



**ENVIRONMENTAL NOISE IMPACT
BOREHOLE DRILLING & GAS EXTRACTION NOISE
AT WEST CLIFF MINE, APPIN, NSW**

REPORT NUMBER: 3723

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1.0 CONSULTING BRIEF

Day Design Pty Ltd was engaged by BHP Billiton – Illawarra Coal Illawarra Coal to investigate the environmental noise impact of Drilling 21 Boreholes at various locations and Extracting “Goaf” Gas from the West Cliff Mine at Appin, NSW. This commission involves the following:

Scope of Work:

- Inspect the site and environs.
- Measure the background noise levels at critical locations and times.
- Establish acceptable noise level criterion.
- Measure noise emissions from gas extraction and disposal plant.
- Calculate the level of noise emission at any nearby residences, taking into account distance losses, topography, ground absorption and screen walls.
- Prepare a site plan identifying gas extraction boreholes and nearby noise sensitive locations.
- Provide recommendations for noise control as necessary.
- Prepare an Environmental Noise Impact Report.

2.0 PROJECT DESCRIPTION & SUMMARY OF FINDINGS

BHP Billiton, Illawarra Coal is currently removing coal from a seam about 500 metres below natural ground level at the West Cliff Mine using the Longwall Mining method. As coal is removed the roof subsides to form a loose conglomeration of rocks and earth called “goaf”. Coal gas tends to permeate the goaf and if not removed, it can leak into the main mine shafts and create a hazard for coal miners.

To overcome this potential problem, boreholes are drilled into the goaf at approximately 300 metre centres along the line of the Longwall coal extraction panels. A Liquid Ring Vacuum Pump (LRVP) is connected to the head of the borehole and air plus gas are extracted from the goaf approx 500 metres below for a period of about six weeks after the coal is extracted. Depending on the concentration, the gas is either flared on the surface or vented to atmosphere. This proposal involves the Drilling and Extraction of Gas from 21 boreholes in Longwall panels 32, 33 and 34 as shown in the attached Day Design Site Plan 3723 Figure 1.

We have inspected the site and noted two nearby residences on the site that could be affected by the noise of borehole drilling and the following goaf gas extraction and flaring. These are shown on the Site Plan Figure 1.

Drilling operations will only be conducted during the daytime from 7.00 am to 6.00 pm Monday to Saturday, but the gas extraction and flaring operation will be continuous 24 hours per day, seven days a week for a period of approximately six (6) weeks at each borehole location, after which the extraction and flaring equipment will be moved to the next borehole. Each borehole



will be plugged and abandoned in accordance with requirements of the Department of Primary Industries (Mineral Resources).

Measured ambient noise levels reveal that the area is very quiet, and noise control will be required for 7 of the 21 boreholes. The terrain is of a gentle undulating character, with a semicircle ridge of hills that will serve as a sound barrier between some boreholes and rural residential locations, as indicated by the bold dotted line on Site Plan Figure 1.

3.0 NOISE SURVEY INSTRUMENTATION

Noise level measurements and analysis were made with instrumentation as follows in Table 3.1:

Table 3.1 Noise Instrumentation

Description	Model No.	Serial No.
Real Time Sound level Analyser	CEL 593	035 426
Condenser Microphone 0.5" diameter	MK 250	3300
Microphone Calibrator	CAL 200	3646
Microphone Windscreen	Acoustically transparent foam	
Infobyte Noise Logger	iM3	38
Condenser Microphone 0.5" diameter	MK 250	6595
Microphone Windscreen	Acoustically transparent foam	

The **CEL 593 Sound Analyser** is a real-time precision integrating sound level meter with octave and third octave filters, which samples noise at a rate of 10 samples per second. The CEL 593 provides L_{eq} , L_1 , L_{10} , L_{50} and L_{90} statistical data at 15 minute intervals (longer or shorter intervals optional) over the desired monitoring period. Results are normally downloaded to computer for rapid processing.

An environmental noise logger is used to continuously monitor ambient noise levels and provide information on the statistical distribution of noise during an extended period of time. The Infobyte Noise Monitor iM3 is a Type 1 precision environmental noise monitor meeting all the applicable requirements of AS1259 for an integrating-averaging sound level meter.

All instrument systems had been laboratory calibrated using instrumentation traceable to Australian National Standards and certified within the last two years thus conforming to Australian Standards. The measurement system was also field calibrated prior to and after noise surveys. Calibration drift was found to be less than 0.3 dB during attended measurements and within 1 dB for long-term measurements. No adjustments for instrument drift during the measurement period were warranted.



4.0 MEASURED AMBIENT NOISE LEVELS

In order to assess the severity of a possible environmental noise problem in a residential area it is necessary to measure the ambient background noise level at the times and locations of worst possible annoyance. The lower the background noise level, the more perceptible the intrusive noise becomes and the more potentially annoying.

The ambient L_{90} background noise level is a statistical measure of the sound pressure level that is exceeded for 90% of the measuring period (typically 15 minutes).

The Rating Background Level (RBL) is defined by the NSW EPA as the median value of the (lower) tenth percentile of L_{90} ambient background noise levels for day, evening or night periods, measured over 7 days during the proposed days and times of operation.

The places of worst possible annoyance are the two rural residences shown on the attached Site Plan 3723 Figure 1. The times of worst possible noise annoyance from Drilling Operation will be in the daytime from 7 am to 6 pm (no drilling in the evening or at night) and for the Vacuum Pump and Flaring Operation will be at night from 10 pm to 7 am when ambient noise levels are typically at their lowest.

An ambient background noise survey was conducted on the site using Logger #38 at a location between "CP07" and "CP06" (Please refer to Site Plan Figure 1.), which was selected because it was not affected by noise from the LRVP or the Drill Rig. Our noise survey recorded ambient noise at the site from Monday 14 May to Monday 21 May 2007. There was some wind and rain on Friday 18th to Saturday 19th May, causing unnaturally high noise levels for a period of about 24 hours as shown in Figure 2. The noise measurements during this period were atypical, so they have been deleted from our assessment data. Background noise levels are stated in Table 4.1.

Table 4.1 Measured Rating Background Levels

Noise Measurement Location	Time Period	Rating Background Level
Logger #38 was located between holes CP06 & CP07 in the nearby rural residential area.	Day (7 am to 6 pm)	31 dBA
	Evening (6 pm to 10 pm)	37 dBA
	Night (10 pm to 7 am)	31 dBA

Meteorological conditions during the testing typically consisted of clear skies with winds of less than 0 to 2 meters per second, temperature of 12 to 22 °C, and relative humidity of 50 to 90 %. Atmospheric conditions were ideal for noise monitoring. Noise measurements were therefore considered reliable and typical for the receptor area. The exact periods of rain and high wind were correlated with Bureau of Meteorology observations made at nearby Campbelltown, NSW.



5.0 ACCEPTABLE NOISE LEVELS

5.1 NSW Industrial Noise Policy

The NSW Environment Protection Authority (now incorporated into the Department of Environment and Climate Change (NSW)) published the NSW Industrial Noise Policy in January 2000. The policy is specifically aimed at assessing noise from industrial noise sources scheduled under the Protection of the Environment Operations Act 1997.

The mine ventilation boreholes and goaf-gas extraction & flaring equipment are not 'scheduled premises' under the Protection of the Environment Operations Act 1997 as the West Cliff Mine is not required to hold a licence under that Act for operations at the site.

The appropriate regulatory authority (EPA or Council) may, by notice in writing given to such a person, prohibit the person from causing, permitting or allowing:

- (a) any specified activity to be carried on at the premises, or
- (b) any specified article to be used or operated at the premises,

or both, in such a manner as to cause the emission from the premises, at all times or on specified days, or between specified times on all days or on specified days, of noise that, when measured at any specified point (whether within or outside the premises,) is in excess of a specified level.

It is an offence to contravene a noise control notice. Prior to being issued with a noise control notice, no offence has been committed.

The Industrial Noise Policy provides a useful framework to assess noise emission from non-scheduled premises, whether that premises produces offensive or non-offensive noise.

The Protection of the Environment Operations Act 1997 defines "Offensive Noise" as noise:

- (a) that, by reason of its level, nature, character or quality, or the time at which it is made, or any other circumstances:
 - (i) is harmful to (or is likely to be harmful to) a person who is outside the premises from which it is emitted, or
 - (ii) interferes unreasonably with (or is likely to interfere unreasonably with) the comfort or repose of a person who is outside the premises from which it is emitted, or
- (b) that is of a level, nature, character or quality prescribed by the regulations or that is made at a time, or in other circumstances prescribed by the regulation.

The limits set out in the NSW Industrial Noise Policy were used as a guide for determining whether predicted levels of noise were considered offensive or not.



5.2 Construction Noise Criteria

Demolition and construction noise are treated differently to normal industrial noise, because it is either impossible or impractical to reduce the noise level of construction equipment to normal industrial noise criteria and it has been found in practice that people will tolerate a slightly higher level of construction noise if they know that the duration will be limited. The EPA states in Chapter 171 of the Environmental Noise Control Manual the acceptable noise level at nearby residences due to construction activities. Chapter 171 is extracted below:

Level Restrictions

(i) *Construction period of 4 weeks and under.*

The L_{10} level measured over a period of not less than 15 minutes when the construction site is in operation must not exceed the background level by more than 20 dB(A).

(ii) *Construction period greater than 4 weeks and not exceeding 26 weeks.*

The L_{10} level measured over a period of not less than 15 minutes when the construction site is in operation must not exceed the background level by more than 10 dB(A).

Time Restrictions

Monday to Friday, 7 am to 6 pm.

Saturday, 7 am to 1 pm if inaudible on residential premises, otherwise: 8 am to 1 pm. No construction work to take place on Sundays or Public Holidays.

Silencing

All possible steps should be taken to silence construction site equipment. It is particularly important that silenced equipment should be used on road or rail works where 24 hour operation is necessary.

The drilling of the goaf holes will be conducted in daytime from 7 am to 6 pm, but the gas extraction and flaring operation cannot be limited to less than 24 hours per day, seven days per week.

Preparation of the Drill Site may take 2 or 3 days, the Drilling Operation will take 7 to 10 days and cleaning up the site afterwards may take another 2 or 3 days, giving a total of say 2 to 2.5 weeks construction noise per Borehole. The Gas Extraction and Flaring Operation is required for approximately six weeks at each hole. Drilling of new holes and Gas Extraction is conducted simultaneously.

Residence 1 could be significantly affected by noise from five Drill Holes CP01, CP02, CP03, CP04 & CP05. Other holes are further way and/or over hills (see the black ridge line on Figure 1), so the total period of noise exposure at this residence will be not more than 32 weeks. This is only marginally greater than the 26 weeks nominated by the Environment Protection



Authority, and noise levels will be significantly less from the more remote locations CP01 and CP05, therefore we have adopted the 26 weeks criterion of the Rating Background Level plus 10 dBA recommended by the Environment Protection Authority as scheduled in Table 5.2.

Residence 2 could be affected by noise from Holes CP04 & CP07 only, so the total period of noise exposure for this residence could be 14 weeks. At this residence, the total noise exposure time is less than 26 weeks, therefore the acceptable level of noise intrusion will be as scheduled in Table 5.2 below.

Table 5.2 Construction Noise Criteria for less than 30 Weeks Noise Duration

Construction Period	Max. Acceptable L₁₀ Noise Level (dBA)
Daytime from 7 am to 6 pm	(31 + 10) dBA = 41 dBA (Drilling)
Evening from 6 pm to 10 pm	(37 + 10) dBA = 47 dBA (Gas extraction)
Night from 10 pm to 7 am	(31 + 5) dBA = 36 dBA (Gas Extraction)

We have established by attended noise measurements that all noise sources are of broadband character, therefore there will be no penalty loading of measured noise levels.

These criteria are to be assessed at the most affected point on or within the nearby residential property boundary – or, if that is more than 30 m from the residence, at the most-affected point within 30 m of the residence during the day, evening and night respectively. For upper floors, the noise is assessed outside the nearest window.



6.0 PLANT NOISE EMISSION

The main sources of noise from these premises are the Borehole Drill Rig, the Liquid Ring Vacuum Pump (LRVP), the diesel Genset that powers the LRVP, the Flares and the Gas Discharge Pipe. The Drill Rig will only be operated in the daytime hours of 7 am to 6 pm, while the Gas Extraction and Flaring equipment will operate continuously around the clock.

6.1 Borehole Drilling Plant Noise Emission

Noise surveys were carried out at Appin on Monday 14 May and Monday 21 May 2007 to determine the character and level of noise generated by the Borehole Drill Rig. A schedule of the L_{10} sound power levels for the equipment is given in Tables 6.1 below.

Table 6.1 Borehole Drilling Plant L_{10} Sound Power Levels

Description	Sound Power Levels (dB) re 1pW at Octave Band Centre Frequencies (Hz)									
	dBA	31.5	63	125	250	500	1k	2k	4k	8k
Borehole Drill Rig	106	109	117	112	106	98	102	99	92	82
Air Compressors (Two)	105	112	111	114	108	103	97	95	90	84
Total L_w	109	114	118	116	110	104	103	100	94	86

The Borehole Drill Rig plus two Air Compressors operate together during normal borehole drilling with an over all sound power level of 109 dBA. The Drill Rig at the time of noise measurement was operating with two air compressors. We were informed by Mr Grant Clarke (Driller Cert III) that for the first couple of days of drilling, two extra air compressors are required. This will increase the noise level by approximately 2 dBA. We have taken this into account in determining the overall level of noise intrusion.

Knowing the sound power level of a noise source (see above Table 6.1), the sound pressure level (as measured with a sound level meter) can be calculated at a remote location using suitable formulae to account for distance losses, ground absorption, sound barriers, atmospheric effects, etc.





Photo 1. Borehole Drilling Plant at Appin, NSW

Without any additional noise control, the noise level generated by the Drilling Operation at a nearby residence is inversely proportional to the distance between the Drill Rig and the residence, as follows in Table 6.2.

Table 6.2 Predicted Drilling Noise levels at Remote Locations

Operation	Separation Distance	Predicted Noise level
Drilling	100 metres	61 dBA
Drilling	200 metres	55 dBA
Drilling	300 metres	51 dBA
Drilling	500 metres	47 dBA
Drilling	1000 metres	41 dBA

Residence 1 is approximately mid-way between Boreholes CP02 & CP04, which are approximately 400 metres apart. By locating the drill rig on the far side of each borehole, the separation distance between the Drill Rig and the residence could be approximately 200 metres. The resulting noise level of 55 dBA would be $(55-41=)$ 14 dBA in excess of the maximum allowable Construction Noise Criterion established in Section 5 of this report, therefore noise controls as recommended in Section 7.0 are required.

Residence 2 is approximately 300 metres from Boreholes CP04 & CP07, which are approximately 300 metres apart. By locating the drill rig on the far side of each borehole, the separation distance between the Drill Rig and the residence could be approximately 320 metres. The resulting noise level of 46 dBA would be $(46-36=)$ 10 dBA in excess of the maximum allowable Construction Noise Criterion established in Section 5 of this report, therefore noise controls as recommended in Section 7.0 are required.

6.2 Gas Extraction and Flaring Plant Noise Emission

Noise surveys were carried out at Appin on Monday 14 May and Monday 21 May 2007 to determine the character and level of noise generated by the Gas Extraction and Flaring Plant. A schedule of the L_{10} sound power levels for the equipment is given in Table 6.3 below.

Table 6.3 Gas Extraction and Flaring Plant L_{10} Sound Power Levels

Description	Sound Power Levels (dB) re 1pW at Octave Band Centre Frequencies (Hz)									
	dBA	31.5	63	125	250	500	1k	2k	4k	8k
Liquid Ring Vacuum Pump and Genset.	100	96	111	108	106	90	92	86	86	74
Flares (2) both operating.	86	107	99	96	83	86	80	70	70	61
Gas Discharge Pipe	78	85	89	88	85	69	68	64	56	54
Total L_w	100	107	111	108	106	91	92	86	86	74



Photo 2. Liquid Ring Vacuum Pump at Appin, NSW



Photo 3. Gas Flares at Appin, NSW

Without any additional noise control, the noise level generated by the Gas Extraction and Flaring Plant at a nearby residence is inversely proportional to the distance between the Gas Extraction Plant and the residence, as follows in Table 6.4:

Table 6.4 Predicted Gas Extraction & Flaring Noise levels at Remote Locations

Operation	Separation Distance	Predicted Noise level
Gas Extraction & Flaring	100 metres	52 dBA
Gas Extraction & Flaring	200 metres	46 dBA
Gas Extraction & Flaring	300 metres	43 dBA
Gas Extraction & Flaring	500 metres	38 dBA
Gas Extraction & Flaring	1000 metres	32 dBA

Residence 1 is approximately mid-way between Boreholes CP02 & CP04, which are approximately 400 metres apart. By locating the Gas Extraction and Flaring Plant on the far side of each borehole, the separation distance between the Plant and the residence could be approximately 200 metres.

The resulting noise level of 46 dBA would be $(46-36=)$ 10 dBA in excess of the maximum allowable Construction Noise Criterion established in Section 5 of this report, therefore noise controls as recommended in Section 7.0 are required.



The sound power level of the Gas Extraction and Flaring Plant is less than that for the Drilling Rig, but the Gas Extraction Plant runs at night when the noise criterion is more stringent therefore the need for noise control is similar for both Drilling and Gas Extraction processes.

7.0 NOISE CONTROL RECOMMENDATIONS

For 14 of the 21 Boreholes, no noise controls will be required. These are Boreholes PA01 to PA05 and CP08 to CP17 (refer: Site Plan Figure 1 for Borehole locations).

However, noise from the Drilling and gas Extraction processes at seven Boreholes CP01 to CP07 will generate noise levels at the two nearby residences in excess of the acceptable noise criterion established in Section 5 of this report and will require Noise Control as recommended below:

7.1 Borehole Drilling Operation Noise Control

Boreholes CP01 to CP07 are close enough to the two residences to generate offensive noise levels. With a minimum separation distance of 200 metres, the predicted maximum L_{10} (15 min) level of noise at any nearby residence due to the Drilling Operation is 55 dBA. The daytime noise criterion is 41 dBA. The required 14 dBA noise reduction can be achieved with a sound barrier wall or by closing the windows and air conditioning of the nearby residences.

The Borehole Drilling Plant has a noise source height of approximately 3 metres above the natural ground surface. To reduce the noise to 41 dBA at a distance of 200 metres, we recommend a barrier height of 7.8 metres at a distance of not less more than 20 metres from the nearest noise source and not more than 40 metres from any major noise source on the Drilling site.

This could be provided by the placement of Shipping Containers stacked three high and extending horizontally for a distance of not less than 10 metres beyond the line of sight between the Drilling Plant and the residence being protected, as shown in the attached Figure 3.

7.2 Goaf Gas Extraction and Flaring Noise Control

The Gas Extraction process is quieter than the Drilling process, but since it is required at night when the noise criterion is more stringent, the noise reduction is much the same as for the Drilling operation. With a minimum separation distance of 200 metres, the predicted maximum L_{10} (15 min) level of noise at any nearby residence due to the Gas Extraction Operation is 46 dBA. The night-time noise criterion is 36 dBA. The required 10 dBA noise reduction can be achieved with a sound barrier wall or by closing the windows and air conditioning of the nearby residences.

The Gas Extraction and Flaring Plant has noise source heights of approximately 3 and 6 metres respectively above the natural ground surface. To reduce the noise to 36 dBA at a distance of



200 metres, we recommend a barrier height of 7.8 metres at a distance of not less more than 20 metres from the nearest noise source and not more than 40 metres from any noise source on the Gas Extraction and Flaring Plant site.

This could be provided by Shipping Containers stacked three high and extending horizontally for a distance of not less than 10 metres beyond the line of sight between the Gas Extraction and Flaring Plant and the residence being protected, as shown in the attached Figure 3.

7.3 Optional Noise Control by Means of Air Conditioning of Residences

The noise control recommended in 7.1 and 7.2 above is to provide sufficient noise reduction that people living at the two rural residences can tolerate the construction noise for a period of up to 30 weeks with their windows open.

If they close their windows to reduce the noise intrusion, there is a risk that the residences will be uncomfortable. However, if air conditioning is provided for all living and sleeping areas within the two residences, they can close their windows to achieve the required 10 to 14 dBA noise reduction.

In some cases it is more economical for a mining operation to provide air conditioning for the nearby residences rather than to erect high noise barriers near the noise-generating plant.

7.4 Administrative Noise Control

Good public relations is worth quite a number of decibels. We recommend that a Liaison Officer be appointed to communicate with the occupants of the two residences and keep them informed as to how and when any noisy plant will be operating close to their homes. Residents should be given a 24 hour telephone number for the Liaison Officer, and be encouraged to call if they have any noise or other complaints during the Borehole Drilling and Gas Extraction period.

7.5 Construction Disclaimer

Recommendations made in this report are intended to resolve acoustical problems only. We make no claim of expertise in areas other than acoustics and draw your attention to the possibility that our recommendations may not meet structural, fire, thermal or other aspects of mining construction.



8.0 NOISE IMPACT STATEMENT

Measurements and computations show that, provided the recommendations in Section 7.0 of this report are implemented, the level of noise emitted by the Borehole Drilling, Gas Extraction and Flaring processes will meet the acceptable noise level requirements of the Department of Environment and Climate Change as detailed in Section 5 of this report.

In this case, we are of the opinion that the most practical noise control option is to install air conditioning systems at the two nearby residences so that the windows of all habitable rooms can be kept closed to reduce noise intrusion. Standard glazing will be adequate to meet the noise limits applicable at these two locations. Special sound-rated glazing will not be required for the modest noise reduction that is required.



Athol Day, MSc(Acoustics), FIE Aust., MAAS, Chartered Professional Engineer.
Principal Acoustical Engineer
for and on behalf of Day Design Pty Ltd.

A.A.A.C. MEMBERSHIP

Day Design Pty Ltd is a member company of the Association of Australian Acoustical Consultants, and the work herein reported has been performed in accordance with the terms of membership.

Attachments:

- Figure 1 – Site Plan
- Figure 2 – Ambient Noise Survey
- Figure 3 – Noise Barrier Diagrams.

