R

Noise Report

Arafura Resources Limited

Nolans Project Environmental Impact Statement

Appendix R: Noise Report

May 2016

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Glossary – Noise and vibration terms

Term	Definition
dB	Decibel is the unit used for expressing the sound pressure level (SPL) or power level (SWL) in acoustics.
dB(A)	Frequency weighting filter used to measure 'A-weighted' sound pressure levels, which conforms approximately to the human ear response, as our hearing is less sensitive at very low and very high frequencies.
Ground Borne Vibration	Ground borne vibration is vibration transmitted from source to receiver via the medium of the ground.
Ground borne Noise	Ground borne noise describes noise transmitted as vibration through the ground and into structures, radiated as low frequency rumbling noise.
$L_{Aeq(period)}$	Equivalent sound pressure level: the steady sound level that, over a specified period of time, would produce the same energy equivalence as the fluctuating sound level actually occurring.
$L_{A10(period)}$	The sound pressure level that is exceeded for 10% of the measurement period.
$L_{A90(period)}$	The sound pressure level that is exceeded for 90% of the measurement period.
L_{Amax}	The maximum sound level recorded during the measurement period.
Peak Particle Velocity	Current practice for assessments of the risk of structural damage to buildings use measurements of Peak Particle Velocity (PPV) ground vibration (v_p), which is the maximum vector sum of three orthogonal time-synchronized velocity components.
Rating Background Level (RBL)	The overall single-figure background level representing each assessment period (day / evening / night) over the whole monitoring period.
RMS	Root mean square.
Vibration	The variation of the magnitude of a quantity which is descriptive of the motion or position of a mechanical system, when the magnitude is alternately greater and smaller than some average value or reference. Vibration can be measured in terms of its displacement, velocity or acceleration. The common units for velocity are millimetres per second (mm/s).

1. Introduction

1.1 Background

Arafura Resources Ltd (Arafura) proposes to construct a rare earth mine at Nolans Bore, located 135 km north west of Alice Springs in the Northern Territory. The proposed mine and associated infrastructure are referred to as the Nolans project. Arafura propose to extract ore for rare earth elements such as neodymium, praseodymium, samarium and europium.

The Nolans project consists of the following components:

- An open cut mine and associated mine infrastructure including a concentrator for beneficiation
- An intermediate processing plant 8 km south of the mine site
- A borefield area
- Transport of product and reagent between Nolans site and railway at Alice Springs is approximately 135 km
- A 300-person camp at the Nolans site for worker accommodation
- Supporting infrastructure such as administration, utilities and waste storage.

In March 2008 the Northern Territory Minister for Natural Resources, Environment and Heritage determined that a draft Environmental Impact Statement (EIS) is required for the Nolans project. Following the proponent lodging an alteration to the proposal to the Northern Territory Environment Protection Authority (NT EPA), the NT EPA subsequently issued revised Terms of Reference (TOR), entitled: Terms of Reference for the Preparation of an Environmental Impact Statement: Nolans Rare Earth Project – Arafura Resources Limited, in May 2015. The EIS is being prepared under a bilateral arrangement between the Commonwealth and Northern Territory governments.

This noise and vibration study aims to address the requirements in section 5.13.2 of the TOR by providing information that allows potential impacts from noise and vibration generated from the Project site.

This report is subject to, and must be read in conjunction with the limitations presented in section 9 and the exclusions, assumptions and qualifications contained throughout the report.

1.2 Scope of work

The scope of works for the noise and vibration impact assessment, as a component study required for the EIS is as follows:

- Initial desk top review to identify key environmental noise catchment areas and noise sensitive receptors from aerial photography
- Unattended noise monitoring for a period of one week at two (2) locations within the vicinity of Aileron Roadhouse sensitive receiver
- Attended noise measurements have also been undertaken at the noise logger locations to supplement the unattended measurements

- Based on monitoring results, determination of project specific noise and vibration criteria for the construction and operation of the Nolans Project, with consideration to the following guidelines:
  - *NT EPA – Noise guidelines for development sites in the Northern Territory (NT EPA 2014)*
  - *NSW Environment Protection Authority (NSW EPA) Industrial Noise Policy (2000),* in the absence of equivalent NT noise guidelines.
- Identification of the likely principal noise and vibration sources during construction and operation of the Project
- Noise modelling using Computer Aided Noise Abatement (CadnaA) software to predict sound pressure levels emanating from the proposed operation of the mine site at the nearest identified noise receiver
- Desktop noise assessment of construction activities
- Desktop assessment of construction and operation vibration impacts
- Desktop assessment of blasting vibration and overpressure impacts
- Provision of in-principle noise and vibration mitigation measures.

2. Project context

2.1 Project description

The Nolans project is proposed to be located in an approximate 14 km^2 mine site. An open pit operation would mine to a depth of approximately 215 m.

In addition to the mining pits, the Nolans project site would contain:

- Overburden storage areas
- Ore stock pile
- Concentrator
- Intermediate processing plant
- Natural gas power plant
- Water treatment plant
- Office and amenities
- Tailings dams and residue storage areas
- Chemical, fuel and explosives storage facilities.

Permanent and temporary accommodation for employees is proposed to be provided in a purpose built accommodation facility located on site. This is discussed further in Section 3.1 of this report.

Ore will be open cut mined and removed by excavators and haul trucks. Ore will be beneficiated onsite before a rare earths concentrate slurry will be pumped approximately 8 km to the south to an intermediate processing plant. Further processing of the rare earths concentrate product will occur at an offshore rare earths separation plant in an established chemical precinct. This separation plant is outside the scope of this assessment.

2.1.1 Process description

The mine will be of conventional open-pit design. Ore and waste rock will be hauled to either to the run of mine stockpile (ROM or waste dumps. The concentrator processes the ROM and long-term stockpile ore via a beneficiation plant circuit consisting of high intensity magnetic separation and floatation cells. A slurry pipeline will pump concentrate across 8 km to the rare earth (RE) processing plant. Rare earths concentrate product and incoming reagents and supply materials will be transported to and from the project site via the Stuart Highway to Alice Springs. Ancillary major plant includes a sulphuric acid plant and an 18 MW power station (natural gas) plant.

2.1.2 Sulfuric acid plant

Sulphur acid will be produced on site by burning sulphur. Sulphur will arrive in Darwin as a bulk product and will be containerised at the Darwin Port and shipped to Alice Springs on the rail. It will then be transported to the site on road trains on the Stuart Highway.

2.1.3 Power station

The power demand for the Nolans project is estimated to be 18.5 MW. There is no local grid supply available. The sulphuric acid plant will enable around 6 MW of power to be generated using excess heat and steam from the acid making process. The balance of the power requirements, 12.5 MW will be produced by high efficiency gas fired generation. The high pressure (natural) gas pipeline from the Amadeus Basin to Darwin passes through the Nolans site. The power plant will be located at the processing plant.

Specifications for the gas fired generation were obtained from a reciprocating engine for natural gas and based on previous assessments conducted by GHD for natural gas fired plants.

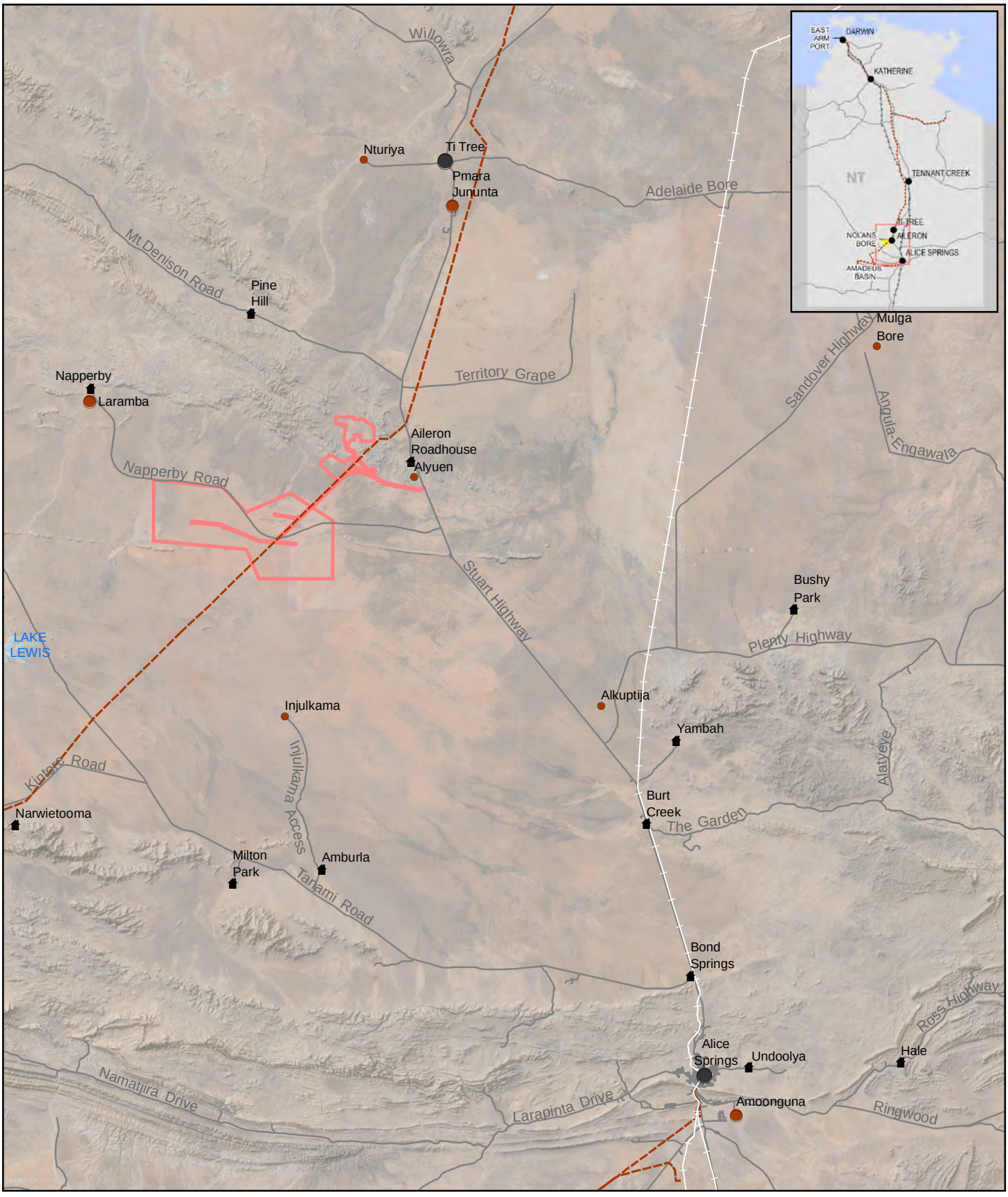
2.2 Study area

The study area for this assessment is defined as including:

- The land within the mineral lease boundary (mine site)
- The Aileron Roadhouse and an access road to the project site
- The Nolans project accommodation village located approximately 5 km southeast of the processing plant.

The Nolans project location and the associated site area are shown in Figure 1 and Figure 2 respectively.

The proposed mine site layout is shown in Figure 3.



LEGEND

- Town
- Community
- Station
- Outstation
- Gas Pipeline
- Major Roads
- Project Areas
- Waterbodies

1:1,000,000 @ A4

0 10 20 30 40

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 53

N

Arafura Resources Limited
Nolans Project

Job Number	43-22301
Revision	0
Date	18 Mar 2016

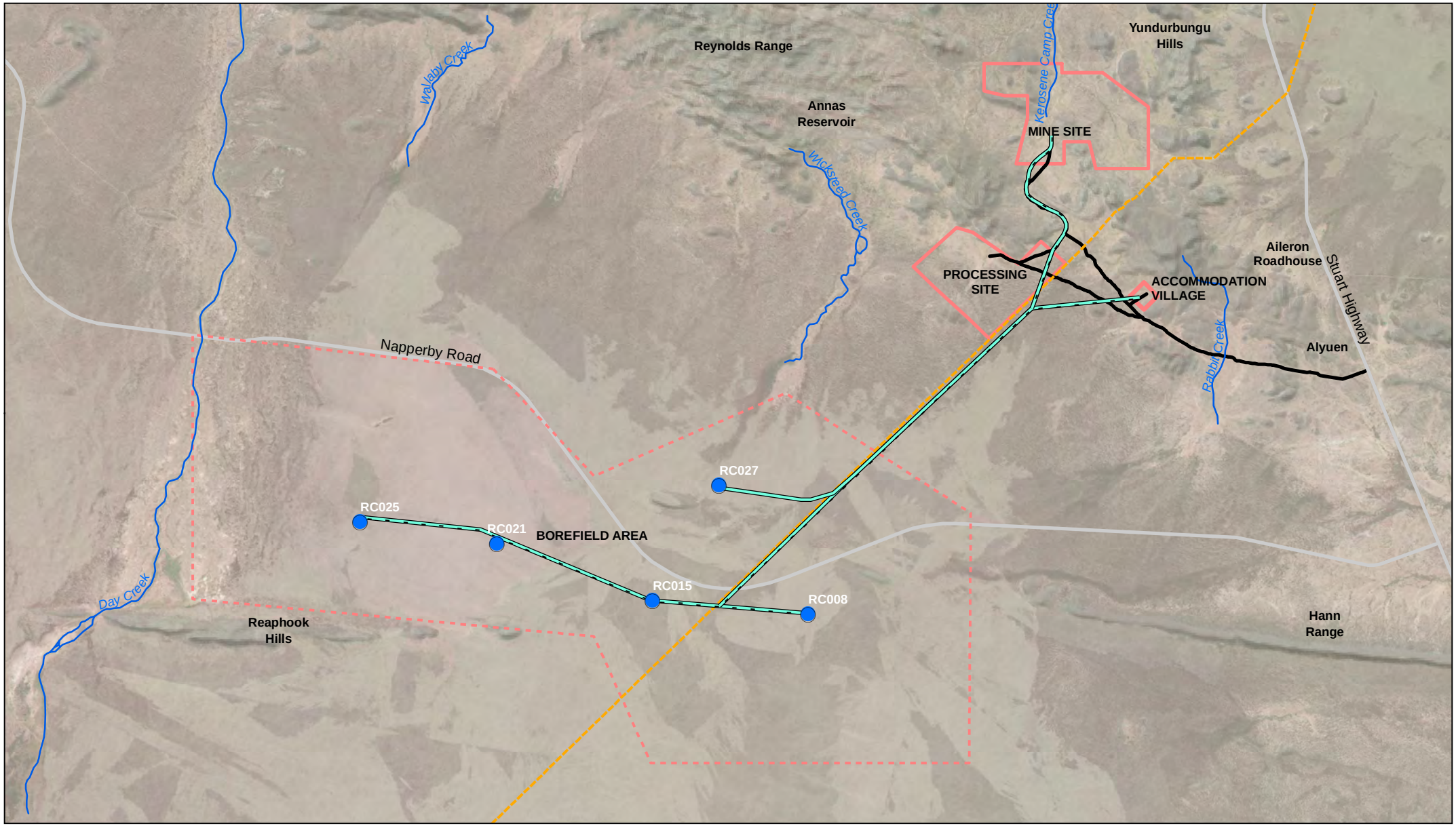
Nolans project location

Figure 1

G:\43\22301\GIS\Maps\4322301_807_ProjectLocation.mxd

Level 5, 66 Smith Street Darwin NT 0800 Australia **T** 61 8 8982 0100 **F** 61 8 8981 1075 **E** drwmail@ghd.com **W** www.ghd.com

Data source: GA - Roads, Gas Pipeline, Waterways, Placenames, Placenames, Lakes (2015). ESRI - Shaded Relief (2009). Google Earth Pro - Imagery (Date extracted: 09/11/2015). ARL - Project Areas (2015). Created by: CM



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0 2 4 6 8

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 53

N

LEGEND

- Water Bores
- Proposed Powerline
- Proposed Pipelines and Easement
- Existing Gas Pipeline and Easement
- Waterways
- Existing Roads
- Existing Access Track
- Borefield Area
- Site Boundaries

Arafura Resources Limited
Nolans Project

Job Number	4322301
Revision	0
Date	18 Mar 2016

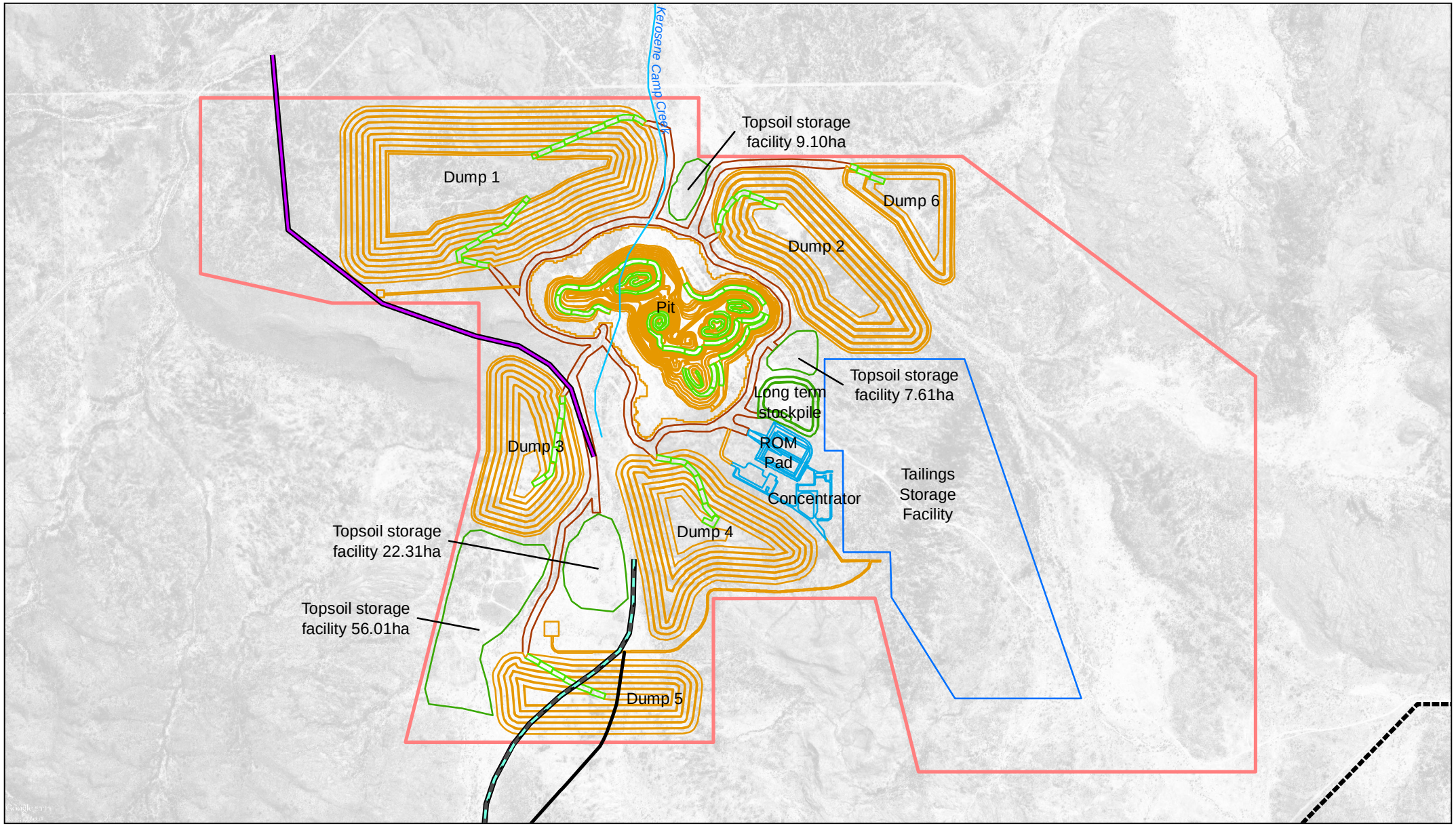
Nolans site

Figure 2

G:\43\22301\GIS\Maps\4322301_804_NolansSite.mxd

Level 5 66 Smith Street Darwin NT 0800 Australia T 61 8 8982 0100 F 61 8 8981 1075 E drwmail@ghd.com W www.ghd.com

Data source: GA - Imagery (2008), Roads, Waterways, Placenames (2015). ESRI - Shaded Relief (2009). ARL - Water Bores, Proposed Pipelines, Borefield Area, Proposed Mine Site, Treatment Plant and Accommodation Village (2015). Created by: CW, CM



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0 250 500 750 1,000

Metres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 53

N

LEGEND

- Powerline
- Potable Water Pipeline
- Diversion Channel
- Water Supply Pipeline
- Waterways
- Access Road
- Existing Gas Pipeline
- Mine Site Boundary

Arafura Resources Limited
Nolans Project

Job Number 4322301
Revision 0
Date 18 Mar 2016

General facilities arrangement mine site

Figure 3

G:\43\22301\GIS\Maps\4322301_805_ProjectInfrastructureMineSite.mxd

Level 5 66 Smith Street Darwin NT 0800 Australia T 61 8 8982 0100 F 61 8 8981 1075 E drwmail@ghd.com W www.ghd.com

Data source: Google Earth Pro - Imagery (Date extracted: 29/04/2015). ARL - Proposed Pipelines, Proposed Mine Site, Proposed Diversion Channel Options, Tailings Storage Facility (2015). Created by: CM

2.3 Noise sources

2.3.1 Construction

Noise and vibration generated as a result of construction activities are outlined below. Construction works are due to commence as soon as all relevant approvals and permits are obtained.

Construction plant and equipment for potential major noise sources expected to be undertaken onsite may include the following:

- Crane
- Backhoe
- Compressor
- Concrete pump
- Dump truck
- Water tanker
- Compactor
- Blasting.

Most construction activities will occur on day shift between 0600 to 1800 hours. Work at other times would only occur if required for special tasks or to recover lost time due to project delays.

An assessment of construction noise and vibration has been made in Sections 5.1 and 5.2.

2.3.2 Operation

Noise sources resulting from operation of the Project are outlined below. Major operational noise sources present during operation would include:

- Excavator
- Truck
- Dozer
- Grader
- Service truck
- Water truck
- Rock breaker
- Lighting plant
- Front end loader
- Light vehicle
- Surface crawler drill

- Reverse Circulation (RC) drill
- Dewatering pump
- Power station
- Acid plant
- Primary crusher
- Screening plant and
- Milling.

It is anticipated that the project will have emergency power generation backup for critical parts of the plant and accommodation village in the event of power failure. However, since the emergency generators only operate temporarily during emergencies, they are not considered as part of the Project's normal day-to-day operating conditions, and therefore have not been included in the operational noise impact assessment of the Project.

Unless otherwise stated, the above noise sources are present continuously during Project operation (24 hours, seven days per week).

Detailed design and engineering have not been completed for the Project and as such sound power levels are based on preliminary design information. Sound power levels from previous projects for similar facilities, Australian Standards and GHD internal database have been used for this assessment. Sound power levels have been provided for the major items of plant and equipment for the Project based on preliminary design information and are considered representative of Project noise sources. An assessment of operational noise has been provided in Section 6.1.

3. Existing noise environment

3.1 Sensitive receivers

The Project is located in a rural area.

Aerial photography, project information and a site visit in August 2010 were used to determine the proximity of the closest noise sensitive receivers.

Small communities and family outstations in the surrounding area are detailed below.

3.1.1 Nearby human sensitive receiver within the project site

The proposed Nolans project accommodation village is considered as the nearest human receiver within the Project site. The village is proposed to be located approximately 5 km southeast of the processing plant (refer to Figure 2).

3.1.2 Nearby human sensitive receiver external to the project site

The following human sensitive receivers have been identified to be located nearby the Project site.

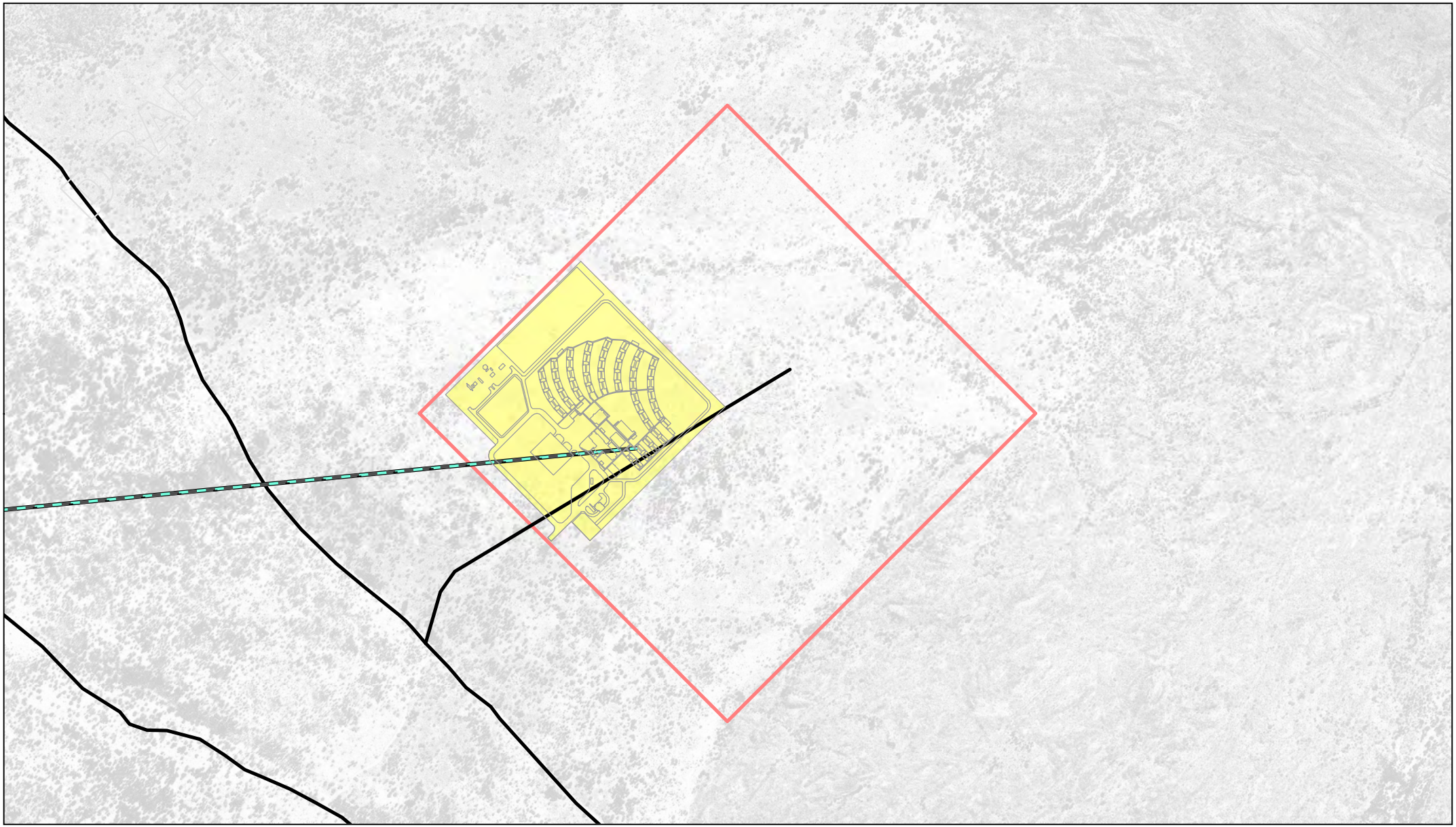
- Aileron Roadhouse – identified to be the nearest small community with human sensitive receivers. The roadhouse is a stop-over for travellers on the Stuart Highway providing various amenities. This receiver is about 15 km south east of the Project site.
- Alyuen (Aileron) – family outstation located about 3 km south of the Aileron Roadhouse and 2 km west of the Stuart Highway.
- Aileron Station Homestead located near the Roadhouse.
- Alkuptija (Gillans Bore) – family outstation 3 km west of Stuart Highway and 70 km south east of Nolans project site.
- Burt Creek (Rice's Camp) – family outstation close to Stuart Highway and 74 km south east of Nolans project site.
- Injulkama (Amburla) – family outstation 49 km south of Nolans project site and 105 km to the north west of Alice Springs.
- Laramba – is the nearest large community near the project site. Access to the community is by the Napperby station road, which runs west from the Stuart Highway. The community is located 83 km from the turnoff, about 50 km west of Project site. Laramba is a large community of mostly Aboriginal people (population approximately 300) including some of the traditional owners of the mine site. It has a school, community health centre and other facilities.
- Napperby station – 5356 km^2 cattle station 50 km to the west of Project site which has been owned and operated by the Chisholm family since 1948. This includes a shared borefield area and Laramba community living area.

- Pine Hill Station contains the (Anyumgyumba) family outstation near the homestead– located 35 km west of the Stuart Highway and approximately 27 km northwest of the Nolans project site (population transient).
- Pmara Jutunta (Six Mile) – major community of about 190 people 40 km to the north east of Nolans project site and close to the Stuart Highway and Ti Tree community.
- Ti Tree community – located 180 km north of Alice Springs along the Stuart Highway. It is a large community with facilities including a school, health centre, library, police station and airstrip. Population is approximately 280 persons. Ti Tree serves as the operational centre for the Anmatjere Community Government Council (ACGC). Nturiya (Ti Tree Station) is 17 km to the west of Ti Tree.
- Annas Reservoir – about 10 km west of Project site. This is an historic reserve and cultural site with no residents. The conservation area is visited infrequently by members of the public and NT Parks staff.

3.1.3 Assessed receivers

For the purpose of this noise and vibration impact assessment, only the following nearest sensitive receivers were assessed, as compliance at these receivers would also indicate compliance at the other further receivers.

- Nolans project accommodation village (refer to Figure 2 and Figure 4)
- Aileron Roadhouse (refer to Figure 1 and Figure 2)
- Annas Reservoir (refer to Figure 1 and Figure 2).



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0 100 200 300 400

Metres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 53

N

LEGEND

- Powerline
- Potable Water Pipeline
- Access Road
- Accommodation Village Boundary
- Accommodation Village

Arafura Resources Limited
Nolans Project

Job Number	4322301
Revision	0
Date	18 Mar 2016

Project general facilities arrangement - accommodation village Figure 4

G:\43\22301\GIS\Maps\4322301_806_ProjectInfrastructureAccommodationVillage.mxd

Level 5 66 Smith Street Darwin NT 0800 Australia **T** 61 8 8982 0100 **F** 61 8 8981 1075 **E** drwmail@ghd.com **W** www.ghd.com

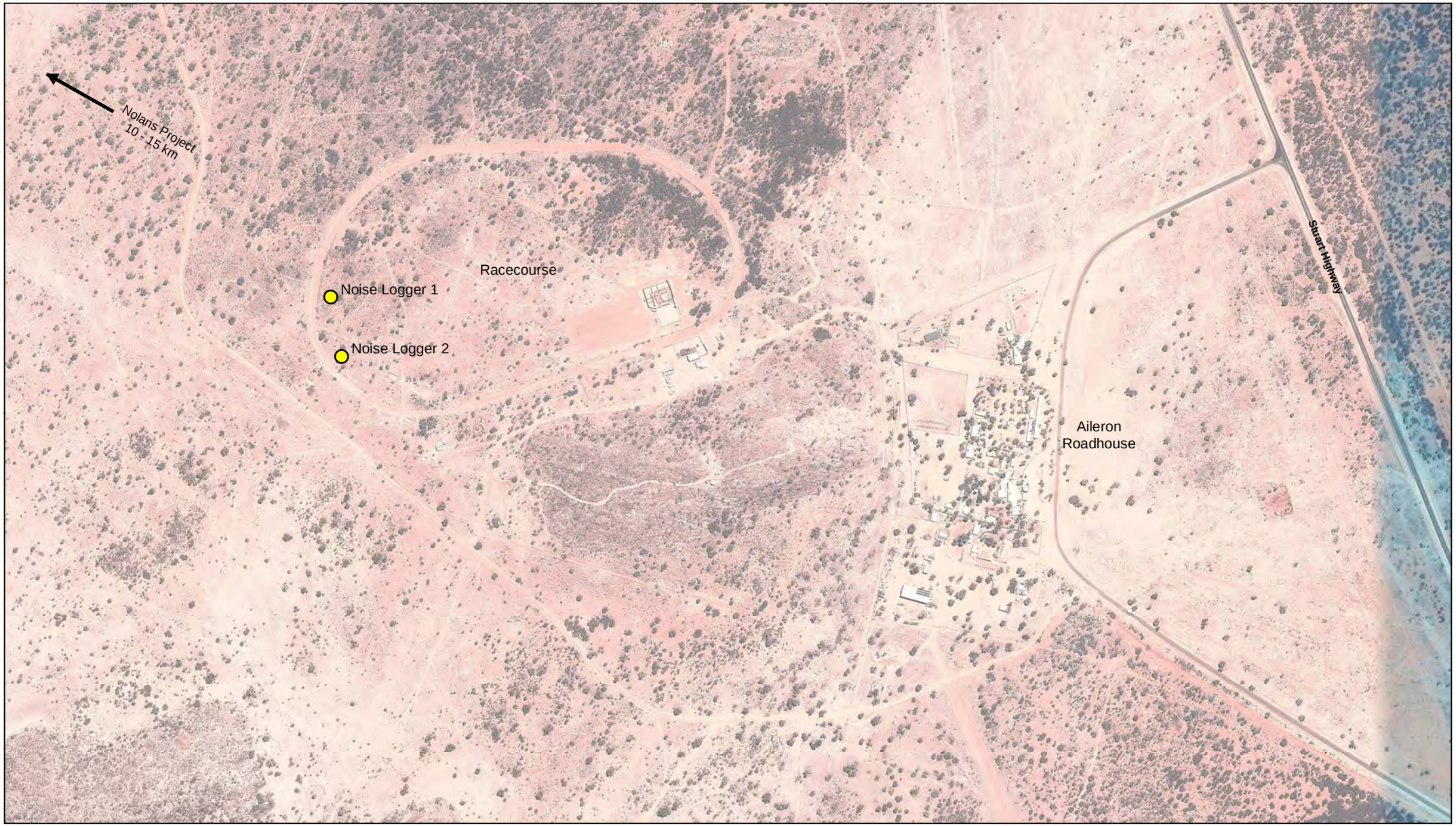
Data source: Google Earth Pro - Imagery (Date extracted: 29/04/2015). ARL - Proposed Pipelines, Proposed Mine Site, Proposed Diversion Channel Options, Tailings Storage Facility (2015). Created by: CM

3.2 Measurement methodology

Attended and unattended noise monitoring was conducted in the area surrounding the proposed project site. The purpose of noise monitoring was to determine the existing background noise levels in the area to assist in setting operational noise goals for the project.

Long-term unattended noise monitoring took place between 10 August 2010 and 18 August 2010. Monitoring occurred at the racecourse about 900 metres west of the Aileron Roadhouse as shown below in Figure 5. The noise loggers were located far enough away from the Roadhouse to minimise the influence of the Roadhouse's diesel generator on background noise levels. Two loggers were used in case one noise logger failed. Attended noise monitoring was also conducted at the unattended noise logger locations.

Weather data were obtained from the Bureau of Meteorology automated weather station at Territory Grape Farm located about 60 km northeast of the project site. These data were considered adequate for the purpose of filtering high wind events and rainfall from the noise data set.



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0 50 100 150 200

Metres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 53

N

LEGEND

Noise Monitoring Locations

Arafura Resources Limited
Nolans Project

Job Number 4322301
Revision 0
Date 18 Mar 2016

Noise monitoring locations (Logger 1 and Logger 2)

Figure 5

G:\43\22301\GIS\Maps\4322301_801_NoiseMonitoringLocations.mxd

Level 5 66 Smith Street Darwin NT 0800 Australia **T** 61 8 8982 0100 **F** 61 8 8981 1075 **E** drwmail@ghd.com **W** www.ghd.com

Data source: Google Earth Pro - Imagery (Date extracted: 08/03/2015). GA - Roads (2015). GHD - Noise Monitoring Locations (2016). Created by: CM

3.3 Unattended noise monitoring results

Two Acoustic Research Laboratories (ARL) EL 215 environmental noise loggers were used for unattended noise monitoring. The loggers are capable of measuring continuous sound pressure levels and able to record L_{A90}, L_{A10}, L_{Aeq} and L_{Amax} noise descriptors. The instruments were programmed to accumulate environmental noise data continuously over sampling periods of 15 minutes for the entire seven days of monitoring period.

The loggers were calibrated with a sound pressure level of 110 dB at 1 kHz using a Quest Type CA-12B sound level calibrator (serial number U1050139) prior to deployment. The loggers were retrieved and calibration was rechecked on completion of the monitoring period. No discrepancies equal to or greater than 1 dB were noted throughout the measurement exercise as is required under Section 5.6 of Australian Standard AS 1055.1:1997 *Acoustics – Description and measurement of environmental noise Part 1: General Procedures* (Standards Australia, 1997).

Data collected by the loggers was downloaded and analysed and any invalid data removed. Invalid data generally refers to periods of time where average wind speeds were greater than 5 m/s at ground level, when rainfall occurred, or for when anomalous noise levels occurred.

Table 1 displays the detail of each noise logger.

Table 1 Unattended noise logger details

Noise logger	Logger 1	Logger 2
Monitoring location	Racecourse (near Aileron Roadhouse)	Racecourse (near Aileron Roadhouse)
Logger serial #	194625	194678
Measurement started	10/8/10 8.30 am	10/8/10 10.00 am
Measurement ceased	18/8/10 12.00 pm	18/8/10 12.15 pm
Pre-measurement calibration	dB(A)	dB(A)
Freq. weighting	A	A
Time response	Fast	Fast

Table 2 and Table 3 present a summary of the long-term noise monitoring data. Statistical noise results are presented in graphical format in Appendix A and Appendix B.

Table 2 Summary of noise monitoring results – Logger 1 dB(A)

Logger	Background L_{A90} dB(A)			Ambient L_{Aeq} dB(A)		
	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)
Tuesday 10 August 2010	-	29	27	-	35	35
Wednesday 11 August 2010	30	29	27	42	34	34
Thursday 12 August 2010	27	26	26	42	32	34
Friday 13 August 2010	27	25	26	41	37	33
Saturday 14 August 2010	28	27	26	43	39	36
Sunday 15 August 2010	26	26	27	41	32	34
Monday 16 August 2010	28	27	26	40	34	35
Tuesday 17 August 2010	31	27	26	47	39	37
Wednesday 18 August 2010	-	-	-	-	-	-
RBL and L_{eq} Overall	**28**	**27**	**26**	**43**	**36**	**35**

Note: '-' refers to invalid data that has been excluded from the data set.

Table 3 Summary of noise monitoring results – Logger 2 dB(A)

Logger	Background L_{A90} dB(A)			Ambient L_{Aeq} dB(A)		
	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)
Tuesday 10 August 2010	-	28	26	-	33	35
Wednesday 11 August 2010	29	28	26	43	34	33
Thursday 12 August 2010	26	25	25	41	31	34
Friday 13 August 2010	27	24	24	43	30	37
Saturday 14 August 2010	28	26	25	45	30	36
Sunday 15 August 2010	25	25	26	43	32	33
Monday 16 August 2010	27	26	25	40	31	33
Tuesday 17 August 2010	31	26	26	51	34	34
Wednesday 18 August 2010	-	-	-	-	-	-
RBL and L_{eq} Overall	**27**	**26**	**25**	**45**	**32**	**34**

Note: '-' refers to invalid data that has been excluded from the data set.

3.4 Attended noise monitoring results

Attended noise monitoring occurred over 15-minute periods at each of the long term monitoring locations. Attended measurements used a Bruel and Kjaer 2250 sound level meter (SLM) (serial number 2506887). This SLM is capable of measuring continuous sound pressure levels and is able to record L_{Amin}, L_{A90}, L_{A10}, L_{Amax} and L_{Aeq} noise descriptors, which conforms to the requirements of Australian Standards *AS IEC 61672.1-2004: Electroacoustics – Sound level meters Part 1: Specifications* (Standards Australia, 2004). On-site calibration conducted immediately before and after the measurements showed negligible variation. Details of the existing noise environment including noise sources and ambient/background noise levels were recorded during these monitoring periods. The results of attended monitoring are shown in Table 4.

Table 4 15-Minute attended noise monitoring results

Monitoring Location and Description	$L_{Aeq,15min}$	$L_{A90,15min}$	$L_{A10,15min}$	Comments on Noise Environment	Weather Conditions
Logger 1 Racecourse (near Aileron Roadhouse) 10/8/2010 2.47 pm	38	32	41	Typical rural environment with birds and nearby insects influencing the ambient noise. Wind in foliage was audible. Dam water pump noise was faintly audible during monitoring.	Clear skies 17 degrees Celsius Wind 2-3 m/s from SE
Logger 1 Racecourse (near Aileron Roadhouse) 11/8/2010 8.12 am	39	34	42	Typical rural environment with animals and nearby insects influencing the ambient noise. Wind in foliage was audible. Stuart Highway traffic noise was faintly audible and intermittent during monitoring.	Clear skies 12 degrees Celsius Wind 1-2 m/s from E
Logger 2 Racecourse (near Aileron Roadhouse) 10/08/2010 3.06 pm	43	34	47	Typical rural environment with birds and nearby insects influencing the ambient noise. Wind in foliage was audible. Dam water pump noise was faintly audible during monitoring.	Clear skies 17 degrees Celsius Wind 2-3 m/s from SE
Logger 2 Racecourse (near Aileron Roadhouse) 11/08/2010 8.29 am	41	33	43	Typical rural environment with birds and nearby insects influencing the ambient noise. Stuart Highway traffic noise was faintly audible and intermittent during monitoring.	Clear skies 13 degrees Celsius Wind 1-2 m/s from E

4. Noise and vibration criteria

4.1 Operational noise criteria

The *Waste Management and Pollution Control Act 1998* arose as the initial action in the development of a *Strategy for Waste Management and Pollution Control in the Northern Territory* that began in 1995.

The Act has no provision for the assessment criteria for operational noise and vibration. There are no other relevant Northern Territory guidelines and criteria for operational noise or vibration. Therefore, operational noise criteria applicable to site noise sources were determined with consideration to the NSW *Industrial Noise Policy* INP (NSW EPA, 2000). The policy is specifically aimed at assessing noise from industrial noise sources scheduled under the NSW *Protection of the Environment Operations Act 1997* (NSW Government, 1997). It is typically used as a guide by NSW Environment Protection Authority (EPA) officers for setting statutory limits in licences for these sources. The policy is designed for large and complex industrial sources and specifies substantial monitoring and assessment procedures. The INP is typically the preferred noise guideline in the absence of other noise policies and guidelines. The INP provides guidance on the assessment of operational noise impacts. The guidelines include Intrusive and Amenity criteria designed to protect receivers from noise significantly louder than the background level and to limit the total noise level from all sources near a sensitive receiver.

Intrusive noise limits set by the INP control the relative audibility of operational noise compared to the background level. The amenity criteria limit the total level of extraneous noise. Both sets of criteria are calculated and the more stringent of the two in each time period applies with consideration to the *Office of Environment and Heritage* (OEH) *Application Notes* (NSW EPA, 2000) pertaining to Section 2.4 of the INP. Table 2.2 in the INP provides modifications to the amenity criteria for existing levels of industrial 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, the amenity noise criteria do not require adjustment.

The 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, and the existing level of noise from industry, commerce, and road traffic. The nearest residential receivers (Nolans project accommodation village and Annas Reservoir) to this development were classified as rural.

The recorded background (L_{A90}) noise data from logger 2 exhibited slightly lower values than logger 1, most likely due to local insect noise. Results from both loggers were less than 30 dB(A) and the NSW INP states that where the background level is found to be less than 30 dB(A) then it is set to 30 dB(A). Similarly for the Nolans project accommodation village and Annas Reservoir receivers (refer to Section 3.1), lowest NSW INP rating background level of 30 dB(A) were assumed.

The project specific noise levels for the proposed mine at individual identified sensitive receivers are provided in Table 5.

Table 5 Project specific noise levels – residential receivers

Criterion	Nearest residential receivers		
	Day 7 am to 6 pm	Evening 6 pm to 10 pm	Night 10 pm to 7 am
A: Rating background level[a]	30 $L_{A90(day)}$	30 $L_{A90(evening)}$	30 $L_{A90(night)}$
B: Intrusiveness criteria (A + 5dB)	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 $L_{Aeq(night)}$
D: Amenity criteria: (INP Table 2.2 Adjusted)	-	-	-
Project specific noise level (Page 21 INP)	**35 $L_{Aeq(15min)}$**	**35 $L_{Aeq(15min)}$**	**35 $L_{Aeq(15min)}$**

[a] Note: The NSW INP states where the rating background level is found to be less than 30 dB(A), then it is set to 30 dB(A).

4.2 Construction noise criteria

Construction noise emitted from the Project is assessed with consideration to the Northern Territory Environment Protection Authority (NT EPA) *Noise guidelines for development sites in the Northern Territory* (NT EPA, May 2014). The NT EPA recommends standard hours for construction activity as detailed in Table 6 .

Table 6 NT EPA acceptable construction times

Work type	Acceptable construction times
Normal construction	Monday to Saturday: 7 am to 7 pm
	Sunday or public holiday: 9 am to 6 pm

The NT EPA provides a noise limit for construction noise levels at residential receivers/residential area uses during the acceptable construction times. These noise limits are calculated based on the adopted rating background level at nearby residential locations, as shown in Table 7.

Table 7 NT EPA construction noise criteria during acceptable construction times

Work type	Acceptable construction times
Residential area	Ambient noise ($L_{Aeq15mins}$) + 5 dB(A)
Mixed commercial/residential use areas	60 dB(A)
Commercial use areas	65 dB(A)
Industrial use areas	70 dB(A)

In the absence of specific assessment interval period, it is assumed that the above criteria apply for dB(A)$L_{eq(15mins)}$. The dB(A)$L_{eq(15mins)}$ descriptor was chosen as it is commonly used as a noise descriptor to represent construction noise characteristics (NSW EPA, 2000).

The above levels apply within 15 m of a noise sensitive receiver or at or on the boundary of the noise sensitive receiver (adjusted for tonality, impulsiveness, and/or modulation) during acceptable construction times.

NT EPA regards "noise emitted from a development site may be considered an environmental nuisance or pollution if:

a. The construction activity is conducted:
   - Outside the hours of 7 am and 7 pm Monday to Saturday or
   - On a Sunday or public holiday outside the hours of 9 am and 6 pm

b. The construction activity generates noise which exceeds the construction noise levels defined in these guidelines

c. The construction activity was not carried out in accordance 'AS 2436 Guide to Noise Control on Construction, Maintenance and Demolition Sites

d. 48-hours' notice was not given to the occupiers of all noise-receiving premises where noise levels for the development site are likely to be of concern including:
   - A description of proposed construction activity likely to cause nuisance
   - The date(s), time(s) and duration for the construction activity likely to cause nuisance
   - The name and phone number of the person to whom a complaint may be made about noise emissions from the site.

OR

e. The activity was not carried out in accordance with a Noise Management Plan *registered with NT EPA."*

Where the above construction noise limit is exceeded, all feasible and reasonable work practices to minimise noise should be applied and all potentially impacted residents should be informed of the nature of the works, expected noise levels, duration of works and a method of contact. This would include the preparation noise management plan (NMP) provided to NT EPA, which is discussed in Section 8.4 of this report.

In the absence of site-specific background noise monitoring data for the Nolans project accommodation village and the Annas Reservoir receivers, the background environmental noise conditions in these receivers are assumed to be similar to those recorded at the Aileron Roadhouse noise loggers. In this case, the recorded ambient (L_{Aeq}) noise data from logger 1 exhibited slightly lower values than logger 2. Hence, logger 1 ambient noise data were used to determine the project specific construction noise criteria, thereby providing a conservative approach.

Based on the above and the RBL determined from site monitoring (see Section 3.3), construction noise goals were derived based on Logger 1 location, as shown in Table 8.

Table 8 Project construction noise criteria

Monitor ID	Receivers	Within Acceptable Construction Times
L1	Nolans project accommodation village Aileron Roadhouse Annas Reservoir	48 dB(A) $L_{Aeq15mins}$

4.2.1 Extended working hours

Extended working hours during construction would be required on some weeknights and potentially weekends, particularly for concrete pours and construction material delivery.

The need for extended working hours will be determined during detailed design and during the construction period.

Given the location of the Nolans project site and the large distance between sources and receivers, construction noise impact is not expected to be an issue. However, NT EPA (NSW EPA, 2000) provides the minimum requirements of noise management for construction works undertaken outside the acceptable construction times, inclusive of community consultation and preparation of a noise management plan (NMP).

Blasting is likely to be required during construction or operation. In the absence of detailed blasting information at the time of writing this report, the requirement for blasting will be reassessed and confirmed upon finalisation of the relevant geotechnical studies and the availability of detailed blasting information. Section 5.3 of this report assesses blasting noise and vibration impact in general.

4.3 Road traffic noise criteria

The NT Department of Planning and Infrastructure (DPI) *Road Traffic Noise on NT Government Controlled Roads Policy* (NTG, November 2014) outlines the responsibilities of DPI to manage and mitigate road traffic noise from government controlled roads.

Stuart Highway is the only government controlled road potentially affected by the project. It is not planned for redevelopment or upgrade. The NT DPI traffic noise requirements for the unplanned significant development controlled road are summarised in Table 9.

The NT DPI states that the developer is solely responsible for managing traffic noise impacts on sensitive receivers. The following matters should be considered:

- Potential traffic noise impact on accommodation village, in particular living and sleeping areas
- Potential traffic noise impact on the Aileron Roadhouse facilities
- Potential increase in local traffic noise levels as a result of the mining operations.

Table 9 NT Criteria for road traffic noise

Road category	Type of project/land use
Road Traffic Noise on NT Government Controlled	**Existing road – Unplanned significant development**

Road category	Type of project/land use
Roads Policy (2014)	*Existing residential* Where there is both a predicted increase in noise level of > 5 dB(A) and the predicted noise target level is > $L_{A10\ 18hour}$ 68 dB(A), target $L_{A10\ 18hour}$ 68 dB(A). *Existing noise sensitive** Where there is both a predicted increase in noise level > 5 dB(A) and the predicted noise level is > $L_{A10\ 18hour}$ 63 dB(A), target $L_{A10\ 18hour}$ 63 dB(A). *Future Residential and Noise Sensitive* Responsibility for noise management of developments undertaken adjacent to an existing or planned future road rests with the proponent (private or government agency).

** Existing noise sensitive – includes aged care, nursing homes and may include schools, libraries and hospitals. Commercial accommodation facilities relying on passing trade are not considered as noise sensitive developments under this policy.*

4.4 Sleep disturbance criteria

In addition to the noise criteria in the above sections, an assessment of sleep disturbance for the potentially affected noise sensitive receivers has also been considered in this report. Where there is the possibility of instantaneous (brief) high-level noise events (such as vehicle movements, steam releases, loading, unloading or impact activities) occur during night-time period (10.00 pm to 7.00 am), consideration shall be given for potential sleep disturbance to the sensitive receivers.

In the absence of local sleep disturbance noise criteria, reference is made to the NSW OEH *Noise Guide for Local Government* (NGLG) (NSW OEH, 2010). The guideline provides guidance for assessing sleep disturbance from short-term noise events. To assess potential disturbance during night-time hours (10.00 pm to 7.00 am), Section 2.4.5 of the NGLG recommends that $L_{A1(1minute)}$ levels outside a bedroom window should not exceed the background level by more than 15 dB(A). Based on a measured background noise level of 25 dB(A) (refer to Section 3.3), the sleep disturbance noise guideline for the night-time period is $L_{A1(1minute)}$ 40dB(A) for all surrounding residential receivers.

4.5 Human comfort vibration criteria

In the absence of any Northern Territory or Australian guidelines relating to human comfort criteria for vibration, criteria have been adopted with consideration to the British Standard 6472 – 2008, *Guide to evaluation of human exposure to vibration in buildings Part 1: Vibration sources other than blasting* (British Standards, 2008), which are recognised as the preferred standard for assessing the “human comfort criteria” for residential building types.

Typically, mine activities generate ground vibration of an intermittent nature. Under BS 6472-1:2008, intermittent vibration is assessed using the vibration dose value (VDV). Table 10 includes acceptable values of vibration dose for residential receivers for daytime and night-time periods.

Table 10 Vibration dose value ranges and probabilities for receiver adverse comment to intermittent vibration ($m/s^{1.75}$)

Location	Low probability of adverse comment[1]	Adverse comment possible	Adverse comment probable[2]
Residential buildings 16 hour day (7.00 am – 11.00 pm)	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Residential buildings 8 hour night (11.00 pm to 7.00 am)	0.1 to 0.2	0.2 to 0.4	0.4 to 0.8

1 Below these ranges adverse comment is not expected.
2 Above these ranges adverse comment is very likely.

These values represent the best judgement available at the time the standard was published and may be used for both vertical and horizontal vibration, providing that they are correctly weighted. Because there is a range of values for each category, it is clear that the judgement can never be precise.

Whilst the assessment of response to vibration in BS 6472-1:2008 is based on VDV and weighted acceleration, for construction related vibration, it is considered more appropriate to provide guidance in terms of peak particle velocity (PPV), since this parameter is likely to be more routinely measured based on the more usual concern over potential building damage.

Humans are capable of detecting vibration at levels that are well below those causing risk of damage to a building. The degrees of perception for humans are suggested by the vibration level categories given in British Standard 5228-2:2009 *Code of practice for noise and vibration on construction and open sites – Part 2: Vibration* (British Standards, 2009) as shown below in Table 11.

Table 11 Guidance on the effects of vibration levels

Approximate vibration level	Typical Degree of perception
0.14 mm/s	Vibration might be just perceptible in the most sensitive situations for most vibration frequencies associated with construction. At lower frequencies, people are less sensitive to vibration.
0.3 mm/s	Vibration might be just perceptible in residential environments.
1.0 mm/s	It is likely that vibration of this level in residential environments will cause complaint, but can be tolerated if prior warning and explanation has been given to residents.
10 mm/s	Vibration is likely to be intolerable for any more than a very brief exposure to this level.

4.5.1 Structural damage vibration criteria

There is no Australian Standard that sets the criteria for the assessment of building damage caused by vibration. Guidance limiting vibration is attained by reference to

German Standard *DIN 4150-3: 1999 Structural Vibration – Part 3: Effects of vibration on structures* (German Standards, 1999).

Table 8 of DIN 4150-3 presents guideline values for the maximum absolute value of the velocity *"…at the foundation of various types of building. Experience has shown that if these values are complied with, damage that reduces the serviceability of the building will not occur. If damage nevertheless occurs, it is to be assumed that other causes are responsible*."

Measured values exceeding those listed in Table 12"*…does not necessarily lead to damage; should they be significantly exceeded, however, further investigations are necessary.*"

The vibration criteria presented in this standard exceed the human comfort criteria presented above. Therefore, as indicated above, the human comfort criteria should be the over-riding criteria for the assessment of any vibration.

Table 12 Guideline values for short term vibration on structures

Line	Type of structure	Guideline values for velocity, (mm/s)		
		1 Hz to 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz[a]
1	Buildings used for commercial purposes, industrial buildings, and buildings of similar design.	20	20 to 40	40 to 50
2	Dwellings and buildings of similar design and/or occupancy	5	5 to 15	15 to 20
3	Structures that, because of their particular sensitivity to vibration, cannot be classified under lines 1 and 2 and are of great intrinsic value (e.g. listed buildings under preservation order)	3	3 to 8	8 to 10

[a] Where frequencies are above 100 Hz the values given in this column may be used as minimum values.

4.6 Blasting criteria

OEH refers to Australian and New Zealand Environment and Conservation Council (ANZECC) *Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration* (ANZECC, September 1990) when dealing with potential blasting noise and vibration. This guideline recommends the noise and vibration limits shown in Table 13.

Table 13 Recommended ANZECC 1990 blasting limits

Airblast overpressure	Ground vibration
115 dB(lin) peak	5 mm/s PPV
The level of 115 dB(lin) may be exceeded on up to 5% of the total number of blasts over a period of 12 months, but never over 120 dB(lin) peak.	The level of 5 mm/s may be exceeded on up to 5% of the total number of blasts over a period of 12 months, but never over 10 mm/s.

ANZECC guideline recommends that blasting should only be permitted during the following hours:

- Monday to Saturday, 9 am to 5 pm and
- No blasting on Sundays or public holidays.

Blasting should generally not take place more than once per day. This requirement does not apply to minor blasts such as clearing crushers, feed chutes, etc. (ANZECC, September 1990).

When considering a time to initiate the blast - weather conditions must be assessed. Generally the atmosphere is most stable early morning and late afternoon due to the absence of direct ground heating from the sun, as per the Queensland Guidance Note QGN 20 v 3 (QLD DEEDI, 2011).

5. Construction noise and vibration impact assessment

5.1 Construction noise

Typical noise levels produced by construction plant anticipated to be used on site were sourced from AS 2436 – 2010 *Guide to Noise Control on Construction, Maintenance and Demolition Sites* (Standards Australia, 2010) and from GHD's internal database.

Propagation calculations take into account sound intensity losses due to hemispherical spreading, with additional losses such as atmospheric absorption, terrain, directivity and ground absorption ignored in the calculations. As a result, predicted received noise levels are expected to slightly overstate actual received levels and provide a measure of conservatism.

Received noise produced by anticipated activities during the construction phase is shown in Table 14 for a variety of distances, with no noise barriers or acoustic shielding in place and with each plant item operating at full power. The sound pressure levels shown are maximum levels produced when machinery is operated under full load.

Table 14 Predicted construction plant item noise levels (dB(A))

Plant item	dB(A) L_w	Distance of source to receiver (m)							
		50	250	500	750	1000	2000	5000	8000
Crane	105	63	49	43	39	37	31	23	19
Backhoe	104	62	48	42	38	36	30	22	18
Compressor	101	59	45	39	35	33	27	19	15
Concrete pump	108	66	52	46	42	40	34	26	22
Dump truck	117	75	61	55	51	49	43	35	31
Water tanker	107	65	51	45	41	39	33	25	21
Compactor	113	71	57	51	47	45	39	31	27

The distance between the proposed construction works and the identified receivers will be greater than 5 km. The predicted results shown in Table 14 suggest that all construction activity noise will generally be under the acceptable construction time's noise criteria.

5.2 Construction vibration

Blasting normally generates the highest levels of ground vibration. Construction equipment can also lead to considerable vibration levels and needs to be assessed to minimise potentially adverse impacts on the surrounding residential receivers. Ground vibration caused by blasting is covered in Section 5.3.

Energy from construction equipment is transmitted into the ground and transformed into vibrations, which attenuate with distance. The magnitude and attenuation of ground vibration is dependent on:

- The efficiency of the energy transfer mechanism of the equipment (i.e. impulsive; reciprocating, rolling or rotating equipment)
- The frequency content
- The impact medium stiffness
- The type of wave (surface or body)
- The ground type and topography.

The above factors cause inherent variability in ground vibration predictions in the absence of site-specific measurement data. The NSW RTA *Environmental Noise Management Manual* (NSW RTA, December 2001) provides typical construction equipment ground vibration levels at 10 m. The rate of vibration attenuation can be calculated from the following regression analysis formula:

$$V = kD^{-n}$$

where

V = PPV

D = Distance

n = attenuation exponent. The value of n generally lies between 1 and 2 with a relatively common value of 1.5[1].

The predicted ground vibrations at various distances are shown in Table 15 for typical construction equipment. Given the distance to the nearest receiver from the proposed site is approximately 5 km, construction vibration is highly unlikely to exceed the human perception criteria.

Table 15 Predicted construction equipment vibration levels (mm/s PPV)

Plant item[2]	Human perception preferred criteria *(maximum criteria)*		Predicted ground vibration				
	Day	Night	10 m	30 m	50 m	100 m	300 m
15 t roller	0.28 *(0.56)*	0.2 *(0.4)*	7.5	1.4	0.7	0.2	<0.1
Dozer	0.28 *(0.56)*	0.2 *(0.4)*	3.3	0.6	0.3	0.1	<0.1
7 t compactor	0.28 *(0.56)*	0.2 *(0.4)*	6.0	1.2	0.5	0.2	<0.1

[1] Construction Vibrations: State of the Art, John Wiss, 1981

[2] NSW RTA Environment noise management manual

Plant item[2]	Human perception preferred criteria *(maximum criteria)*		Predicted ground vibration				
	Day	Night	10 m	30 m	50 m	100 m	300 m
Rock breaking	0.28 *(0.56)*	0.2 *(0.4)*	7	1.3	0.6	0.2	<0.1
Backhoe	0.28 *(0.56)*	0.2 *(0.4)*	1	0.2	0.1	<0.1	<0.1

5.3 Blasting overpressure and vibration

Blasting is likely to be required during construction, however in the absence of detailed blasting information at the time of writing this report, this section provides indicative vibration impact assessment for typical blasting activity.

Blasting may be used in areas where hydraulic excavators with hammer attachments are ineffective because of large formations of hard rock.

Construction blasting was assessed to determine the potentially adverse impacts on the surrounding residential receivers. Blasting impacts were estimated with consideration to *Australian Standard AS 2187.2:2006 Explosives – Storage and use Part 2: Use of Explosives* (Standards Australia, 2006) and based on available information. Blasting vibrations are non-linear in nature and variability in ground type and meteorological conditions make it difficult to accurately predict ground vibration and airblast overpressure without site-specific measurement data. The blasting predictions should only be used as a guide.

As required in the ANZECC guideline, blasting should only occur between the hours of 9.00 am to 5.00 pm (Monday to Saturday), but not on Sundays or public holidays.

5.3.1 Estimation of airblast overpressure

Airblast overpressure can be estimated using the following equation:

$$P = K_a \left(\frac{R}{Q^{1/3}} \right)^a$$

Where:

P is the pressure (kPa)

R is the distance from charge (m)

Q is the charge mass (kg)

Ka is the site constant. AS2187.2:2006 suggests for confined blasthole charges values are commonly in the range of 10 to 100. A value of 50 has been adopted for this assessment.

a site exponent. For confined blasthole charges AS 2187.2:2006 suggests a = -1.45 as a satisfactory estimate.

Airblast overpressure propagation can be increased with unfavourable meteorological conditions and decreased with topographic shielding. Unconfined surface charges would considerably increase the airblast overpressure propagation.

5.3.2 Estimation of ground vibration

Ground vibration was estimated using the following equation:

$$V = K_G \left(\frac{R}{Q^{1/2}} \right)^{-1.6}$$

Where:

V is the peak vector sum ground vibration ppv (mm/s)

R is the distance from charge (m)

Q is the maximum instantaneous charge (MIC) (kg)

K_G is the ground constant AS2187.2 gives a site constant for a free face in average field conditions of 1140 which has been used for the predictions. This value can vary from 1/5 times – 4 times depending on ground conditions and other factors.

5.3.3 Blasting predictions

Reducing the charge mass or increasing the distance reduces the airblast overpressure and ground vibration. Airblast overpressure and ground vibration were predicted for a range of charge masses. These are shown in Figure 6 and Figure 7 for varying distances and assuming average conditions.

Charge mass estimates to achieve the maximum construction airblast overpressure criteria of 115 dB(L) and ground vibration criteria of 5 mm/s PPV are shown in Table 16.

Table 16 Charge mass estimates

Distance to receiver (m)	MIC (kg) to meet 115 dB(L)	MIC to meet 5 mm/s PPV
7000	>100	>100
6000	>100	>100
5000	>100	>100
4000	>100	>100
3000	>100	>100
2000	>100	>100
1000	28	>100
500	3.5	>100

No details of the blast configuration and design have been supplied at this stage. A maximum instantaneous charge (MIC) of greater than 100 kg should not be required and

a charge of 50 kg or less is likely to be appropriate. As the nearest receiver is greater than 5 km away, ground vibration from blasting is not predicted to be an issue.

Ground vibration generally attenuates faster than airblast overpressure, and airblast overpressure is generally the critical factor controlling the distance at which blasting can occur without exceeding the human perception preferred criteria. Blasting at distances to receivers of less than 500 m would be restricted by the MIC.

Adverse meteorological conditions such as temperature inversions and wind direction can significantly increase airblast overpressure levels. Temperature inversions are most common during night and early morning periods. This should not affect blasting during the recommended standard hours stipulated in ANZECC.

GHD acknowledge that if blasting activity occurs, the design of blast would be determined by the blast contractor and that the above information has been assumed for this assessment only in the absence of specific information regarding blasting at the proposed site.

As shown in Figure 6 and Figure 7, the blast overpressure and vibration levels for the assessed charge masses are expected to be well under the criteria at the nearest sensitive receiver located approximately 5 km away.

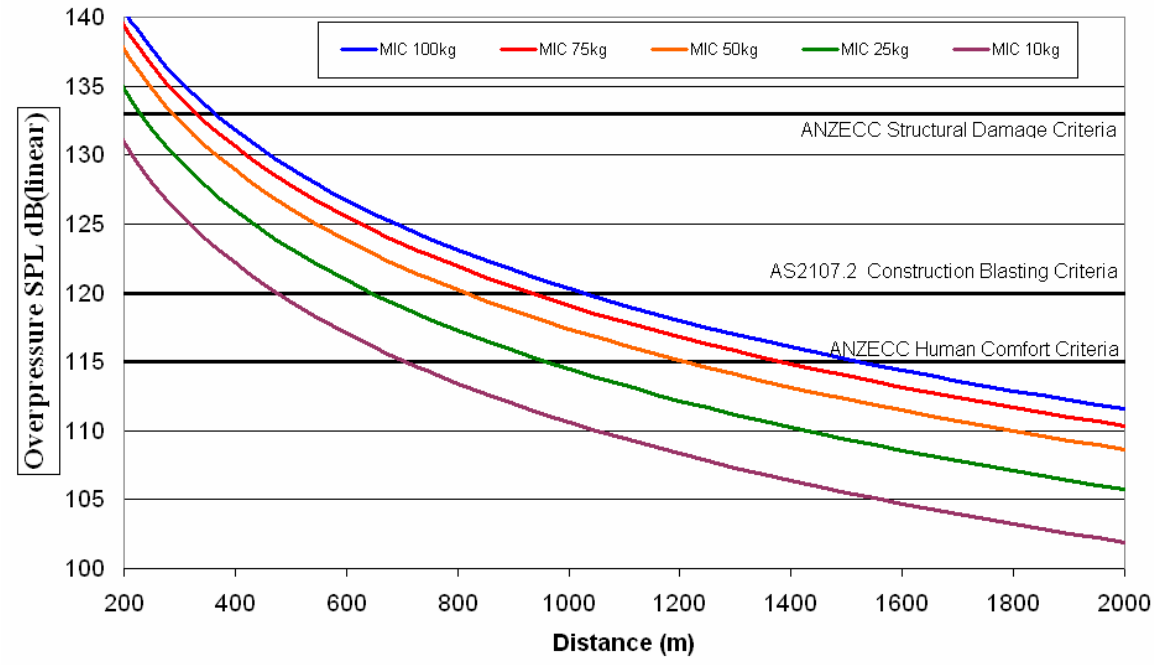


Figure 6 Airblast overpressure predictions for different charge masses and distances

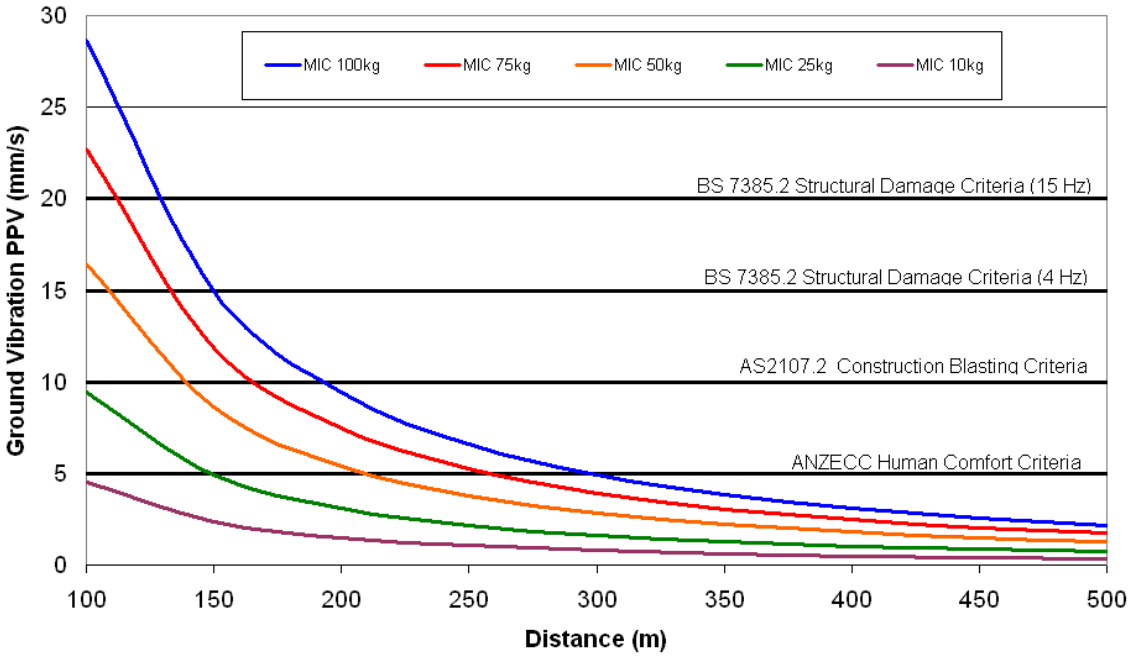


Figure 7 Ground vibration predictions for different charge masses and distances

5.4 Summary of impact

Key risk pathways associated with construction noise and vibration have been identified in the risk register for the project, and which are discussed below.

The operation of identified construction equipment (detailed in Section 5.1) that produce considerable noise and vibration emissions, have been shown to be well within construction noise criteria. As expected, and identified in the risk register, the noise and vibration produced by the construction equipment onsite may have the potential to generate excessive noise and vibration impact which may cause nuisance at the nearby sensitive receivers. However, due to the substantial distance between the noise generating equipment and the sensitive human receiver locations, the environmental impact can be considered low impact, and therefore is acceptable.

6. Operational noise and vibration impact assessment

6.1 Operational noise

6.1.1 Modelling methodology

Acoustic modelling was undertaken using CadnaA v4.5 noise modelling software to predict the effects of industrial (operational) noise generated by the Project.

CadnaA is a computer program for the calculation, assessment and prognosis of noise propagation. CadnaA calculates environmental noise propagation according to ISO 9613-2, "*Acoustics – Attenuation of sound during propagation outdoors"* (ISO, 1996). Propagation calculations take into account sound intensity losses due to hemispherical spreading, atmospheric absorption and ground absorption.

The ISO 9613-2 algorithm also takes into account the presence of a well-developed moderate ground based temperature inversion, such as that which commonly occurs on clear, calm nights or during 'downwind' conditions, which are favourable to sound propagation. As a result, predicted received noise levels are expected to represent a worst-case scenario.

Note that the assessment has been modelled based on available data. The proposed layouts for the mine and processing sites and noise generating equipment were based on information provided at the time of the assessment.

The following general settings were used in the model:

- The surrounding areas of the site are predominantly rocky and grassland, therefore the ground effects were modelled with ground absorption of 0.5 as specified in ISO 9613
- All sensitive receivers were modelled at 1.5 m height above ground
- Site topography and three-dimensional terrain were used in the model, with a 2 m contour grid.

6.1.2 Modelling scenario

Due to staging, noise impact will vary over the proposed life of the mine, depending on where machinery is operating. Areas where these changes will occur are the mine pit and the waste rock dump. In the absence of detailed plant locations and site layout, for the noise assessment, a worst possible case scenario has been modelled, which includes machinery operating within the area located, as much as practicable, nearest to the direction of the sensitive receivers.

6.1.3 Modelled primary noise sources

Modelled sound power levels for mobile and fixed sources for the proposed mine and processing sites are summarised in Table 17. The plant and equipment listed in the table are expected to be the major noise sources from the Project, and that the associated sound power levels are maximum predicted levels produced when machinery is operating under full load.

The modelled plant and equipment in Table 17 have been modelled as point sources.

Typical mining equipment noise levels in Table 17 have been obtained from:

- Australian Standard AS 2436 – 2010 *Guide to Noise Control on Construction, Maintenance and Demolition Sites* (Standards Australia, 2010)
- Engineering Noise Control (ENC) software
- GHD's internal database from past projects experience.

Table 17 Modelled operational noise sources

Plant item	Make and model	dB(A) L_w per unit	Peak quantity	Modelled source height (m)
Excavator	Hitachi EXI 200	123	3	3
Dump truck	CAT 777F	117	11	4
Dozer	CAT D9T	111	3	3
Grader	CAT 16M	109	2	4
Service truck	MAN 6x6	107	1	3
Water truck	MAN 6x6	107	2	3
Rock breaker	CAT 336DL	118	1	1
Lighting plant	Alight	90	12	1
Front end loader	CAT 990H	112	2	4
Surface crawler drill	Sandvik DP1100	119	6	2
RC drill	Atlas Copco RC127	119	1	2
Dewatering pump	Chesterton	98	3	1
Acid plant compressor	n/a	122	1	5 (ground based plant source) 20 (stack source)
Milling	n/a	118		4
Screener	n/a	111	1	2
Primary crusher	n/a	116	1	3
Secondary crusher	n/a	112	1	3

Plant item	Make and model	dB(A) L_w per unit	Peak quantity	Modelled source height (m)
5 MW gas turbines	n/a	127 (engine noise) 136 (exhaust stack)	3	5 (ground based plant source) 12.5 (stack source)

6.1.4 Modelling Assumptions

The following modelling conditions and assumptions have been made regarding the operational noise assessment:

- It is assumed that all modelled equipment will be running continuously 24 hours, 7 days per week.
- The following equipment have been assumed to be operating within the vicinity of the pit areas:
  - Excavator
  - Rock breaker
  - Front end loader
  - Water truck
  - Surface crawler drill
  - RC drill
  - Dewatering pump
  - Lighting plant.
- The following equipment have been assumed to be operating within the vicinity of the dumping areas or haul road:
  - Truck
  - Dozer
  - Grader
  - Service truck.
- The following equipment have been assumed to be operating within the vicinity of the processing site:
  - Acid plant (modelled at coordinate location X: 318102, Y: 7494090, with 20 m stack height – refer to GHD *Air Quality Report*)
  - Primary crusher (modelled at coordinate location X: 319800, Y: 7500950)
  - Screens (modelled at coordinate location X: 319959, Y: 7500850)
  - Milling (modelled at coordinate location X: 320050, Y: 7500670)
  - Gas fired power station (modelled at coordinate location X: 318128, Y: 7494010, with 12.5 m stack height).
- Note that the gas turbines and acid plant exhaust stacks were modelled unsilenced and as point sources located at a height of 12.5 m and 20 m above ground, respectively. Should the final design of the power station and acid plant layouts, as well as the associated *manufacturer noise data do not reflect the above*

configuration characteristics applied to the noise model, further noise assessment may be required to determine the necessity of noise attenuation to ensure compliance with the prescribed noise criteria.

- Any activities outside the Project site boundary are not taken into account in the operational noise modelling.

6.1.5 Predicted operational noise impact

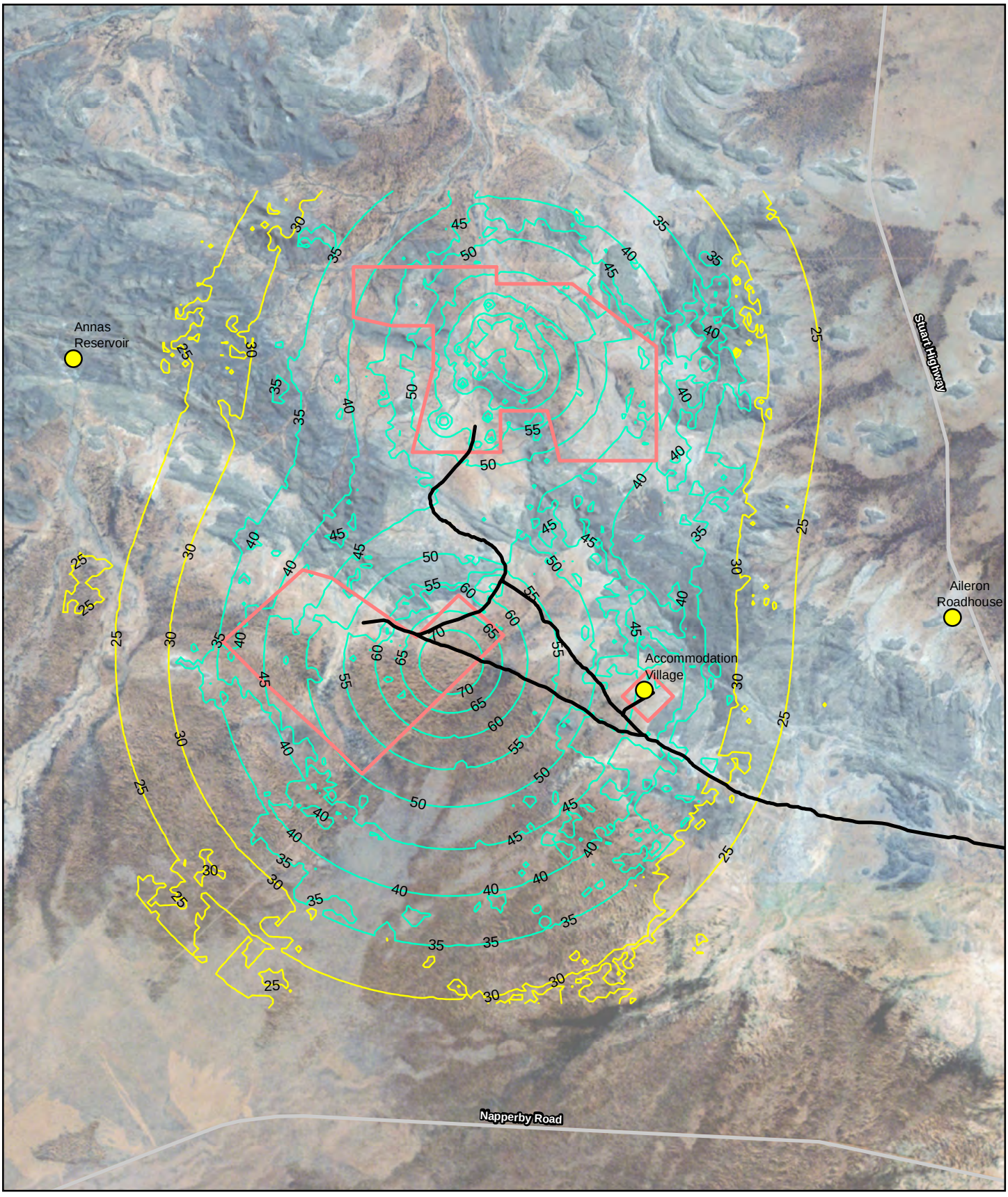
The predicted sound pressure levels due to the operation of the Project at nearby noise sensitive receivers are summarised in Table 18.

Operational noise model contours are also shown graphically in Figure 8.

Table 18 shows that the Project's operational noise impact at the Aileron Roadhouse and Annas Reservoir receivers are expected to be below the noise criterion. However, potential 10 dB(A) exceedance is predicted to occur at the Nolans project accommodation village receiver, based on the modelling assumptions. Further discussion on the noise modelling results is provided in Section 0.

Table 18 Predicted operational sound pressure levels db(a) at modelled receivers

Nearest sensitive receiver locations	Period	Project noise criteria $dB(A)L_{Aeq(15min)}$	Predicted noise levels $dB(A)L_{Aeq(15min)}$	Comply
Nolans project accommodation village	All period	35	45	No
Aileron Roadhouse	All period	35	12	Yes
Annas Reservoir	All period	35	< 5	Yes



LEGEND

Receivers
Roads
Access Road

Noise Contours

< 35 dB(A)LAeq
>= 35 dB(A)LAeq

Project Areas

1:125,000 @ A4
0 1 2 3 4
Kilometres
Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 53

N

Arafura Resources Limited
Nolans Project

Predicted operational noise impact contours

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Revision	0
Date	18 Mar 2016

Figure 8

G:\43\22301\GIS\Maps\4322301_802_PredictedOperationalNoiseImpactContour.mxd

Level 5, 66 Smith Street Darwin NT 0800 Australia **T** 61 8 8982 0100 **F** 61 8 8981 1075 **E** drwmail@ghd.com **W** www.ghd.com

Data source: GA - Roads, Waterways, Placenames, Placenames, Lakes (2015). ESRI - Shaded Relief (2009). Google Earth Pro - Imagery (Date extracted: 05/11/2015). ARL - Project Areas (2015). Created by: CM

6.1.6 Discussion of noise modelling results

The predicted noise modelling results in Section 6.1.5 are based on the modelling assumptions stated in this report. These assumptions were made, in the absence of project specific information to progress the noise modelling assessment.

Further analysis of predicted dominant noise sources at the Nolans project accommodation village receiver, due to the predicted exceedance, has indicated that the gas turbines stacks at the power station site are the primary contributors. GHD noted that project specific equipment selection and specifications are not available at the time of writing this report.

Should more detailed information of the actual proposed equipment selections and specifications become available, and that it shows there would be potential significant difference to the above assumptions or the assumptions stated throughout this report, it is recommended that noise modelling should be updated.

Nevertheless, given the modelled results predicted in Section 6.1.5 indicate potential exceedances of the assessment criteria, it is recommended that the operational noise mitigation measures detailed in Section 6.1.7 and Section 7 be considered as a guidance to minimise potential noise impact as far as practicable.

6.1.7 Project specific noise mitigation measures

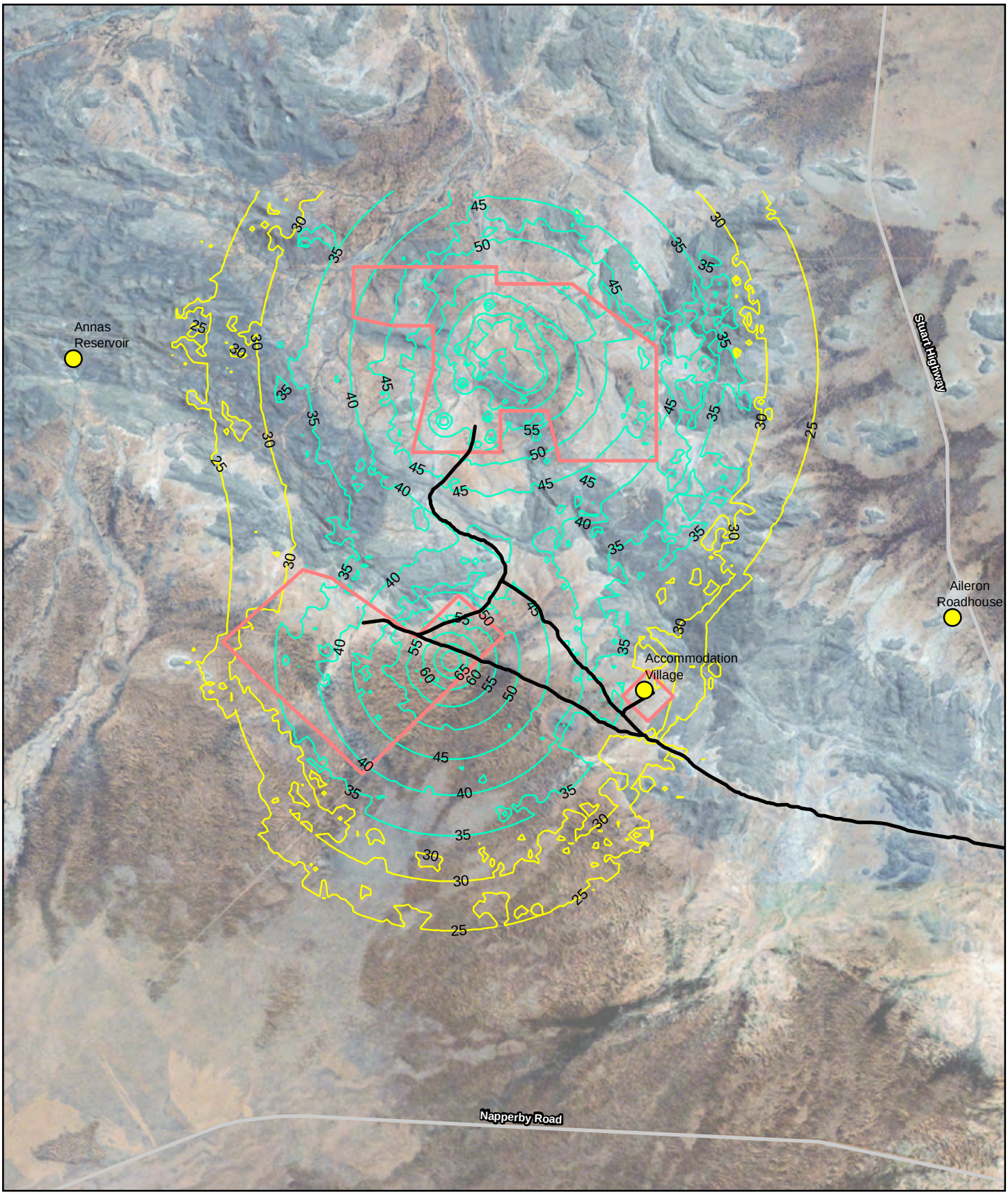
Noise model results shown in Section 6.1.5 of this report indicate the Project has the potential to exceed the assessment noise criteria at the Nolans project accommodation village sensitive receiver. GHD recommend that noise attenuator (silencer or equivalent) be installed at the gas turbine exhaust stacks to minimise the noise impact at the receiver. The installed attenuator should achieve an overall noise reduction level of not less than 20 dB(A) to the stack noise levels.

The predicted operational noise levels with the application of this specific noise mitigation measures are shown in Table 19, which shows compliance with the assessment noise criteria.

Operational noise model contours with noise mitigation measure are shown graphically in Figure 9.

Table 19 Predicted operational sound pressure levels dB(A) at modelled receivers with noise mitigation measures

Nearest Sensitive Receiver Locations	Period	Project Noise Criteria dB(A)$L_{Aeq(15min)}$	Predicted noise Levels dB(A)$L_{Aeq(15min)}$	Comply
Nolans project accommodation village	All period	35	34	Yes
Aileron Roadhouse	All period	35	8	Yes
Annas Reservoir	All period	35	13	Yes



LEGEND

- Receivers
- Roads
- Access Road
- **Noise Contours**
- < 35 dB(A)LAeq
- >= 35 dB(A)LAeq
- Project Areas

1:125,000 @ A4

0 1 2 3 4

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 53

N

Arafura Resources Limited
Nolans Project

Job Number	43-22301
Revision	0
Date	18 Mar 2016

Predicted operational noise impact contours with noise mitigation measures

Figure 9

G:\43\22301\GIS\Maps\4322301_803_PredictedOperationalNoiseImpactContourMitig.mxd

Level 5, 66 Smith Street Darwin NT 0800 Australia **T** 61 8 8982 0100 **F** 61 8 8981 1075 **E** drwmail@ghd.com **W** www.ghd.com

Data source: GA - Roads, Waterways, Placenames, Placenames, Lakes (2015). ESRI - Shaded Relief (2009). Google Earth Pro - Imagery (Date extracted: 05/11/2015). ARL - Project Areas (2015). Created by: CM

6.1.8 Traffic noise impacts

Road access for construction, service, delivery and workforce traffic will be via upgraded station roads in the area, which ultimately connect to Stuart Highway.

The distance between the sealed access road past the Nolans project accommodation village is approximately 1.5 km. The Aileron Roadhouse is located about 11 km, east from the village. Based on typical truck sound power level of 107 dB(A) (refer to Table 17 and AS 2436), using hemispherical spreading sound propagation calculations, this equates to a sound pressure level of 35 dB(A) at 1.5 km and 19 dB(A) at 9.5 km. In consideration on these calculations, as well as the intermittent nature of truck movements, traffic noise along the access roads due to the Project is not expected to cause significant impact at the assessed receivers.

As previously mentioned in Section 4.3, Stuart Highway is a government controlled road potentially affected by the project. It is not planned for redevelopment or upgrade. The Aileron Roadhouse receiver is located approximately 5.5 km to the north of the intersection between Nolans site access road and Stuart Highway.

GHD's traffic study indicated that consumables required to facilitate mining and processing of rare earths will be transported to the site from Darwin via Alice Springs using the Adelaide-Darwin railway and the Stuart Highway. Rare earths product will be exported from site to Darwin Port via Alice Springs, also using the Stuart Highway and the Adelaide-Darwin railway.

Hence, the Stuart Highway road section to be used by the Project is starting at the intersection of the Nolans Project road access, to the south to Alice Springs, whereas Aileron Roadhouse receiver is located about 5.5 km to the north of the Stuart Highway-Nolans Project access road (refer to Figure 10). Due to the significant distances, project traffic noise impact along Stuart Highway is not expected to cause significant impact at the Aileron Roadhouse receiver.

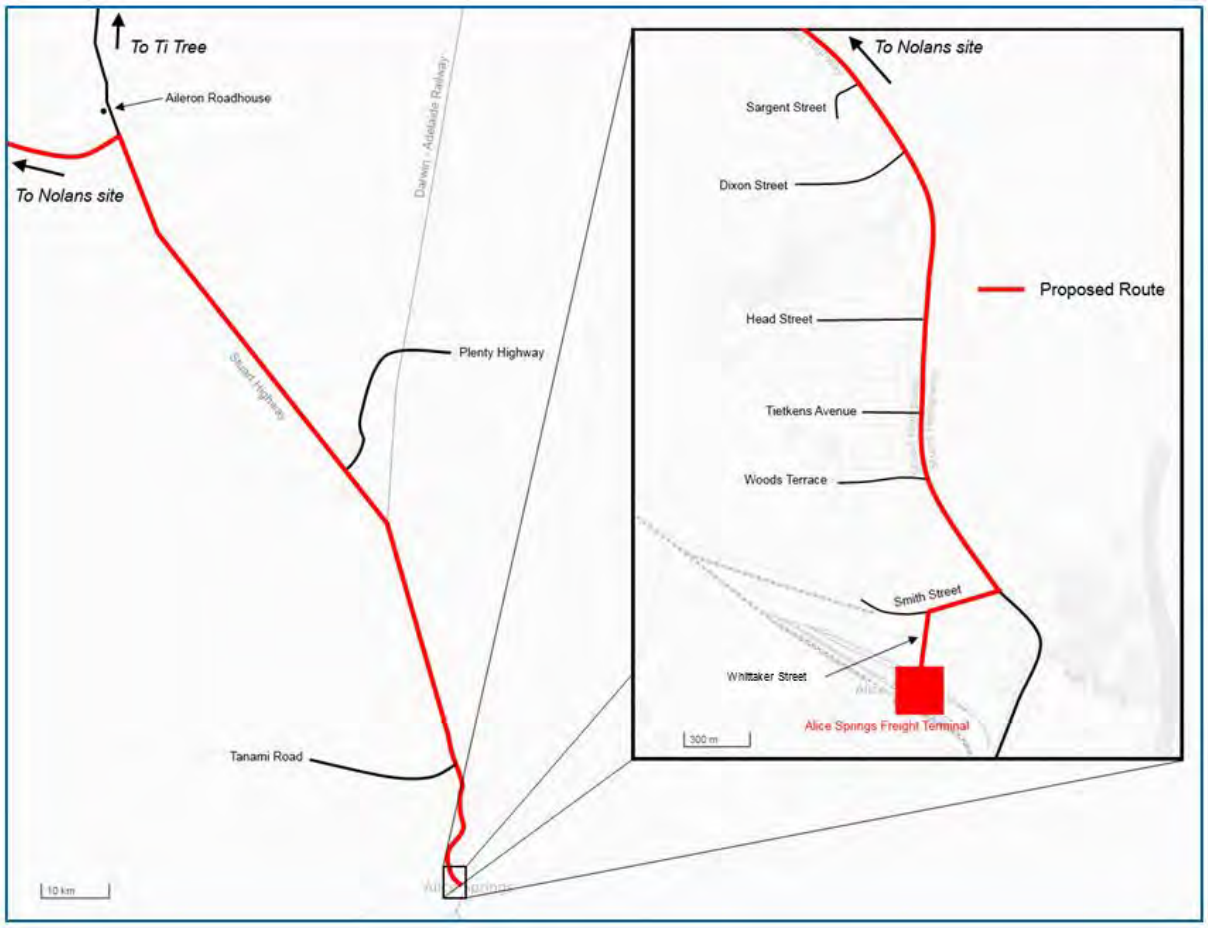


Figure 10 The proposed access route from / to Alice Springs

6.1.9 Operation blasting impact

Refer to Section 5.3.3 of this report.

6.2 Operational vibration

Based on the equipment detailed in Section 6.1.3 and indicative ground-borne vibration assessment in Section 5.2, it is expected that ground-borne vibration impacts associated with the operation of the Nolans project would be insignificant at identified nearby sensitive receivers.

Using vibration impact information in Section 5.2, it is the responsible of the contractor to ensure that the operation of the equipment during mine activities does not cause vibration impact to any sacred or heritage sites surrounding the mine site.

As a general recommendation all rotating equipment within the project site should be vibration isolated using vibration isolation mounts, as per manufacturer's recommendations.

6.3 Noise impacts on native fauna and livestock

6.3.1 Overview

Research indicates that there are no government policies or widely accepted guidelines with regard to noise criteria for animals at this point in time. Information is provided in technical literature and has been reviewed for the Project.

6.3.2 Livestock

The noise goals provided in this report are based on human response and annoyance factors and, as such, are not applicable to livestock or other non-human receivers. Sudden noise has the potential to startle or upset domestic livestock and pets.

Heggies Pty Ltd conducted a literature review as part of their assessment of blasting noise impacts on livestock for the proposed Caval Ridge Coal Mine Project (Heggies, 2009). Heggies cites results from a study on the response of farm animals to sonic booms (sonic booms being similar in character to airblast from blasting), which indicated that reactions of sheep, horses and cattle to sonic booms (125 dB to 136 dB) were considered slight to mild.

The numbers of animals observed under sonic boom conditions include 10,000 commercial feedlot beef cattle, 100 horses, 150 sheep and 320 lactating dairy cattle. Booms test schedule was designed at varying intervals during morning hours Monday to Friday of each week.

Results showed that there was only 19 of 104 booms caused even a mild reaction on sheep, horses and dairy cattle in temporary cessation of eating, rising of heads and slight startle effects. The total individual milk yield has been observed during the test period and no affect has been found on the overall milk production.

Given these conclusions, it is considered unlikely that the Project would have an adverse effect on livestock in the vicinity of the Project.

6.3.3 Native fauna

Disturbance to fauna associated with generation of unexpected and/or excessive noise and vibration from mining and processing activities during construction can result in the displacement of fauna and disruption to nesting/roosting/foraging behaviour. With mitigation measures in place the risk of impact associated with noise and vibration has been assessed as being low.

Potential noise impacts on fauna is discussed in the *Nolans Project Biodiversity Fauna Report* (GHD 2016).

6.3.4 Summary

Mitigation measures for reducing potential impacts on wildlife from noise and vibration include:

- Minimising noise where possible
- Limiting high-impact noise and vibration, such as blasting, to daylight hours only to reduce the impact on nocturnal fauna. It is recommended that blasting on-site should be designed by a qualified contractor and include consideration of the blasting noise and vibration limits outlined in this report.

6.4 Summary of impact

Key risk pathways associated with operational noise and vibration have been identified in the risk register for the project, and which are discussed below.

The operation of Nolans Project includes the mining activities and the processing plants (detailed in Section 6.1.3), that produce considerable noise emissions, have been shown to have the potential to exceed the Project noise criteria at the nearby mine accommodation village receivers. This was predicted to be dominated by the operation of the power station, as identified in the risk register with medium impact risk. Project specific operational noise mitigation measures as well as general measures have been provided in Sections 6.1.7 and 7.2 to assist in minimising the impact risk to low level.

Operational vibration impact to the nearby noise sensitive receivers was assessed to be below the vibration criteria of the Project, and therefore is considered low risk.

7. General noise and vibration mitigation measures

GHD recommends that the following general measures be taken into consideration during construction and operation of the Project to minimise the risks of noise impact.

7.1 Construction noise

NT EPA has recommended the development of a noise management plan (NMP), which is to include, as a minimum:

- *"Justification for work on the development site, that is likely to be undertaken outside of the acceptable construction times (between the hours of 7 am and 7 pm Monday to Saturday and/or between the hours of 9 am to 6 pm on a Sunday or public holidays 7 days a week.*

  Whilst acknowledging Arafura's proposed construction hours between 6 am to 6 pm, and the rural location of the project, justification of work outside this period may be required.
- *Details and the duration of the activities on the development site likely to cause noise emissions that may exceed the construction noise levels defined in noise guidelines for development sites in the Northern Territory (NT EPA 2013) during a period specified in Clause 10.1.*
- *Details clearly demonstrating how site activity will comply with 'AS 2436 Guide to Noise and Vibration Control on Construction, Maintenance and Demolition Sites'.*
- *Documented complaint response procedures and how the procedures will be implemented.*
- *Documentation on the verifiable consultation and feedback program with occupants of all affected premises, demonstrating that all occupants were provided with advice on dates, times and nature of any potentially noisy and disruptive activity including measures proposed to mitigate such activity as well as noise complaint contact details.*
- *Name of the onsite person who will be responsible for implementing the NMP and the name and phone number of the person to whom a complaint may be made about noise emissions from the site."*

In addition, the following general construction noise mitigation measures could be considered.

- Where possible, activities that could result in elevated noise levels will be scheduled during NT EPA prescribed acceptable construction times (0700 to 1900 hours Monday to Saturday). However, justification of work outside the NT EPA acceptable construction times may be needed should this be not possible.
- Review available fixed and mobile equipment fleet and prefer more recent and silenced equipment whenever possible. In any case, all equipment used on site should be in good condition and good working order.

- Plan to use equipment, which is fit for the required tasks in terms of power requirements.
- All engine covers should be kept closed while equipment is operating.
- As far as possible, material drop heights into or out of trucks should be minimised.
- Broadband reversing alarms (audible movement alarms) should be used for all site equipment, subject to meeting occupational health and safety requirements.
- All combustion engine plant, such as generators, compressors and welders should be checked to ensure they produce minimal noise.
- Vehicles should be kept properly serviced. The use of exhaust brakes should be eliminated, where practicable.
- Where practical, machines should be operated at low speed or power and should be switched off when not being used rather than left idling for prolonged periods.
- Machines found to produce excessive noise compared to industry normal standard should be removed from the site or stood down until repairs or modifications can be made.

7.2 Operational noise

7.2.1 General noise mitigation measures

The following measures have been provided for consideration to minimise operational noise impact.

- Where appropriate, selection of quiet equipment/system (including the power station) early in the design phase should be considered as part of the Project's operational noise management measures to minimise noise emissions. This would assist in minimising the off-site impact and help in preserving the hearing quality and reducing the Health and Safety for the on-site employees.
- All mobile equipment should be selected to minimise noise emissions and maintained in good repair. Machines found to produce excessive noise compared to normal industry expectations should be removed from the site or stood down until repairs or modifications can be made.
- Broadband reversing alarms (audible movement alarms) should be used for all site equipment, subject to meeting occupational health and safety requirements.

7.2.2 General work practices

All site workers should be aware of the potential for noise impacts and encouraged to take practical and reasonable measures to minimise the impact during the course of their activities. These measures should include:

- Where practical, machines should be operated at low speed or power and switched off when not being used rather than left idling for prolonged periods.
- Minimising reversing with beepers
- Avoid metal to metal contact on material
- All engine covers should be kept closed while equipment is operating.

7.3 Vibration

It is recommended that the following construction and operational vibration mitigation measures be considered to reduce the impact on the surrounding receivers:

- Use smaller capacity vibratory rollers
- Consider the use of static rollers opposed to vibratory roller/compactors where possible
- Vibration intensive activities should be implemented during the least sensitive time periods
- Sequence operations so that vibration intensive activities do not occur simultaneously, where possible.

7.4 Community consultation and complaint management

Although it is not expected the operations of the Nolans project will cause adverse noise or vibration impacts, community consultation and a complaint management system may need to be implemented during construction and operation of the Project, as per TOR (May 2015) requirement. The system may include the following measures as relevant:

- A community liaison phone number and permanent site contact number should be established and made available to nearby residents and other noise sensitive receivers so that noise related complaints can be received and addressed in a timely manner.
- Investigation as to whether any unusual activities were taking place at the time of the complaint that may have generated higher noise levels than usual.
- Conduct noise and/or vibration monitoring (as applicable) at the complainant's location if the complaint is deemed justified. Monitoring would be undertaken and reported within five days (or as practicable and reasonable) of receiving a complaint, if that activity is continuing, so that the monitoring findings can be incorporated to the written response provided to the complainant.
- If exceedances were detected, corrective actions would be implemented, included in the response to the complainant and recorded.
- Upon receipt of a noise and/or vibration complaint, complaints would be addressed in accordance with the above complaint management system. Based on experience with similar projects, response to the complaint would include but not limited to:
- Provision of a written response to a complaint within seven days.
- Provision of an email response to an electronic complaint within two days if the complaint cannot be resolved by an initial response.

7.5 Blasting mitigation measures

Any blast on site should be designed by a qualified contractor and include consideration of the blasting noise and vibration limits outlined in this report.

8. Conclusion

This noise and vibration assessment report addresses section 5.13.2 of the Term of Reference (TOR) (May 2015) requirements. The report outlines the methodology and results of background noise monitoring and identifies the potential noise and vibration impacts from construction and operation at the proposed mine and processing sites.

8.1 Nearby sensitive receivers

Aerial photography and a site visit in August 2010 were used to determine the proximity of the closest noise sensitive receivers.

The community of Aileron Roadhouse and Annas Reservoir are identified to be the nearest human sensitive receivers external to the Project site, and are currently located approximately 13 km to the south-east and 10 km to the west of the mine site respectively. The Nolans project accommodation village of the Project is proposed to be located within the Project site, at approximately 5 km southeast of the processing plant.

8.2 Existing noise levels

Measured background noise levels at the nearest identified receiver are low and typical of a rural environment. Measured background noise levels were below the minimum recommended noise level in the NSW INP. Therefore, the minimum background noise levels were adjusted up to the recommended 30 dB(A) L_{A90} before setting the operational noise criteria.

8.3 Noise and vibration criteria

Noise criteria applicable for the nearby Project noise sensitive receivers were derived based on the following regulations and guidelines:

- *Northern Territory Environment Protection Authority (NT EPA) Noise guidelines for development sites in the Northern Territory*
- *NSW Industrial Noise Policy (INP) 2000*

Applicable construction noise criteria for the Project is 48 dB(A)$L_{eq(15min)}$ and applicable operational noise criteria is 35 dB(A)$L_{eq(15min)}$.

8.4 Construction noise

Noise impact from construction of the proposed Nolans project is predicted to comply with the adopted criteria at all noise sensitive receivers. Further, general construction noise mitigation measures have been provided in Section 7.2.1 to minimise the risks of noise impact.

8.5 Operational noise

Predicted operational noise impact assessment indicated that noise impact at the Aileron Roadhouse receiver is expected to be below the noise criterion off site. However, potential 10 dB(A) exceedance is predicted to occur at the Nolans project accommodation village receiver on site.

Further analysis of predicted dominant noise sources at the Nolans project accommodation village receiver, has indicated that the gas turbines stacks at the power station site are the primary contributors. Subject to concept design, GHD recommend that noise attenuator (silencer or equivalent) be installed at the gas turbine exhaust stacks to minimise the noise impact at the receiver. The installed attenuator should achieve an overall noise reduction level of not less than 20 dB(A) to the stack noise levels.

However, GHD noted that the above results are based on modelling assumptions, due to project specific equipment selection and specifications are not available at the time of writing this report. Should more detailed information of the actual proposed equipment selections and specifications become available, and that it shows there would be potential significant difference to the above assumptions or the assumptions stated throughout this report, it is recommended that noise modelling should be updated.

8.6 Traffic noise

Road access for the traffic including construction, service, delivery vehicles will be via and upgraded sealed station road connection to Stuart Highway.

Due to substantial distance separation between the access road and the sensitive receivers, as well as the transport route along Stuart Highway to Alice Springs, traffic noise from the Project not expected to cause significant impact at the assessed receivers.

8.7 Construction and operational vibration

Due to the extensive distance (5 km or more) from source-to-receiver, it is expected that equipment vibration associated with the construction and operation of the Project would be insignificant at identified nearby sensitive receivers.

8.8 Blasting

In the absence of project specific blasting information, indicative airblast overpressure and ground vibration assessment from blasting activities at the proposed mine had been undertaken and are predicted to comply with the adopted criteria.

8.9 Mitigation measures

General construction and operational noise mitigation measures and controls have been provided in Section 7 of this report to minimise the risk of Project noise impact.

This report is subject to, and must be read in conjunction with the limitations presented in section 9 and the exclusions, assumptions and qualifications contained throughout the report.

9. Limitations

This report has been prepared by GHD for Arafura Resources Limited and may only be used and relied on by Arafura Resources Limited for the purpose agreed between GHD and the Arafura Resources Limited as set out in section 1.2 of this report.

GHD otherwise disclaims responsibility to any person other than Arafura Resources Limited arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described throughout this report. GHD disclaims liability arising from any of the assumptions being incorrect.

To the maximum extent permitted by law, all implied warranties and conditions in relation to the services provided by GHD and the Report are excluded unless there are expressly stated to apply in the Report.

GHD has prepared this report on the basis of information provided by Arafura Resources Limited and others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

The opinions, conclusions and any recommendations in this report are based on information obtained from, and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.

Investigations undertaken in respect of this report are constrained by the particular site conditions, such as the location of buildings, existing surrounding industries, services and vegetation, etc. As a result, not all relevant site features and conditions may have been identified in this report.

Site conditions may change after the date of this report. GHD does not accept responsibility arising from, or in connection with, any change to the site conditions. GHD is also not responsible for updating this report if the site conditions change.

The assessment in this report was based on on-site inspections and measurements obtained by GHD between 10 August 2010 and 18 August 2010. Note that it is the nature of environmental assessment that all variations in environmental conditions cannot be assessed and all uncertainty concerning the conditions of the ambient noise environment cannot be eliminated. In addition, 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. Professional judgement must be expected in the investigation and interpretation of observations.

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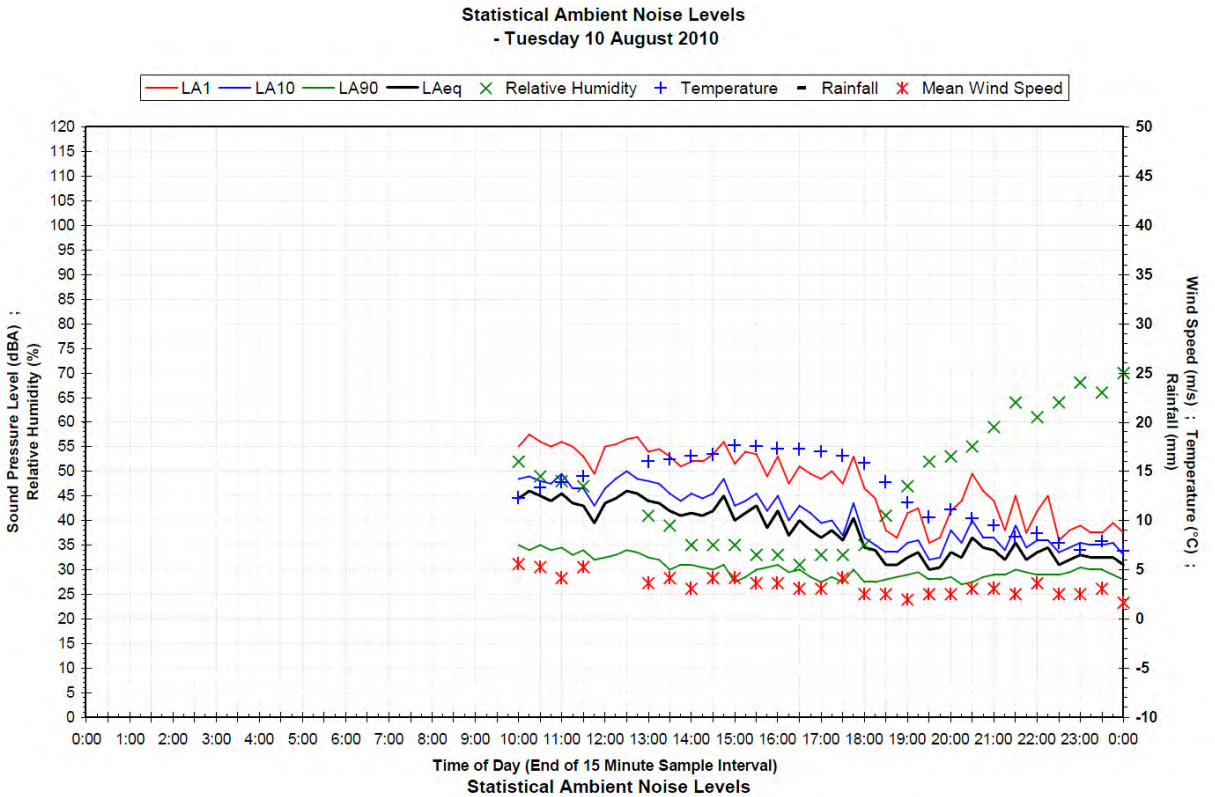
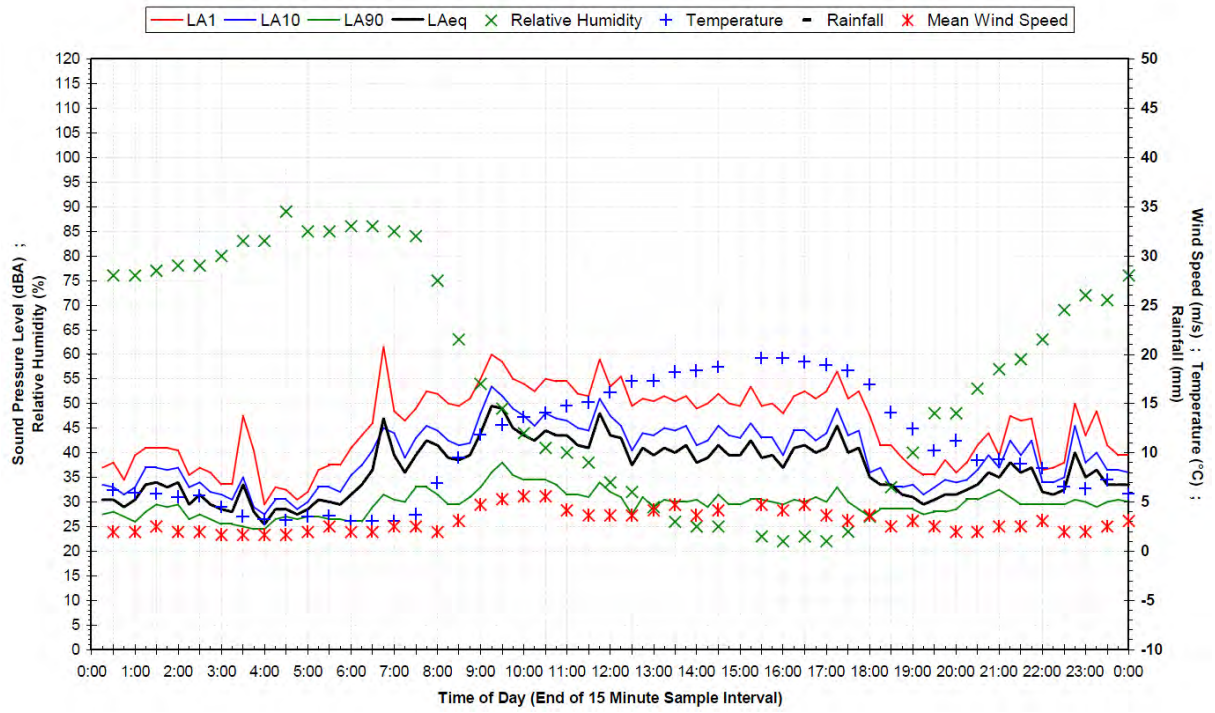
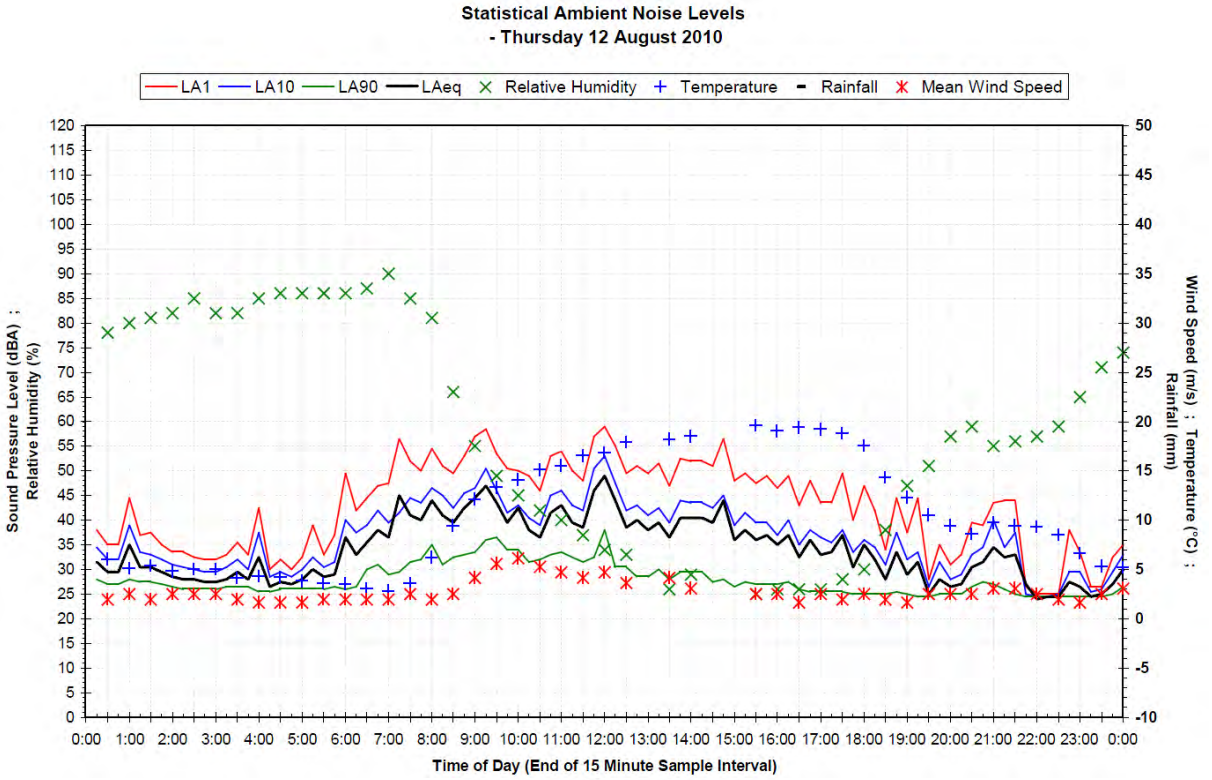
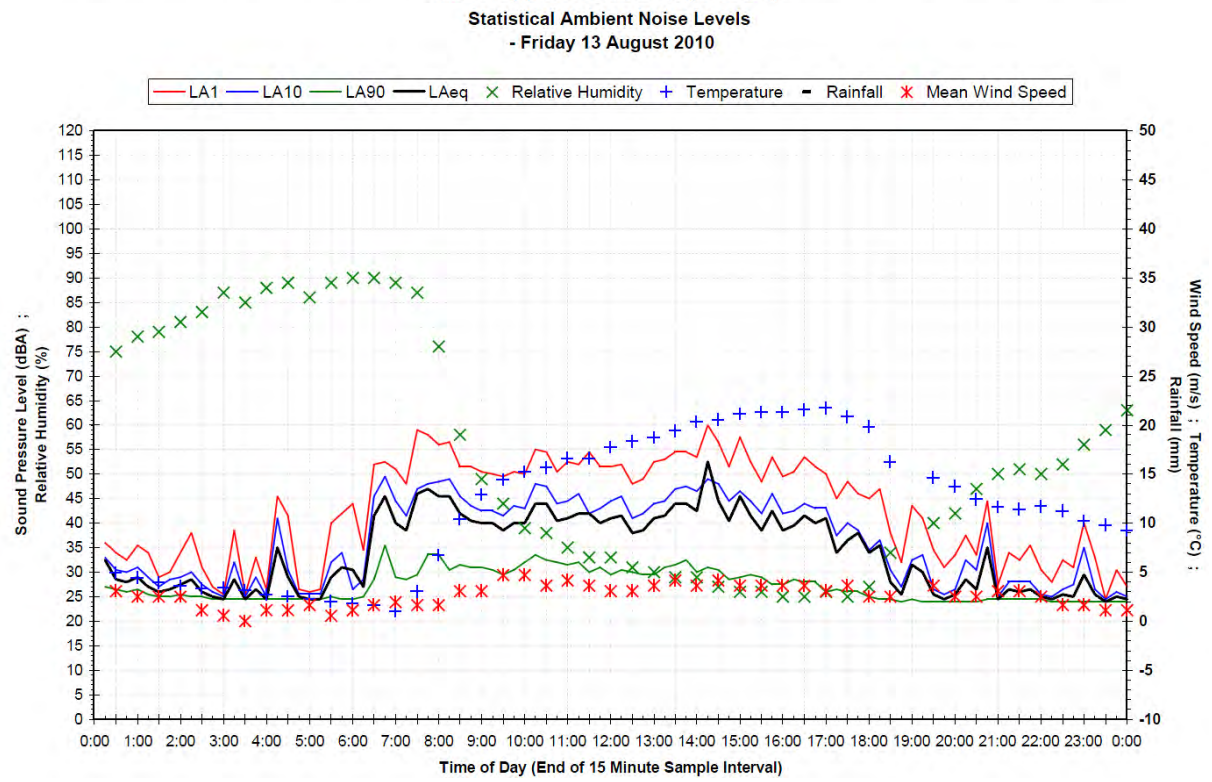
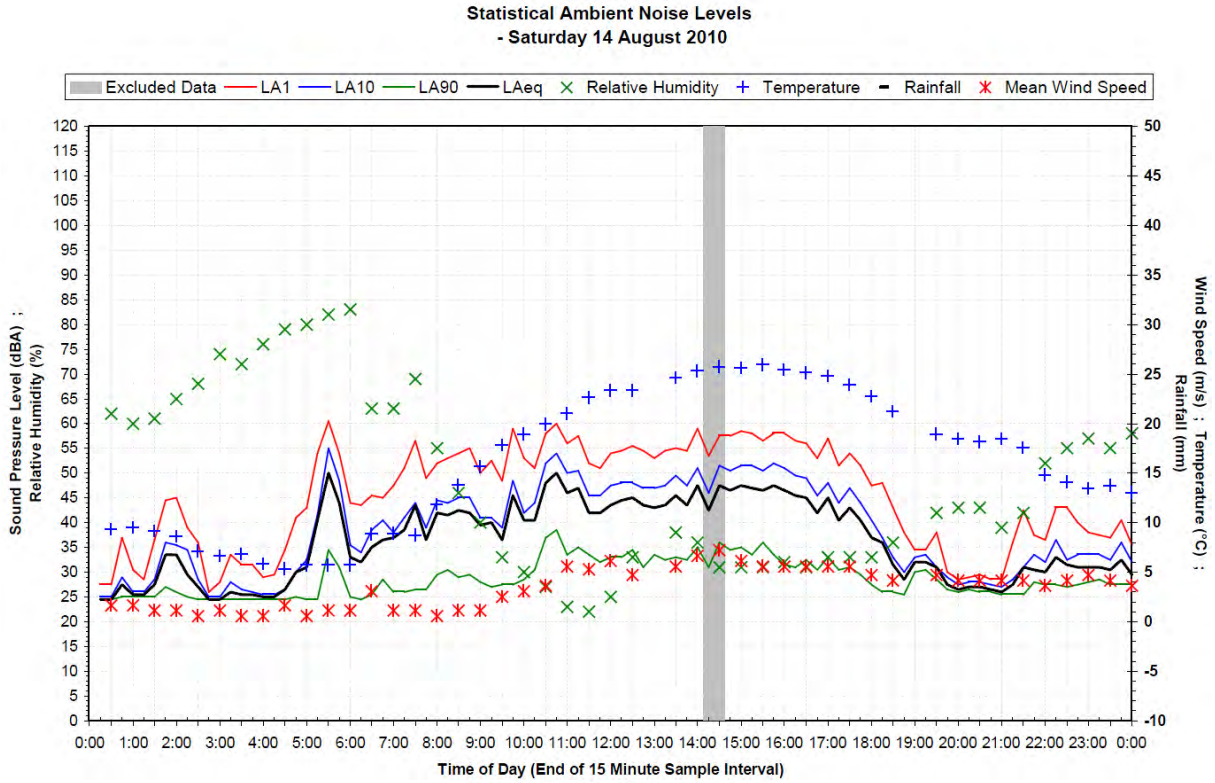
Appendix A – Noise monitoring charts logger 1

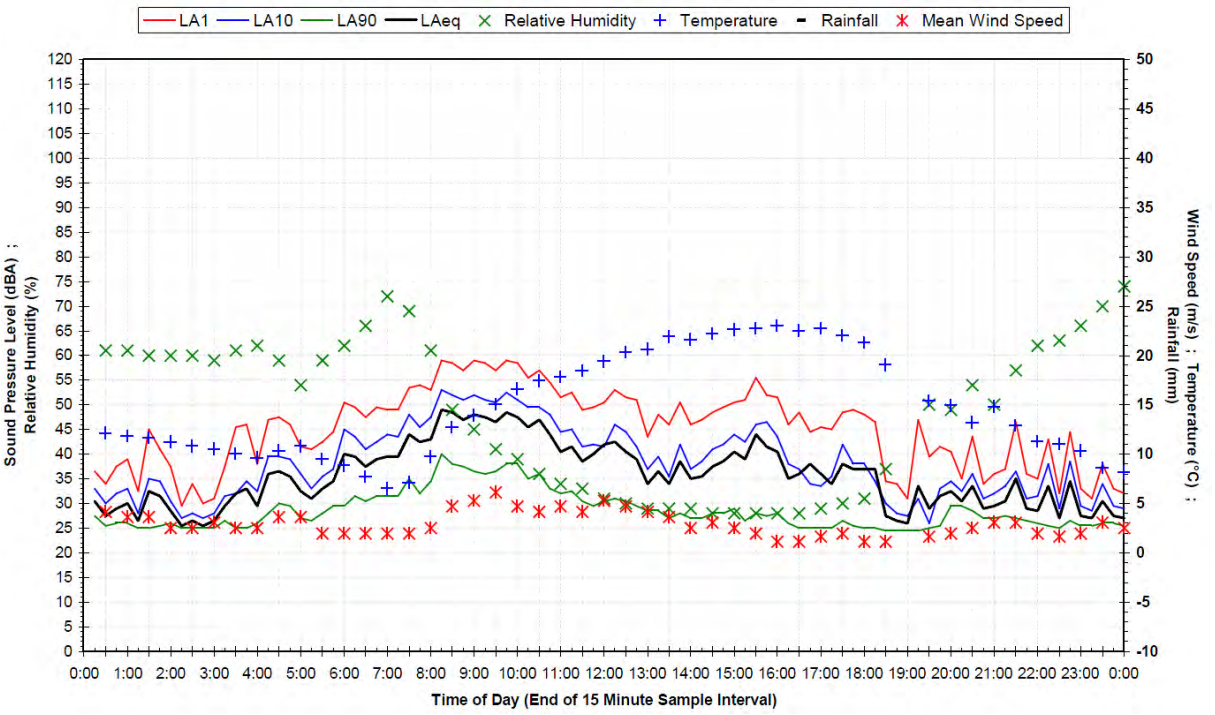

Statistical Ambient Noise Levels
- Tuesday 10 August 2010
LA1
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ;
Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ;
Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)

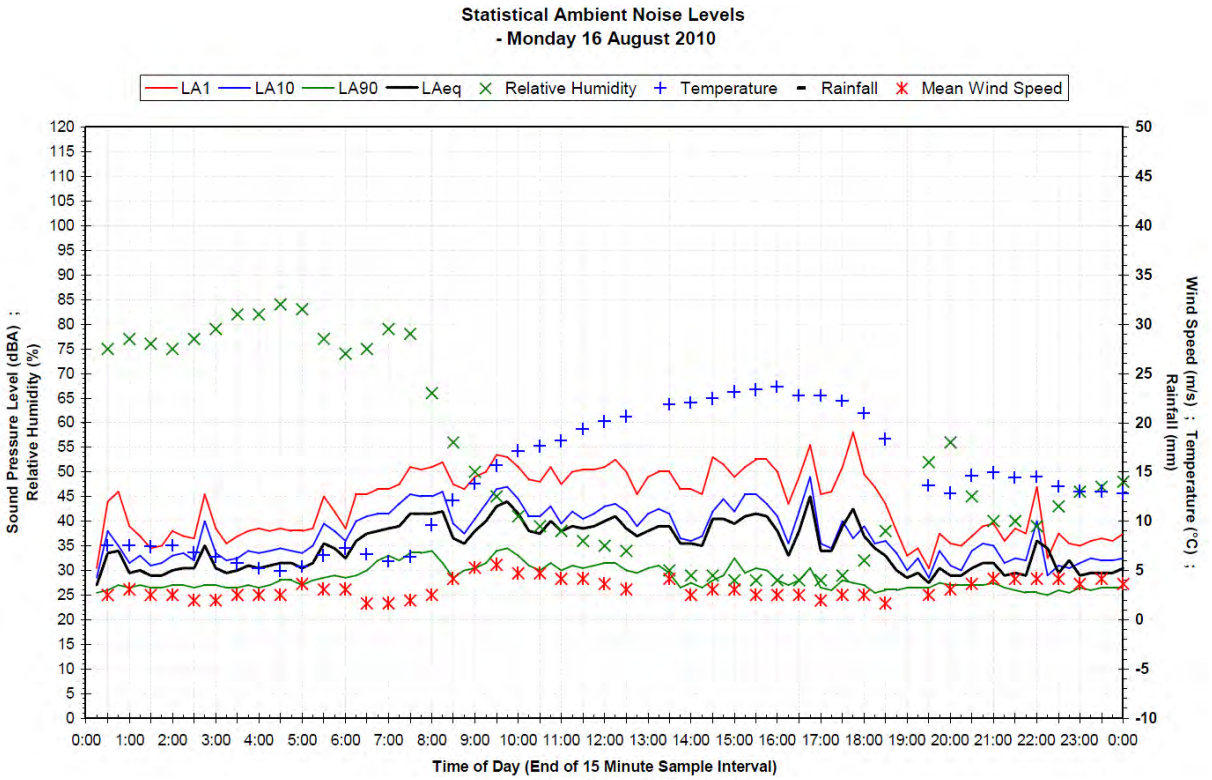

Statistical Ambient Noise Levels
- Wednesday 11 August 2010
LA1
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ;
Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ;
Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)

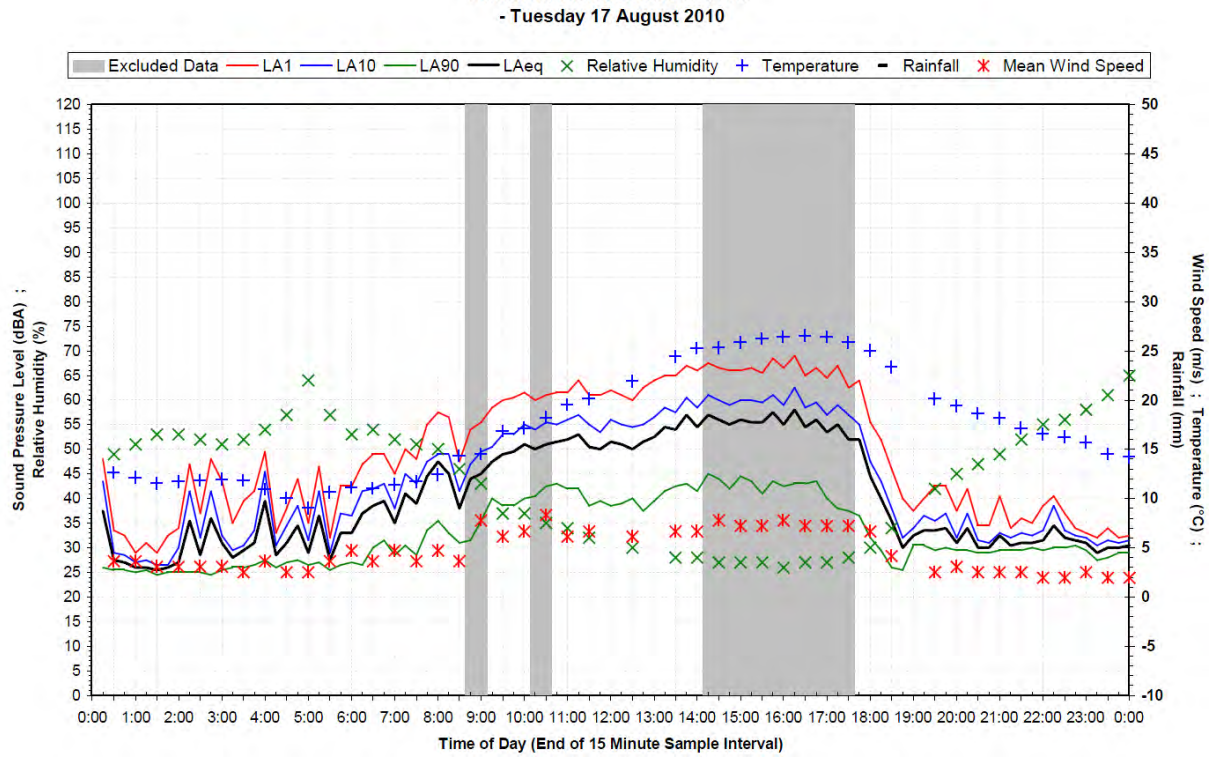

Statistical Ambient Noise Levels
- Thursday 12 August 2010
LA1
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)

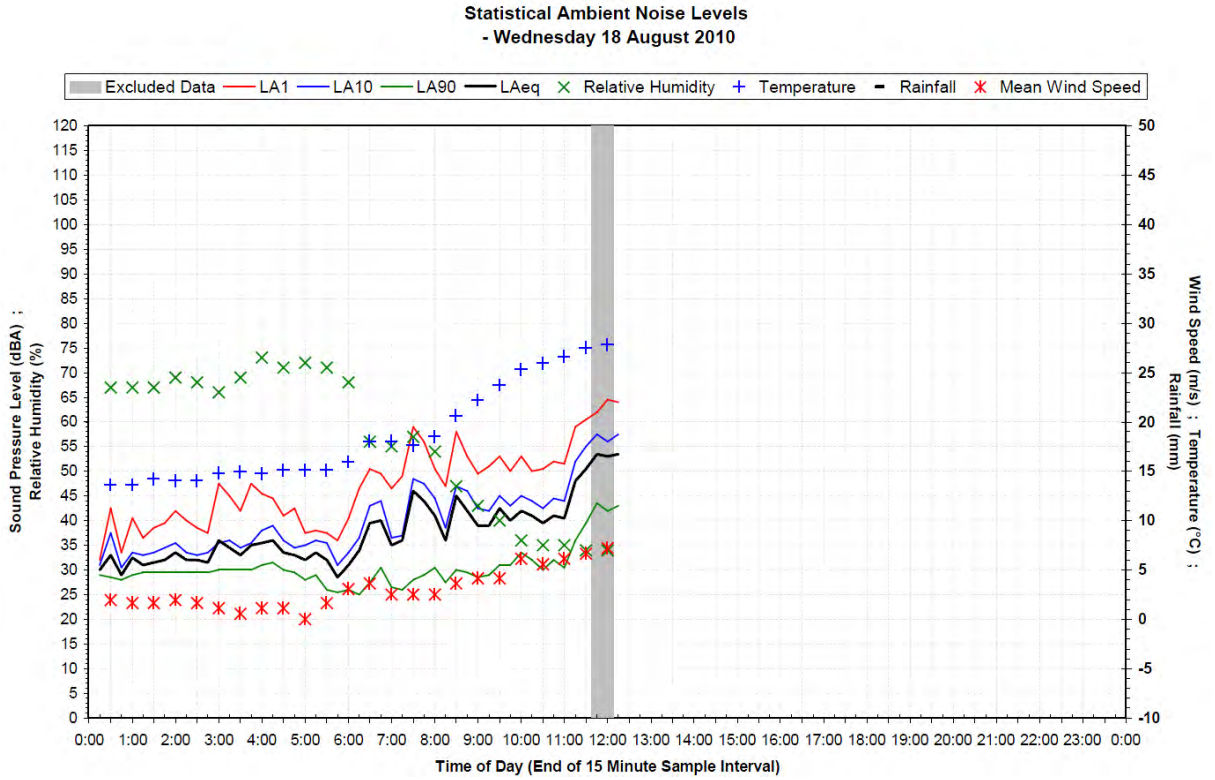

Statistical Ambient Noise Levels
- Friday 13 August 2010
LA1
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)


Statistical Ambient Noise Levels
- Saturday 14 August 2010
Excluded Data
LA1
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)

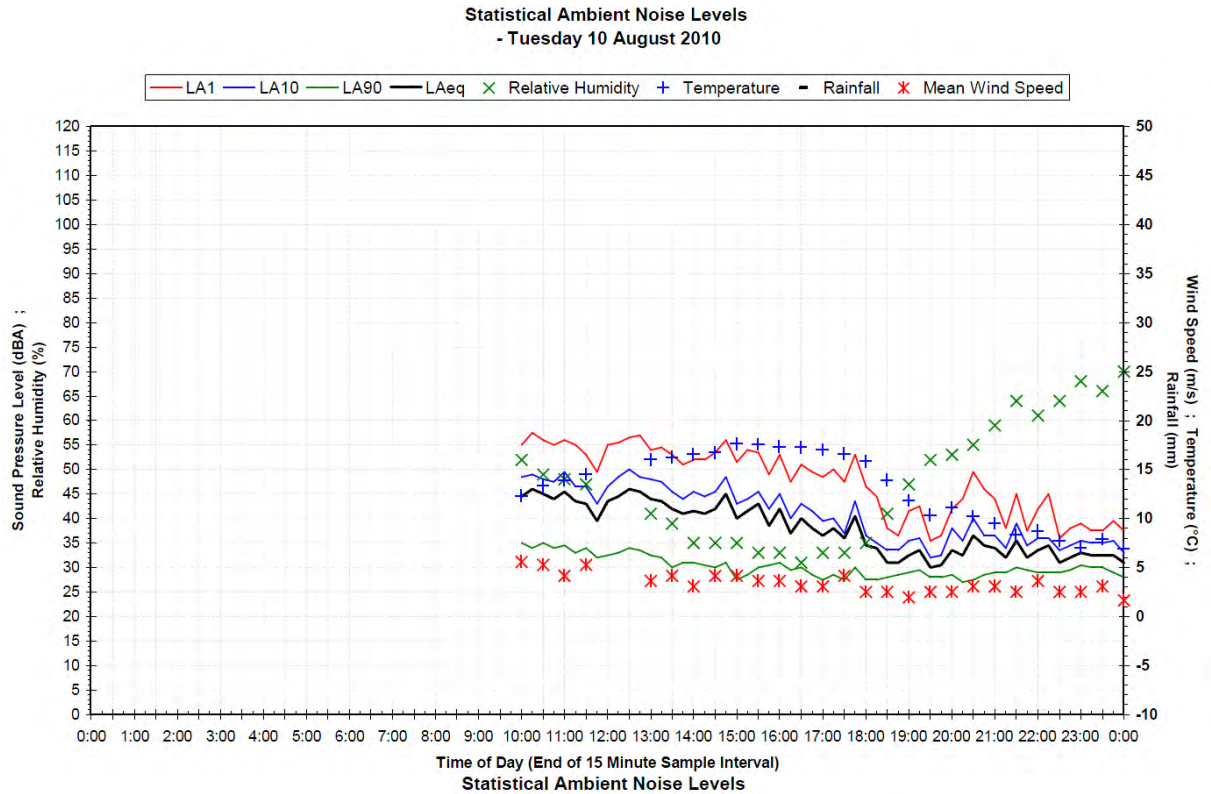

Statistical Ambient Noise Levels
- Sunday 15 August 2010
LA1
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)

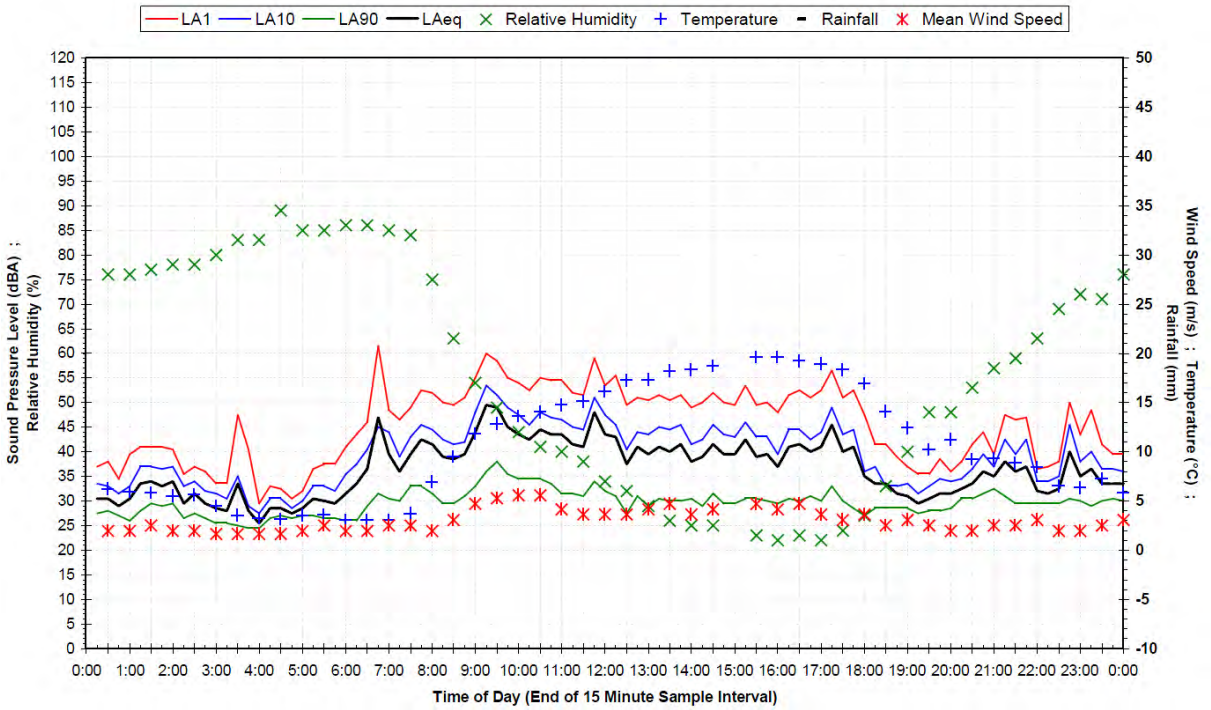

Statistical Ambient Noise Levels
- Monday 16 August 2010
LA1
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)

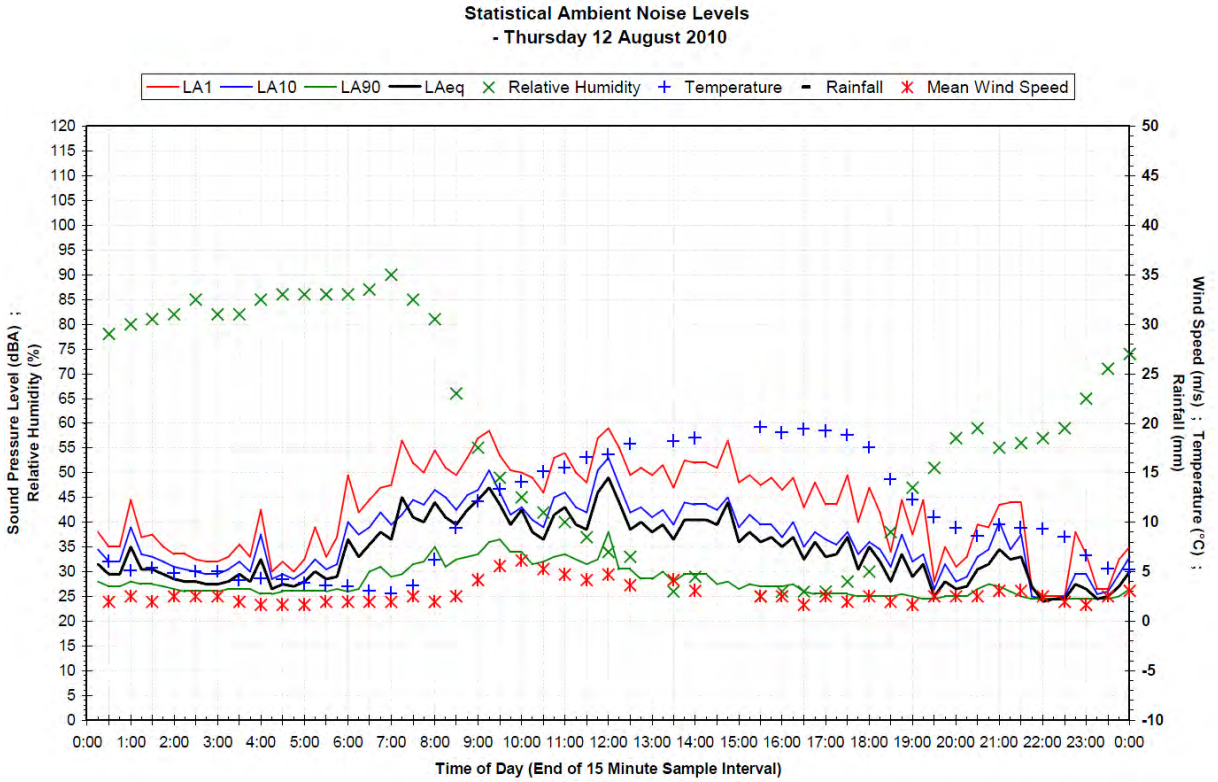

Statistical Ambient Noise Levels
- Tuesday 17 August 2010
Excluded Data
LA1
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)

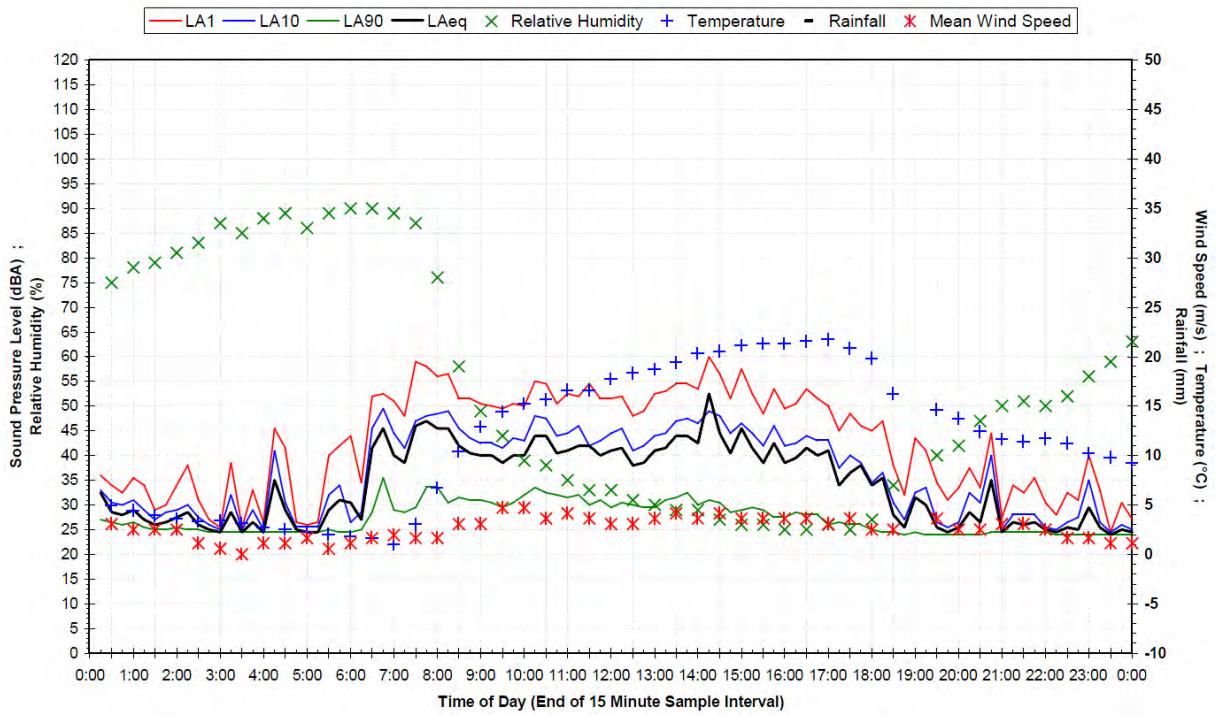

Statistical Ambient Noise Levels
- Wednesday 18 August 2010
Excluded Data
LA1
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)

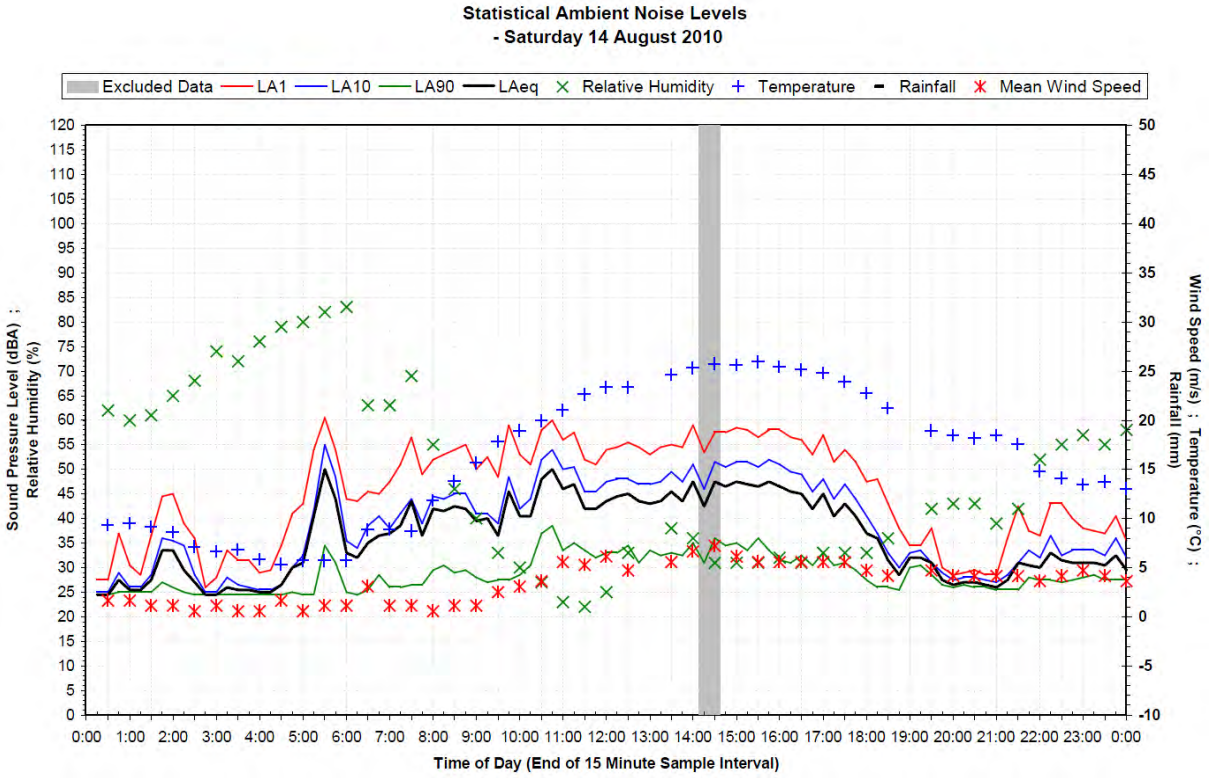
Appendix B – Noise monitoring charts logger 2


Statistical Ambient Noise Levels
- Tuesday 10 August 2010
LA1
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ;
Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ;
Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)


Statistical Ambient Noise Levels
- Wednesday 11 August 2010
LA1
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ;
Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ;
Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)


Statistical Ambient Noise Levels
- Thursday 12 August 2010
LA1
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)


Statistical Ambient Noise Levels
- Friday 13 August 2010
LA1
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)


Statistical Ambient Noise Levels
- Saturday 14 August 2010
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LA1
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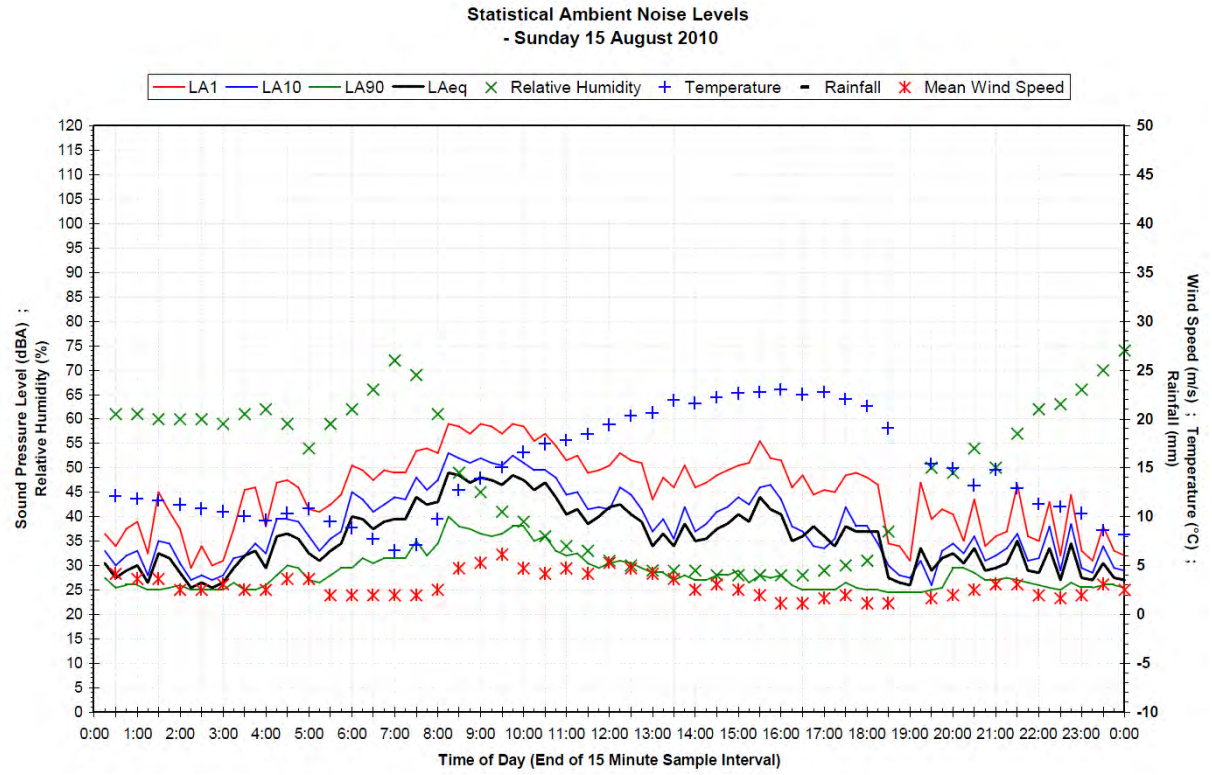
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)


Statistical Ambient Noise Levels
- Sunday 15 August 2010
LA1
LA10
LA90
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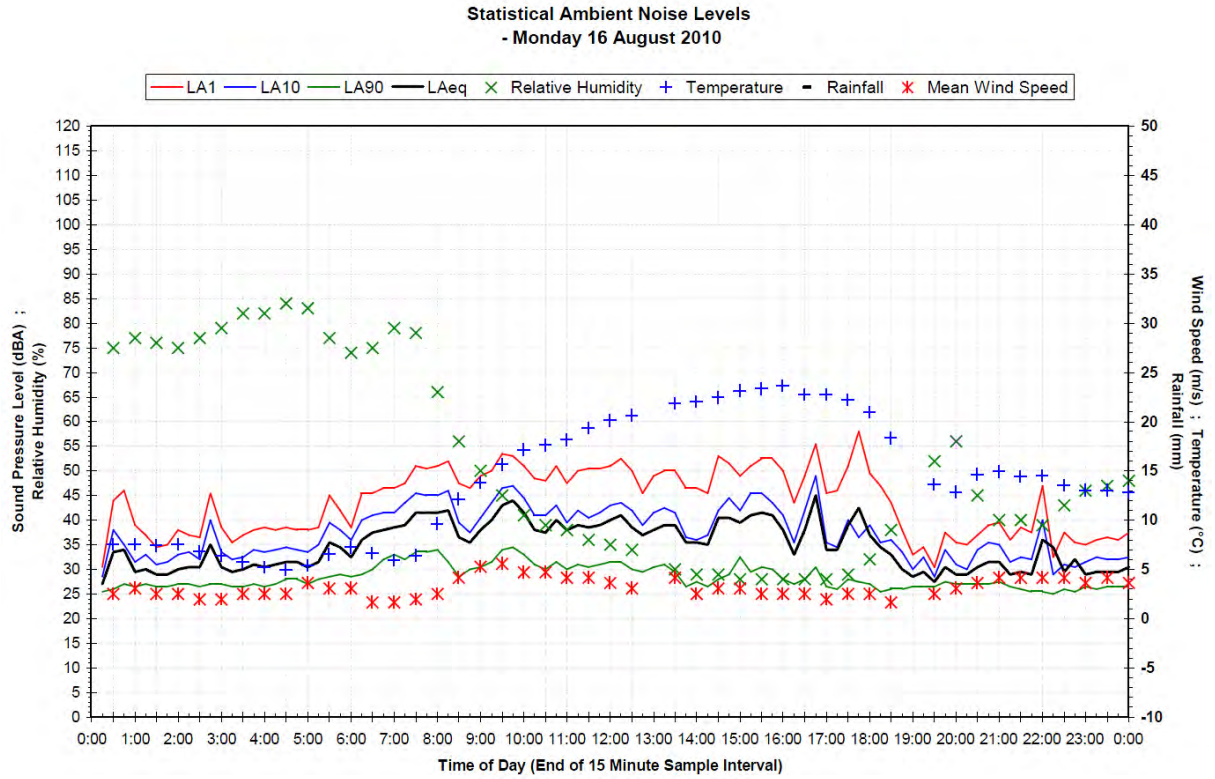
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)


Statistical Ambient Noise Levels
- Monday 16 August 2010
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Relative Humidity
Temperature
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Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
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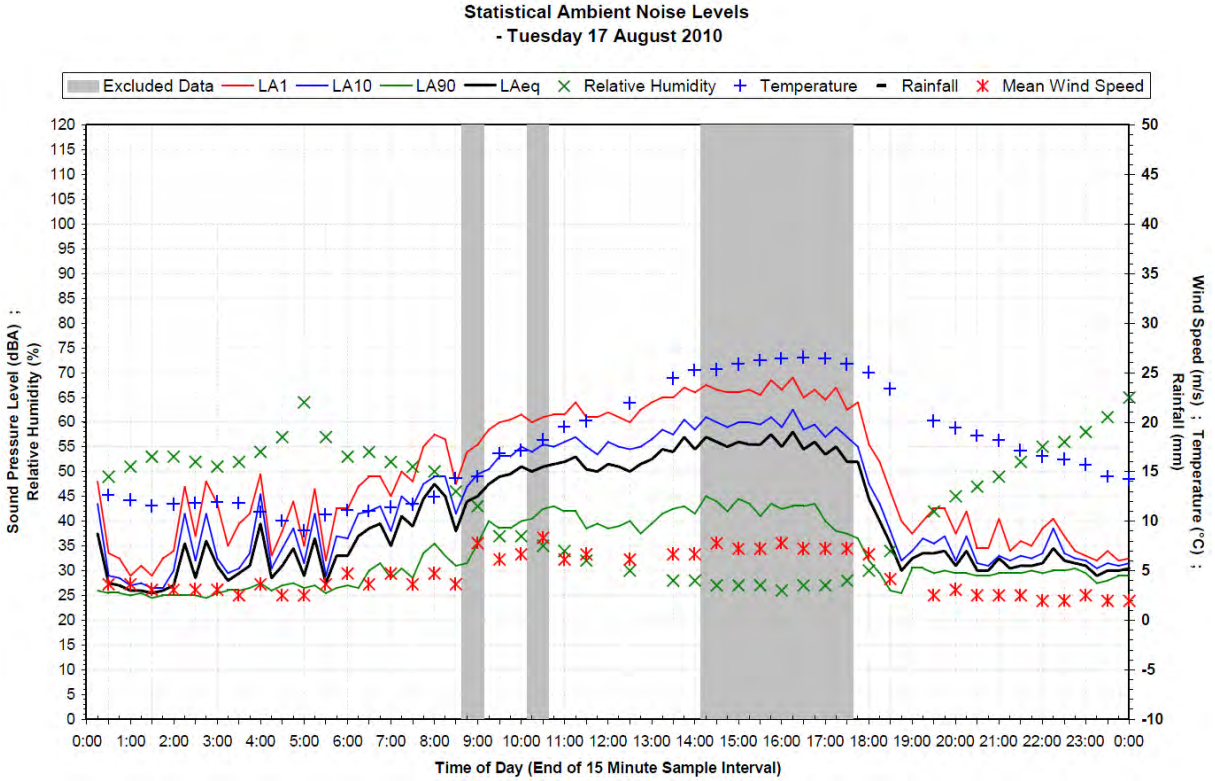
Statistical Ambient Noise Levels
- Tuesday 17 August 2010
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LA1
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Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
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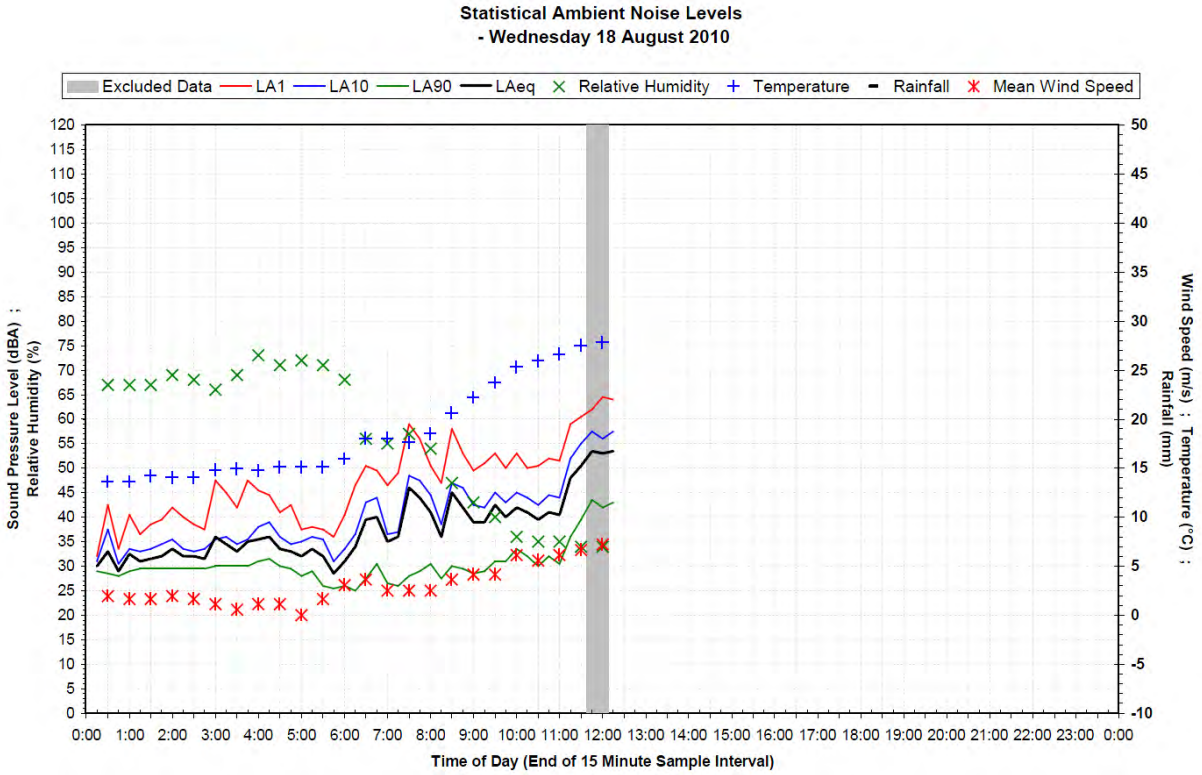
Statistical Ambient Noise Levels
- Wednesday 18 August 2010
Excluded Data
LA1
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Relative Humidity
Temperature
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Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)

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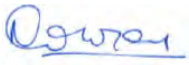
0	S. Gunawan	K Fitzpatrick		Nicole Conroy		29/03/16

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