Sensitive Noise Receptors

The proposed reasonably foreseeable development (RFD) area development will comprise the drilling of 2,650 wells in the Surat and Bowen Basins. Land within the CSG fields study area comprises rural farmland with land uses including grazing, cropping, forestry, and pre-existing gas field development. Existing infrastructure is minimal, however there are a number of rural secondary roads linking the major regional road network as well as numerous CSG field access roads. Existing noise sources are typical of rural areas and include fauna (birds and insects), traffic and local noises associated with rural based human occupation. CSG field activities from Santos' operational CSG wells are also noted as an existing noise source.

Sensitive receptors as defined in the *Environmental Protection (Noise) Policy 1997 (EPP Noise)* and the EPA (2006) *EcoAccess Guideline – Noise and Vibration from Blasting* were not identified due to the vast spatial coverage of the CSG fields development. Instead, existing ambient noise and vibration levels were recorded at various distances from the proposed locations of CSG fields construction and operational works.

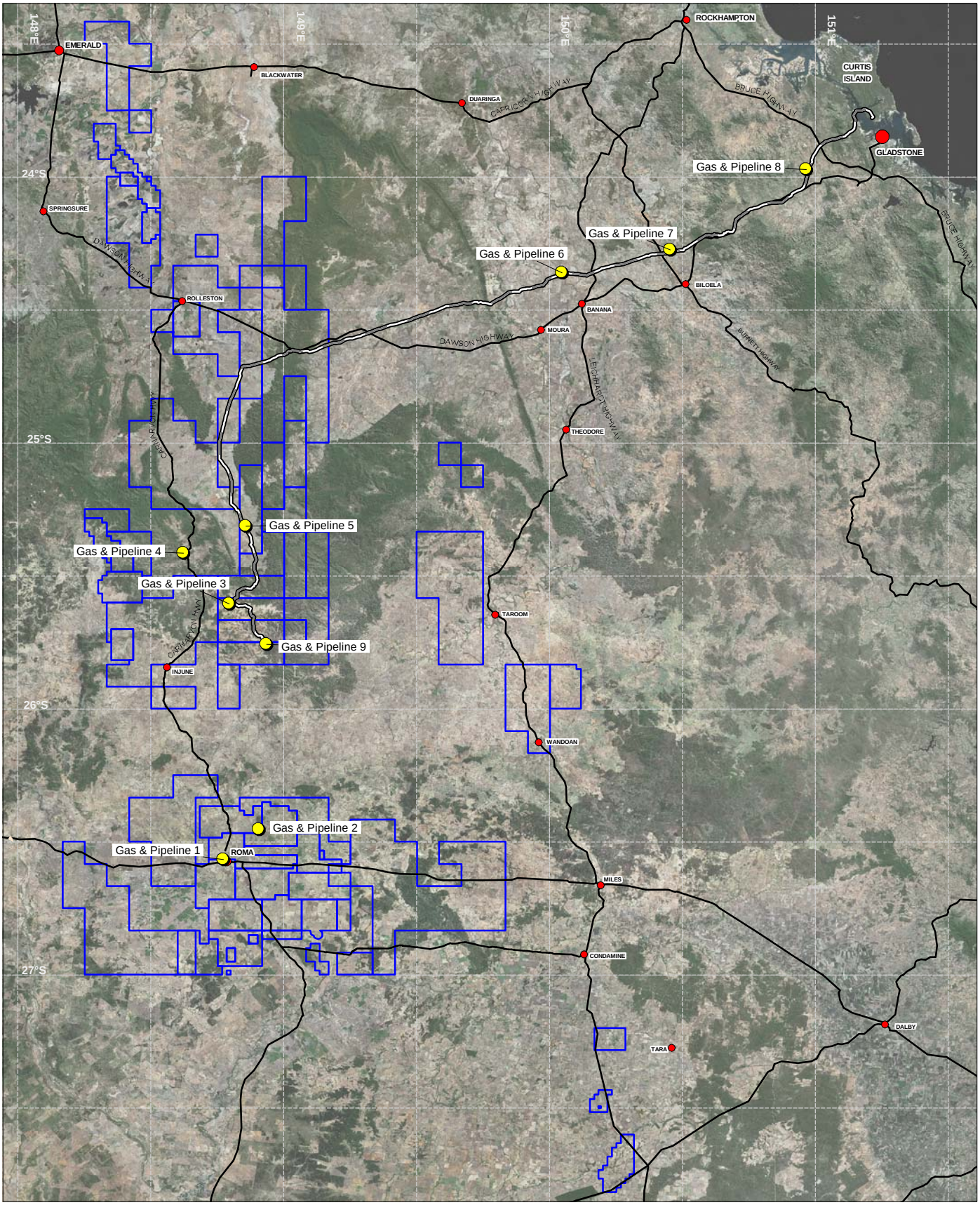
6.10.4.2 Existing Ambient Noise

To determine the existing ambient noise environment in the vicinity of the CSG fields development, attended and long term unattended ambient noise monitoring was conducted at four locations. The locations were selected to provide spatial coverage of the communities surrounding the CSG fields and are considered representative of the surrounding rural area. A full description of the monitoring sites is provided in Table 6.10.7 and their location in relation to the CSG fields is illustrated in Figure 6.10.1.

Unattended Monitoring

Unattended monitoring was conducted continuously at each of the four monitoring sites using ARL EL-215 and EL-316 Noise Loggers (NATA certified). Unattended monitoring was used to determine the RBL which is the 90th percentile background (L_{A90}) noise level during an assessment period (day evening and night) for the duration of monitoring. The RBL was developed in accordance with the *Queensland Environmental Protection Agency's EcoAccess Guideline Planning for Noise Control*. Unattended monitoring was conducted between the following dates:

- 16 June 2008 to 30 June 2008 (Gas & Pipeline 1 – 5); and
- 15 July 2008 to 28 July 2008 (Gas & Pipeline 9).



Client	Project	Title	
	GLADSTONE LNG PROJECT ENVIRONMENTAL IMPACT STATEMENT	**AMBIENT NOISE MONITORING LOCATIONS FOR THE CSG FIELDS AND PIPELINE**	
	Drawn: CA	Approved: JB	Date: 30-01-2009
	Job No: **4262 6220**	File No: 42626220-g-861.wor	Figure: **6.10.1**
			Rev:A **A4**

Attended Monitoring

Assessment Monitoring Sites

Attended monitoring was also conducted at each of the four monitoring sites using a Rion NA-27 Precision Sound Level Meter. Attended monitoring was undertaken to confirm noise levels with an operator present. It also enabled the identification of nearby noise sources during the recording period to enable interpretation of results. Attended monitoring was conducted for one 15 minute period during the day (7am - 6pm), evening (6pm – 10pm) and night (10pm – 7am) recording periods. Attended monitoring was conducted between the following dates:

- 16 to 19 June 2008 (Gas & Pipeline 1 – 5); and
- 15 July 2008 (Gas & Pipeline 9).

Plant SWL- Compressor and Drill Rig

Short term attended measurements were undertaken to determine the sound power level (SWL) of plant items associated with an existing compressor site (Site 2) and a completions drill rig for use in modelling predictions. Attended noise measurements were undertaken on the compressor site and the completions drill rig as these two were both considered significant noise sources for the CSG fields.

The compressor site comprised of four large compressors, two mid size compressors and three small-sized compressors. Attended noise measurements were carried out at seven locations ranging from 20 m to 95 m outside of the compressor compound (for safety reasons).

The completions drill rig site included various plant items such as a carrier well head, mud pump, generators (three in total) and booster compressor. Attended noise measurements were carried out at six locations ranging from approximately 10 m to 20 m from the drill rig outside of the exclusion zone (for safety reasons).

Table 6.10.7 Ambient Noise Monitoring Locations

Monitoring Site	Description of Monitoring Site	
	Location	Logger Position
Gas & Pipeline 1	Santos Roma: Currey Street.	Positioned on fence in front corner of property.
Gas & Pipeline 2	North-east of Roma: Beverley Property – Beverley Road.	Within paddock~300 m from house*.
Gas & Pipeline 3	Fairview Road: 400 m west of intersection with Beilba Road.	Positioned on fence approximately 15 m from house.
Gas & Pipeline 4	Carnarvon Development Road : 55 km north of Injune.	Positioned on fence approximately 100 m from house.
Gas & Pipeline 5	Acadia Valley: Acadia Valley Road.	Positioned in paddock ~300 m from house*.
Gas & Pipeline 9	Springwater Overseer's Cottage (corner of Mt Alma Road & Kaluda Road).	Positioned 50 m away from house*.

* unable to be positioned closer to house due to machinery noise in immediate vicinity.

6.10.4.3 Ambient Noise Sources

Ambient noise sources include road traffic noise at Gas & Pipeline 9 with intermittent noise sources associated with birdlife. Seasonal noise sources such as insects (typical during the summer months) and prevailing weather conditions. Gas & Pipeline location 2 was noted as being extremely quiet during the evening and night-time periods. Although Gas & Pipeline locations 3, 4, 5 and 9 were not visited during

evening and night-time periods (due to safety reasons), it is expected that the noise environment at these two locations is very similar to Gas & Pipeline location 2.

A summary of noise sources identified during attended monitoring and results is provided in Table 6.10.8.

Table 6.10.8 Attended Monitoring Results and Noise Sources

Monitoring Location	Date	Time (end of 15 min period)	Measured Noise Level (Dba)			Comments
			LA90	LAeq	LA10	
Gas & Pipeline 1	16/06/08	9.45 am	41	60	60	Traffic along Currey Street dominant noise source; construction noise from nearby building site; and birds active.
	16/06/08	6.15 pm	43	57	57	Traffic along Currey Street dominant noise source; and birds and insects active (dominant with no traffic).
	16/06/08	11.15 pm	34	38	40	Insects and bird noise; distant traffic noise (not Currey Street, possibly Warrego Hwy / main street through Roma).
Gas & Pipeline 2	16/06/08	2.45 pm	20	32	32	Insects and birds dominant; one passing 4WD. Very quiet at this location.
	16/06/08	9.45 pm	17	23	19	Very quiet at this location. Minor bird noise.
	16/06/08	10.30 pm	16	29	19	Very quiet at this location. Minor bird noise.
Gas & Pipeline 3	17/06/08	12.45 pm	27	42	37	Birds active and dominant; minor insect noise; truck pass-by on Fairview Road (55-65 dBA); light tree movement with breeze.
	-	-	-	-	-	No evening attended measurement due to safety of site access at night.
	-	-	-	-	-	No night attended measurement due to safety of site access at night.
Gas & Pipeline 4	17/06/08	5.45 pm	26	40	41	Birds, insects and cow noise dominant noise sources. Distance traffic just audible (trucks ~ 35 dBA).
	17/06/08	6.15 pm	19	34	34	Insect, bird and cow noise all dominant though not loud; distant traffic on Carnarvon Development Road audible (truck ~ 35-40 dBA, car ~25-32 dBA).
	-	-	-	-	-	No night attended measurement due to safety of site access at night.
Gas & Pipeline 5	17/06/08	3.15 pm	21	30	32	Insects and birds dominant; light tree movement in breeze; 4WD drove by on dirt road (45-47 dBA over 15 seconds).
	-	-	-	-	-	No evening attended measurement due to safety of site access at night.
	-	-	-	-	-	No night attended measurement due to safety of site access at night.
Gas & Pipeline 9	15/07/08	10.45 am	28	36	39	Birds dominant, light tree movement. Passing 4WDs audible (~38-42 dBA), 5 pass-bys in 15 min block. Distant construction noise from booster site.
	-	-	-	-	-	No evening attended measurement due to safety of site access at night.
	-	-	-	-	-	No night attended measurement due to safety of site access at night.

Note: Daytime (7.00 am to 6.00 pm), evening (6.00 pm to 10.00 pm) and night-time (10.00 pm to 7.00 am).

Noise Monitoring Results

Rating Background Level

The RBL levels were derived from the monitoring program following adjustment to take into consideration the noise floor of the logger as well as extraneous noise such as insects and wind. The adjusted ambient noise monitoring results are presented in Table 6.10.9.

Table 6.10.9 Ambient Noise Monitoring Results

Monitoring Location	Rating Background Level (dBA)		
	Day	Evening	Night
Gas & Pipeline 1	37	34	28
Gas & Pipeline 2	23	18 [1]	17 [1]
Gas & Pipeline 3	24	18 [1]	18 [1]
Gas & Pipeline 4	27	19[1]	18[1]
Gas & Pipeline 5	21 [1]	18 [1]	17[1]
Gas & Pipeline 9	30	29	29

Note 1: Adjusted to account for the noise floor of logger (noise floor referring to the lower limit that the noise logger can record noise). The adjustments to account for the noise floor are based on analysis of logger results, attended noise measurements and field observations.

The maximum LAeq (1hour) noise level representative of the ambient noise environment was noted for the daytime, evening and night-time periods. The representative maximum LAeq (1hour) noise levels at each location are shown in Table 6.10.10.

Table 6.10.10 Maximum LAeq (1hour) Noise Levels

Monitoring Location	Maximum LAeq(1hour) (dBA)		
	Day	Evening	Night
Gas & Pipeline 1	58	53	55
Gas & Pipeline 2	55	45	45
Gas & Pipeline 3	54	37	41
Gas & Pipeline 4	52	38	43
Gas & Pipeline 5	46	29	40
Gas & Pipeline 9	49	40	47

Compressor and Drill Rig SWL

The SWL for the compressor Site 2 and the completions drill rig are presented in Table 6.10.11. The sound power level is a logarithmic measure of the emitted sound power from a noise sources in comparison to the sound pressure level (SPL) which is a logarithmic measure of the sound pressure at a distance from the noise source.

Table 6.10.11 Measured SWL Compressor and Drill Rig

Site	dBA	Sound Power Level (dBA) Octave Band Centre Frequency (Hz)								
		31.5	63	125	250	500	1k	2k	4k	8k
Compressor Site 2	123	91	105	111	114	116	114	117	114	102
Completions Drill Rig	116	75	104	100	102	110	111	110	104	99

6.10.5 Potential Impacts and Mitigation Measures

6.10.5.1 Noise Impact Assessment

The assessment included the identification of potential noise sources associated with the CSG fields and development of a noise model which included the SWL of the identified noise sources. The noise model enabled the calculation of predicted noise levels associated with CSG fields development construction and operational activities.

Due to the large spatial area of the CSG fields study area, predictions have been carried out at various offset distances from construction and operational activities conducted in these areas to determine the distances at which the appropriate noise criteria (refer Section 6.10.3.) will be achieved.

Potential Noise Sources

The CSG fields development will include the drilling of operational gas wells and construction of 12 compressor sites. The gas wells will be connected to the infield gas gathering network which feeds into the main gas transmission pipeline (refer Section 7.10). The gathering network is made up of small, low pressure, high density polyethylene (HDPE) pipes which will be buried underground. The compressor sites are installed to help boost the pressure of the gas flowing from the well heads and gathering network to allow it to flow through the gas transmission pipeline.

Construction

Specific construction activities associated with the CSG fields development include:

- Gas well construction (including drilling); and
- Compressor site construction.

Construction of the CSG wells includes the following tasks:

1) Survey and fencing;
2) Set up of temporary facilities (if required);
3) Clear and grade of an approximate 100m x 100m pad and earthen pit;
4) Construct a flare pit;
5) Installing cellar (2 m^3 space which the drilling assembly passes) and surface conductor pipe;
6) Drilling of well (approximate centre of 100 m x 100 m pad);
7) If economic quantities of gas are discovered from this well, casings are inserted (usually steel pipes) and concrete is pumped in between the casing and the earth;
8) Completions drilling commences to complete well; and
9) Installing wellhead valve assembly and production casing string.

All construction activities occur on a pad area of approximately 100 m x 100 m. The drilling process is carried out continuously (i.e. on a 24 hours per day basis) and can take from approximately 2 - 3 days to two weeks depending on the depth of the well and the geology of the area.

Construction of a field compressor site includes the following tasks:

1) Survey and fencing;
2) Set up of temporary facilities (if required);
3) Clear and grade of site up to an area approximately 250 m x 250 m;
4) Concrete pads and foundations where required (much of the site is simply covered with gravel or remains as dirt); and
5) Construction of compressors, buildings and other facilities.

Measured SWLs for the compressor site and drill rig are provided in Table 6.10.11. The SWL of construction plant are provided in Appendix U1.

Operation

Potential noise sources during the operational phase primarily relate to the operation of gas well heads and compressor stations. Gas well heads comprise a small gas pump which during operation has a SWL of 90 dBA.

Noise Modelling

Noise modelling was carried out using SoundPLAN (Version 6.4) utilising the CONCAWE prediction methodology. The computer model calculates noise emission levels and considers source SWL (compressor ~123 dBA; well heads ~90 dBA), location, distance attenuation, ground absorption, air absorption, shielding attenuation, and meteorological conditions including wind effects. Predictions were carried out for various offset distances from construction and operational activities of the CSG fields development to determine the distances at which the appropriate noise criteria will be achieved. Noise predictions were based on the assumption that there is flat, soft ground between the noise source and the receptor.

Modelled offset distances included:

- 50 m;
- 100 m;
- 250 m;
- 500 m;
- 1,000 m;
- 2,000 m; and
- 5,000 m.

Further details on the methodology and equipment SWL used in the model are provided in Appendix U1.

6.10.5.2 Predicted Noise Impacts and Mitigation

Construction Phase

CSG Wells

The predicted noise levels for all stages of the CSG well construction works are shown in Table 6.10.12. The most significant noise generating stages of the construction works are Stage 1 (clear and grade - day time operation < 1 week duration) and Stage 5 (casings and completions rig - 24 hour operation for approximately 2 - 3 days duration up to a two weeks). Construction noise is predicted to meet the noise criteria during the evening and night time periods at assessment locations with an offset greater than 425 m for all stages of work. While no noise criteria apply to day time construction works, all stages of work

are predicted to meet evening and night noise criteria where the 425 m offset is applied. A summary of minimum offset distances for each stage of work is described in Table 6.10.12.

Table 6.10.12 Predicted Noise by Offset Distance

Stage	Activity	Noise Criteria[1] (dBA)	Predicted Noise Level at Buffer Distance (dBA)							Minimum Required Buffer (m)
			Buffer Distance (m)							
			50	100	250	500	1,000	2,000	5,000	
Stage 1	Clear and grade	50	76	68	57	47	39	29	15	425
Stage 2	Setup of temporary facilities	50	68	61	48	37	26	16	0	225
Stage 3	Cellar and surface conductor pipe	50	66	59	47	37	28	18	4	225
Stage 4	Drilling	50	70	63	51	42	33	24	9	275
Stage 5	Casings and completions rig	50	74	66	55	46	37	27	12	400
Stage 6	Wellhead valves	50	69	62	51	42	33	23	8	275

Note: 1. Sleep disturbance noise criteria.

Compressor Sites

The predicted noise levels for all stages of compressor site construction works are shown in Table 6.10.13. The most significant noise generating stage of the construction works is Stage 1 (clear and grade - day time operation <1 week duration). Construction noise is predicted to meet the noise criteria during the evening and night time periods at assessment locations with an offset greater than 425 m for all stages of work. While no noise criteria apply to day time construction works, all stages of work are predicted to meet evening and night noise criteria where the 425 m offset is applied. A summary of minimum offset distances for each stage of work is described in Table 6.10.13.

Table 6.10.13 Predicted Construction Noise by Offset Distance - Compressor Site

Stage	Activity	Noise Criteria[1] (dBA)	Predicted Noise Level at Buffer Distance (dBA)							Minimum Required Buffer (m)
			Buffer Distance (m)							
			50	100	250	500	1,000	2,000	5,000	
Stage 1	Clear and grade	50	76	68	57	47	39	29	15	425
Stage 2	Concrete pad and foundations	50	68	61	49	40	31	21	5	250
Stage 3	Set up of facilities	50	69	62	50	41	32	22	6	250
Stage 4	Construction of compressors and coolers	50	69	62	50	41	32	22	6	250

Note: 1. Sleep disturbance noise criteria

Construction Mitigation

The adoption of offset buffer distances will reduce the likelihood of construction noise and vibration impacts on surrounding residents to the CSG fields development. Where applicable, construction work during evening and night-time periods (6.30 pm to 6.30 am) and on Sundays/Public Holidays will be undertaken in accordance with "best practice" noise management. AS 2436-1981 "*Guide to Noise Control on Construction, Maintenance and Demolition Sites"* sets out numerous practical recommendations to assist in mitigation construction noise emissions. Noise control strategies that should be considered for construction activities carried out on the CSG fields are listed below.

- Source Noise Control Strategies
  - Quietest plant and equipment that can economically undertake the work should be selected, wherever possible.
  - Regular maintenance of equipment in order to keep it in good working order.
- Work Practice Control Strategies
  - Construction work to occur, wherever possible, within the daytime period.
  - Where practicable, avoid the coincidence of plant and equipment working simultaneously close together.
  - Operators of construction equipment to be made aware of the potential noise problems and of techniques to minimise noise emission through a continuous process of operator education.
- Community Liaison Strategies
  - Utilise existing community consultation framework to provide access to information for the community and maintain positive relations with residents.

Operational Phase

Operational Noise Assessment

The predicted operational noise levels associated with the CSG wells and compressor sites were assessed against the background criteria which is the most stringent applicable noise criterion from the EPA (2004) guidelines (see Section 6.10.3). The offset buffer distance at which the background creep noise criterion of 25 dBA is expected to be met for compressor sites and gas well head pumps are shown in Table 6.10.14.

Table 6.10.14 Predicted Operations Noise by Offset Distance

Process	Relevant Background Creep Criterion (dBA)	Offset Buffer Distance (m)
Compressor Site	25	3,400
Gas Well Pump	25	300

Low Frequency Noise

Low frequency noise is considered to be a characteristic of compressor site operation (LLINeq - LAeq = 19 dB). The relevant low frequency noise criteria (23 dBA LpA,LF) is predicted to be achieved at an offset distance of approximately 2,500 m from the compressor site without any noise mitigation measures. Operational noise from the gas well head pump does not display low frequency noise characteristics.

Operation Mitigation

Compressor Sites

The adoption of an offset buffer of 3,400 m will be required without mitigation measures for the operation of field compressor sites to meet noise criteria. Following the adoption of noise mitigation measures (refer Table 6.10.15), an offset distance of 1,000 m can be achieved with all four mitigation options applied which will meet the criteria for both overall and low frequency noise. The need for mitigation measures will depend on distance to noise sensitive receptors, where practicable, locating the field compressor site at distances greater than 3,400 m from noise sensitive residences will eliminate the need for mitigation measures.

Table 6.10.15 Compressor Site Operational Mitigation Measures

Mitigation	Noise Reduction (dBA) - Octave Band centre frequency (Hz)								Adjusted Minimum Buffer Distance (m)
	63	125	250	500	1000	2000	4000	8000	
Hospital grade exhaust silencer (assumed to be standard)	25	45	45	25	25	25	25	25	1000
Secondary absorptive exhaust silencer	10	15	20	30	30	20	15	10	
Absorptive splitter attenuator – 50 % free area, 1.2m long	2	6	11	20	23	19	12	10	
100 mm thick mineral wool insulated panel with steel facing (inner perforated)	15 (3)	20 (11)	25 (13)	30 (20)	30 (28)	35 (35)	45 (40)	45 (42)	

Source: URS (2008)

Note: Numbers in brackets refer to measured reductions (in octave bands) from previous work Heggies has undertaken. These measurements were based on a 130 mm thick mineral wool insulated panel with steel facing, double skin construction.

Gas Well Head

The adoption of a minimum offset buffer distance of 300 m from a sensitive receptor will negate the need for mitigation measures. Where this buffer distance is not able to be achieved, noise mitigation measures such as an enclosure or partial enclosure may be incorporated.

6.10.6 Vibration Impact Assessment

6.10.6.1 Potential Vibration Sources

Construction Phase

The potential vibration sources for the construction phase are transport and drilling activities.

Operational Phase

There are no potential vibration sources associated with the operational phase of CSG wells. Transport is a potential vibration source for the operational phase of the CSG fields.

6.10.7 Predicted Vibration Impacts and Mitigation

6.10.7.1 Construction Phase

Drilling

Vibration levels during surface compaction and cellar installation have been measured at approximately 0.3 mm/s at a distance of 20 m from the drill rig. Vibration levels at the edge of the 100 m pad are expected to be imperceptible (i.e. less than 0.15 mm/s).

Truck Traffic

Vibration levels from truck traffic utilising the roads on site are expected to be significantly below both "building damage" and "human comfort" criteria. It is expected that any vibration from truck movements will be imperceptible (i.e. less than 0.15 mm/s).

6.10.7.2 Operational Phase

The vibration associated with vehicle movements was predicted to be insignificant and not requiring any mitigation measures to meet vibration criteria. No other vibration sources inducing ground vibration over a long distance are associated with the CSG fields development.

6.10.8 Transport Noise Impact Assessment

6.10.8.1 Potential Traffic Sources

It is proposed that 20 seater 4WD buses will be utilised to transport workers flying in and out from Roma to the accommodation facilities at the CSG fields. Transport noise generated by the project will be highest during the construction phase with approximately 40 daily traffic movements associated with workforce movement. During the operational phase, daily traffic flow will be approximately 29 vehicle movements per day. Further information on traffic numbers/movements are provided in Section 4.

6.10.8.2 Predicted Transport Noise Impacts and Mitigation

New Roads

The predicted LA10 (18hour) noise level at a distance of 25 m from the pavement edge for road traffic associated with the operational phase of the CSG fields is 57 - 59 dBA (assumes 100 % heavy vehicles and dirt/chip-seal road surface). This predicted level is significantly lower than the applicable 63 dBA LA10 (18hour) road traffic noise criterion for new roads.

Existing Road Noise

Based on anticipated traffic movements associated with workers (via 20 seater buses), an increase of greater than 2 dBA from road traffic associated with the GLNG Project may occur for roads with existing traffic volumes (assuming 15 % heavy vehicles typical of a rural highway) are less than the following:

- 250 vehicles per day when the contribution of CSG fields traffic during the construction phase is 40 vehicles per day (100 % of CSG field vehicles are classified as heavy vehicles).
- 180 vehicles per day when the contribution of CSG fields traffic during the operational phase is 29 vehicles per day (100 % of CSG field vehicles are classified as heavy vehicles).

If current traffic volumes per day and/or percentage of heavy vehicles are higher than those nominated above, the incremental increase in road traffic noise levels will be lower than 2 dBA (refer Section 4).

It should be noted that incremental changes in road traffic noise levels of greater than +2 dBA will only occur for roads where the existing traffic volumes are low. Therefore, the overall noise emissions from road traffic will also be minimal.

Transport Mitigation

Due to the low potential for traffic related noise impacts, no mitigation measures are proposed.

6.10.9 Cumulative Noise Impacts

Section 1 identifies other CSG development projects planned for the surrounding region. Some of these projects are up to 100 km from the GLNG Project CSG field areas and some may be within the GLNG Project future development (FD) area. There is limited information available as to the planned development of those projects or the quantity and timing of the development of the wells or associated infrastructure; however, a qualitative assessment can be made of the possible cumulative impacts.

Santos will develop the CSG fields in accordance with the EIS. There will be no other development by other petroleum producers in the tenements described in the CSG fields. Infrastructure impacts will not exceed those stated in the project description.

It is however, possible that other companies may develop CSG facilities within the CSG fields FD as part of their planned CSG development projects in addition to the existing CSG domestic supply facilities. This will mean that there will be more CSG development in the FD area than the Santos project. As an area is developed, the number of wells will increase, but the spacing of wells will not intensify.

Cumulative noise impacts were inherently assessed through the background creep (L_{A90}) and planning noise level (L_{Aeq}) criteria (see Section 6.10.3 above) contained in the EPA (2004) guidelines. The criteria take into account the existing ambient noise level associated with existing industry road and railway traffic and a comparison with recommended ambient noise levels for various land use types.

The cumulative effect of noise emission from the CSG development and any other proposed industrial developments (including any other CSG developments) is assessed to not exceed the recommended ambient noise levels, on the basis that any other proposed industrial developments would be required to achieve the same noise criteria which are applicable for the GLNG Project. In some circumstances the existing ambient noise level may already be above the recommended noise levels. Where this is the case, noise generated by the GSG development will be maintained at approximately 8 or 10 dBA below the existing ambient noise level. This should ensure that the cumulative noise impacts of the project will be negligible

It is expected that the other CSG field development projects would include some or all of the proposed mitigation measures in relation to noise impacts described in this section. By utilising these mitigation measures, it is anticipated that there will be a minimal cumulative impact on the surrounding environment.

Table 6.10.16 provides a summary of potential noise and vibration impacts and proposed mitigation measures for the CSG fields.

Table 6.10.16 Potential Noise and Vibration Impacts and Mitigation Measures

Aspect	Potential Impact	Mitigation Measures	Objective
Construction			
Sensitive noise receptors.	Simultaneous noise generation from construction equipment (SWL), road traffic and existing field operations (compressor stations) causing cumulative noise impacts.	• Select well and infrastructure locations in accordance with required offset distance guidelines. • Avoid use of routes near sensitive receptors for construction haulage where practicable. • Fit all construction equipment with noise attenuation mufflers. • Maintain equipment to reduce noise generation. • Limit construction work during evening and night-time periods (6.30 pm to 6.30 am) and on Sundays/Public Holidays.	Minimise potential for cumulative noise impacts from construction and field operation activities.
Operation			
Sensitive noise receptors.	Simultaneous noise generation from construction equipment (SWL), road traffic and existing field operations (compressor stations).	• Select well and infrastructure locations in accordance with required offset distance guidelines. • Avoid use of routes near sensitive receptors for construction haulage where practicable. • Fit all construction equipment with noise attenuation mufflers. • Maintain equipment to reduce noise generation.	Minimise potential for cumulative noise impacts from construction and field operation activities.
Sensitive noise receptors- excess noise.	Noise generation compressor site operation.	• Maintain compressor equipment to minimise noise generation.	Minimise impact of compressor noise

Aspect	Potential Impact	Mitigation Measures	Objective
Sensitive noise receptors- excess noise.	Noise generation from upset conditions (explosion).	• Select well and infrastructure locations in accordance with required offset distance guidelines. • Conduct rigorous preventative maintenance of equipment to minimise potential for upset non-scheduled outages.	Minimise potential for upset condition and impacts to nearby sensitive receptors .
Decommissioning			
Sensitive noise receptors.	Simultaneous noise generation from demolition activities, equipment (SWL) and existing field operations (compressor stations) causing cumulative noise impacts.	• Select well and infrastructure locations in accordance with required offset distance guidelines. • Avoid use of routes near sensitive receptors for construction haulage where practicable. • Fit all construction equipment with noise attenuation mufflers. • Maintain equipment to reduce noise generation. • Limit construction work during evening and night-time periods (6.30 pm to 6.30 am) and on Sundays/Public Holidays.	Minimise impact of noise created by decommissioning work.

6.10.10 Summary of Findings

The noise and vibration assessment has found that compliance with the applicable noise criteria is able to be achieved with appropriate noise mitigation measures and allowing for the appropriate offset buffer distances between construction and operational activities and noise sensitive receptors.

For field compressor sites an offset buffer distance of 1,000 m (with noise mitigation measures) or 3,400 m (without mitigation) is required to meet noise criteria.

The road traffic noise assessment carried out for project-related vehicle movements revealed that impacts from road traffic noise are predicted to be minimal.

There are no major vibration sources associated with the operational phase of the CSG fields development likely to generate vibration at sensitive receptors.