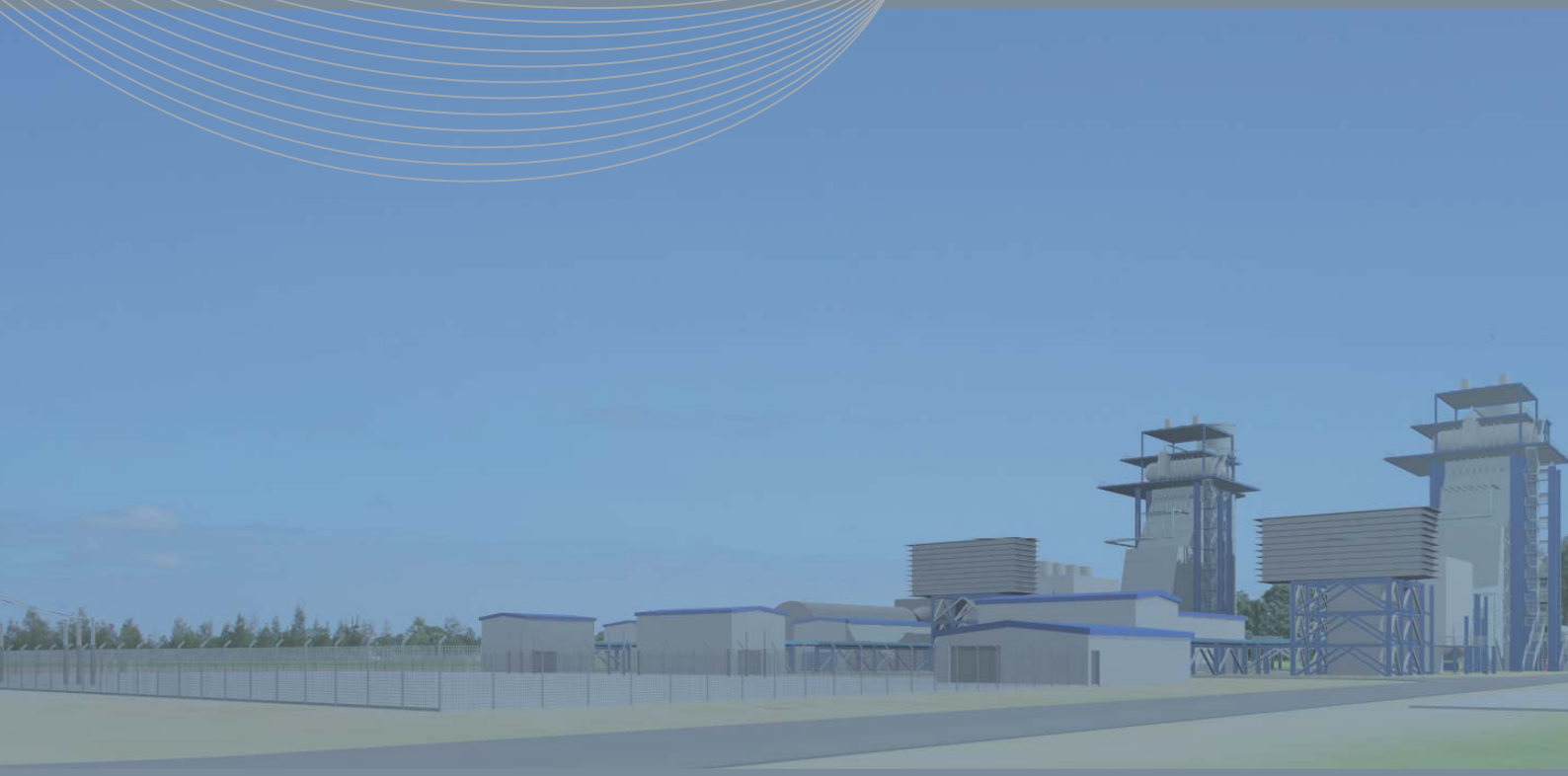
GHD CLIENTS | PEOPLE | PERFORMANCE

Delta electricity



Appendix H

Noise impact assessment (GHD)

CLIENTS | PEOPLE | PERFORMANCE

Delta Electricity

Noise Impact Assessment

Proposed Gas Turbine Power Facility at Bamarang, near Nowra

December 2005

INFRASTRUCTURE | MINING & INDUSTRY | DEFENCE | PROPERTY & BUILDINGS | ENVIRONMENT

Contents

Table Index

Figure Index

Appendices

Executive Summary

Noise monitoring and assessment was undertaken on behalf of Delta Electricity as part of an environmental assessment, to assess the acoustic impact of the proposed gas turbine power facility located at Bamarang, near Nowra NSW. The basis of the assessment was to ascertain whether the proposed facility would have an acoustical effect on the amenity of residences living in close proximity of the site, during both construction and operation of the power facility.

Attended and unattended noise monitoring was undertaken to determine the existing background and ambient noise environment in the vicinity of the proposed power facility, and to provide an estimation of the noise output of the facility. Detailed noise modelling was undertaken based on provided sound power levels of primary noise sources for the proposed facility.

Construction pile driving is potentially the greatest source of vibration associated with construction equipment expected to be used for the project. By avoiding impact pile driving where possible in vibration sensitive areas through the use of drilled piles or the use of a sonic or vibratory piles as mentioned in the assessment it can be expected that adverse vibration impacts can be significantly minimised.

Construction noise has the potential to exceed project specific noise goals in a worst case scenario with all plant and equipment operating at their full sound power levels. As this scenario is highly unlikely to occur, construction noise is not expected to exceed project specific noise goals.

Based on distance to the nearest anticipated receivers, vibration is not likely to be an issue.

Modelling was undertaken under differing meteorological and operational (i.e. with and without noise attenuation measures in place) for both Stages of the proposed development.

Results of the modelling indicate project specific noise goals may potentially be exceeded at any one of the monitoring locations during operation under differing meteorological conditions, in the absence of any noise attenuation measures.

The revised noise mitigation scenario based on general industrial practice suggests that if all equipment are attenuated to a minimum sound power level of 91 dB(A) then the project specific noise goals for Stage 1 & 2 can be met at the monitoring locations. It is therefore recommended that such noise level specifications be implemented to all equipment manufacturers of this proposed gas turbine power plant.

Given the implementation of recommended noise mitigation measures as presented in Section 7 and the EPC process which will ensure manufacturers have demonstrated that site specific noise goals can be achieved during operation of respective plant and/or machinery, it is considered that project specific noise goals may be achieved at all three monitoring locations.

1. Introduction

GHD was commissioned by Delta Electricity (Delta), as part of an environmental assessment, to assess the acoustic impact of the proposed gas turbine power facility located at Bamarang, near Nowra NSW. The basis of the assessment was to ascertain whether the proposed facility would have an acoustic effect on the amenity of residences living in close proximity of the site, during both construction and operation of the power facility.

1.1 Background

The proposal involves the construction of a gas turbine power facility and associated infrastructure, including transmission connections. Development of the power facility infrastructure is proposed to be undertaken in two stages.

1.2 Scope of Works

The scope of works undertaken included:

- Review of supplied background data (i.e. conceptual drawings, master plans and aerial photographs);
- Development of sampling methodology and identification of suitable monitoring locations through the background review and consultation with the client;
- Site inspection and noise monitoring assessment. This included:
  - Long-term background noise monitoring at three representative locations of the ambient noise environment for a period of seven days at residences/locations indicative of the local ambient noise environment;
  - Noise data assessed and filtered to remove invalid data due to extraneous noise or adverse weather conditions;
  - Noise levels recorded and assessed against the statistical parameters L_{Amax}, L_{Amin} L_{A10}, L_{A90}, and L_{Aeq}, with consideration to relevant DEC guidelines;
  - Based on noise monitoring, establish project specific noise goals for the two stages of proposed development; and
  - Noise modelling undertaken for this project based on the two stages of development to ascertain the acoustic contribution of the development with consideration to project specific noise goals.
- Data Interpretation;

- Preparation of Report with consideration to NSW DEC publications INP, ECRTN and ENCM Chapter 171 Construction site noise, including:
  - A brief description of the project;
  - A brief description of the ambient noise environment;
  - Location of the noise monitoring with respect to the proposed development works;
  - Charts of the noise parameters including, $L_{A10,}$ L_{A90}, and $L_{Aeq,}$ for the unattended noise monitoring;
  - Based on monitoring results, establish project specific noise goals for the construction and operation of the proposed power plant with consideration to the NSW DEC publications INP, ECRTN, ENCM Chapter 171 Construction site noise;
  - Discussion of the noise monitoring and modelling results with relation to project specific noise goals and guidelines; and
  - Outlining possible noise mitigation measures where the noise assessment suggests that project specific noise goals may be exceeded.

1.3 Approach

The following steps were undertaken:

- Compliance criteria for the proposed development were determined;
- Existing ambient noise sources identified and classified as operational (local or tonal), or extraneous;
- Site noise monitoring locations (3) selected for unattended long-term monitoring;
- Site noise monitoring measurements undertaken;
- Assessment of noise measurements made leading to the determination of background and various statistical time related noise levels;
- Evaluation of extraneous noises and constant noise;
- Projection of noise to residential areas;
- Assessment of compliance; and
- Comment on noise control options.

1.4 Limitations

This report has been prepared for Delta Electricity. The purpose of the report is to provide an independent review of the acoustic output of the proposed CCGT power facility at Bamarang NSW.

It is not the intention of the assessment to cover every element of the acoustic environment, but rather to conduct the assessment with consideration to the prescribed work scope.

The findings of the noise assessment represent the findings apparent at the date and time of the monitoring and the conditions of the area at that time. It is the nature of environmental monitoring that all variations in environmental conditions cannot be accessed and all uncertainty concerning the conditions of the ambient noise environment cannot be eliminated. Professional judgement must be exercised in the investigation and interpretation of observations.

In conducting this assessment and preparing the report, current guidelines for noise were referred to. This work has been conducted in good faith with GHD's understanding of the client's brief and the generally accepted consulting practice.

No other warranty, expressed or implied, is made as to the information and professional advice included in this report. It is not intended for other parties or other uses.

2. Project Description

The proposal involves the construction of a gas turbine power facility and associated infrastructure, including transmission connections. The proposal is to be developed in two stages:

- Stage 1 – installation of open cycle (OCGT) gas turbines for a peaking facility; and
- Stage 2 – conversion to a combined cycle (CCGT) power facility to meet intermediate/base load demands.

Infrastructure of the power facility is proposed to consist of:

- Two gas turbines in an open cycle configuration (OCGT), including a turbine hall, control building and cooling system in Stage 1;
- The addition of a heat recovery steam generator (HRSG) to each gas turbine and the addition of a steam generator to form a combined cycle gas turbine configuration (CCGT) in Stage 2;
- A switchyard;
- Underground gas supply connected to the eastern gas pipeline (located approximately 2 km to the east of the site);
- Electrical transmission lines to connect to the Integral Energy 132 kV lines (located approximately 6 km to the east of the site); and
- Condenser cooling plant or force draft cooling towers.

The staged approach has been developed to ensure that Delta is able to respond to increased electricity demands in a timely manner. Stage 1 would ensure that the power generation plant is able to meet demands during peak periods on the national electricity grid. This would result in the plant only operating during periods when electricity demands peak. As the overall demand for electricity increases, it is anticipated that the project would operate over longer periods of time, resulting in Stage 2 operating conditions, which would see it producing electricity to meet base load demands.

Following completion of Stage 2, the plant would have a capacity of 400 MW.

The site location and noise monitoring locations are included in Figure 1.

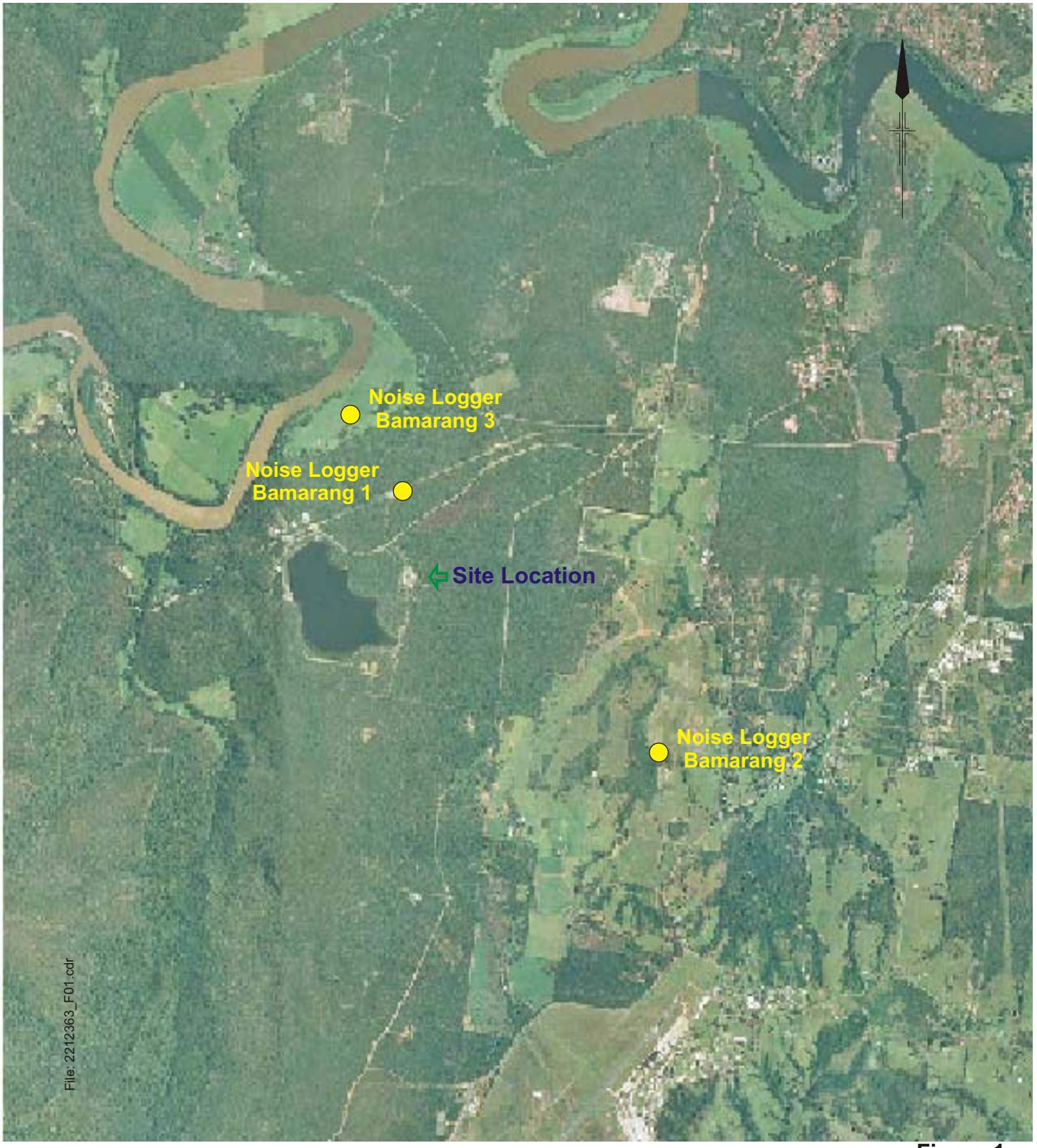


Figure 1
Subject Site and
Noise Monitoring Locations

Date: 1 August 2005

3. Assessment Methodology

Unattended noise monitoring was undertaken using three Acoustic Research Laboratories (ARL) EL215 Type 2 noise loggers. Long term monitoring was undertaken to establish a representative indication of the ambient noise environment, as various fluctuations in any given 15-minute statistical measurement can occur. Long-term monitoring, using continuous noise loggers accounts for this through logarithmic averaging.

Attended noise measurements were also undertaken using a SVAN 912 sound level meter. Attended noise measurements assist in gaining an understanding of the acoustic environment through site recorded noise levels and attended observations. Measurements were taken approximately 1.3 metres above the ground. The sound level meter was programmed to record 15-minute statistical noise data. Field calibrations were undertaken before and after the measurements and were within +/- 0.3dB for all calibration checks.

3.1 Monitoring Locations

Three ARL EL215 Type 2 continuous noise loggers were used to monitor the noise environment at the following locations:

- **Location 1 (L1)**: Located in Part Lot 22 DP 746233, Yalwal Road at the mud brick business directly opposite the proposed plant site (to the north).
- **Location 2 (L2):** Located at 213 Gannet Road at private residence to the south east of the proposed plant site.
- **Location 3 (L3):** Located at residence at 190 Bamarang Road, downgradient of the proposed plant site (to the north).

Liaison with Delta Electricity and a site inspection determined the most appropriate long-term noise monitoring locations for the assessment.

The mud brick business directly opposite the site on Yalwal Road was the closest residence, as the site is occupied by a worker (residing in an on-site caravan) full-time. Additionally, a development application is currently in with Council to construct a more permanent residence on the site.

The property at 213 Gannet Road located to the south east of the site, is within a new subdivision, representing the closest cluster of residential properties to the site.

A third noise logger was placed at a residential property located along Bamarang Road, to the immediate north of the proposed plant site. The property was located within a valley approximately 20 m RL below the proposed site. Bushland and a sandstone escarpment were located between the site and the monitoring location.

Therefore, based on location, the three monitoring points chosen were deemed to be sites that were indicative and representative of the local ambient noise environment which may have the potential to be noise affected by the proposed development.

Long-term noise monitoring took place between 21 July and 3 August 2005. The instruments were programmed to accumulate environmental noise data continuously over a sampling period of 15 minutes for the entire monitoring period.

Noise loggers were programmed to record A-weighted sound levels, with L_{90}, L_{eq} and L_{10} statistics plotted on daily graphs. The L_{10} values refer to noise levels that are exceeded 10% of the time and is often used to describe construction noise and sometimes as a traffic noise descriptor, whilst the L_{90} values refer to noise levels that are exceeded 90% of the time. This is representative of the lower noise levels in the environment and is commonly referred to as the background noise level. The L_{eq} is the equivalent continuous noise level which would have the same total acoustic energy over the measurement period as the varying noise actually measured, so it is in effect an energy average. Internal software then calculated and stored the Ln percentile noise levels for each sampling period, which was later retrieved for detailed analysis.

The instruments were calibrated before and after the logging periods. Table 3.1 below provides details of the noise loggers and their locations.

Table 3.1 Continuous Noise Logger Details

Measurement Title	L1-Lot 22 DP 746233	L2-213 Gannet Road	L3-190 Bamarang Road
Monitoring Location	Mud brick business, Yalwal Road	213 Gannet Road property	Bamarang Road
Logger Serial No.	194676	194560	193400
Measurement Started at	15:45 July 21 2005	17:30 July 21 2005	16:00 July 27 2005
Measurement Stopped at	08:30 July 28 2005	10:00 July 28 2005	08:30 August 3 2005
Pre-measurement Reference	110.0	110.0	110.0
Post-measurement Reference	109.8	110.0	110.8
Frequency Weighting	A	A	A
Time Response	Fast	Fast	Fast
Engineering Units	dB(A) SPL	dB(A) SPL	dB(A) SPL

4. Existing Environment

Noise sensitive receptors are generally defined as residential areas, hospitals, schools, caravan parks and other similar uses where people are present for an extended period of time.

Identified sensitive locations within the vicinity of the proposed power plant site are limited to isolated residences on large rural allotments. The site is approximately 750 m from the nearest residence, across Yalwal Road to the north.

The subject site is located within a rural bushland setting. No significant traffic or existing industrial noise sources are present within the vicinity of the site. During fieldworks, local fauna and noise sources consistent with the land use and setting of the site were the primary influence to ambient noise profiles.

4.1 Noise Monitoring Results

Figures 2, 3 and 4 provide a graphical summary of the long term noise monitoring conducted at the three monitoring locations.

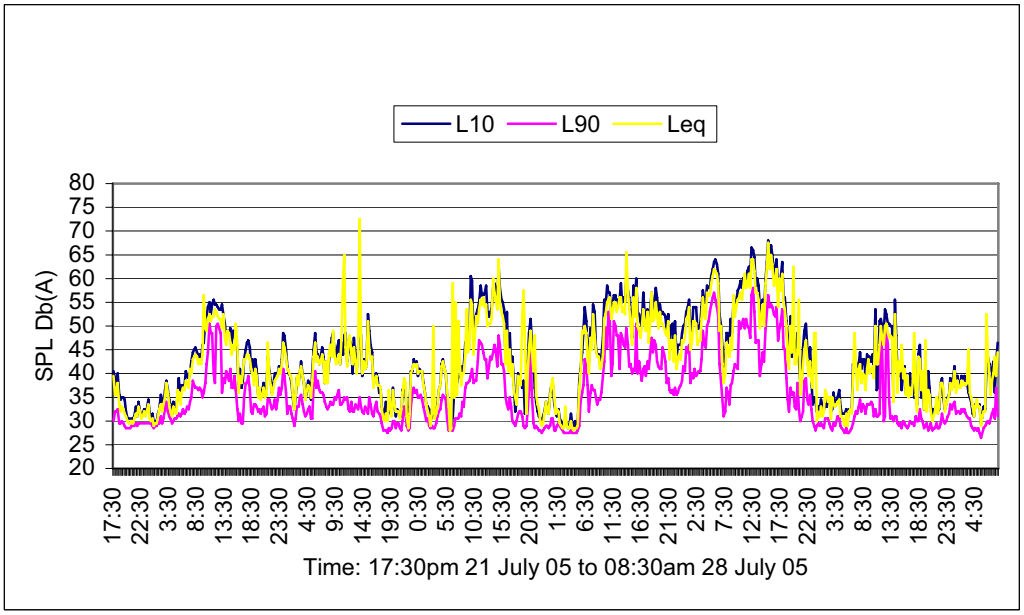


Figure 2 15 Minute Statistical Noise Results – L-1 Lot 22 DP 746233

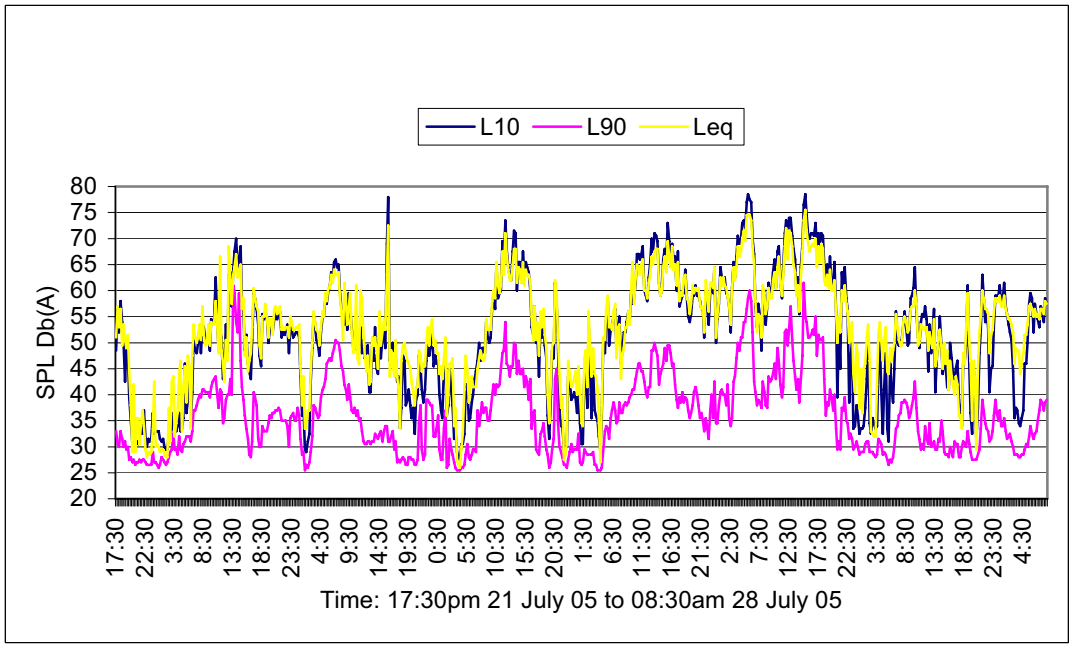


Figure 3 15 Minute Statistical Noise Results – L-2 213 Gannet Road

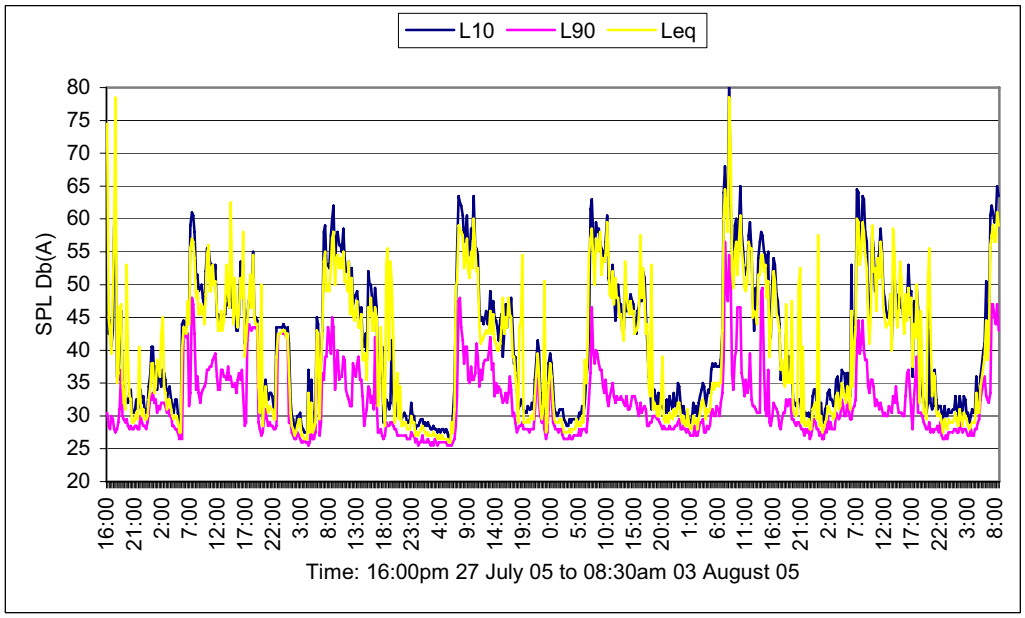


Figure 4 15 Minute Statistical Noise Results – L-3 190 Bamarang Road

Comparison of data at monitoring locations located at Lot 22 DP 746233 and 213 Gannet Road indicate increased noise levels on the morning of July 26 between the period 10 am until approximately 12 noon. Weather information from the Bureau of Meteorology indicate weather conditions during this period would not have any significant effect on noise data (ie. wind speeds were relatively uniform and generally <5 m/s). Anecdotal evidence obtained during fieldworks indicated the area is intermittently subject to fly-overs from the nearby HMAS Albatross Base, which may have affected noise levels, however this is considered representative of the ambient noise environment. The data is therefore considered valid.

Long term noise monitoring and attended observations indicate a noise environment that is primarily dominated by local fauna (birds). Background noise levels are relatively low which is indicative of a rural environment with low traffic levels.

Calculated background L_{A90} day, evening, and night, for the monitoring period are provided in the following tables.

Table 4.1 Noise Monitoring Results – Background L_{A90} Noise Levels at Lot 22 DP 746233

Date	Day 7 am to 6 pm	Evening 6 pm to 10 pm	Night 10 pm to 7 am
21/07/05	29.5	28.5	29.3
22/07/05	33.0	31.5	30.5
23/07/05	31.5	28.0	28.0
24/07/05	30.5	28.5	27.5
25/07/05	36.0	36.5	36.5
26/07/05	37.1	31.5	28.0
27/07/05	29.0	28.3	
RBL	**31.5**	**28.3***	**28.6***

* Note – The INP states that where the rating background level is found to be less than 30 dB(A), then it is set at 30 dB(A), therefore these values have been adjusted to 30dB for further calculations.

Table 4.2 Noise Monitoring Results – Background L_{A90} Noise Levels at 213 Gannet Road

Date	Day 7 am to 6 pm	Evening 6 pm to 10 pm	Night 10 pm to 7 am
21/07/05	30.1	27.0	26.5
22/07/05	31.5	33.0	27.8
23/07/05	30.5	26.5	26.0
24/07/05	33.7	26.8	26.0
25/07/05	38.0	35.2	34.5
26/07/05	38.7	30.3	27.8
27/07/05	28.5	27.5	28.5
RBL	**31.5**	**27.5***	**27.8***

* Note – The INP states that where the rating background level is found to be less than 30 dB(A), then it is set at 30 dB(A), therefore these values have been adjusted to 30dB for further calculations.

Table 4.3 Noise Monitoring Results – Background L_{A90} Noise Levels at 190 Bamarang Road

Date	Day 7 am to 6 pm	Evening 6 pm to 10 pm	Night 10 pm to 7 am
28/07/05	27.9	28.0	27.8
29/07/05	33.5	27.8	26.0
30/07/05	27.7	27.0	25.5
31/07/05	31.0	28.0	26.5
01/08/05	31.2	28.0	27.0
02/08/05	29.7	27.8	27.0
03/08/05	30.0	27.5	27.0
RBL	**30.0**	**27.8***	**27.0***

* Note – The INP states that where the rating background level is found to be less than 30 dB(A), then it is set at 30 dB(A), therefore these values have been adjusted to 30dB for further calculations.

4.2 Attended Noise Monitoring

Attended noise monitoring was undertaken on July 28 at the three nominated noise monitoring locations and at the proposed power facility site.

The monitoring was conducted under cool conditions (approximately 18 ^{o}C). A south westerly breeze less than 5 m/s was occurring during the monitoring, which may have slightly influenced the noise measurements with additional sources such as rustling leaves. Attended observations noted noise sources indicative of a rural or suburban environment which was primarily described by wildlife and periodic localised noise sources.

The attended monitoring was conducted to gain a further understanding of the existing ambient noise environment in the vicinity of the proposed facility.

Results from the attended monitoring is provided in the following table.

Table 4.4 Attended Noise Monitoring July 28 2005 15 minute statistical dB(A)

Location	Time	L10	L90	Leq	Lmax	Lmin
Proposed Site – Demolition not audible	07:40 am	55.1	36.2	44.2	62.7	31.7
Proposed Site –Demolition audible*	08:14 am	68.7	47.6	57.7	81.1	41.0
Lott 22 DP 746233 (Yalwal Road)	08:33 am	64.7	34.7	53.6	81.8	28.3
Lott 22 DP 746233 (Yalwal Road)	08:50 am	64.0	35.0	53.2	82.0	29.8
213 Gannet Road	10:12 am	67.1	42.8	55.0	74.8	37.5
213 Gannet Road	10:28 am	65.9	41.4	54.6	73.7	36.9
190 Bamarang Road	09:13 am	56.2	38.7	46.5	68.3	35.3
190 Bamarang Road	09:29 am	57.4	40.1	47.6	70.5	35.9

Notes * - Demolition was being undertaken of the existing residence during monitoring. One 15-minute session was undertaken within audible distance of the works being undertaken, whilst the other was undertaken at a distance where demolition works were not audible.

Bird calls routinely contributed between 45 – 48 dB (A) and leaves rustling often contributed between 47 – 52 dB (A).

Attended observations at the proposed power facility site noted that the ambient noise environment at this location was primarily described by local fauna (birds). An additional 15-minute measurement was undertaken at the proposed site whilst demolition of the former residence was occurring, with the dominant noise source consisting of the loading and unloading of rubble into the transport vehicles. Traffic along Yalwal Road was not audible during the attended measurements.

Attended observations at Lot 22 DP 746233 (mud brick residence opposite the site on Yalwal Road) noted a similar ambient noise environment as the proposed site. The ambient noise environment was largely influenced by birds. During the attended monitoring, a forklift was operated intermittently for periods of less than 1-minute intervals. Distant traffic along Longreach Road to the east was occasionally audible during the attended monitoring.

Attended observations at 213 Gannet Road (private residence) was also dominated by birds. During attended monitoring, a distant jet was audible for less than a 1-minute period. The resident noted that aircraft noise is regular within the vicinity of this location, specifically, landing jets during both day and evenings.

Attended observations at the residence located at 190 Bamarang Road also noted an ambient noise environment influenced by birds. Local dogs were also audible in the distance. No vehicular traffic was noted along Bamarang Road during the attended monitoring.

5. Environmental Noise Criteria

5.1 Operational Noise Criteria

The INP provides guidance on the assessment of operational noise impacts. The guidelines include both intrusive and amenity criteria that are designed to protect receivers from noise significantly louder than the background level and to limit the total noise level from all sources near a receiver.

Intrusive noise limits set by the INP control the relative audibility of operational noise compared to the background level. Amenity criteria limit the total level of extraneous noise. Both sets of criteria are calculated and the lowest of the two in each time period normally apply. Table 2.2 in the INP provides modifications to the amenity criteria for existing levels of rural noise.

Attended observations noted that existing levels of industrial noise in the area are not a significant contributor to the existing ambient noise level in the vicinity of the development therefore no Table 2.2 adjustments are necessary for the amenity noise criteria. Intrusive criteria are simply 5 decibels above the measured (or adopted) background level with a minimum of 35 dB(A).

The rating background level is the level used for assessment purposes. Where the rating background level is found to be less than 30 dB(A), then it is set to 30 dB(A).

Amenity criteria are determined based on the overall acoustic characteristics of the receiver area and the existing level of noise excluding other noises that are uncharacteristic of the usual noise environment. Residential receiver areas are characterised into ‘urban’, ‘suburban’, ‘rural’ or other categories based on land uses, the existing level of noise from industry, commerce, and road traffic.

Monitoring location Lot 22 DP 746233 is considered to be industrial, as the site is currently used for the manufacture of mudbricks and products, however the NSW DEC’s INP states that the “primary means for identifying the type of receiver is how the receiver area is zoned in the relevant planning instrument”. As the site is zoned 1(d) – General Rural under Shoalhaven Councils LEP, the site is therefore considered to be assessed as a ‘rural’ setting. 213 Gannet Road and 190 Bamarang Road are considered to be located within a rural area as they are dominated by natural sounds with only localised traffic and are located within the 1(d) General Rural zoning.

The INP specifies that a rural area may be located in either a rural, rural-residential, environment protection zone or scenic protection zone, as defined by an LEP or other planning instrument.

The project specific noise levels are provided in Table 5.1.

Table 5.1 Project Specific Noise Levels

	Lot 22 DP 746233			213 Gannet Road			190 Bamarang Road		
Criterion	Day 7 am to 6 pm	Evening 6 pm to 10 pm	Night 10 pm to 7 am	Day 7 am to 6 pm	Evening 6 pm to 10 pm	Night 10 pm to 7 am	Day 7 am to 6 pm	Evening 6 pm to 10 pm	Night 10 pm to 7 am
A: Rating Background Level	32 $L_{A90(day)}$	28* $L_{A90(evening)}$	29* $L_{A90(night)}$	32 $L_{A90(day)}$	28* $L_{A90(evening)}$	28* $L_{A90(night)}$	30 $L_{A90(day)}$	28* $L_{A90(evening)}$	27* $L_{A90(night)}$
B: Intrusiveness Criteria (A + 5dB)	37 $L_{Aeq(15min)}$	35 $L_{Aeq(15min)}$	35 $L_{Aeq(15min)}$	37 $L_{Aeq(15min)}$	35 $L_{Aeq(15min)}$	35 $L_{Aeq(15min)}$	35 $L_{Aeq(15min)}$	35 $L_{Aeq(15min)}$	35 $L_{Aeq(15min)}$
C: Rural Amenity Criteria (Table 2.1 INP)	50 $L_{Aeq(day)}$	45 $L_{Aeq(evening)}$	40 $L_{Aeq(night)}$	50 $L_{Aeq(day)}$	45 $L_{Aeq(evening)}$	40 $L_{Aeq(night)}$	50 $L_{Aeq(day)}$	45 $L_{Aeq(evening)}$	40 $L_{Aeq(night)}$
D: Amenity Criteria: (INP Table 2.2 Adjusted)	50 $L_{Aeq(day)}$	45 $L_{Aeq(evening)}$	40 $L_{Aeq(night)}$	50 $L_{Aeq(day)}$	45 $L_{Aeq(evening)}$	40 $L_{Aeq(night)}$	50 $L_{Aeq(day)}$	45 $L_{Aeq(evening)}$	40 $L_{Aeq(night)}$
E: Project Specific Noise Level (Pg 21 INP)	37 $L_{Aeq(15min)}$	35 $L_{Aeq(15min)}$	35 $L_{Aeq(night)}$	37 $L_{Aeq(15min)}$	35 $L_{Aeq(evening)}$	35 $L_{Aeq(night)}$	35 $L_{Aeq(15min)}$	35 $L_{Aeq(evening)}$	35 $L_{Aeq(night)}$

* Note – The INP states that where the rating background level is found to be less than 30 dB(A), then it is set at a minimum of 30 dB(A), therefore these values have been adjusted to 30 dB for further calculations.

5.2 Construction Noise Criteria

Criteria for the construction phase applied to the assessment were sourced from Section 171 of the DEC's Environmental Noise Control Manual. The criteria was established using the measured background noise levels and applying a conversion factor based on the expected construction period. Construction noise criteria based on Tables 4.1-4.3 background noise levels are shown in Table 5.2.

Table 5.2 Construction Noise Criteria

Construction Period	Level Restrictions	Lot 22 DP 746233 L_{A10}	213 Gannet Road L_{A10}	190 Bamarang Road L_{A10}
Less than 4 weeks	Background + 20 dB	52	52	50
Less than 26 weeks	Background + 10 dB	42	42	40
More than 26 weeks	Background + 5 dB	37	37	35

Normal construction hours are between 7 am to 6 pm Monday to Friday, and 8 am to 1 pm Saturday and at no time on Sundays and public holidays. Construction activity outside those hours is not preferred but can usually occur provided the normal operational noise criteria are met and construction noise is not substantially audible or intrusive inside a dwelling.

5.3 Vibration Criteria

The NSW DEC publication Environmental Noise Control Manual provides guidelines for vibration in Chapter 174. The guidelines are provided in Table 5.3.

Table 5.3 Vibration Guidelines Criteria at Residences

Place	Time	Continuous Vibration (m/s^2)	Intermittent or Impulsive (m/s^2)
Residential	Day	2	60
	Night	1.4	20

5.4 Sleep Disturbance Criteria

The NSW DEC publication ENCM, Chapter 19 provides consideration for sleep arousal levels. It states that noise control should be applied with the general intent to protect people from sleep arousal. The purpose of sleep arousal guidelines is to address short high level noise likely to cause awakening during night time period 10 pm to 7 am and 8 am on Sundays and Public Holidays. To achieve this, the L1 level of any specific noise source should not exceed the background noise level (L_{90}) by more than 15 dB(A) when measured outside the bedroom window.

6. Assessment of Potential Impacts

6.1 Model Set-up

The closest residential receptor to the proposed power facility site is located approximately 750 m to the north across Yalwal Road. Day, evening and background night noise levels were slightly lower at location 190 Bamarang Road.

Acoustic modelling was undertaken using Computer Aided Noise Abatement (CadnaA) to predict the effects of industrial noise generated by the proposed power facility. It should be noted that modelling was undertaken in the absence of any noise attenuation parameters, which would normally form part of the development phase of the project.

CadnaA is a computer program for the calculation, assessment and prognosis of noise exposure. CadnaA calculates environmental noise propagation according to ISO 9613-2 and road traffic noise according to CRTN, which was developed by the UK Department of Transport.

Modelling results are based on available information provided and should only be used as a guide for comparative purposes.

Modelling was based on raw noise data provided by major equipment manufacturers for the respective equipment prior to incorporation of any noise mitigation measures.

Plant layout and building structures were based on information provided at the time of the assessment.

Sound power levels including the 1/3 octave bands are provided in Table 6.1 – 6.5 for all stage 1 and stage 2 plant equipment.

Table 6.1 Standard Package Combustion Turbine Generator

Octave Band Sound Power Level (Lw), dB										Overall Lw	
Source Component	Octave Band Centre Frequency, Hz										
	31.5	63	125	250	500	1K	2K	4K	8K	dBA	dB
CT Inlet	114	105	101	91	87	83	90	93	95	99	115
CT Inlet Elbow & Duct	109	105	98	94	91	94	95	91	83	100	111
CT Compartment	114	113	109	106	100	99	101	99	96	107	118
GEN Compartment	114	115	115	105	101	100	98	93	89	106	120
Exhaust Duct	114	113	108	100	97	95	92	89	80	101	117
COMP Ventilation	95	93	92	90	90	85	85	78	74	92	100
CT Fin Fan Cooler	n/a	101	100	100	98	93	89	85	78	99	106

Table 6.2 Standard Package Heat Recovery Steam Generator

Octave Band Sound Power Level (Lw), dB										Overall Lw	
Source Component	Octave Band Center Frequency, Hz										
	31.5	63	125	250	500	1K	2K	4K	8K	dB A	dB
Transition Ductwork	124	120	116	112	108	105	102	96	83	111	126
Boiler Section	120	115	112	108	103	101	98	92	78	107	122
Stack Exit	118	115	120	119	114	107	99	91	75	115	125

Table 6.3 Generator Set-up Transformers

Octave Band Sound Power Level (Lw), dB										Overall Lw	
Source Component	Octave Band Center Frequency, Hz										
	31.5	63	125	250	500	1K	2K	4K	8K	dBA	dB
GSUT	102	108	110	105	105	99	94	89	82	105	114

Table 6.4 Major Pumps

Octave Band Sound Power Level (Lw), dB										Overall Lw	
Source Component	Octave Band Center Frequency, Hz										
	31.5	63	125	250	500	1K	2K	4K	8K	dBA	dB
Pump/Motor Assembly	103	109	107	106	105	104	103	102	98	110	115

Table 6.5 Cooling Tower

Octave Band Sound Power Level (Lw), dB										Overall Lw	
Source Component	Octave Band Center Frequency, Hz										
	31.5	63	125	250	500	1K	2K	4K	8K	dBA	dB
Fan (per cell)	109	112	112	109	106	102	99	96	88	108	117
Inlet Face (per cell)	77	77	79	82	89	93	93	94	93	100	100

Gas turbine operations were modelled to represent a worst case scenario. Modelling was undertaken based on the following differing meteorological and operational conditions:

- Scenario 1 – Stage 1 development, calm weather conditions, with no wind during day time period;
- Scenario 2 - Stage 1 development, Class F[1] concawe weather conditions, wind speed 2 m/s towards north west (Lot 22 DP 746233 and 190 Bamarang Road) during early morning period;
- Scenario 3 – Stage 1 development, Class F concawe weather conditions, wind speed 2 m/s towards south east (213 Gannet Road) during early morning period;

[1] The default inversion parameter Class F has been used based on the area classified as a non-arid area.

- Scenario 4 – Stage 2 development, calm weather conditions, with no wind during day time period;
- Scenario 5 - Stage 2 development, Class F concawe weather conditions, wind speed 2 m/s towards north west (Lot 22 DP 746233 and 190 Bamarang Road) during early morning period; and
- Scenario 6 – Stage 2 development, Class F concawe weather conditions, wind speed 2 m/s towards south east (213 Gannet Road) during early morning period.

6.2 Operational Noise Assessment - Stage 1 Development

Results of the modelling suggest project specific noise goals may be exceeded during the Stage 1 development at the residence nearest the proposed power facility under the following modelled scenarios:

- During neutral weather conditions and during Class F wind direction towards the north west and the south east at Lot 22 DP 746233 in the absence of noise attenuation measures. At present, there is no permanent residence at Lot 22 DP 746233, however it is understood there are plans for the construction of a permanent residential dwelling; and
- at location 213 Gannet Road during Class F conditions with wind direction towards the south east (receiver location) in the absence of noise attenuation measures.

Predicted noise contour plots are presented in Figures A1 – A3 in **Appendix A**.

6.3 Operational Noise Assessment - Stage 2 Development

Results of the modelling suggest project specific noise goals may be exceeded during the Stage 2 development at the residence nearest the proposed power facility under the following modelled scenarios:

- Under all meteorological and operational conditions without any noise attenuation measures at residential properties located at Lot 22 DP 746233, 213 Gannet Road and 190 Bamarang Road; and
- Under Class F weather conditions with wind direction towards the north west (receiver location) at location Lot 22 DP 746233 with an upgrade of 96 dB(A) SWL.

Predicted noise contour plots are presented in Figures A4 – A6 in **Appendix A**.

6.4 Modelled Operation Results

Modelled sound pressure levels at the residential receiver locations for both development stages without any noise attenuation measures are summarised in Table 6.6.

Table 6.6 Modelled Unattended Receiver Sound Pressure Levels dB (A) – WITHOUT Noise Attenuation Measures

	Scenario 1- Stage 1 Neutral Weather dB(A)	Scenario 2- Stage 1 F Class towards north west dB(A)	Scenario 3- Stage 1 F Class towards south east dB(A)	Scenario 4- Stage 2 F Class Neutral Weather dB(A)	Scenario 5- Stage 2 F Class towards north west dB(A)	Scenario 6- Stage 2 F Class towards south east dB(A)	Project Specific Noise Goals dB(A)
Lot 22 DP 746233	**40.8**	**46.0**	**40.8**	**48.9**	**54.0**	**50.2**	35
213 Gannet Road	30.7	30.7	**36.5**	**38.8**	**38.5**	**44.9**	35
Bamarang 190 Road	26.7	32.1	26.7	**35.3**	**41.1**	**35.3**	35

Note – **40.8** indicates respective scenario exceeds project specific noise goal.

6.5 Construction Noise Assessment

The construction noise criteria are set for noise levels determined as $L_{10(15min)}$. During a full 15-minute period the machinery items to be used on site will operate at maximum sound power levels for only brief stages. At other times the machinery may produce lower sound levels while carrying out activities not requiring full power.

In addition, mobile machinery will likely move about during the 15 minutes, variously altering the directivity of the noise source with respect to individual receivers.

As it is likely construction activities would be undertaken over 26 consecutive weeks, the construction noise criterion should be considered as being Background + 5 dB(A) – Lot 22 DP 746233 - 37 dB(A), 213 Gannet Road - 37 dB(A) and 190 Bamarang Road - 35 dB(A). As a consequence, in a worst case configuration, noise levels may have the potential to reach project specific noise levels during construction. However, it is highly unlikely that all of the machinery would be operating at full power at the same time for an extended period.

Typical noise levels produced by construction plant anticipated to be used on site were sourced from AS 2436 – 1981 Guide to Noise Control on Construction, Maintenance and Demolition Sites and from GHD's internal database. The power levels were then distance attenuated from the proposed construction site. Propagation calculations take into account sound intensity losses due to spherical spreading, with additional minor losses such as atmospheric absorption, directivity and ground absorption ignored in the calculations. As a result, predicted received noise levels are expected to slightly overstate actual received levels and thus provide a measure of conservatism.

Received noise at each assessed distance, from each item of plant on site, is added (where appropriate) to determine the total received noise at that distance from construction activities and compared to the criteria.

Received noise produced by anticipated activities, during the construction of the upgraded facility is shown in Table 6.7 for a variety of distances to a typical receiver, with no noise barriers or acoustic shielding in place and with each plant item operating at full power.

Table 6.7 Predicted Plant Item Noise Levels, dB(A)

Plant Activity SWL dB(A)	40 m	80 m	160 m	320m	640m	1280m
Crane 110	70	64	58	52	46	40
Backhoe 108	68	62	56	50	44	38
Compressor 100	60	54	48	42	36	30
Concrete Pump 109	69	63	57	41	35	29
Dump Truck 108	68	62	56	50	44	38
Water Tanker 109	69	63	57	51	45	39
Compactor 110	70	64	58	52	46	40
Concrete Saw 118	78	72	66	60	54	48
Paver 113	73	67	61	55	49	43
Rock Breaker 118	78	72	66	60	54	48
Piling Impact Boring 120	80	74	68	62	56	50

The sound power levels shown in Table 6.1 are maximum levels produced when machinery is operated under full load.

6.6 Construction Vibration Assessment

Vibration generated by pile driving is expected to generate the most significant vibrations levels. Rolling activities, and trucking movements are also expected to generate some levels ground borne vibration. Table 6.8 outlines typical vibration levels for different plant activities sourced from the NSW RTA Publication Environmental Noise Management Manual.

Table 6.8 Typical Vibration Levels – Construction Equipment

Item	Peak Particle Velocity at 10m (mm/s)
Piling	12-30
Loader Breaking Kerbs	6-8
15 Tonne Compactor	7-8
7 Tonne Compactor	5-7
Roller	5-6
Pavement Breaker	4.5-6
Dozer	2.5-4
Backhoe	1
Jackhammer	0.5

As the nearest residences are located at least 500 m away from the proposed site, vibration criteria are not expected to be exceeded.

6.7 Sleep Disturbance Assessment

The INP states that the L1 level of any specific noise source should not exceed the background noise level (L_{90}) by more than 15 dB(A) when measured outside the bedroom window.

The adjusted operational noise levels with and without noise attenuation measures are provided in Tables 6.9 and 6.10 respectively.

Table 6.9 Sleep Disturbance Noise Levels – Without Noise Attenuation

	Stage 1 Development dB(A)	Stage 2 Development dB(A)	Project Specific Noise Goals dB(A)	Sleep Disturbance Level (Background +15 dB)
Lot 22 DP 746233	46.8	51.9	35	50
213 Gannet Road	36.5	43.2	35	50
Bamarang 190 Road	32.1	37.9	35	50

Note * - The highest value for each respective scenario has been adopted for conservatism.

Table 6.10 Sleep Disturbance Noise Levels – With Noise Attenuation

	Stage 1 Development dB(A)	Stage 2 Development dB(A)	Project Specific Noise Goals dB(A)	Sleep Disturbance Level (Background +15 dB)
Lot 22 DP 746233	32.1	37.1	35	50
213 Gannet Road	23.4	28.4	35	50
Bamarang 190 Road	14.4	19.4	35	50

Noise modelling suggests that sleep disturbance criteria can be met at all three monitoring locations during operation of the power facility both with and without the implementation of noise attenuation measures.

7. Recommended Mitigation Measures

7.1 Mitigation Scenarios

The exceedance levels are based on CCGT equipment raw data supplied by the manufacturers with no noise mitigation measures implemented. To meet the industrial noise policy noise mitigation measures need to be implemented with individual pieces of plant. . However no acoustic attenuation data for the items of plant is currently available for the required attenuation of their individual component.

Therefore, CADNA-A was used to provide a mitigation scenario for each set of equipment having sound pressure level 80 and 85 dBA (SPL) respectively at 1m from the noise source which corresponds to the general industrial practice noise requirements. These sound pressure levels were converted to sound power for levels for modelling purposes using the equation:

$$SPL = SWL - 20\log r - 11$$

Where:

- SPL = Sound Pressure Level
- SWL = Sound Power Level
- r =1m

Therefore the resultant sound power levels used in the model were 91 and 96 SWL dB(A) respectively. From this the resultant predicted sound pressure levels at the receiver points can be determined as a guide. The following mitigation scenarios were modelled:

- Scenario 7 – Stage 2 development, calm weather conditions, with no wind during day time period with 91 dB(A) SWL upgrade;
- Scenario 8 - Stage 2 development, Class F concawe weather conditions, wind speed 2 m/s towards north west (Lot 22 DP 746233 and 190 Bamarang Road) during early morning period with 91 dB(A) SWL upgrade;
- Scenario 9 – Stage 2 development, Class F concawe weather conditions, wind speed 2 m/s towards south east (213 Gannet Road) during early morning period with mitigation of 91 dB(A) SWL upgrade;
- Scenario 10 – Stage 2 development, calm weather conditions, with no wind during day time period with mitigation of 96 SWL dB(A) upgrade;
- Scenario 11 - Stage 2 development, Class F concawe weather conditions, wind speed 2 m/s towards north west (Lot 22 DP 746233 and 190 Bamarang Road) during early morning period with mitigation of 96 SWL dB(A) upgrade; and

- Scenario 12 – Stage 2 development, Class F concawe weather conditions, wind speed 2 m/s towards south east (213 Gannet Road) during early morning period with mitigation of 96 SWL dB(A) upgrade.

Predicted noise contour plots are presented in Figures A7 – A12 in **Appendix A**.

Modelled sound pressure levels at the residential receiver locations for the Stage 2 development represents a worst case scenario with all plant items operating, including noise generating equipment from Stage 1 development. Therefore the Stage 1 development with SWL specified as 91 dB(A) for all significant noise generating equipment, is predicted to meet the relevant project specific noise goals.

Modelled sound pressure levels with noise attenuation measures in place are summarised in Table 7.1.

Table 7.1 Modelled Unattended Receiver Sound Pressure Levels dB (A) – WITH noise attenuation measures

	Scenario 7- Upgrade 80 dB(A) Neutral Weather	Scenario 8- Upgrade 80 dB(A) F Class towards north west	Scenario 9- Upgrade 80 dB(A) F Class towards south east	Scenario 10- Upgrade 85 dB(A) F Class Neutral Weather	Scenario 11- Upgrade 85 dB(A) F Class towards north west dB(A)	Scenario 12- Upgrade 85 dB(A) F Class towards south east	Project Specific Noise Goals dB(A)
Lot 22 DP 746233	39.2	32.9	29.2	34.2	37.9	34.2	35
213 Gannet Road	19.4	19.4	23.8	24.6	24.6	29.0	35
Bamarang 190 Road	11.9	15.1	11.9	17.0	20.2	17.0	35

Note – **37.9** indicates respective scenario exceeds project specific noise goal.

To achieve the recommended noise mitigation scenario to achieve project specific noise goals, the above-mentioned noise emission guarantee is recommended to be specified and should be provided by each individual equipment manufacturer. The mitigation scenarios outlined should only be used as a guide to the achievable outcome.

The following tables list the sources used for this mitigation scenario.

Table 7.2 Mitigation Scenario Equipment Sound Power Levels dB(A)

Equipment	No. Items	SWL dB(A) Scenario 10,11 & 12	SWL dB(A) Scenario 7,8 & 9
Combustion Turbine Generator	2	96	91
Heat Recovery Steam Generator	1	96	91
Cooling Tower	6	96	91
Generator Step-up Transformer	3	96	91
Steam Turbine Generator	1	96	91

7.2 Noise Attenuation Options

It is presumed major components of the proposed CCGT power plant at Bamarang such as the combustion gas turbines, heat recovery steam generators, steam turbine and cooling towers would be selected from prospective Original Equipment Manufacturers (OEMs) following competitive tendering processes, which would occur as part of the detailed design development of the project. It is expected that the components selected would be 'off the shelf' units, provided by OEMs. Exact noise outputs, and therefore the necessary features that would need to be incorporated in the design to ensure that noise criteria will be achieved, can only be determined once the tendering processes are finalized.

The specification provided to prospective OEMs would dictate the acoustic performance and are recommended to be based on the conditions of consent from this Noise Impact Assessment. The OEMs would develop the mitigation measures such that the noise attenuation is maximised and impacts are minimised. The usual industrial practice, is to provide a performance-based specification approach involving a sound level specification, rather than a prescriptive requirement to include specific mitigation measures. This will promote design flexibility for the OEMs and to enhance their ability to achieve the optimum outcome in an efficient and effective way.

7.2.1 Potential Noise mitigation options for major equipment of the proposed CCGT power plant facility

This assessment has outlined sound power level requirements in order to achieve the project specific noise goals. It is not the intent of this report to outlined the prescriptive requirements for this project. However the following represents typical noise mitigation strategies for major equipment of similar power plant facilities.

Combustion Gas Turbine (CGT)

Typical noise emission mitigation improvements to be deployed for CGT include:

- Air inlet silencing;
- Acoustic insulation on the outside of the air inlet;
- Upgrades of the standard CGT acoustic enclosure;
- Upgrades of the cooling system with low noise fans and/or acoustic treatment;
- Upgrades of exhaust silencing;
- Acoustic walls and/or additional acoustic treatment for the generator enclosure;
- Placing the gas turbine in a building is usually the last resort due to capital outlay considerations; and
- The air inlet and cooling systems are generally outdoor sources and could potentially be attenuated.

Heat Recovery Steam Generator (HRSG)

Outlined below are general noise mitigation strategies that typically deployed in HRSGs of combined cycle power plants. This information here provided is only to be used as general guidance in developing the HRSG mitigation strategies, which is one part of the overall facility noise mitigation plan. HRSG noise mitigation strategies typically include:

- The installation of a silencer in the exhaust stack;
- Increasing the casing thickness/mass of the transition and/or boiler sections;
- Erecting barrier walls;
- Installation of an acoustical shroud over all or portions of the transition duct; and
- Installation of silencer in the transition portion of HRSG (this is normally the last resort i.e. when all other noise mitigation measures have been deployed and the noise requirement is still not met.)

Steam Turbine Generator (STG)

STG noise mitigation strategies typically include:

- Insulation of STG casing with acoustic blankets;
- Increase insulation thickness of all steam piping leading to STG;
- Installation of acoustic casing for STG; and
- Indoor installation of entire STG for the purpose of noise mitigation and weather protection.

Cooling Towers (CT)

CT noise mitigation strategies typically include:

- Barrier walls around CT;
- Implementing a low noise fan motor;
- Having acoustically designed fan blades;
- A silencer at force draft fan inlet; and
- A silencer at force draft fan outlet (not the preferred option as it will increase the fan backpressure and hence the fan power required).

It is additionally recommended that a noise monitoring program as part of a noise management strategy be implemented. The program would assess the noise compliance of the CCGT power plant, review and amend noise the noise management strategy as needed once the CCGT power plant is in operation.

7.3 Construction Noise Mitigation Measures

To minimise noise emissions during construction, the following management and mitigation measures are available to ameliorate likely noise impacts:

- All combustion engine plant, such as generators, compressors and welders will be checked to ensure they produce minimal noise with particular attention to residential grade exhaust silencers;
- Vehicles will be kept properly serviced and fitted with appropriate mufflers. The use of exhaust brakes will be eliminated, where practicable;
- Where practical, all vehicular movements to and from the construction site must be made only during normal working hours;
- Where practical, machines will be operated at low speed or power and will be switched off when not being used rather than left idling for prolonged periods;
- Machines found to produce excessive noise compared to industry best practice will be removed from the site or stood down until repairs or modifications can be made; and
- Where practical, impact wrenches will be used sparingly with hand tools or quiet hydraulic torque units preferred.

With regard to potential traffic noise, by keeping plant related vehicles serviced, fitted with mufflers and eliminating exhaust brake usage, noise due to trucking activity associated with the operation and construction of the CCGT power plant can be significantly mitigated.

8. Conclusion

Noise monitoring and assessment was undertaken on behalf of Delta Electricity as part of an environmental assessment, to assess the acoustic impact of the proposed gas turbine power facility located at Bamarang, near Nowra NSW. The basis of the assessment was to ascertain whether the proposed facility would have an acoustical effect on the amenity of residences living in close proximity of the site, during both construction and operation of the power facility.

Attended and unattended noise monitoring was undertaken to determine the existing background and ambient noise environment in the vicinity of the proposed power facility, and to provide an estimation of the noise output of the facility. Detailed noise modelling was undertaken based on provided sound power levels of primary noise sources for the proposed facility.

Construction pile driving is potentially the greatest source of vibration associated with construction equipment expected to be used for the project. By avoiding impact pile driving where possible in vibration sensitive areas through the use of drilled piles or the use of a sonic or vibratory piles as mentioned in the assessment it can be expected that adverse vibration impacts can be significantly minimised.

Construction noise has the potential to exceed project specific noise goals in a worst case scenario with all plant and equipment operating at their full sound power levels. As this scenario is highly unlikely to occur, construction noise is not expected to exceed project specific noise goals.

Based on distance to the nearest anticipated receivers, vibration is not likely to be an issue.

Modelling was undertaken under differing meteorological and operational (i.e. with and without noise attenuation measures in place) for both Stages of the proposed development.

Results of the modelling indicate project specific noise goals may potentially be exceeded at any one of the monitoring locations during operation under differing meteorological conditions, in the absence of any noise attenuation measures.

The revised noise mitigation scenario based on general industrial practice suggests that if all equipment are attenuated to a minimum sound power level of 91 dB(A) upgrade then the project specific noise goals for Stage 1 & 2 can be met at all monitoring locations. It is therefore recommended that such noise level specifications be implemented to all equipment manufacturers of this proposed gas turbine power plant.

Given the implementation of recommended noise mitigation measures as presented in Section 7 and the EPC process which will ensure manufacturers have demonstrated that site specific noise goals can be achieved during operation of respective plant and/or machinery, it is considered that project specific noise goals may be achieved at all three monitoring locations.

9. References

Australian Standards (AS 2436), 1981, Guide to Noise Control on Construction, Maintenance and Demolition Sites.

NSW DEC, Environmental Criteria for Road Traffic Noise, May, 1999.

NSW DEC, Environmental Criteria for Industrial Noise Policy (INP), January 2000.

NSW DEC, Environmental Noise Control Manual, June 1994.