11. NOISE AND VIBRATION

This chapter describes the supplementary noise and vibration impact assessment undertaken to address changes made to the project description after the Arrow LNG Plant EIS (Coffey Environments, 2012) was finalised and exhibited. The chapter presents the findings of the supplementary noise and vibration impact assessment conducted by Sonus Pty Ltd (Sonus) which is attached as Appendix 4.

11.1 Studies and Assessments Completed for the EIS

This section provides an overview of the noise and vibration impact assessment completed for the EIS and the main conclusions from that assessment.

Sonus was engaged to conduct the noise and vibration impact assessment for the Arrow LNG Plant EIS. Their findings are discussed and their report is presented in Chapter 22 and Appendix 16 of the EIS, respectively.

The assessment involved the collection of noise and vibration data at a series of monitoring locations to establish existing background noise and vibration levels. Project noise and vibration criteria were then developed based on relevant guidelines and standards.

Noise levels associated with the project were predicted at noise sensitive receptors using the Conservation of Clean Air and Water in Europe (CONCAWE) noise propagation model for four worst-case operational scenarios. Modelling of construction noise indicated that the project noise criteria would be exceeded at several noise sensitive receptors during night-time periods. Mitigation measures were developed to reduce construction noise below the project criteria during the night-time period.

Modelling of noise associated with operation of the LNG plant showed that noise levels would exceed the project noise criteria at several noise sensitive receptor locations for all four of the worst-case scenarios assessed. Acoustic treatments were proposed for the LNG plant to bring noise levels into compliance with the project noise criteria at all sensitive receptors.

Vibration levels associated with the project were predicted from previous measurements of activity during construction and operation of similar projects. Construction vibration levels from the LNG plant, feed gas pipeline and other construction sites and activities were well below the threshold of human detection at the nearest sensitive receptors. Similarly, vibration levels at assessment locations were predicted to be below the threshold of human detection during operations.

Blasting noise and vibration impacts associated with the project were not assessed in the EIS as detailed information (e.g., location requiring blasting, size of charge, timing and frequency) was not available at the time of writing the EIS.

Commitments relating to the mitigation of noise and vibration impacts were developed based on expert advice from Sonus. Table 11.1 lists the commitments presented in the EIS.

Table 11.1 Noise and vibration EIS commitments

No.	Commitment
C22.01	Identify during the detailed design of the LNG plant, specific acoustic treatment to be applied to each noise source.
C22.02	Where practical, locate noise-making equipment to maximise the distance between noise sources (e.g., diesel generators) and sensitive receptors. The use of structures or natural topography to create barriers to noise may be used to lessen the noise impacts on sensitive receptors.
C22.03	Include appropriate methods to manage blasting activities in the construction environmental management plan. If required, carry out blasting activities in accordance with the guidelines for blasting noise and vibration.
C22.04	Regularly maintain all machinery and equipment and check for excessive noise generation.
C22.05	Where noise from a construction activity would exceed the project night time noise criteria of 45 dB(A) at a sensitive receptor, schedule, where practical, construction activities to occur between 7.00 a.m. and 10.00 p.m.
C22.06	Continually review the timing of construction activities to identify opportunities to reschedule concurrent activities where excessive noise is expected.
C22.07	Ensure that project related noise generated during operation complies with the project noise criteria at all assessment locations.

11.2 Study Purpose

The supplementary noise and vibration impact assessment addresses changes to the project description. These aspects are discussed below.

11.2.1 Project Description Changes

Following, is a summary of project description changes that are relevant to the noise and vibration impact assessment undertaken for the project. These changes were identified as having the potential to produce noise and vibration results different from those reported in the EIS.

Power Generation Options

The options being taken forward for power generation have changed. The all electrical option that was modelled as part of the noise and vibration impact assessment for the EIS (scenarios 2 and 4) has been discontinued. The power generation options are detailed below:

- Base case: all mechanical option (also known as Power Island Mode). This is the base case that was assessed in the EIS and was modelled as part of the original noise and vibration impact assessment (scenarios 1 and 3), with the exception that the configuration and layout of the equipment have changed as described below.
- Alternate case: mechanical/electrical option (also known as Partial Auxiliary Power Import Mode). This reflects the mechanical / electrical case that was identified but not fully assessed in the original noise and vibration impact assessment. The site based components of the mechanical/electrical option have been updated as a result of front end engineering design (FEED).

LNG Plant Layout

The layout of the LNG plant has changed. As shown on Figure 4.2, the turbine generators for both the base and alternative cases have been relocated to the west side of the LNG trains. They were described in the EIS as being located on the east side of the LNG trains.

Noise Source Data

The main noise sources and the associated sound power levels have been updated as a result of the FEED process and the power generation and LNG plant ancillary infrastructure has been rearranged on the site. This updated noise source data has the potential to impact on some of the assumptions made in the original noise and vibration impact assessment.

Changes to Construction Machinery

Transport and machinery assumptions have been further developed since the EIS was finalised and exhibited. This has resulted in changes to some of the types of construction machinery, plant and equipment required for construction of the LNG plant. Excavation volumes have also been amended.

Dredging Activity

Two new dredge sites have been included in the project description: an access channel from the Targinie Channel to the Boatshed Point materials offloading facility (MOF) and a swing basin and enlarged access area around the Boatshed Point MOF. Additional dredging is also proposed at two of the original dredge sites: dredge site 3 near Boatshed Point and dredge site 5 near the LNG jetty. The distance to some sensitive receptors has been reduced due to this extended area of dredging.

11.2.2 Submissions

Several submissions on the EIS raised issues relating to noise and vibration, including the need to address blasting impacts and underwater noise. The full details of these submissions and the responses to the specific issues raised are presented in Part B of the Supplementary Report to the EIS.

11.3 Study Method

The supplementary noise and vibration impact assessment has been conducted in accordance with the methods described in the EIS. The CONCAWE model was rerun with noise level data revised to reflect project description changes.

Noise criteria were set for the project and provide targets for noise levels to be achieved at monitoring locations (that represent sensitive receptors). The criteria have changed marginally from those presented in the EIS, and the revised criteria are presented in Table 11.2 accordingly. The predominant change is to the night-time construction criteria which, through post-EIS consultation with Queensland Department of Environment and Heritage Protection (DEHP) has been reduced from 45 dB(A) to 40 dB(A).

With the exception of this change, the project noise criteria are consistent with those outlined in the EIS. The operation noise criterion for assessment locations AL 1, AL 3 and AL 6 of 33 dB(A) is higher than for assessment locations AL 2, AL 4 and AL 5 (28 dB(A)). This is consistent with the EIS and has been developed to account for the higher background noise levels at AL 1, AL 3 and AL 6.

Table 11.2 Summary of proposed noise criteria

Activity	Source	Assessment Location	Outdoor Noise Criterion (dB(A))			Assessment Meteorological Conditions
			Day[1]	Evening[2]	Night[3]	
Operation	LNG plant	AL 1	33			Neutral (CONCAWE Category 4)
		AL 6				
		AL 3	33			Worst-case (CONCAWE Category 6)
		AL 2	28			
		AL 4	28			Neutral (CONCAWE Category 4)
		AL 5				
Construction	LNG plant Marine facilities Feed gas pipeline Dredging	AL 1	*All reasonable and practicable measures to reduce the noise impact*		40[4]	Neutral (CONCAWE Category 4)
		AL 2				
		AL 3				
		AL 4				
		AL 5				
		AL 6				

Notes: 1. Day-time is 7am to 6pm. 2. Evening is 6pm to 10pm. 3. Night-time is 10pm to 7am. 4 Criterion reduced from 45 dB(A) to 40 dB(A) as agreed with DEHP.

11.4 Study Findings

This section describes the key findings of the supplementary noise and vibration impact assessment, including any changes to the impacts that were outlined in the EIS.

11.4.1 Noise

This section describes the predicted noise levels associated with the project in light of the project description changes.

Construction: Dredging

Noise from dredging activity at dredge site 3 near Boatshed Point and dredge site 5 near the LNG jetty were re-assessed. As set out in Table 11.3, predicted noise levels due to dredging at the site near Boatshed Point were up to 5 dB(A) higher than the results reported in the EIS at a number of assessment locations. Predicted noise levels from dredging at the site near the LNG jetty were generally consistent with those reported in the EIS. Based on the prediction, noise levels will achieve the night-time project noise criteria of 40 dB(A) at all assessment locations except AL 6 and AL 1 when dredging is being conducted at dredge site 3. It is expected that dredging works will largely be undertaken during the day and evening time when all reasonable and practicable measures will be taken to reduce noise impacts.

Construction: General

Information on the revised construction machinery and equipment required to fulfil the updated project description was found to be consistent with the assumptions that were considered in the EIS. The requirement for, and location of, blasting has not yet been determined. However, each blast can be designed to meet noise and overpressure criteria. Construction will predominantly be carried out during the day-time and all reasonable and practicable measures will be taken to reduce the noise impact on sensitive receptors. General construction works will be planned and scheduled to achieve the reduced night-time project construction criterion of 40 dB(A).

Table 11.3 Predicted noise levels from dredging at Boatshed Point and LNG jetty

Assessment Location	Predicted Noise Levels at Dredge Sites (dB(A))			
	Boatshed Point (Dredge Site 3)		LNG Jetty (Dredge Site 5)	
	Reported in the EIS	Updated	Reported in the EIS	Updated
AL 1	53	**54**	33	32
AL 2	12	16	14	14
AL 3	22	27	25	25
AL 4	29	30	24	24
AL 5	23	25	21	21
AL 6	45	**45**	30	30

Operation

Modelling completed as a part of the supplementary noise and vibration impact assessment indicates that operational noise levels will be lower than those reported in the EIS. The results of modelling without acoustic treatment are shown in Table 11.4. In the updated predications noise levels at AL 1 and AL 6 exceed the project noise criteria for both power options without additional acoustic treatment being applied.

Table 11.4 Predicted noise levels from continuous operation activities without acoustic treatment

Assessment Location	Noise Criteria dB(A)	Predicted Operational Noise Level (dB(A))					
		All Mechanical				Mechanical/electrical	
		Reported in the EIS		Updated		Two LNG Trains	Four LNG Trains
		Two LNG Trains	Four LNG Trains	Two LNG Trains	Four LNG Trains		
AL 1	33	**47**	**49**	**37**	**38**	**36**	**38**
AL 2	28	22	25	12	15	12	15
AL 3	33	31	**34**	22	24	21	24
AL 4	28	**34**	**37**	24	27	24	27
AL 5	28	28	**31**	18	21	18	21
AL 6	33	**45**	**47**	**35**	**37**	**35**	**37**

11.4.2 Vibration

Changes to the project description have not resulted in a material change to the type of equipment or the location of the equipment relative to noise sensitive receptors. The vibration impacts outlined in the EIS as being associated with construction and operation of the LNG plant remain valid. Vibration levels will be well below the threshold of human detection.

11.4.3 Potential Impacts and Management Measures

Noise

Predicted noise levels indicate that the reduced night-time criteria of 40 dB(A) will likely be exceeded at monitoring locations AL 6 and AL 1 if dredging activities are conducted at night-time. Mitigation and management measures will be required to achieve this night-time project noise criterion. The most effective mitigation and management measure associated with dredging

related noise impacts is scheduling of dredging works in the vicinity of AL 1 and AL 6 so that they occur during the least sensitive times of the day.

General construction noise has the potential to impact on sensitive receptor locations. There is no day-time construction noise criteria set for the project. During development of the project, night-time or 24-hour construction activities may be necessary. The night-time criterion of 40 dB(A) will most effectively be achieved through planning and scheduling of works to avoid noisy activities at night-time.

During operations, additional acoustic treatments will need to be considered to manage predicted exceedence of the noise criteria at AL 6 and AL 1. Potential additional acoustic treatments considered as a part of the supplementary noise and vibration impact assessment are:

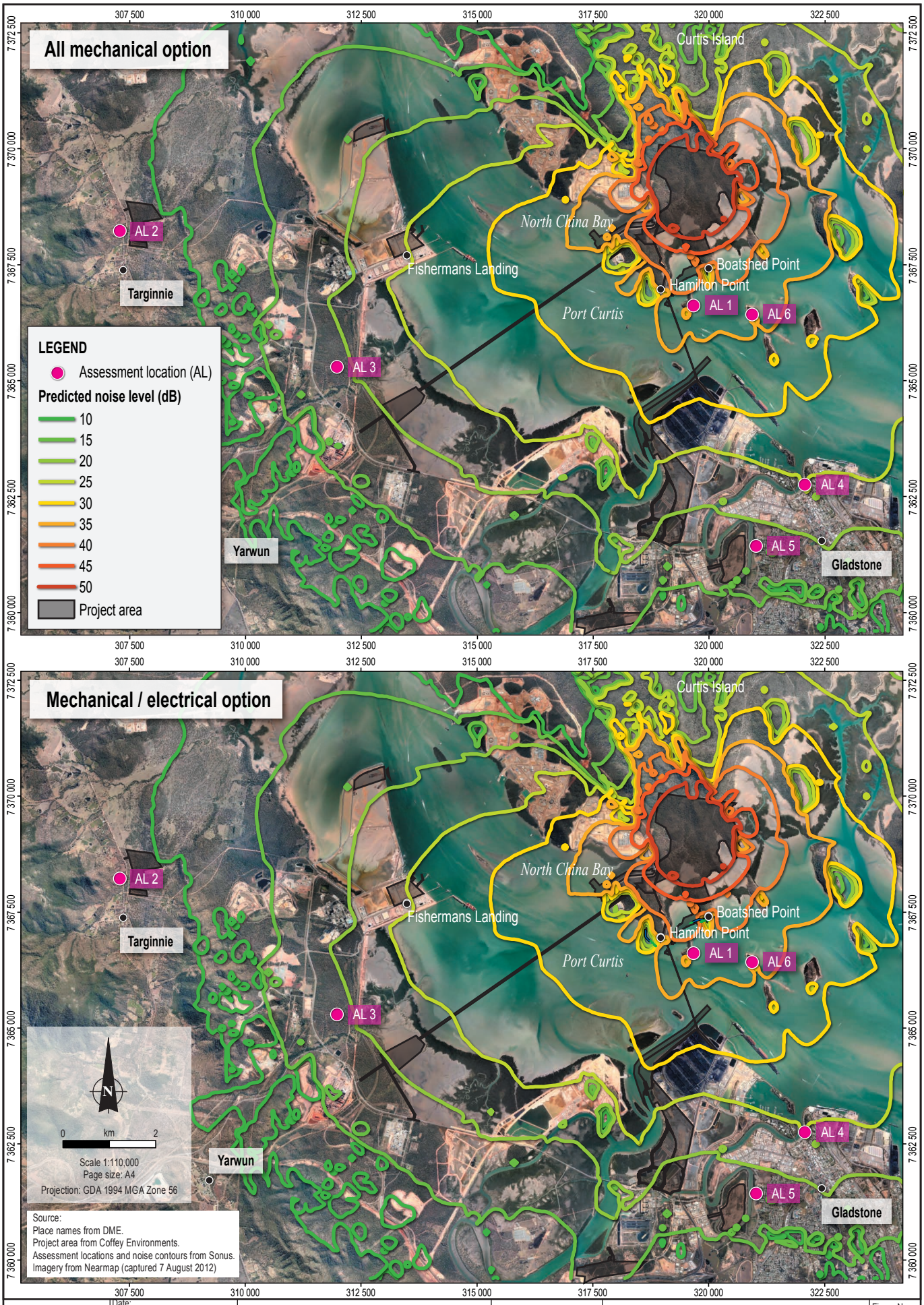
- Redesign of the air cooled heat exchangers to achieve a further sound power level reduction of 10 dB.
- Upgrade of the process gas turbine enclosure.
- Enclosure of pumps such as lean solvent booster pumps, hot water pumps and LNG rundown pumps (enclosure to include drive motors).

Table 11.5 details the predicted noise levels at each assessment location for both power option modes with the above additional acoustic treatment applied. Predicted noise contours with potential acoustic treatment are shown in Figure 11.1.

Table 11.5 Predicted noise levels from LNG plant operation with additional acoustic treatment

Assessment Location	Noise Criteria dB(A)	Predicted Operational Noise Level (dB(A))					
		All Mechanical				Mechanical/electrical	
		Reported in the EIS		Updated		Two LNG Trains	Four LNG Trains
		Two LNG Trains	Four LNG Trains	Two LNG Trains	Four LNG Trains		
AL1	33	33	33	**34**	**36**	**34**	**35**
AL2	28	11	12	8	10	7	10
AL3	33	19	20	18	20	17	20
AL4	28	22	22	20	23	20	23
AL5	28	16	16	14	17	14	17
AL6	33	31	32	32	33	31	33

The predictions indicate that with additional acoustic treatment applied, noise levels at assessment locations will be similar to those reported in the EIS (within 1 to 3 dB(A)) for the all mechanical option. The predictions show that the noise criteria can be achieved with feasible acoustic treatments, at all assessment locations, except AL 1. Additional management measures may be required for location AL 1 to ensure that noise does not constitute an environmental nuisance at that location that is currently a sensitive receptor. This prediction is applicable for both power options being progressed.



coffey environments	Date: 05.12.2012 MXT: 7033CC_16_GIS044_v1_1 File Name: 7033_16_F11.01_GIS_FT	Arrow Energy Arrow LNG Plant	arrow energy go further	Noise contours of the predicted noise levels with acoustic treatment for four LNG trains	Figure No: 11.1

To achieve the project noise criteria at AL 1, additional acoustic treatments would be required. Potential acoustics treatment may include upgrading the process compressor enclosures, power generation unit enclosures and gas turbine exhaust stack silencer and enclosing remaining pumps and associated motors on site. These treatments have not been modelled at this time but can be considered through the detailed engineering design process, as necessary.

Low-frequency noise levels associated with operation of the LNG plant have been remodelled under neutral meteorological conditions with potential acoustic treatments in place. The predictions indicate that low-frequency noise levels inside the dwelling at AL 6 will be no greater than 15 dB(A) for both power generation options. Low-frequency noise levels ($L_{pA,LF}$) inside a dwelling at AL 1 are predicted to be no greater than 16 dB(A). This is below the indoor noise criterion of 20 dB(A) and is lower than the levels for both power options reported in the EIS.

Vibration

As the vibration impacts outlined in the EIS remain valid, no changes to the mitigation measures for managing vibration outlined in the EIS are proposed.

Cumulative Assessment

The cumulative noise impact assessment reported in the EIS accounted for other developments by proposing noise criteria at the closest noise sensitive receptors that are 10 dB(A) more stringent than Environmental Protection (Noise) Policy 2008 requirements. As the noise and vibration impacts associated with the project remain largely unchanged from the initial assessment, no change is proposed to the cumulative noise and vibration impacts reported in the EIS.

11.5 Conclusion

The findings of the supplementary noise and vibration impact assessment indicate that construction noise levels are generally consistent with those reported in the EIS. Dredging noise levels will achieve the night-time project noise criteria for construction of 40 dB(A) at all assessment locations except AL 6 and AL 1 if dredging is being undertaken at dredge site 3 near Boatshed Point at night-time. All reasonable measures will be taken during construction to minimise the impact of construction noise during the day-time. The night-time criterion of 40 dB(A) will most effectively be achieved through planning and scheduling of works to avoid noisy activities at night-time.

Predicted noise levels during operation are lower than those reported in the EIS but will exceed the project noise criteria at AL 1 and AL 6 for both power options without additional acoustic treatment being applied. With additional feasible acoustic treatments applied, the relevant noise criterion will be achieved at AL 6. Management measures may be applied to ensure that noise at AL 1 does not constitute an environmental nuisance. Additional acoustic treatments beyond those modelled for the supplementary noise and vibration impact assessment will be required to achieve the criterion at AL 1. The vibration impacts outlined in the EIS for construction and operation of the LNG plant remain valid and are well below the threshold of human detection.

The project description changes result in predicted noise impacts, that in some cases are different from those reported in the EIS. With the application of additional feasible acoustic treatment and management measures the project noise criteria can be achieved at all noise sensitive receptors.

11.6 Commitments Update

One measure to manage potential noise and vibration impacts presented in the EIS has been revised and one new commitment has been added as set out in Table 11.6. All other measures are unchanged and are included in Attachment 7, Commitments Update.

Table 11.6 Commitments update: noise and vibration

No.	Commitment	Comment
C22.05A	Where noise from a construction activity would exceed the project night time noise criteria of ~~45~~40 dB(A) at a sensitive receptor, schedule, where practical, construction activities to occur between 7.00 a.m. and 10.00 p.m.	Updated criteria
C22.08	If blasting is considered necessary, standard practices will be followed so that all blasting activities will be designed to meet the relevant overpressure and ground-vibration criteria at sensitive receptor locations.	New commitment