Jemena Northern Gas Pipeline Pty Ltd

Northern Gas Pipeline

Draft Environmental Impact Statement

APPENDIX T – NOISE ASSESSMENT

Public

August 2016

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Environmental Monitoring and Assessment

Noise Assessment - Northern Gas Pipeline

- FINAL

Jemena Limited

399-RP-EV-011 – Noise Assessment Report

August 2016

Issued: 2 August 2016

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DOCUMENT CONTROL SHEET

Document Details

Project Reference: 4504

Document Title: Noise Assessment - Northern Gas Pipeline - FINAL

Client: Jemena Limited

Document Reference: /Network/Projects/4504/Reporting/Noise/4504-noisereport-03-1.odt

Revision History

ANE Version:	NGP Version:	Description:	Date:	Author:	Approved by:
00	-	Draft for Internal Review	16/05/16	Beau Weyers	-
01	A	Draft for Client	16/05/16	Beau Weyers	Claire Richardson
	B	Revised Draft for Review	20/06/16	Beau Weyers	Claire Richardson
02	0	Final	01/07/16	Beau Weyers	Claire Richardson
03	1	Final	02/08/16	Beau Weyers	Claire Richardson
04					
05					
06					

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The validity and comprehensiveness of supplied information has not been independently verified and, for the purposes of this report, it is assumed that the information provided to Air Noise Environment Pty Ltd for the purposes of this project is both complete and accurate.

Executive Summary

The Northern Gas Pipeline (NGP) project involves the construction of 622 km of pipeline, beginning at Warrego, Northern Territory and extending east towards Mt Isa, Queensland. To address the potential noise impacts of the NGP project, Air Noise Environment has been commissioned by Jemena to undertake a noise assessment. The assessment has been completed using computational modelling and results have been compared to relevant criteria for construction and operational noise outlined in the Queensland Environmental Protection (Noise) Policy 2008, Northern Territory Environmental Protection Authority (EPA) Noise guidelines for development sites in the Northern Territory (2014), and 'Streamlined model conditions for petroleum activities' (2014) published by the Queensland Department of Environment and Heritage Protection (EHP). Consideration of the potential to impact on ecologically sensitive areas has also been considered.

As part of the pipeline operations, End of Line (EOL) and Start of Line (SOL) facilities will be constructed at either end of the pipeline. These facilities will comprise gas engine alternators (GEAs) and compressor turbines, which will result in continuous and potentially loud noise sources operating continuously in areas of minimal pre-existing noise. In addition to these facilities, there are potential noise impacts relating to the flare (SOL) and gas venting at the SOL and EOL, as well as at 3 Mainline Valve (MLV) locations along the pipeline. Potential noise impacts during construction of the main line and facilities have also been considered.

Noise modelling of facilities, gas venting and flaring was completed using the Cadna noise model which utilises the ISO 9613 calculation procedure. Noise source data was based on relevant predictive equations and operational parameters provided by Jemena.

To assess noise impacts on sensitive areas, criteria from the EHP model conditions for petroleum activities has been adopted based on ambient noise monitoring completed at 7 representative locations along the proposed route. The model conditions provide criteria for short-term, medium-term and long-term noise events. Based on the definitions for these noise events, the short-term criteria is applicable to the proposed gas flaring gas venting. SOL and EOL facilities have been assessed against the lowest criteria as they will operate 24/7. Potential disturbance to fauna and threatened species has also been considered.

Modelling has assumed a nominal enclosure, intake muffler, and exhaust muffler to the gas turbine engines at the SOL and EOL facilities.

There are no sensitive human receivers within 28 km of the SOL facility including the flare, and therefore the adopted noise level of 109 dB(A), and emission point height of 15 metres is found to be acceptable and additional acoustic mitigation measures are not required.

The EOL facility is located approximately 1.2 km from the nearest sensitive receivers (9 houses) and 1.8 km from the township. Compliance is predicted for the operational facility. For the gas venting at the EOL facility this mitigation involves provision of a gas vent silencer or alternative nozzle to achieve a sound power lower of 130 dB(A) or less.

For the MLV gas venting locations 1 through 3 along the main line, given the significant separation to

any sensitive receivers (18 km), full compliance is predicted with the adopted criteria.

Gas venting and flare noise may result in temporary disturbance to fauna habitats within a 1 km radius, however, due to the short duration and temporary nature of these events, fauna (birds, mammals, and bats) are likely to be temporarily disturbed and then return when the noisy activities cease. Fauna are expected to habituate to these continuous noise levels, hence mitigation measures are recommended to be considered for bat colonies only, in close proximity to these noise sources.

It is important to recognise that the adopted noise criteria may be considered conservative for the assessment of the proposed gas venting and flare operations. While the EHP model noise conditions allow for consideration of the limited frequency of occurrence of some petroleum activities, they do not specifically cater for the expected very low infrequent occurrence of gas venting and flaring for the NGP project (which is significantly less than the frequency defined in the model conditions).

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1 Introduction

1.1 Scope of Study

Jemena Ltd commissioned Air Noise Environment Pty Ltd to undertake a desktop noise assessment for the Northern Gas Pipeline (NGP) Project, extending from Warrego (Northern Territory) to Mt Isa (Queensland).

The study has been undertaken to assess the potential noise impacts on nearby sensitive receptors during the construction and operational phase of the pipeline. To assess the potential for impacts, computational modelling has been undertaken and results have been compared to criteria relevant to Queensland and Northern Territory, as presented in the following documents:

- Queensland Environmental Protection (Noise) Policy 2008;
- Northern Territory Environmental Protection Authority (EPA) Noise guidelines for development sites in the Northern Territory (2014).
- 'Streamlined model conditions for petroleum activities' (2014) published by the Queensland Department of Environment and Heritage Protection (EHP).

To assist in defining the applicable noise criteria, unattended noise monitoring data has been collected for a sample of representative areas near to the proposed alignment.

1.2 Terms of Reference

The Northern Territory Environmental Protection Authority issued Terms of Reference for the NGP Project in December 2015. In relation to noise, the ToR specifies the following:

> *"The EIS should outline proposed management to mitigate any identified risks from the Project with regard to noise and vibration emissions, including but not limited to transport logistic network, blasting and rock hammering. If relevant, the EIS should describe proposed communication with any residents and communities predicted to be impacted by noise and vibration from the project."*

This noise assessment report addresses the requirements of the ToR. An assessment of both construction and operational noise emission risks has been completed. Where relevant, recommendations have been provided for achieving project noise goals. A Noise Management Plan (NMP) is provided separately to this modelling assessment report presenting a summary of noise management measures and monitoring requirements for the project.

1.3 This Report

This report summarises the methodology, results and conclusions of the noise assessments. A glossary of terms are presented in Appendix A to assist the reader.

2 Proposed Pipeline

2.1 Pipeline Route

The Northern Gas Pipeline (NGP) is proposed to be 622 km long, beginning at Warrego (Northern Territory) and extending east towards Mt Isa (Queensland). The majority of the pipeline is located in the Northern Territory and the final 165 km will be located in Queensland. The proposed pipeline will connect gas supplies from offshore and land-based sources in the Northern Territory to the eastern gas markets.

Several pipeline facilities are proposed at specific points along the pipeline route. These facilities include the following:

- Start of Line (SOL) facility at Warrego;
- End of Line (EOL) facility at Mt Isa; and
- Main Line Valve (MLV) sites for maintenance and operational requirements (total of 3).

The main potential noise emissions from the operational phase of the pipeline are associated with the gas venting and flaring during maintenance or emergency procedures, and burning of fuel for powering the SOL and EOL facilities. During the construction phase, potential impacts will be associated with construction plant and equipment and any blasting activities associated with land clearing.

Figure 2.1 presents the pipeline route and key features of the pipeline. Figure 2.2 presents a close-up of the pipeline route and EOL facility in Mt Isa.

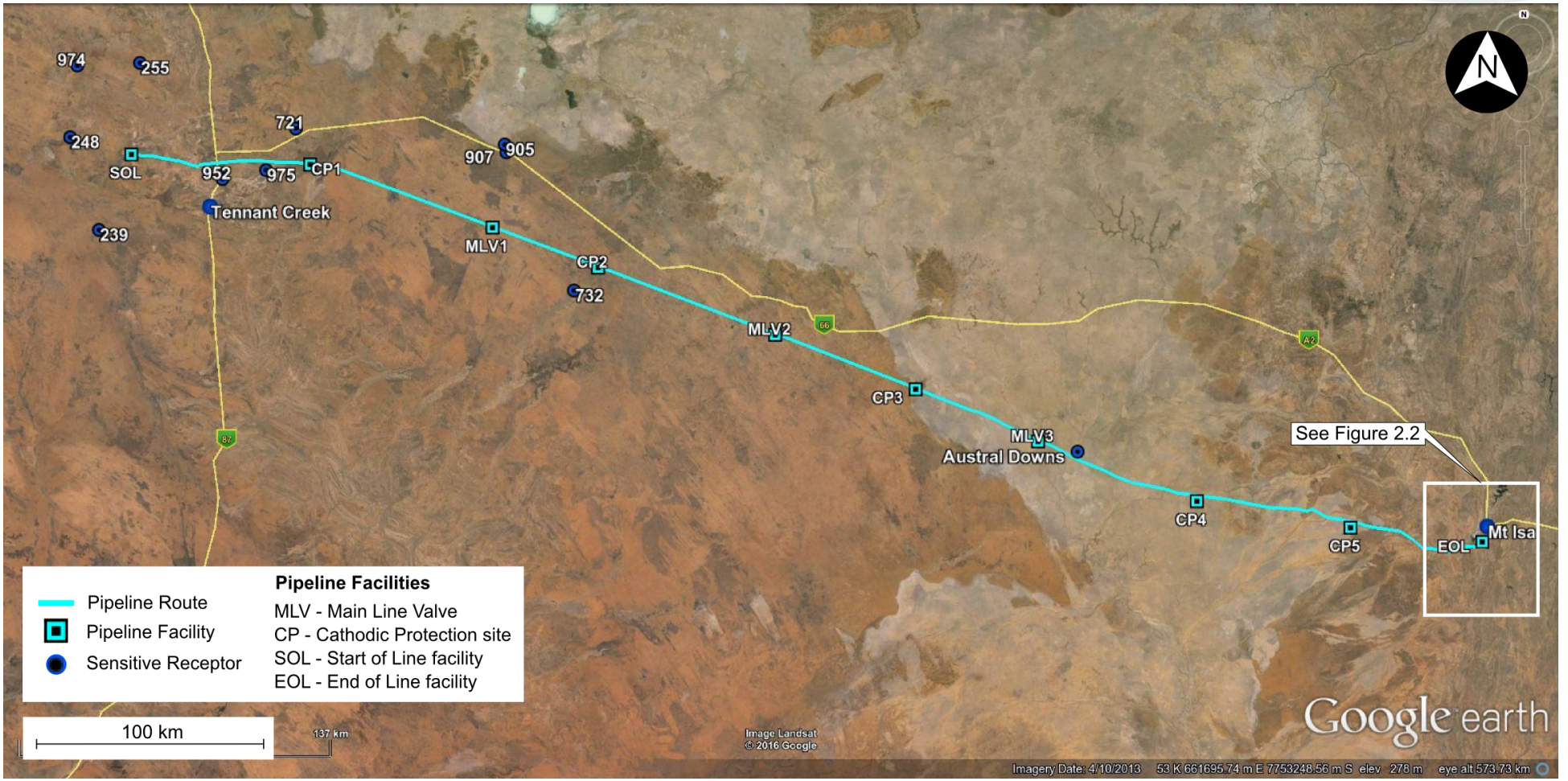


Figure 2.1 - Pipeline Route and SOL Facility

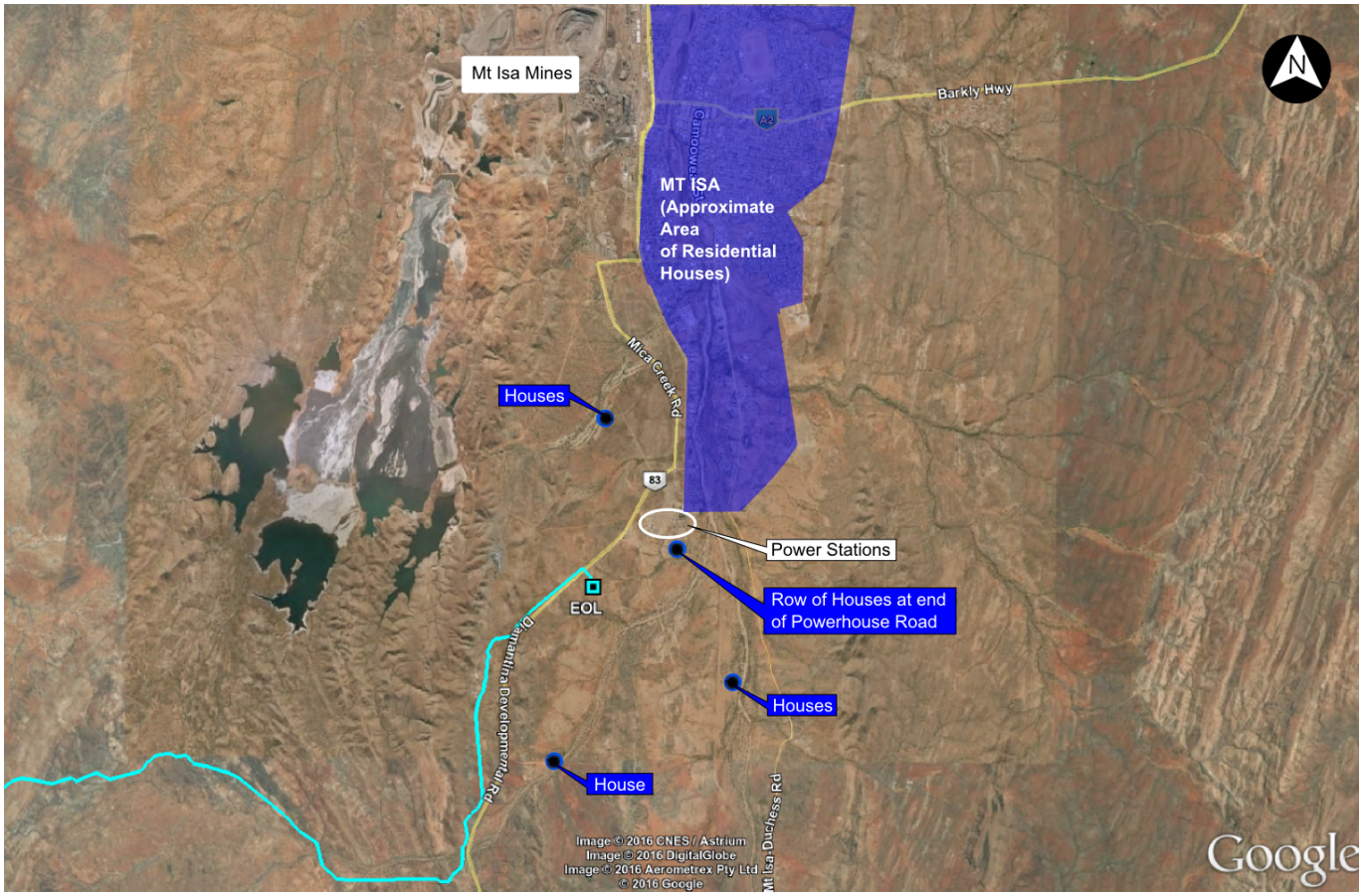


Figure 2.2 - Eastern Portion of Pipeline Route and EOL Facility

2.2 Nearest Sensitive Receptors

The pipeline route traverses primarily through isolated rural areas, thus limiting the number of sensitive receptors that could be affected by construction and operations. For pipeline activities, a typical (and conservative) radius of influence in a rural area with very low background levels may be considered to be 10 km. Potential noise impacts are typically negligible outside this radius.

For the Western portion of the alignment, potentially affected sensitive receptors include a small number of family outstations and a pastoral homestead (18 km east of MLV3). The nearest family outstation (No. 975) is 3.4 km south of the pipeline route. The pastoral homestead is 3.5 km north of the route.

At the eastern end, the nearest sensitive receptors include a homestead south of Mt Isa and Mt Isa city. The homestead is approximately 2 km from the EOL facility and 1 km from the pipeline route. The nearest houses in the Mt Isa city area are approximately 2 km north-east of the EOL facility.

An abandoned mine and camp is located 2 km west of the SOL facility. The site has been closed for

more than a decade and is designated contaminated land. Future occupation of the mining camp is unlikely in the future. Therefore, the site has not been considered as a potential sensitive receptor. The Warrego compressor station adjacent to the proposed SOL facility is noted to be in operation, however does not constitute a sensitive receiver.

Figure 2.1 and Table 2.1 identifies sensitive receptors within 20 km of the pipeline route. Figure 2.1 also identifies the nearest sensitive receptors (family outstations 239, 248, 255 and 974) to the SOL facility. These receptors are noted to be between 28 to 46 km from this facility. As discussed earlier, potential noise impacts are generally limited to within 10 km of a pipeline, therefore only those receptors within a 20 km radius of the pipeline facilities are considered in detail in the noise assessment.

Table 2.1 - Summary of Sensitive Receptors within 20 km of Pipeline Route

Receptor	Distance from Pipeline Route	Distance from Nearest Pipeline Facility	Population / No. of Dwellings
Tennant Creek	16.5 km South	41.5 km south-east of SOL Facility 121 km west of MLV1	3,061
Family Outstation 952	6.8 km South	41.8 km south-east of SOL Facility 121 km west of MLV1	3 houses
Family Outstation 975	3.4 km South	60 km east of SOL facility 101 km north-west of MLV1	2 houses
Family Outstation 721	14.8 km north	73 km east of SOL facility 95 km north-west of MLV1	8 houses
Family Outstation 732	12.4 km south	44 km south-east of MLV1	4 houses
Pastoral Homestead	3.5 km north	18 km east of MLV3	3 houses and a school
Homestead South of Mt Isa	1 km east	2.5 km south of EOL facility	Single house
Diamantina and Leichardt Power Stations Residences (Powerhouse Road)	1.2 km north-east	1.2 km north-east of EOL facility and pipeline	9 houses
Mt Isa	1.8 km north-east	1.8 km north-east of EOL facility	Township

Table 2.2 presents a summary of minimum separation distances to sensitive receptors for the SOL and EOL facilities, and MLV sites.

Predictions of the noise levels at the adjacent abandoned compressor station, and Warrego mine site (2 km west) have been reviewed, however are not considered for compliance.

Table 2.2 - Separation Distances of Pipeline Facilities

Pipeline Facility	Distance to Nearest Receptor
Start of Line Facility	28 km east of Family Outstation 248
End of Line Facility	1.8 km south-west of nearest house in Mt Isa
MLV1	33 km south of Family Outstation 907
MLV2	88 km east of Family Outstation 732
MLV3	18 km west of a pastoral homestead

2.3 Potential Ecological Receivers

Based on the available desktop ecological survey data, it is noted that threatened fauna species could be located around the SOL and EOL facilities. Therefore, threatened species are also considered as sensitive receptors in the assessment.

It is noted that along the proposed construction route a number of sensitive ecological noise receptors could exist (based on desktop ecological surveys) as follows:

- KP590 to KP623:
    - Carpentarian Antechinus (Pseudantechinus mimulus)
    - Purple-necked Rock-wallaby (Petrogale purpureicollis). Both are threatened species.

Areas that may also be sensitive to noise impacts include:

- river and creek crossings, as they often provide important refuge habitat for a range of native fauna.
- swamps that may occur in the lateritic sand plains and rises (between KP223 to KP350), as they often provide important refuge habitat for a range of native fauna.

Analysis of potential impacts on these potentially sensitive ecological areas has been considered in the modelling.

2.4 Pipeline Operational Facilities

2.4.1 SOL Facility

The Start of Line (SOL) facility consists of gas treatment and compression infrastructure to pressurise the natural gas for transportation to the Mt Isa End of Line (EOL) facility. The facility will also comprise of various filtration and separation equipment to remove liquids and impurities which may have formed in the gas pipeline through condensation. For emergency purposes, a flare and pipeline

vent system is proposed to be constructed. Other supporting infrastructure includes an office, workshop, accommodation room, waste water treatment system, and car park. Key equipment with a potential for noise emission impacts are as follows:

- 2 x Export Compressor turbines;
- 2 x Residue Compressor turbines;
- 3 x Gas Engine Alternators (GEAs);
- High Pressure/Low Pressure (HP/LP) Flare; and
- Gas vent.

Use of the gas vent and flare will occur during commissioning, periodic testing, variations in incoming gas quality and in emergency situations. The gas venting (complete blow-down) will occur only for a short duration approximately 1-hour every 6 months.

The noise emissions associated with the flare system are characterised by the gas jet noise and combustion roar, which is associated with noise produced from energy release during the combustion process. The gas jet noise is dominated by high frequency components and is highly directional. Combustion roar on the other hand is dominated by low frequency components and is not considered highly directional. The flare system is expected to be up to 40 metres in height and is expected to operate continuously, however predominately on a pilot basis.

As noted previously, the nearest sensitive receptors to the SOL facility are 28 km to the west. At such a large separation distance, these receptors are not expected to be affected by noise emissions from the SOL facility operations, however have been considered in the modelling sections.

Predictions of the noise levels at the adjacent Warrego compressor station (not a sensitive receiver), and abandoned Warrego mine site (2 km west) have been reviewed, however are not considered for compliance.

The SOL facility will operate continuously. Figure 2.3 presents the proposed layout of the SOL facility.

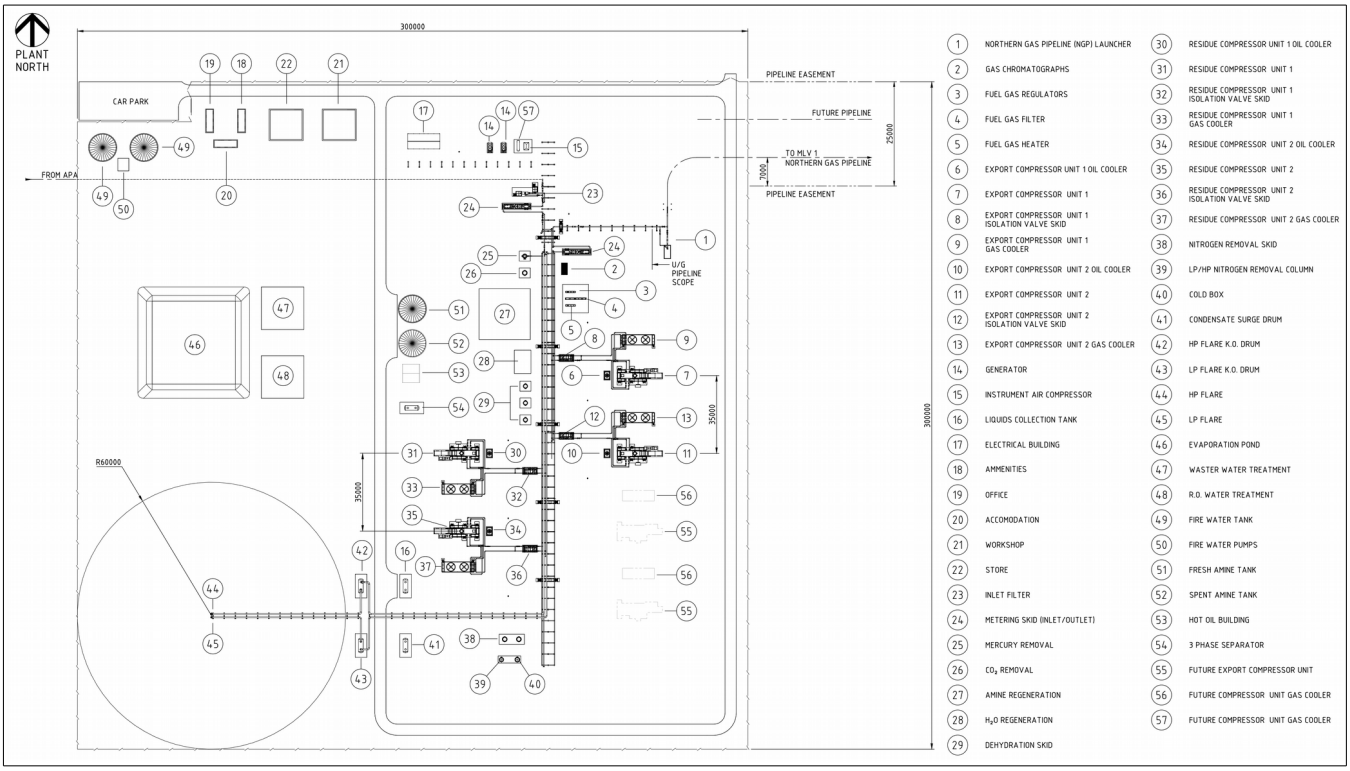


Figure 2.3 - Proposed SOL Facility Layout

2.4.2 EOL Facility

The End of Line (EOL) Facility provides additional gas compression infrastructure. Key equipment with a potential for noise emission impacts are as follows:

- 2 x compressor turbines;
- 1 x Gas Engine Alternators (GEAs);
- 1 x Boiler Heat Exchanger; and
- gas vent.

The EOL facility will operate continuously. Use of the gas vent will occur during commissioning, periodic testing and in emergency situations. The gas venting (complete blow-down) will occur only for a short duration approximately 1-hour every 6 months. Figure 2.4 presents the proposed layout of the EOL facility.

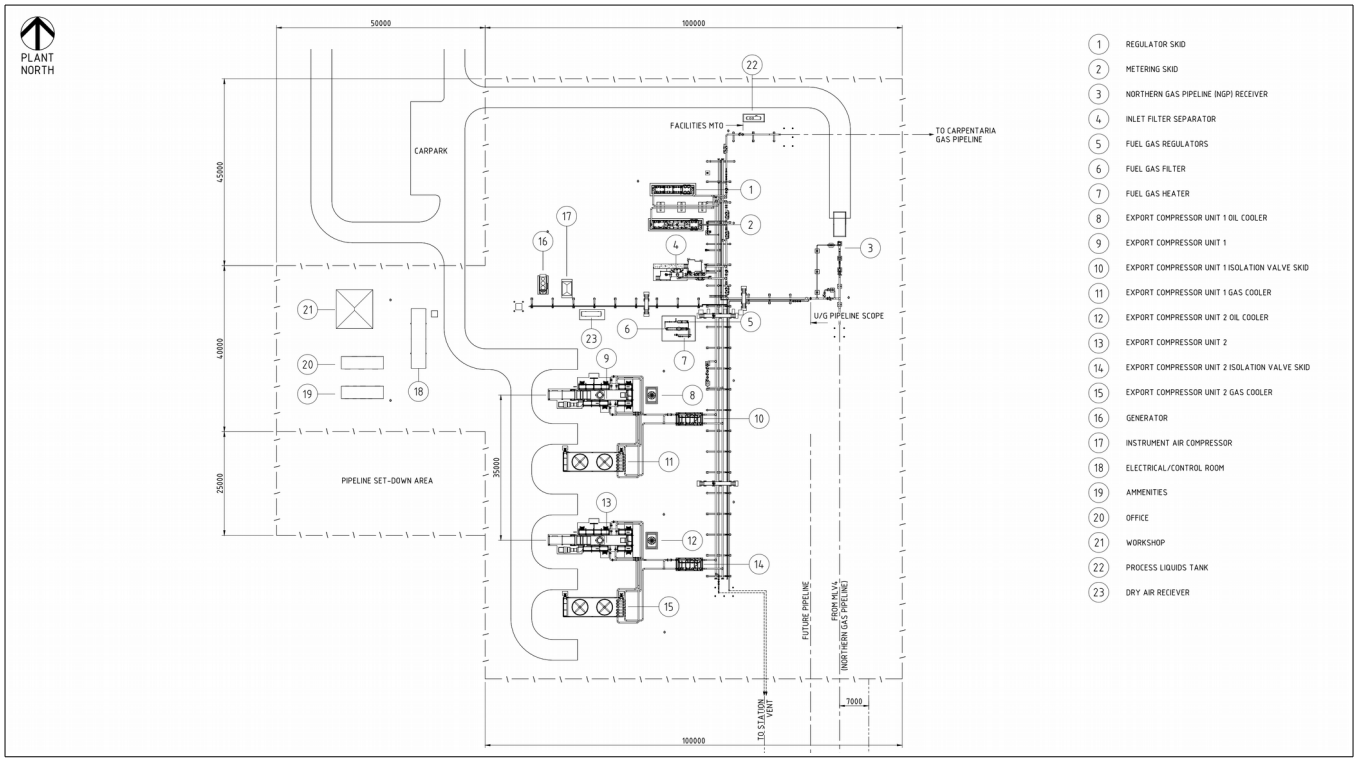


Figure 2.4 - Proposed EOL Facility Layout

2.4.3 Gas Venting

Gas venting will occur during emergency release of gas and maintenance periods at the SOL and EOL facilities. Gas venting will occur during periodic testing and in emergency situations. The gas venting (complete blow-down) will occur only for a short duration approximately 1-hour every 6 months. For testing purposes, venting at the EOL and SOL facilities will also occur during commissioning.

There is a potential for noise impacts due to the high velocity of the gas release during emergency de-pressurisation. The high exit velocity often results in a tonal characteristic (in the higher frequencies) during the gas venting process. Venting would typically take 15 minutes from when the valve is opened to when atmospheric pressure in the pipeline section is reached. As de-pressurisation occurs, the exit velocity gradually decreases, therefore, peak noise levels occur at the commencement of venting.

In addition to the gas vents at the SOL and EOL facilities, 3 main line valves (MLVs) are proposed along the pipeline route. The MLV sites provide a means of controlling gas flow along the pipeline and, during an emergency, the valves are closed to isolate a section of the pipeline. Once isolated, the gas from the relevant section is vented prior to incident investigation and/or maintenance taking place.

2.5 Pipeline Constructions

Pipeline construction will be undertaken by individual crews (e.g. trenching, pipe laying) with each crew working sequentially along the pipeline route during construction.

A 30 m wide Right of Way (ROW) will be utilised for the majority of the pipeline. In general terms, the pipeline construction process involves the following stages:

- clearing the Right of Way (ROW);
- preparing the pipeline (e.g. stringing, bending);
- excavating a trench for the pipeline;
- lowering the pipeline;
- backfilling and restoration.

Construction works specific to certain sections of the pipeline will also be required. This includes construction of the EOL and SOL facilities at each of the pipeline, blasting only at hard rock locations and thrustboring for trenchless crossings.

Five construction camps are proposed along the pipeline route.

Potential noise impacts primarily relate to vehicular and mobile plant noise emissions from earthworks, construction and and truck movements.

The construction hours for activities occurring near to sensitive receiver areas are proposed to be within the legislated construction hours as far as is practicable. The legislative construction hours for each state or territory are shown in Table 2.3. It is noted that no specific legislation for construction vehicles using state roads is provided. Where construction activities occur remote from sensitive receivers, and/or if no complaints are received as a result of construction noise, it is considered feasible they could occur 24 hours.

Table 2.3 - Legislative Construction Hours

Activity	Construction Hours Adjacent Sensitive Areas	Description and Justification
Pipeline Progression / Construction Sites / Blasting	Daytime construction hours: Northern Territory • 7 am to 7 pm Monday - Saturday. Queensland • 6:30 am to 6:30 pm Monday to Saturdays.	- The majority of construction equipment would be used during the day including impulsive or tonal sources such as rock breakers, concrete cutting, grinding. - Temporary possession of roads may need to be undertaken outside standard construction hours for safety and to reduce traffic delays for commuters.
Construction Traffic	24 hours per day, up to seven days per week.	- Construction traffic routes have been selected to minimise impacts on residential areas. - Construction traffic would be limited and managed during peak hours and special events.

3 Existing Acoustic Environment

3.1 Overview

In April and May of 2016, Air Noise Environment undertook background noise monitoring over a two week period, at a total of 7 locations in the areas surrounding the proposed pipeline alignment and facilities from Mt Isa to Warrego. The results of the background noise monitoring at all locations suggest that the surrounding area has existing noise levels comparable with a rural area with limited traffic noise. Only those receivers near the Diamantina and Leichardt Power Stations in Mt Isa experienced levels above typical rural background noise levels (due to noise emissions from the power stations).

The following sections provide an overview of the monitoring positions selected for the assessment, methodology adopted for the monitoring and a summary of the results of the baseline noise assessment.

3.2 Existing Noise Sources

The pipeline route predominantly traverses through remote areas where there are a limited number of anthropogenic noise sources, and largely barren areas with minimal ecological noise other than birds and insects at dawn and dusk. For the majority of the route extending from Warrego to immediately west of the Mt Isa region, road traffic and residential noise emissions from the sensitive receiver areas represent the nearest existing noise emission sources. Nearby roads include the Stuart Highway, Barkly Highway and other local unpaved roads.

While these local highways are considered to be the nearest noise emission sources potentially affecting sensitive receptors of the project, they are still relatively remote from the nearest affected sensitive receptors to the pipeline route (i.e. Outstation 975 is 7.2 km south of the Barkly Highway, a pastoral homestead is 55 km from the Barkly Highway). The pastoral homestead (18 km east of MLV3) is also located adjacent to an unpaved road which connects the Barkly Highway to the southern Sandover Highway. Based on site observations, this unpaved road is not highly trafficked.

At the eastern end of the pipeline and EOL facility, the Mt Isa community is influenced by operations of the Mt Isa Mine, which comprises a number of mining operations. Noise emissions from the mine include excavation activities, operation of heavy machinery and processing equipment, and vehicular traffic.

Besides the Mt Isa Mine, other key noise sources closest to the project sensitive receptors are the Diamantina and Leichardt Power Stations located on Powerhouse Road (east of Diamantina Development Road). These power stations were noted to significantly influence the noise character of the nearby sensitive receiver areas (MP7). Figure 3.1 identifies the location of Mt Isa Mine and nearby power stations in proximity to the nearest sensitive receptors.

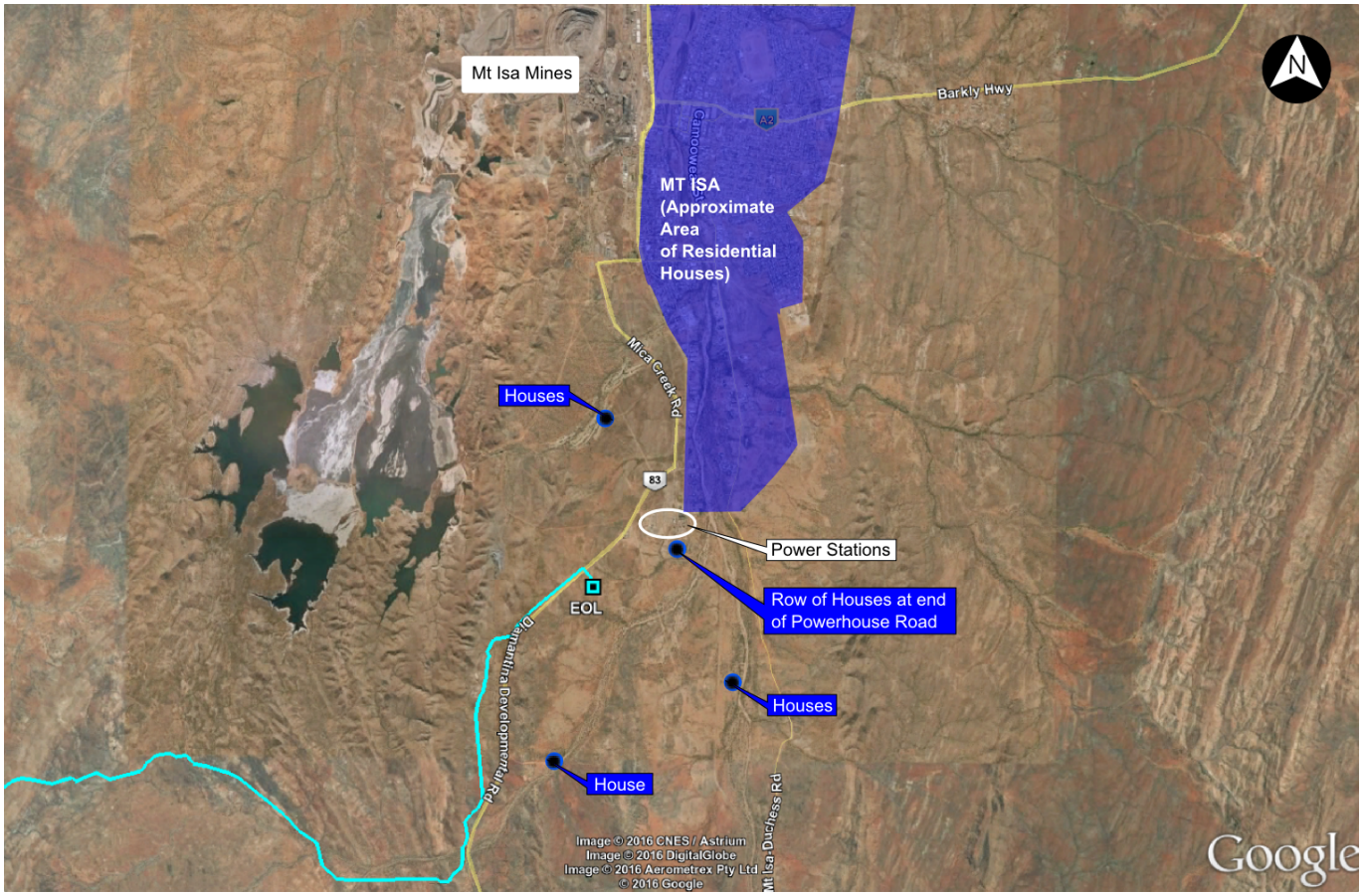


Figure 3.1 - Mt Isa Existing Noise Sources

3.3 Noise Monitoring Locations

For the purposes of the assessment, noise monitoring positions were chosen to provide an indication of typical existing noise levels at the nearest noise sensitive areas to the proposed pipeline facilities and construction along the pipeline.

Table 3.1 provides a summary of the monitoring positions selected for the assessment and the approximate distance of each of the positions to the proposed pipeline and facilities. The monitoring locations are depicted on Figures 3.2 and 3.3.

Table 3.1 - Noise Monitoring Locations

Monitoring Position	Distance to Pipeline / Facility	Descriptor	Receptor Type
MP1	1.8 km	SOL Facility area	Tennant Creek and surrounds
MP2	3.3 km	Aboriginal Community (975)	Rural Residential
MP3	3.5 km	Pastoral Homestead	Rural Residential
MP4	2.6 km	Mt Isa (North East of Diamantina and Leichardt Power Stations located on Powerhouse Road)	Urban Residential
MP5	4.9 km	Mt Isa Township (25 Dowsett Cr)	Urban Residential
MP6	930 m	Homestead south of Mt Isa	Rural Residential (adjacent major road)
MP7	1.6 km	Adjacent Diamantina and Leichardt Power Stations located on Powerhouse Road	Urban Residential (adjacent major infrastructure)

Figure 3.2 - Noise Monitoring Locations

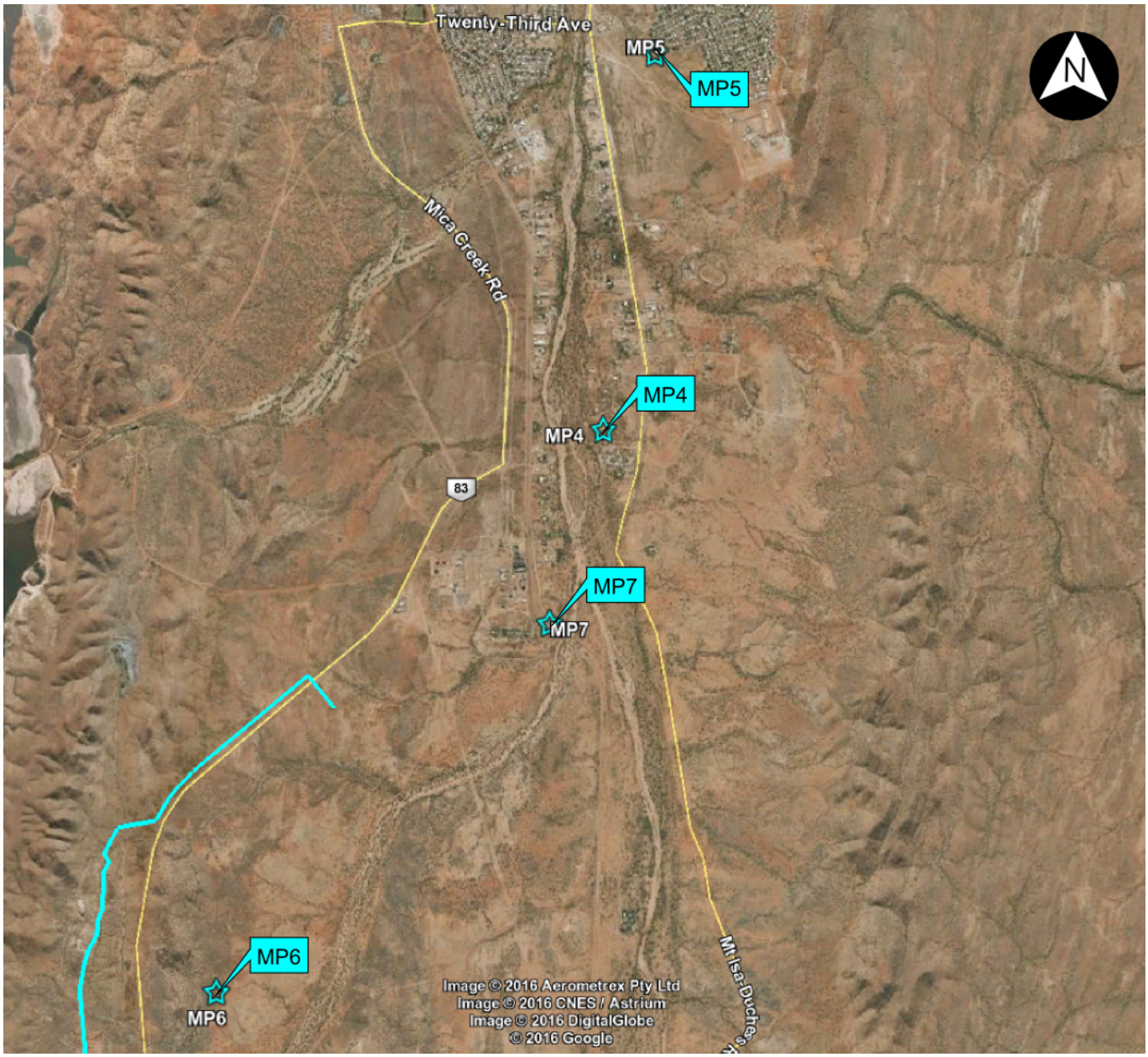


Figure 3.3 - Detailed Image of Mount Isa Noise Monitoring Locations

3.4 Noise Monitoring Methodology

Noise measurements were undertaken in accordance with the following guidelines:

- Australian Standard 'AS 1055 Acoustics – Description and Measurement of Environmental Noise' and the Queensland Department of Environment;
- Heritage Protection (EHP) Noise Measurement Manual (2013); and
- Northern Territory Environmental Protection Authority (EPA) Noise guidelines for development sites in the Northern Territory (2014).

Noise measurements were completed using environment noise loggers as detailed in Table 3.2 below. All instruments were situated in free-field positions. An averaging time of 15-minutes was adopted and measurements were made over a the time periods as detailed below. The microphones were positioned at a height of 1.2 m above ground level and fitted with a windshield throughout the measurements.

Table 3.2 - Noise Monitoring Equipment and Testing Dates

Position	Equipment (Serial No.)	Date and Time[a]		NATA Calibration Current Until	Field Calibration	
		Start	Finish		Pre-Check	Post-Check
MP1	Ngara (87808B)	17/04/16 06:45	24/04/16 19:30	22/07/17	93.7	93.8
MP2	Ngara (87808B)	26/05/16 12:30	3/06/16 04:45	22/07/17	94.0	94.1
MP3	Ngara (878065)	16/04/16 11:00	24/04/16 02:45	17/11/17	94.1	94.0
MP4	Ngara (87809C)	15/04/16 17:45	23/04/16 10:00	15/03/18	93.9	94.0
MP5	Norsonic 140 (1404663)	15/04/16 17:10	24/04/16 10:30	6/07/17	94.1	94.1
MP6	Norsonic 140 (1405306)	15/04/16 15:45 17/04/16 15:45[b]	24/04/16 02:00	9/07/17	94.3	94.2
MP7	Norsonic 140 (1404664)	01/05/16 17:35	03/05/16 13:15	8/07/17	93.9	93.9
Field Calibrator	Pulsar 105 (48333)	-	-	05/11/16	-	-

[a] All times in Local Time
[b] Instrument relocated away from construction noise on 17/04/16

Bureau of Meteorology data was collected from Tennant Creek and Mt Isa stations to represent the MP1 and MP2, and MP4 – MP7 locations respectively. On site meteorological monitoring was undertaken at MP3 as there were no representative existing meteorological monitoring stations in this locality. Review of the meteorological conditions was undertaken to identify any periods where rainfall or wind conditions may have resulted in impacts to the monitoring data. For the purposes of the assessment, monitoring data collected during rain periods and winds above 5 m/s were removed from the dataset to prevent weather related bias. Appendix B presents a summary of the meteorological data.

Review of the wind and rain data confirm that, winds during the monitoring period were typically dominated by slight or gentle breezes (north-westerly and westerly winds), with minimal rainfall during the monitoring period. A few hours of winds greater than 5 m/s were measured on the 17, 22, 23, and 24 April 2016. Data during these periods were excluded from the ambient monitoring averages to avoid weather related bias.

3.5 Observed Existing Noise Sources

During the site visits an audit of existing sources of noise potentially impacting on the monitoring positions was undertaken.

Noise sources associated with the general residential areas include typical residential activity and light vehicle movements on regular occasions. Outside of these general residential areas, receptors MP3 and MP6 additional noise sources were noted to be generators and irrigation pumps.

During the day time, bird and insect noise were generally audible. Other sources specifically identified as impacting on individual monitoring positions were the Diamantina and Leichardt Power Stations, at Mt Isa.

3.6 Noise Monitoring Results

3.6.1 Overview

Full 15-minute statistical datasets and review of site observations and monitoring for each location are presented in Appendix B, including the associated meteorological data. The following sections provide a review of the site observations, and summary of key statistical indicators relevant in defining applicable assessment noise goals.

3.6.2 Summary Monitoring Positions

Table 3.3 presents the derived ambient monitoring data for each monitoring positions, utilised to define criteria in Section 4.

Table 3.3 - Summary of Background Noise Levels

Period	Median $L_{Aeq,1\ hour}$				Median min$L_{A90,1\ hour}$			
	Day 7am - 6pm	Evening 6pm - 10pm	Night 10pm - 7am	Dawn 6am - 7am	Day 7am - 6pm	Evening 6pm - 10pm	Night 10pm - 7am	Dawn 6am - 7am
MP1	36.1	39.6	33.3	33.5	21.1	26.5	18.1	19.8
MP2	37.5	36.5	34.6	37.0	21.9	29.3	32.5	32.7
MP3	40.9	52.1	41.4	41.0	26.8	49.1	28.1	29.4
MP4	40.7	49.8	46.2	38.1	28.7	34.3	29.1	29.3

Period	Median $L_{Aeq,1\ hour}$				Median min$L_{A90,1\ hour}$			
	Day 7am - 6pm	Evening 6pm - 10pm	Night 10pm - 7am	Dawn 6am - 7am	Day 7am - 6pm	Evening 6pm - 10pm	Night 10pm - 7am	Dawn 6am - 7am
MP5	42.3	49.2	41.3	42.1	31.5	36.6	30.3	35.3
MP6	41.9	44.1	48.9	41.0	29.4	33.8	31.0	31.3
MP7	39.7	46.0	48.2	51.2	34.0	39.4	38.0	36.9

4 Assessment Criteria

4.1 Operational Noise

The Queensland Department of Environment and Heritage Protection provides guidelines for establishing noise criteria for petroleum pipeline activities in the documents 'Prescribing noise conditions for petroleum activities' (15 March 2013) and 'Streamlined model conditions for petroleum activities' (2014). The documents specify noise emission limits that are considered to meet the intent of the Queensland Environmental Protection (Noise) Policy 2008, which is to protect and enhance the acoustic environment within Queensland. No operational noise criteria is specified by the NT EPA in any of the relevant environmental acts or guidelines. Therefore, the QLD noise criteria has been applied across the whole of the project area.

Table 4.1 presents the the EHP streamlined noise conditions relevant for the project.

Table 4.1 - Noise Emission Limits for Petroleum Activities (dB(A))

Period	Parameter	Short-Term Criteria	Medium-Term Criteria	Long-Term Criteria
Day 7 am – 6 pm	$L_{Aeq,adj,15\text{-}min}$	BG + 10	BG + 8	BG + 5
Evening 6 pm – 10 pm	$L_{Aeq,adj,15\text{-}min}$	BG + 10	BG + 8	BG + 5
Night 10 pm – 6 am	$L_{Aeq,adj,15\text{-}min}$ Max $L_{pA,15mins}$	BG + 3 55	BG + 3 55	BG + 3
Dawn 6 am - 7 am	$L_{Aeq,adj,15\text{-}min}$	BG + 10	BG + 8	BG + 5

The EHP provides the following definitions in relation to the categories of short-term, medium-term and long-term:

- 'A short term noise event is a noise exposure, when perceived at a receptor premise, which persists for an aggregate period not greater than eight hours and does not re-occur for a period of at least seven days. Recurrence is deemed to apply where a noise of comparable level is observed at the same receptor location for a period of one hour or more, even if it originates from a different source or source location.
- A medium term noise event is a noise exposure, when perceived at a receptor premise, which persists for an aggregate period not greater than five days and does not re-occur for a period of at least four weeks. Recurrence is deemed to apply where a noise of comparable level is observed at the same receptor location for a period of one hour or more, even if it originates from a different source or source location.

- A long term noise event is a noise exposure, when perceived at a receptor premise, which persists for a period of greater than five days, even when there are respite periods when the noise is inaudible within those five days.'

The long term criteria is applicable to the day-to-day operation of the EOL facility, which are expected to operate continuously. Table 4.2 presents the adopted criteria for residential receptors nearest to the EOL facility (Mt Isa area only).

Table 4.2 - Adopted Operational Noise Criteria for EOL facility

Nearest Sensitive Residential Receptors	Adopted Background Level (Day/Evening/Night)[a] dB(A)	L_{Aeq} Noise Criteria dB(A)	
		Day/Evening/Dawn	Night
Powerhouse Road Houses, Mt Isa (1.2 km)	34	39	37
Other Mt Isa Houses	29	34	32

[a] Measured background levels (i.e. Rating Background Levels) were noted to be lowest during the day time for monitoring positions representative of the above sensitive receptors (MP7 for Powerhouse Road houses and MP4 to MP6 for other Mt Isa houses). Therefore, the day time RBL has been adopted for the evening and night period also.

In addition to the above criteria, it is also necessary to assess the potential for low frequency noise impacts from the operation of the EOL facility. The EHP model conditions for petroleum activities identify the following criteria for low frequency:

- 60 dB(C) measured outside the sensitive receptor; and
- the difference between the external A-weighted and C-weighted noise levels is no greater than 20 dB; or
- 50 dB(Z) measured inside the sensitive receptor; and
- the difference between the internal A-weighted and Z-weighted (Max $L_{pZ,\ 15\ min}$) noise levels is no greater than 15 dB.

As internal noise levels cannot be accurately determined only the external low frequency noise goals have been referred to in this assessment. Prediction of internal noise levels requires availability of building construction details for the properties of interest, and this information is not available for the receptor groups considered in the assessment.

As discussed earlier, the nearest residential receptors to the SOL facility are at least 28 km away. Noise impacts would not be expected at such a large distance. Given this, operational noise from the SOL facility has only been considered for the potential to impact on nearby fauna.

4.2 Construction Phase

4.2.1 Noise Criteria

The NT EPA specifies construction noise criteria in the Noise Guidelines for Development Sites in the Northern Territory (May 2014). The guideline specifies the following noise criteria for residential use areas:

L_{Aeq} = Background Noise Level + 5 dB

It is noted that the only sensitive residential receptors likely to be impacted by construction in the Northern Territory include Outstation 975 (3.4 km from pipeline) and the pastoral homestead (3.5 km from pipeline).

For sensitive residential receptors in Queensland (located around the Mt Isa area), a background plus 5 dB criteria has also been adopted. The streamlined noise conditions for petroleum activities do not specifically address construction activity however, it is noted that a Background + 5 dB criteria is consistent with the long-term criteria.

Table 4.3 presents the adopted noise criteria at residential receptors nearest to proposed construction activity.

Table 4.3 - Adopted Construction Noise Criteria

Nearest Sensitive Residential Receptors to Construction	Adopted Background Level (Day/Evening/Night)[a] dB(A)	L_{Aeq} Day/Evening/Night Criteria dB(A)
Outstation 975 (3.4 km)	25	30
Pastoral Homestead (3.5 km)	27	32
Powerhouse Road Houses, Mt Isa (1.2 km)	34	39
Other Mt Isa Houses	29	34

[a] Measured background levels (i.e. Rating Background Levels) were noted to be lowest during the day time for monitoring positions representative of the above sensitive receptors (MP7 for Powerhouse Road houses and MP4 to MP6 for other Mt Isa houses). Therefore, the day time RBL has been adopted for the evening and night period also.

4.2.2 Vibration Criteria

Guidelines and standards that can be referred to for assessing vibration impacts from construction include the following:

- Environmental Noise Management – Assessing Vibration: A Technical Guide (2006), published by the NSW EPA;
- BS 7385-2: 1993 - Evaluation and measurement for vibration in buildings – Part 2: Guide to damage levels from groundborne vibration.

The NSW technical guide provides vibration criteria associated with human annoyance for the three categories of vibration:

- Continuous vibration (e.g. road traffic, continuous construction activity);
- Impulsive vibration includes less than 3 distinct vibration events in an assessment period (e.g. occasional dropping of heavy equipment); and
- Intermittent vibration includes interrupted periods of continuous vibration (e.g. drilling), repeated periods of impulsive vibration (e.g. pile driving) or continuous vibration that varies significantly in amplitude.

Table 4.4 and 4.5 presents the criteria for continuous/impulsive vibration and intermittent vibration, respectively.

Table 4.4: Continuous/Impulsive Vibration Criteria – Peak velocity (mm/s)

Location	Assessment Period	Preferred Limit (mm/s)	Maximum Limit (mm/s)
Continuous Vibration			
Critical areas	Day/night-time	0.14	0.28
Residences	Day-time Night-time	0.28 0.20	0.56 0.40
Offices, schools, educational institutions and places of worship	Day/night-time	0.56	1.1
Workshops	Day/night-time	1.1	2.2
Impulsive Vibration			
Critical areas	Day/night-time	0.14	0.28
Residences	Day-time Night-time	8.6 2.8	17 5.6
Offices, schools, educational institutions and places of worship	Day/night-time	18	36
Workshops	Day/night-time	18	36

Table 4.5: Intermittent vibration criteria ($m/s^{1.75}$)

Location	Assessment Period	Preferred Value	Maximum Value
Critical areas	Day/night-time	0.10	0.20
Residences	Day-time Night-time	0.20 0.13	0.40 0.26
Offices, schools,	Day/night-time	0.40	0.80

Location	Assessment Period	Preferred Value	Maximum Value
educational institutions and places of worship			
Workshops	Day/night-time	0.80	1.60

The above criteria is suitable for assessing human annoyance in response to vibration levels. In order to assess potential damage to buildings, reference has been made to British Standard *BS 7385-2: 1993 Evaluation and measurement for vibration in buildings – Part 2: Guide to damage levels from groundborne vibration*. Table 4.6 presents vibration criteria for assessing the potential for building damage.

Table 4.6: Transient Vibration Levels for Building Damage

Type of Building	Peak Particle Velocity (mm/s)[a]	
	4 Hz to 15 Hz	15 Hz and above
Reinforced or framed structures - industrial and heavy commercial buildings	50 mm/s at 4 Hz and above	50 mm/s at 4 Hz and above
Unreinforced or light framed structures – residential or light commercial type buildings	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above
[a] a 50% factor should be applied to the limits for the unreinforced or light framed structure vibration limits where low rise buildings are being considered or where resonance in the vibration is created.		

4.2.3 Blasting

Due to the unique nature of blasting, noise and vibration criteria separate to typical construction activities are required. The Queensland EHP provide noise and vibration criteria for blasting in the guideline 'Noise and vibration from blasting' (23 March 2006).

The criteria are as follows:

> *'**Noise Criteria***
>
> *Blasting activities must be carried out in such a manner that if blasting noise should propagate to a noise-sensitive place, then*
>
> *(a) the air blast overpressure must not be more than 115 dB(linear) peak for nine out of any 10 consecutive blasts initiated, regardless of the intervals between blasts; and*
>
> *(b) the air blast overpressure must not exceed 120 dB(linear) peak for any blast.*
>
> ***Vibration Criteria***
>
> *Blasting operations must be carried out in such a manner that if ground vibration should propagate to a noise-sensitive place:*
>
> *(a) the ground-borne vibration must not exceed a peak particle velocity of 5 mm/s for nine*

out of any 10 consecutive blasts initiated, regardless of the interval between blasts; and

(b) the ground-borne vibration must not exceed a peak particle velocity of 10 mm/s for any blast.'

The above criteria are applicable at 4 m from the affected sensitive receptor facade. In the absence of NT criteria, reference has been made to the QLD EHP guideline.

4.3 Ecological Criteria

4.3.1 Overview

Published research is available relating to the potential for noise impacts on fauna however, there are no government policies or other guidelines specifying a noise limit in relation to fauna. This is likely to be due to the range of species that have been researched, each with its own unique response to noise. Some specific studies of animal behaviour from noise disturbance are considered below.

4.3.2 Birds and Mammals

Literature discussing the effects of noise on birds generally focuses on environments where chronic noise has caused vacation from an area over time due to the inability of some species to adequately communicate above ambient noise levels (e.g. in busy urban areas or near to large industries). Based on research, there are no government policies or other widely-accepted guidelines in respect to the noise levels which may be acceptable to wildlife. The levels or character of noise that may "startle" or otherwise affect the feeding or breeding pattern of birds or other animals are also not firmly established in the technical literature.

A literature search of DIALOG and other scientific databases was completed by Worley Parsons[1], identified a paper by the NSW Department of Agriculture and Fisheries (Poole 1982[2]) and a study by the Swedish University (Algers et al 1978[3]) on the effects of continuous noise on animals.

It was concluded that birds tend to accept and/or adapt to constant steady noise levels, even of a relatively high level in the order of 70 dB(A). Poole found that continuous exposure to higher noise levels (from 70 dB(A) to 85 dB(A) and above) may cause some degree of behavioural changes in birds, non-specific to species. Observations of behaviour patterns also indicate a higher tolerance to intermittent, moderate level noise events such as road traffic. Sudden loud or impulsive or impact noises are capable of causing birds and other wild animals to become startled, which if repeated in the longer term, may affect feeding and possibly breeding habits in some bird species. On the other hand, there are instances where such noises have been used in an attempt to drive flocks of birds (and bats) away from particular sites (airports, waste disposal sites, etc.). Due possibly to the more "domesticated" nature of these bird species, the success of such trials have been limited.

1 201001-00367-00-EN-REP-0002, prepared by Worley Parsons resources and energy, 29-Apr-13

2 Poole G, 1982. Sound Advise Poultry Notes. NSW Department of Agriculture and Fisheries.

3 Algers B, Ekesbo I, Strombery S, 1978. Noise Measurement in Farm Animal Environments. ACTA Veterinaria Scandinavica. Suppl.68, p19

4.3.3 Bats

A study of colony bats (Jinhong Luo et al 2014[4]), identified that torpid bats will rapidly habituate to repeated and prolonged noise exposure, and generally respond most strongly to colony and vegetation noise, and only weakly to traffic noise. It may be considered that certain construction activities may simulate vegetation noise, and higher frequency noise of bats (e,g, drilling). This is further supported by another study completed to investigate the impact on foraging preference by the greater mouse-eared bats (Andrea Schaub et al 2008[5]), identified that they would avoid foraging in areas where ambient noise masked the potential identification of prey noise. The experimental data suggest that foraging areas very close to highways and presumably also to other sources of intense, broadband noise (12 dB above ambient levels) are degraded in their suitability as foraging areas for such 'passive listening' bats, and would therefore be deterred from utilising such areas.

4.3.4 Summary of Criteria

Overall, the available body of research indicates that potential impacts primarily relate to short-term noise events which can result in flight and alert responses in animals. For the proposed pipeline, the following short-term noise events could result in temporary startle responses, however these events are not expected to result in long term impacts with the fauna likely to return upon cessation of the noisy activity:

- construction activity including blasting; and
- gas venting at facilities and MLVs.

The potential for noise impacts on fauna is expected to be minimal given that the above activities occur infrequently and for short durations. For construction of the mainline, construction would be progressive therefore, any fauna in proximity to construction would be affected for very short periods of time only. Gas venting is also expected to for short periods and relatively infrequently (i.e. during commissioning, testing every 6 months for 15-minute periods and in emergency situations). Therefore, potential noise impacts on fauna from venting would also be limited.

Therefore consideration of long term noise levels that are 12 dB(A) above existing L_{Aeq} levels, and above a specific threshold level of L_{Aeq} of 65 dB(A) have been considered as screening tools for ecological noise impacts.

4 Jinhong Luo, B.-Markus Clarin, Ivailo M. Borissov and Björn M. Siemers, Are torpid bats immune to anthorpogenic noise? The Journal of Experimental Biology (2014) 217, 1072-1078 doi:10.1242/jeb.092890

5 Andrea Schaub, Joachim Ostwald and Björn M. Siemers, 2008, Foraging bats avoid noise, The Journal of Experimental Biology 211, 3174-3180

5 Assessment of Construction Impacts

5.1 Prediction Methodology

For the purposes of predicting impacts associated with construction noise on nearby sensitive receptors, noise predictions have been undertaken for each stage of construction. The predictions have been undertaken in accordance with *ISO Standard 9613 (1996) Acoustics - Attenuation of sound during propagation outdoors*.

5.2 Modelling Scenarios

Table 5.1 presents the construction scenarios considered in the predictions including the number of noise sources expected to operate and source noise levels. Source noise levels have been obtained from relevant noise databases including the comprehensive construction noise data based published by the UK Department for Environment, Food and Rural Affairs (DEFRA). Where L_{Aeq} data is unavailable corrections to the L_{Amax} values have been made based on anticipated usage per hour.

The predictions are considered conservative as they assume all sources are operating simultaneously under worst-case meteorological conditions (downwind or moderate temperature inversion).

5.3 Predicted Noise Levels

Table 5.2 presents predicted noise levels for each construction scenario. Construction noise predictions have been completed for a range of receptor distances between 20 m and 20 km, however beyond 8 km were found to be negligible and have not been reported.

Table 5.1: Modelled Construction Scenarios

Description	Noise level L_{Aeq} dB(A)	Vegetation Clearing	RoW and Site Road Preparation	Rock Exposure and Drilling	Ditching	Pipe Stringing	Bending	Welding	Alignment and Lowering	Padding and Backfill	Tie-In	Clean-Up	Cathodic Protection	Hydrotesting	Road Maintenance	Pipe Transport	Above Ground Infrastructure (e.g. Mainline Valves)	Camp Preparation	General Services	Compressor Station
16 kVa Generator	93													2						
Agitator	114																			2
Air compressor 250 cfm (diesel)	104																			2
Air Compressor 10 m3/min 8 Barg	105			1																
Air Compressor 34 m3/min 8 bar g	104													2						
Bending Machine 10” - 16“	111						1													
Blast Cleaning	110																			1
Bucketwheel Trenchers	111				3															
Cat 14H / 16H Grader - 200 Hp	108		3									1			1					
Cat 325L excavator - 168Hp	103												1					1		
Cat 330 excavator – 222Hp	105	2		2	1	1	1		2	2		2					1			
Challenger Tack Rig	104							2												
Concrete Batch Plant	113																			1
Concrete mixer 1 m3	109																1			
Crane 15/20 tons (4x4)	98																1		1	
crane 25/30 Tons (4x4)	98													1				1		4
Diesel Welding Machine 400 Amp	104										8			2						
Dozer Cat D7-H - 215 Hp	107		1							3		2			1			1		
Dozer Cat D8-N – 285 Hp	108		3									1								

Description	Noise level L_{Aeq} dB(A)	Vegetation Clearling	RoW and Site Road Preparation	Rock Exposure and Drilling	Ditching	Pipe Stringing	Bending	Welding	Alignment and Lowering	Padding and Backfill	Tie-In	Clean-Up	Cathodic Protection	Hydrotesting	Road Maintenance	Pipe Transport	Above Ground Infrastructure (e.g. Mainline Valves)	Camp Preparation	General Services	Compressor Station
Dozer Cat D9-N – 370 Hp	113			1																
Dump Truck 14 m3 (4x4)	108									4		1			3		2			
Excavators	110																			2
Feeding / Filling Pumps	108													5						
Food Truck	90																		2	
Fork lift	113																		1	
Generator Unit 125 kVa (Silencer on Exhaust) 5 of 7 Running	113																	3		1
Generator Unit 15 kVa	93																			2
Graders	114																	2		
Greasing Truck	114																		2	
H.P Pumps	108													3						
Hammer for Backhoe Cat 330L	114				1															
Mandrel for Bending Machine	92						1													
Mini Bus 10 seats (4x4)	90	1	1		1	1	1		1	1	3	1			1					1
Mini Bus 24 Seats (4x4)	90			1						1		1								
Pay Welder	102							8												
Rock Drill Equipment – 1 Drill	109			3																
Semi Trailer Flat / Low Bed (20 – 40 tons)	107													1		24		10	3	
Service Truck	114																			1
Sideboom Cat 572 - 300 Hp	110						1	2	3		2						2			

Description	Noise level L_{Aeq} dB(A)	Vegetation Clearling	RoW and Site Road Preparation	Rock Exposure and Drilling	Ditching	Pipe Stringing	Bending	Welding	Alignment and Lowering	Padding and Backfill	Tie-In	Clean-Up	Cathodic Protection	Hydrotesting	Road Maintenance	Pipe Transport	Above Ground Infrastructure (e.g. Mainline Valves)	Camp Preparation	General Services	Compressor Station
Station Wagon 4x4	79													1						
Superior SPD 350 Padding Machine	113									3										
Tanker 10 m3	102														1		1	2	3	
Tipper	107																			1
Truck - 5 tons (4x4)	97			1		1					4		1				3	1	8	
Truck - 5 tons (4x4) with Crane	112													2				1		
Ute 4x4	79		3	1	1	1	1		1		4	1	1	1	1	1				1
Vermeer 1055 Rocksaw	114				2															
Vibrating Roller 7 tons	104														1		1	1		1
Water tank for Hydros test 16 m3	108													2						
Water Truck	100																			1
Welding machines	107																			6
Wheel Loader Cat 966 F - 220 Hp	111	1	1							2		1			1			1		
Workshop truck	114															1				

Table 5.2: Predicted Construction Noise Levels

Distance from Construction Activity (m)	tion Clearing	RoW and Site Road Preparation	Rock Exposure and Drilling[a]	Ditching	Pipe Stringing	Bending	Welding	Alignment and Lowering	Padding and Backfill	Tie-In	Clean-Up	Cathodic Protection	Hydrotesting	Road Maintenance	Pipe Transport	Above Ground Infrastructure (e.g. Mainline Valves)	Camp Preparation	General Services	Compressor Station
20	74	82	83	87	72	80	82	82	86	82	81	70	86	81	87	83	89	86	88
50	63	71	72	75	60	69	70	70	75	71	70	58	74	69	75	71	77	74	76
100	56	64	65	68	53	62	63	63	68	64	63	51	67	63	68	64	70	67	70
150	52	60	61	64	49	58	59	59	64	60	59	48	64	59	64	60	66	63	66
200	49	57	58	62	47	55	57	57	61	57	56	45	61	56	62	58	64	61	63
300	45	53	54	58	43	51	53	53	57	53	52	41	57	52	58	54	60	57	59
400	42	50	51	55	40	48	50	50	54	50	50	38	54	49	55	51	57	54	56
500	40	48	49	53	38	46	48	48	52	48	47	36	52	47	53	49	55	52	54
1000	33	41	42	45	30	39	40	40	45	41	40	28	44	39	45	41	47	44	46
1500	28	36	37	40	25	34	35	35	40	36	35	23	39	35	40	36	42	39	41
2000	24	32	33	36	21	30	31	31	36	32	31	20	36	31	36	32	38	35	38
4000	12	20	21	25	10	18	20	20	24	20	19	8	24	19	25	21	27	24	26
8000	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10

a 'Rock Exposure and Drilling' refers to all general operating equipment, except for blasting activities (blasting details are discussed in Section 5.6.3)

The results of the noise predictions indicate noise levels decrease to between 30 dB(A) to 40 dB(A) at a distance of 2 km from construction. The nearest sensitive receptors to pipeline construction are as follows:

- Outstation 975 - 3.4 km from pipeline (30 dB(A) criteria);
- The Pastoral Homestead - 3.5 km from pipeline (32 dB(A) criteria);
- Powerhouse Road houses, Mt Isa - 1.2 km from pipeline (39 dB(A) criteria); and
- Other houses in Mt Isa area - at least 1 km (34 dB(A) criteria).

Table 5.3 presents the radius of potential noise impacts in comparison to the day time criteria for specific receptor types. Receptors located within these distances have a potential to experience noise levels above the criteria (under worst-case meteorological conditions).

Table 5.3: Radius of Impact for Construction Scenarios

Construction Scenario	Radius of Impact (m)			
	Outstations 30 dB(A) Criteria	**Pastoral Homestead 32 dB(A) Criteria**	**Mt Isa 34 dB(A) Criteria**	**Powerhouse Road (Mt Isa) 39 dB(A) Criteria**
Mainline Construction				
Vegetation Clearing	1,300	1,050	900	550
RoW and Site Road Preparation	2,300	2,000	1,700	1,150
Rock Exposure and Drilling	2,400	2,100	1,800	1,250
Ditching	3,000	2,600	2,300	1,650
Pipe Stringing	1,000	850	700	450
Bending	2,000	1,700	1,500	1,000
Welding	2,200	1,900	1,600	1,100
Alignment and Lowering	2,150	1,900	1,600	1,100
Padding and Backfill	2,900	2,600	2,300	1,600
Tie-In	2,300	2,000	1,700	1,150
Clean-Up	2,150	1,900	1,600	1,100
Cathodic Protection	850	750	600	400
Hydrotesting	2,850	2,500	2,200	1,600
Road Maintenance	2,100	1,800	1,600	1,050
Pipe Transport	3,000	2,650	2,350	1,700
Nearest Receptor Distance to Pipeline	***3.2 km Outstation 975***	***3.5 km***	***1.0 km Homestead 2.5 km Township***	***1.2 km***
Mainline Valve Construction	2,300	2,000	1,800	1,200
Nearest Receptor Distance to MLVs	***32 km Outstation 907***	***18 km***	***198 km***	***198 km***
Camp Preparation	3,350	3,000	2,650	1,900

Construction Scenario	Radius of Impact (m)			
	Outstations 30 dB(A) Criteria	Pastoral Homestead 32 dB(A) Criteria	Mt Isa 34 dB(A) Criteria	Powerhouse Road (Mt Isa) 39 dB(A) Criteria
Nearest Receptor Distance to Camps	***4.5 km Outstation 975***	***9.5 km***	***41 km Homestead 43 km Township***	***42.5 km***
SOL and EOL construction	3,200	2,850	2,500	1,800
Nearest Receptor Distance to SOL and EOL	***28 km Outstation 248***	***180 km***	***2.6 km Homestead 2.5 km Township***	***1.2 km***

The construction noise predictions take into account worst-case meteorology (source-to-receiver conditions and temperature inversions). Noise levels may be up to 5 dB lower under calm conditions (with a radius of influence up to 500 m less).

5.4 Discussion of Construction Noise Predictions

5.4.1 Sensitive Receivers

In summary, the modelling results for construction activities predict impacts on sensitive receivers as follows:

- Homestead south-west of Mt Isa
  - Mainline Construction - a number of construction activities are predicted to result in exceedance of the adopted noise criteria at this location, generally when occur within 2.5 km of the residence.
- Powerhouse Road residences
  - Mainline Construction - some exceedance of noise criteria at Powerhouse Road residences during ditching, padding and backfilling, hydrotesting and pipe transport,
  - EOL facility - some minor exceedance of noise criteria during venting.

No exceedances of noise criteria are predicted at other sensitive receivers or areas. No exceedances of noise criteria at sensitive receivers are predicted from the Main Mine Camp facilities, Mainline Valve facilities or the SOL facility.

Noise management measures to minimise construction noise impacts for the project are discussed in the Noise Management Plan document[6] (Ref: 399-PA-EV-001).

As discussed in Section 4.2.2, the potential for vibration impacts from operation of typical heavy

6 Noise and Vibration Management Plan – Northern Gas Pipeline, May 2016, prepared by Air Noise Environment Pty Ltd for Jemena Limited (Ref: 399-PA-EV-001 – Noise Management Plan)

machinery such as excavators, dozers and graders is likely to be limited. The nearest sensitive area (homestead south of Mt Isa) is over 1 kilometre away – it is unlikely that structural damage would occur at distances greater than 75 m for typical construction activity..

In addition, the Fly/Portable camps are proposed to occur between the Main Camps only, and between Main Camp 1 and Mount Isa, it is anticipated staff will operate out of Main Camp 1 or Mt Isa. No potential for exceedance of noise criteria other than traffic along main roads are anticipated as a result of portable camps.

5.4.2 Fauna

The potential for noise impacts on fauna is expected to be minimal given that the construction activities occur infrequently and for short durations.

For short duration noise, e.g. construction of the mainline, construction would be progressive. Therefore, any fauna in proximity to construction would be affected for very short periods of time, with the 65 dB(A) screening criteria only exceeded within 200 m of the construction activities.

For longer term noise (days/weeks), which may impact on permanent nesting, roosting or colony area noise levels, potential for disturbance from noise is predicted up to 1 km from the activities. Longer term noise is expected to occur where generators and other plant will run for extended periods of time, e.g.:

- mainline valve construction,
- temporary camps, and
- main camp sites.

Table 5.2 presents the predicted noise levels for each activity at given separation distances. Fauna areas falling within the separation distances from proposed activities predicted to exceed 65 dB(A) and 42 dB(A) for short and long term construction activities respectively have the potential to be impacted.

An assessment of the degree of impact to specific or significant habitat areas, and/or identified threatened species, is being considered by ecologists.

5.5 Construction Traffic

State Route 83 (Diamantina Development Road) is proposed as the main route for accessing the construction route until the works progress past Camp 1. State Route 83 is an existing, heavily trafficked access route to Mt Isa. Therefore, the increase in traffic from pipeline construction activities is unlikely to result in a measurable increase in road traffic noise levels.

Given the isolated nature of the majority of the pipeline route, and the use of construction camps along the ROW, increase in traffic from construction activities is unlikely to result in a significant increase in noise levels at sensitive receptors.

A possible exception to this is the pastoral homestead (18 km east of MLV3). The unpaved road passing the homestead is not heavily trafficked, therefore construction traffic could increase traffic volumes at the pastoral homestead during the day period. However, given the rapid rate of construction, the duration of impacts would be minimal. Appropriate management measures are discussed in the Noise Management Plan.

5.6 Vibration

Review of the proposed alignment for the NGP construction activities indicates minimal potential for vibration impacts at the nearest existing sensitive receptors. In order to assess the potential impacts, predicted vibration levels at standard separation distances has been reviewed against the relevant vibration criteria (outlined in Section 4.2.2).

5.6.1 Potential Vibration Sources

Table 5.4 identifies the construction equipment that are likely to be have the greatest potential to contribute to vibration levels at nearby sensitive receptors including their vibration source levels.

Table 5.4 - Construction Equipment Vibration Source Levels – Peak Particle Velocity (mm/s)

Equipment Item	PPV at 10 metres (mm/s)[a]	Source
Piling[b]	12-30	DECCW
Roller	5-6	DECCW
7 tonne compactor	5-7	DECCW
Loaded trucks (rough surfaces)	5	USA DT[1]
Loaded trucks (smooth surfaces)	1-2	USA DT[1]
Excavator	2.5-4	DECCW

[a] *Transit Noise and Vibration Impact Assessment, US Department of Transportation, May 2006.*
[b] *Piling is not confirmed to be required during construction.*

5.6.2 Predicted Vibration Levels – Construction Equipment

Based on the vibration source levels at 10 metres (presented in Table 5.4), peak particle velocities have been predicted at various separation distances. The NSW DECCW indicates that in predicting vibration levels, it can be assumed that the vibration level is inversely proportional to distance (with the relationship varying between $d^{-0.8}$ to $d^{-1.6}$ based on field data). The US Department of Transportation's Transit Noise and Vibration Impact Assessment (May 2006) presents the following construction vibration propagation formula assuming an inverse relationship:

PPV@d2 = PPV@d1 x (d2/d1)1.5

where: d1 = distance 1 (reference distance for source data) (m)

d2 = distance 2 (separation distance for predicted PPV) (m)

PPV = peak particle velocity (mm/s)

The above formula has been considered for predicted PPVs at various distances from construction equipment. Based on the above information, Table 5.5 presents PPV predictions for various construction equipment.

Table 5.5 - Predicted Peak Particle Velocity at Sensitive Receptors (mm/s)

Distance from Source (m)	Predicted Peak Particle Velocity (mm/s)					
	Roller	7 tonne compactor	Excavator	Piling	Loaded trucks (rough surfaces)	Loaded trucks (smooth surfaces)
10	6.00	7.00	4.00	12 – 30	5.00	1 – 2
20	2.12	2.47	1.41	4.2 – 10.6	1.77	0.35 – 0.71
30	1.15	1.35	0.77	2.3 – 5.8	0.96	0.19 – 0.38
40	0.75	0.88	0.50	1.5 – 3.8	0.63	0.13 – 0.25
50	0.54	0.63	0.36	1.1 – 2.7	0.45	0.09 – 0.18
60	0.41	0.48	0.27	0.82 – 2.04	0.34	0.07 – 0.14
70	0.32	0.38	0.22	0.65 – 1.62	0.27	0.06 – 0.11
80	0.27	0.31	0.18	0.53 – 1.33	0.22	0.05 – 0.09
90	0.22	0.26	0.15	0.44 – 1.11	0.19	0.04 – 0.07
100	0.19	0.22	0.13	0.38 – 0.95	0.16	0.03 – 0.06
150	0.1	0.12	0.07	0.21 – 0.52	0.09	0.02 – 0.03
Type	Continuous	Continuous	Continuous	Intermittent	Intermittent	Intermittent
Annoyance Criteria	*Residential 0.28 (preferred) / 0.56 (max)* *School 0.56 (preferred) / 1.1 (max)*			-		
Building Criteria	*Residential* *15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz* *20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above*					

The predicted vibration levels presented in Table 5.5 indicate compliance with the continuous preferred and maximum vibration criteria for locations at a separation distance of 80-90 metres and 50-60 metres, respectively.

Predicted sensitive receivers are all well above 100 m in separation from the proposed construction route.

For intermittent vibration associated with haul vehicles and piling, it is difficult to provide an appropriate comparison with the relevant criteria (which is presented as a Vibration Dose Value (VDV) in $m/s^{1.75}$). The calculation of a VDV requires both the overall weighted rms (root mean square) acceleration (m/s^2) typically obtained from on-site measurements and the estimated time period for vibration events.

It is not proposed to include piling activities, however the piling PPV at 150 metres is predicted to be

within the maximum continuous criteria of 0.56 mm/s. This comparison with the continuous criteria (as a conservative approach) indicates that vibration levels associated with piling are not considered to be significant beyond these distances.

Based on the above predictions, mitigation measures and management procedures are not identified as necessary unless activities occur within 150 m of a sensitive receiver.

Vibration management procedures are discussed in the noise management plan document[7].

5.6.3 Blasting

Blasting will occur at certain sections of the pipeline only and based on a review of the locations, a house south of Mt Isa and Outstation 975 are the nearest residential receptors (1 km and 4 km respectively). The sections of the mainline requiring blasting range from 0.5 to 4.2 km in length and are located within KP28 to KP58 and KP589 to KP620. The length of blast section is dependant on the type of rock under consideration.

Any blasting would occur in a fully confined blast hole, minimising the potential for excessive blast overpressure. Trench blasting requires holes to be drilled at regular intervals along the length to be blasted. Assuming a blast hole every 1 m, dimensions of the trench (1.2 m deep, 0.7 m wide) and a powder factor of 2 kg/m^3 for hard rock, an charge mass of 1.7 kg/hole is estimated. Trench blasting involves the use of delayed charges for each blast hole (as opposed to a single blast across the length of a section). This approach will assist in reducing the airblast overpressure and vibration levels experienced in the surrounding area.

For predicting air blast overpressure and in the absence of site specific data, the following equation has been adopted as referenced in *AS 2187.2-2006 Explosives - Storage and use - Use of explosives*:

$$P = K_a (R / Q^{1/3})^a$$

P = pressure (kPa), converted to dB(Linear) using 20*log(P/P_o), where P_o is the reference air pressure of 20 mPa.

Q = explosive charge mass (kg)

R = distance from charge (m)

K_a = site constant for confined blast, 50

a = site exponent, -1.45

For predicting vibration levels, the following equation has been adopted:

$$V = 1140 (R / Q^{1/2})^{-1.6}$$

V = peak particle velocity, mm/s

R = distance from charge (m)

7 Noise and Vibration Management Plan – Northern Gas Pipeline, May 2016, prepared by Air Noise Environment Pty Ltd for Jemena Limited.

Q = maximum instantaneous charge (kg)

The predicted vibration and airblast overpressure levels are presented in Table 5.6 for various distances from blasting. Figures 5.1 and 5.2 present graphical representation of the impact radius from the blast source.

Table 5.6 - Maximum Allowable Charge Mass

Distance from Blast (m)	Predicted Vibration Level (mm/s)	Predicted Airblast Overpressure (dBL)[a]
40	4.9	**144**
100	1.1	**132**
400	0.1	115
1000 (House south of Mt Isa)	< 0.1	103
4000 (Outstation 975)	< 0.1	86
Criteria	***5***	***115 dB (9 out of 10 consecutive blasts)*** ***120 dB (any other blast)***

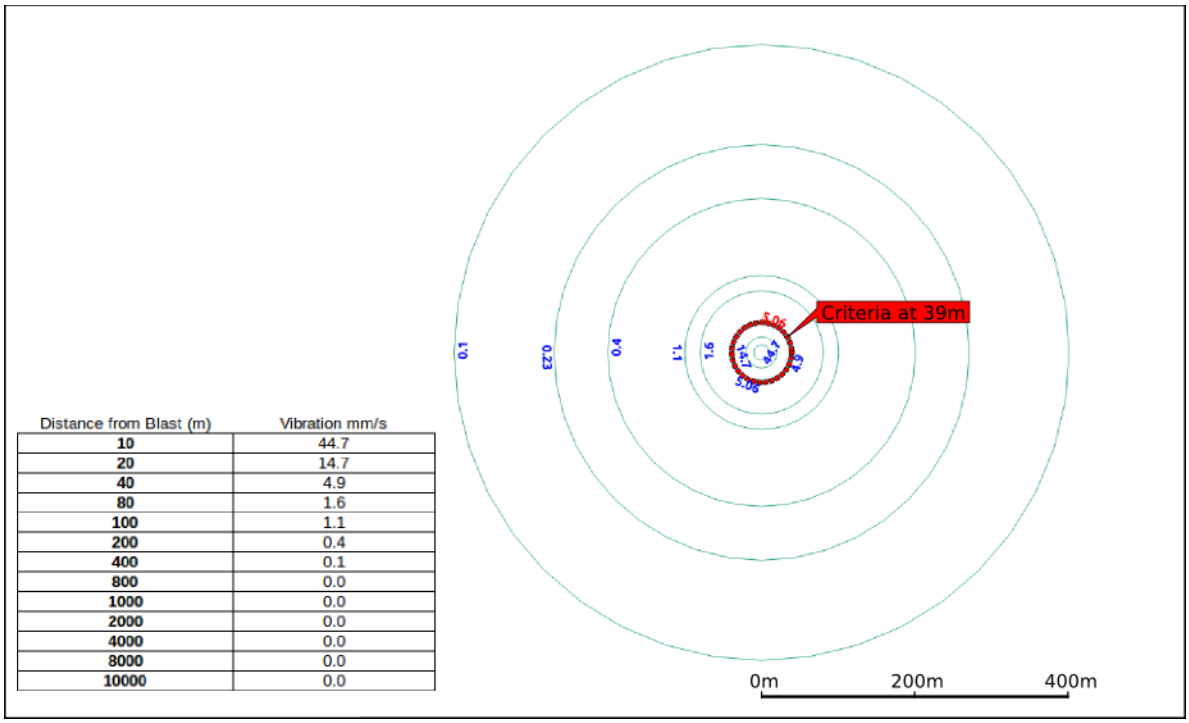
[a] AS 2187.2 indicates that the site constant (K_a) for confined blasting overpressure predictions commonly varies between 10 to 100. A mid-value of 50 has been adopted in the absence of site specific data.

The predicted results indicate compliance with the blasting criteria by a significant margin at the nearest residential receptors.

Sensitive fauna in proximity to the blasting could be affected by vibration and overpressure, however, the duration of days requiring blasting in a particular area would be limited (i.e. progressive blasting). No specific criteria for fauna impacts to vibration are established, and as a screening tool, the sensitive receiver screening value of 115 dBL for air blast over pressure has been considered.

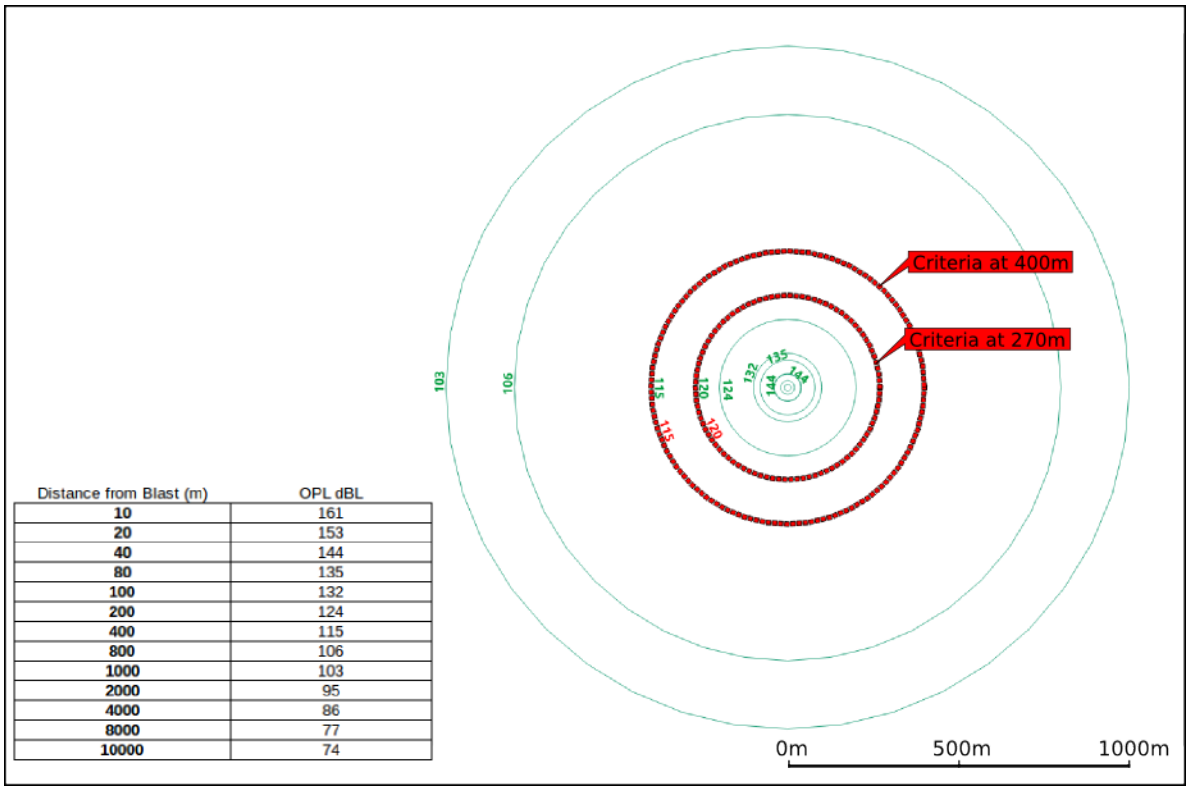
Based on the screening criteria, a ground-based survey is recommended to specifically identify sensitive fauna within 400 m of blasting. An assessment of the degree of impact to specific or significant habitat areas, and/or identified threatened species, is being considered by ecologists.

If there is a significant sensitive habitat within 400 m of the alignment, consideration could be given to alternatives to blasting, additional mitigation to known sensitive fauna areas (blast shielding) or temporary relocation of fauna where possible.



Distance from Blast (m)	Vibration mm/s
10	44.7
20	14.7
40	4.9
80	1.6
100	1.1
200	0.4
400	0.1
800	0.0
1000	0.0
2000	0.0
4000	0.0
8000	0.0
10000	0.0

Figure 5.1 - Radius of Influence – Predicted Vibration Levels from Blasting



Distance from Blast (m)	OPL dBL
10	161
20	153
40	144
80	135
100	132
200	124
400	115
800	106
1000	103
2000	95
4000	86
8000	77
10000	74

Figure 5.2 - Radius of Influence – Predicted Airblast Overpressure Levels from Blasting

5.6.4 Utility Services, and Heritage or Sensitive Buildings

Guidelines for structural damage to buried pipework and heritage buildings due to vibration has been derived from the German Standard DIN 4150 -3 “Structural Vibration Part 3 – Effects of Vibration on Structures ”, as presented in Section 4.2.2.

There is potential for damage to pipe structures where piling or rock breaking equipment are used within 10 m of the pipe. Prior to commencement of construction, it is recommended that the utility infrastructure providers are contacted to determine the location of any services and identify services which may be particularly susceptible to vibration impacts.

If any heritage structures or other significant cultural assets are identified within 20 m of general construction, or 40 m of piling activities, it is recommended that monitoring of vibration impacts on the structure of any heritage building be undertaken throughout nearby construction works. It is noted that piling has not specifically been identified as a requirement at the time of preparation of this assessment.

6 Operational Noise Assessment

6.1 Modelling Methodology

For the purposes of predicting impacts associated with noise emissions from the proposed gas venting and flaring on nearby sensitive receptors, noise modelling of the sources was completed using the proprietary software Cadna (Computer Aided Noise Abatement Model) developed by DataKustik. Cadna incorporates the influence of meteorology, terrain, ground type and air absorption in addition to source characteristics to predict noise impacts at receptor locations. All predictions have been undertaken in accordance with *ISO Standard 9613 (1996) Acoustics - Attenuation of sound during propagation outdoors,* which assumes source-to-receiver wind conditions (1 to 3 m/s) or a temperature inversion under calm conditions.

Cadna/A has the ability to generate noise contours and graphical representations of noise propagation in the area surrounding the proposed facility. The model incorporates influences of meteorology, terrain, ground type and air absorption in addition to source characteristics to predict noise impacts at receptor locations.

6.2 Background Information

6.2.1 Meteorological Data

The project area extending from Warrego to Mt Isa may be classified as having a semi-arid climate. Mean annual rainfall ranges from 400 to 474 mm based on historical data from the Bureau of Meteorology stations at Tennant Creek, Camooweal and Mt Isa monitoring. Average temperatures range from 17-20 ^{o}C (minimum) to 32-33 ^{o}C (maximum).

Figure 6.1 presents measured wind roses for three Bureau of Meteorological weather stations located close to the pipeline route. The Tennant Creek wind rose shows that the project area is dominated by an easterly component at the western end of the pipeline. Towards the eastern end (as represented by Camooweal and Mt Isa monitoring data), wind conditions are dominant by the southerly and south-easterly components. Overall, westerly winds are a minor feature along the length of the pipeline route. Calm conditions are noted to be relatively low at Tennant Creek (1.3%) but the proportion of calms increases towards Mt Isa (9.2%).

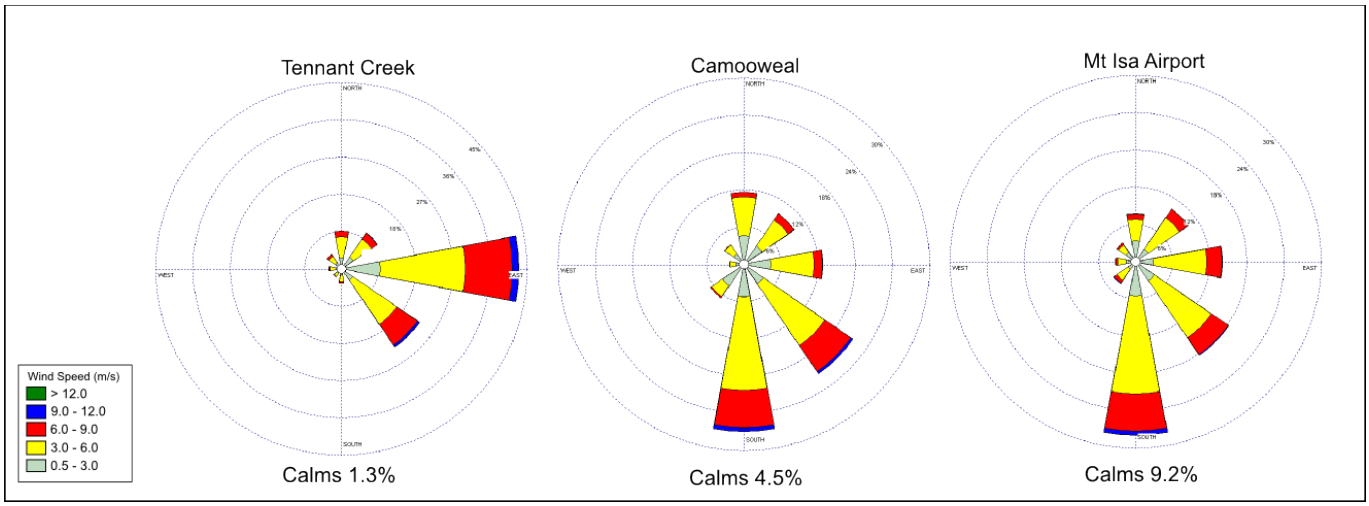


Figure 6.1 - 2011 – 2015 BOM Wind Roses

Planning for Noise Control[8] describes the consideration of temperature inversions and wind effects on the noise modelling. The average annual rainfall of <500 mm, describes the area as arid. The wind rose data indicates that winds greater than 3 m/s at 10 m above ground occur for more than 30% of the year. Based on these observations, the meteorological scenarios considered in the modelling assume meteorological conditions as follows:

- Temperature: 20 degrees Celsius;
- Humidity: 50 %;
- Source to Receiver Wind speed: 3 $m.s^{-1}$;
- Daytime - Stability Class D (representative of normal atmospheric conditions).
- Night-time -Stability Class G (representative of strong inversions).

6.2.2 Terrain and Receptors

Noise contour plots based on a 20 m grid spacing have been predicted for a radius of up to 10 km for the End of Line facility outside Mt Isa for each modelling scenario (plant and gas venting). Receptors have been modelled at sensitive receiver areas within Mt Isa and surrounds to identify exceedances of the noise criteria and results are presented in tabulated form for each modelling scenario in terms of highest predicted noise levels.

For the MLV and Start of Line facilities due to the significant distance to nearest sensitive receivers, modelling of noise levels at various setback distances have been considered, and then reviewed for potential sensitive receivers within the affected areas.

8 Guideline Noise control, Planning for noise control, Department of Environment and Heritage, 16 January 2015.

6.2.3 Miscellaneous Parameters and Considerations

Additional assumptions adopted in the sound propagation modelling are as follows:

- All modelled operational sources operate continuously 24 hours a day. This is an absolute worst case, as a number of the operations incorporated in the modelling are intermittent and only operate for short periods during the day, or during emergency situations.
- Due to the arid character of the area a ground absorption of 0.25 has been assumed.
- The modelling does not consider shielding by terrain or existing buildings, hence may overestimate where there terrain features or existing buildings shield specific receptors from the noise source under consideration.

Noise sources have been entered into the model as sound power levels from a point source at a representative geometric height above ground with spherical emission profile into the surrounding area. The adopted sound power levels of plant and equipment are considered based on available data for the equipment proposed to be utilised.

6.2.4 Modelling Scenarios

The following operating scenarios have been considered in the following sections:

- Start of Line (SOL) Facility;
  - Typical plant operations
  - Changeover period (redundant plant operating, 5 hours per week)
  - Typical plant operations with venting
  - Typical plant operations with flaring
- End of Line (EOL) Facility;
  - Typical plant operations
  - Changeover period (redundant plant operating, 5 hours per week)
  - Mitigation of Gas Turbine via Enclosures
  - Typical plant operations with venting
- Mainline Valves (MLV);
  - Venting

6.3 Potential Noise Emissions (Noise Source Data)

Noise data for the flare and gas vent system has been derived from predictive equations based on the following operating parameters:

- Gas turbine – casing, inlet and exhaust contributions,

- Unsilenced exhaust sound pressure level (based on 100 dB(A) @ 15m)
- Adjustments to Casing, Inlet of Turbine[9], including mitigation via enclosure and medium low pressure-drop muffler (Table 6.2), compressor enclosure designed to achieve average SPL of 85 dB(A) @ 1m.
- Turbine exhaust silencer insertion loss provided (Table 6.2)

- Gas flaring – a noise level of 109 dB(A) sound power level has been adopted to the proposed flare. Frequency data has been estimated based on data from available scientific literature[10];
- Gas venting noise level based on operational data and predictive equations[11]:
  - maximum mass flow rate of 25 kg/s (primarily methane gas);
  - typical vent outlet of 200 mm has been assumed.

Using these parameters and relevant noise prediction equations, 1/1 octave band data has been calculated for operational noise, changeover turbine noise (1 hour per week), gas venting during the worst-case phase (at commencement) and gas flaring.

Modelled noise source data are presented in Table 6.1.

Table 6.1 - Modelled Noise Source Data, Sound Power Level (dB)

Source	Octave Band Centre Frequency dB(lin)									Total dB(A)
	31.5	63	125	250	500	1K	2K	4K	8K	
Gas Turbine, Unsilenced Exhaust	123	127	125	128	132	127	119	109	99	131.5
Gas Turbine, Inlet	105	106	107	107	110	116	121	121	118	124
Gas Turbine, Casing	109	112	114	115	115	115	115	115	115	117
Radiating Gas Turbine Noise (including enclosure)	91	93	95	95	95	94	93	92	91	100
Gas Engine Alternator (GEA)	-	77	81	84	80	81	82	88	-	90
Instrument Air Package (IAE)	-	92	80	88	81	82	84	75	-	88
Aftercooler	-	94	91	88	88	84	84	85	-	91
Gas Flare – Combustion	119	120	115	109	104	103	100	96	90	109

9 Bies, D.A. & Hansen C.H., Engineering Noise Control, Unwin Hyman, 2009.

10 Baukal, C., The John Zink Hamworthy Combustion Handbook, 2nd Edition, CRC press, 2013.

11 Bies, D.A. & Hansen C.H., Engineering Noise Control, Unwin Hyman, 2009.

Source	Octave Band Centre Frequency dB(lin)									Total dB(A)
	31.5	63	125	250	500	1K	2K	4K	8K	
Roar										
Gas Venting	133	137	138	137	134	127	121	115	108	135

Table 6.2 - Modelled Noise Reduction Indices, Enclosures and Mufflers (dB)

Source	Octave Band Centre Frequency dB(lin)									
	31.5	63	125	250	500	1K	2K	4K	8K	Total dB(A)
Gas Turbine, Exhaust Silencer	3	5	10	21	32	37	39	38	34	-
Gas Turbine, Enclosure Type 2[a],[12]	4	5	5	6	6	7	8	9	10	-
Gas Turbine, Inlet Low pressure-drop muffler[8]	-	15	20	18	16	15	14	13	13	-
[a] Glass fibre of mineral wool thermal insulation covered with a minimum 20 gauge aluminium or 24 gauge steel.										

It is noted that under normal use of the site, minimal vehicle movements are likely. Therefore noise from vehicles accessing the site have not been considered in the noise assessment.

The flare and gas venting has been modelled at heights of 40 m and 15 m, respectively.

The locations of the flare and MLV sites where venting is to occur are provided in Section 2.

12 Bies, D.A. & Hansen C.H., Engineering Noise Control, Unwin Hyman, 2009.

7 Predicted Results - Operation

7.1 SOL Facility

7.1.1 Plant Operation

Table 7.1 presents the predicted noise level at fixed distances, including the boundary position, from the standard operations at the SOL facility. Standard operations include the use of two compressor turbines and two Gas Engine Alternators (GEAs). It should be noted that predictions allow for basic single skin metal plant enclosure and an inlet muffler. Where a more substantial plant building is provided (eg, blockwork) or inlet silencers, lower noise emissions would be expected.

Table 7.1 - Predicted Noise Levels SOL Plant Operation

Distance / Location	Predicted $L_{Aeq,adj}$	Predicted L_{Ceq}	L_{Ceq} - L_{Aeq}[a]
Boundary	55.6	70.4	14.8
Existing Phillip Creek Compressor Building	54.5	69.5	15.0
1 km	39.7	57.1	17.4
2 km	32.2	49.1	16.9
5 km	22.4	33.6	11.2
10 km	14.2	18.7	4.5
20 km	9.8	10.7	0.9
Criteria	***Sensitive 28 dB(A)*** ***Fauna 42 dB(A) (BG + 12)***	***60 dB(C)***	***No greater than 20 dB***

[a] L_{Aeq} level is inclusive of noise source and minimum ambient noise level.

There are no existing sensitive residential receivers within 28 km of the proposed SOL facility. An existing compressor station (Phillip Creek station) is located nearby. Predictions up to 3 dB(A) higher are likely during the 5 hour compressor changeover period each week.

Some potential influence on ecological receptors is predicted at distances up to 1 km (12 dB(A) above background).

Review of the predicted noise levels indicate, for the proposed exhaust muffler and nominal plant enclosure and inlet muffler to the gas turbine engines, reasonable and compliant noise levels are predicted beyond 2 km.

7.1.2 SOL Flare Operation

Table 7.2 presents the highest predicted noise level at the nearest sensitive receptors for gas flaring at the SOL facility.

Table 7.2 - Predicted Noise Levels SOL Flare Operation

Distance / Location	Predicted $L_{Aeq,adj}$	Predicted L_{Ceq}	L_{Ceq} - L_{Aeq}[a]
Boundary	61.3	76.4	15.1
Existing Compressor Building	59.7	75.1	15.3
1 km	44.6	63.0	18.0
2 km	36.9	57.6	18.5
5 km	26.6	50.1	14.5
10 km	18.0	43.2	8.1
20 km	13.6	39.5	4.5
Criteria	***Sensitive 30 dB(A)*** ***Fauna 65 dB(A)*** ***Fauna 42 dB(A) (BG + 12)***	***60 dB(C)***	***No greater than 20 dB***

[a] L_{Aeq} level is inclusive of noise source and minimum ambient noise level.

The flaring is under operational control and operates predominately on a pilot basis. Full gas jet and combustion roar noise generated during periodic blow-down activities will be restricted to daytime operation. During an emergency flaring of this type may occur an any-time, however given the emergent nature, is not reviewed against sensitive receiver criteria. During the day, noise levels are predicted to comply with the relevant noise criteria at all surrounding sensitive receptors beyond 4 km. Based on this, for the currently proposed flare location, a noise level of 109 dB(A) (sound power level) and a height of 15 metres are considered appropriate from an acoustic perspective given the existing surrounds. No sensitive receivers are located within 20 km and therefore compliance is predicted.

Potential impacts on ecological receptors are predicted at distances up to 1 km (12 dB(A) above background).

7.1.3 SOL Gas Venting

Table 7.3 presents the highest predicted noise level at the nearest sensitive receptors for gas venting at the SOL facility. The predicted L_{AMax} noise levels for gas venting represent levels during the commencement of venting when noise levels are highest. Noise levels gradually decrease during the

venting process as the pressure differential between the pipeline and atmosphere decreases.

Predictions for L_{Aeq} have been made on the assumption that maximum noise level is sustained for up to 5-minutes, and the remaining 10-minutes is at least 20 dB(A) lower.

Table 7.3 - Predicted Noise Levels SOL Gas Venting

Distance / Location	Predicted L_{Amax}	Predicted L_{Aeq}	Predicted L_{Ceq}	L_{Ceq} - L_{Aeq}[a]
Boundary	79.5	59.5	69.1	9.6
Existing Compressor Building	76.5	56.5	66.3	9.8
1 km	61.3	41.3	52.6	11.3
2 km	54.7	34.7	47.5	12.5
5 km	43.5	23.5	39.6	4.6
10 km	32.4	12.4	32.3	<0
20 km	26.5	6.5	28.3	<0
Criteria	***Short-Term L_{Amax} 55 dB(A) Fauna 65 dB(A)***	***Short-Term L_{Aeq} 37 dB(A)***	***60 dB(C)***	***No greater than 20 dB***

[a] L_{Aeq} level is inclusive of noise source and minimum ambient noise level.

The gas venting at the SOL facility would only occur during emergency or maintenance activities (approximately once every 6 months for 15-minutes) and would be restricted to daytime operation where possible.

Noise levels are predicted to exceed the $L_{Aeq,adj}$ short term criteria at distanced of up to 1.5 km, and the L_{Amax} criteria at distances of up to 2 km. Noise levels are predicted to be only marginally above the L_{Ceq} criteria at the neighbouring remnant compressor building site. Given the short duration of the maximum noise level during gas venting, which will quickly decrease in noise level during the 15-minute period, this may be an acceptable level of noise, especially during maintenance operations where activities can be restricted to daytime periods. No sensitive receivers are located within 20 km and therefore compliance with the adopted noise criteria is predicted at all existing sensitive receivers.

Noise impacts on ecological receptors are predicted at distances up to 5 km (12 dB(A) above background). However, due to the short and occasional duration of the noise sources, the predicted levels are unlikely to permanently disturb colonies or established animal communities outside a 1 km radius.

7.2 EOL Facility

7.2.1 Overview

Computational modelling of the EOL facility has been completed to identify the sphere of influence of noise on the southern Mt Isa community and surrounds. Predictions of highest level of noise for each modelled scenario have been completed for each receptor group identified in Figure 7.1.

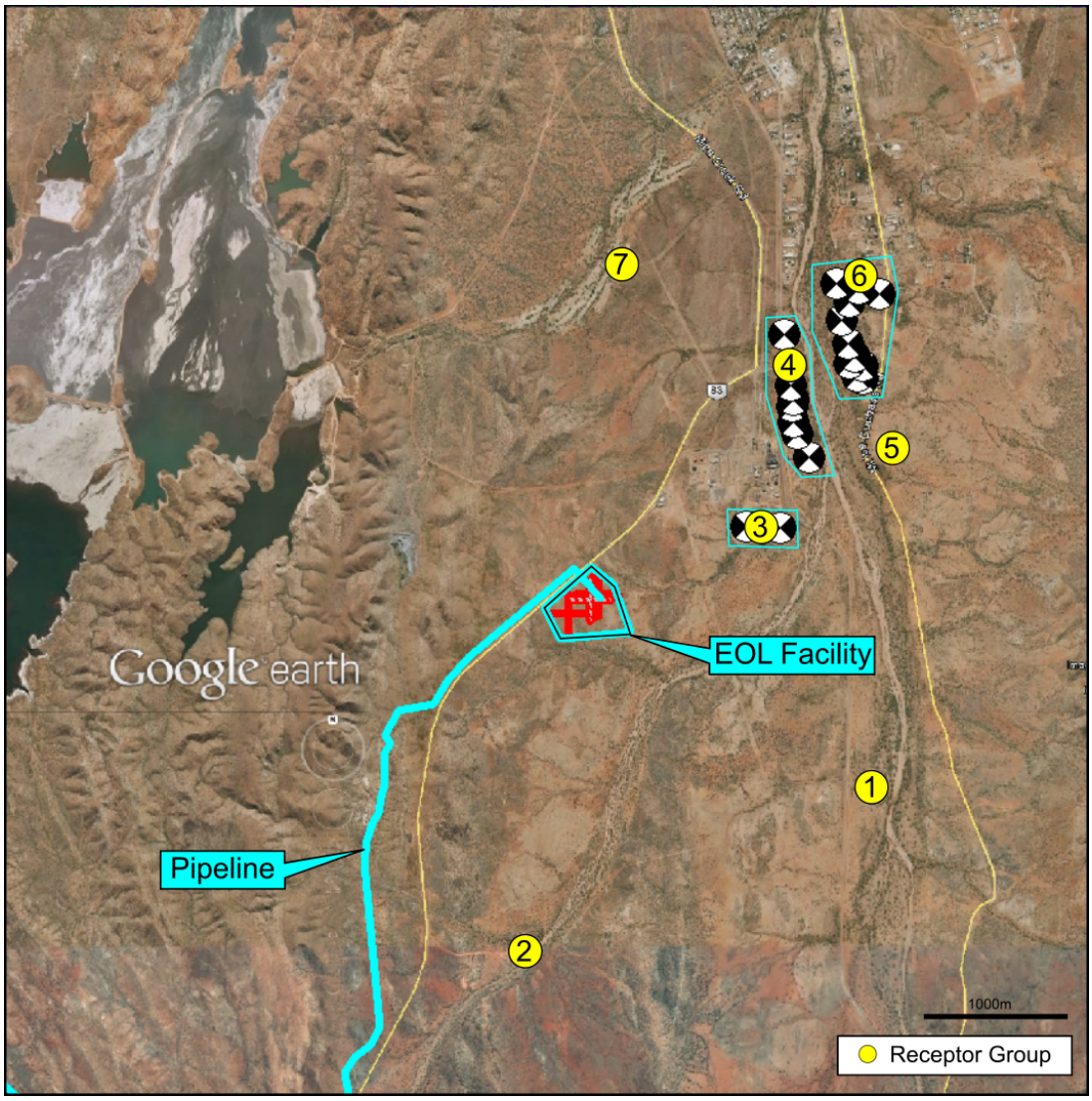


Figure 7.1 - Southern Mt Isa Receptor Groups and EOL Facility

7.2.2 EOL Plant Operation

Table 7.4 presents the predicted noise level at fixed distances, including the boundary position, from the standard operations operations at the EOL facility near Mt Isa. Standard operations include one compressor turbine and one GEA. Figure 7.2 presents predicted noise contours. It should be noted

that predictions allow for basic single skin metal plant enclosure and an inlet muffler. Where a more substantial plant building is provided (eg, blockwork) or inlet silencers, lower noise emissions would be expected.

Table 7.4 - Predicted Noise Levels EOL Plant Operation

Receiver Group	Predicted $L_{Aeq,adj}$	Criteria $L_{aeq,adj}$ (Day/Evening/ Night)	Predicted L_{Ceq}	L_{Ceq} - L_{Aeq}[a]
1. South-East of Mt Isa	18.8	**34/34/32**	38.5	4.4
2. Homestead South-West of Mt Isa	18.0	**34/34/32**	38.0	3.8
3. Powerhouse Road	35.1	**39/39/37**	54.6	17.1
4. Mt Isa Township	31.8	**34/34/32**	50.6	6.8
5. Mt Isa Township	18.5	**34/34/32**	38.2	4.5
6. Mt Isa Township	18.6	**34/34/32**	38.4	4.2
7. Mt Isa Township	18.9	**34/34/32**	38.6	4.5
Criteria	**-**	**-**	***60 dB(C)***	***No greater than 20 dB***

[a] L_{Aeq} level is inclusive of noise source and minimum ambient noise level.

Compliance with long term operating noise criteria is predicted for all identified sensitive receivers during normal operation of the proposed EOL facility plant.

Review of the predicted noise levels indicate, for the proposed exhaust muffler and nominal plant enclosure and inlet muffler to the gas turbine engines, reasonable and compliant noise levels are predicted.

Minimal impact on ecological receptors is predicted except where the colonies are located within 1 km of the site (which have levels that could be up to 12 dB(A) above background).

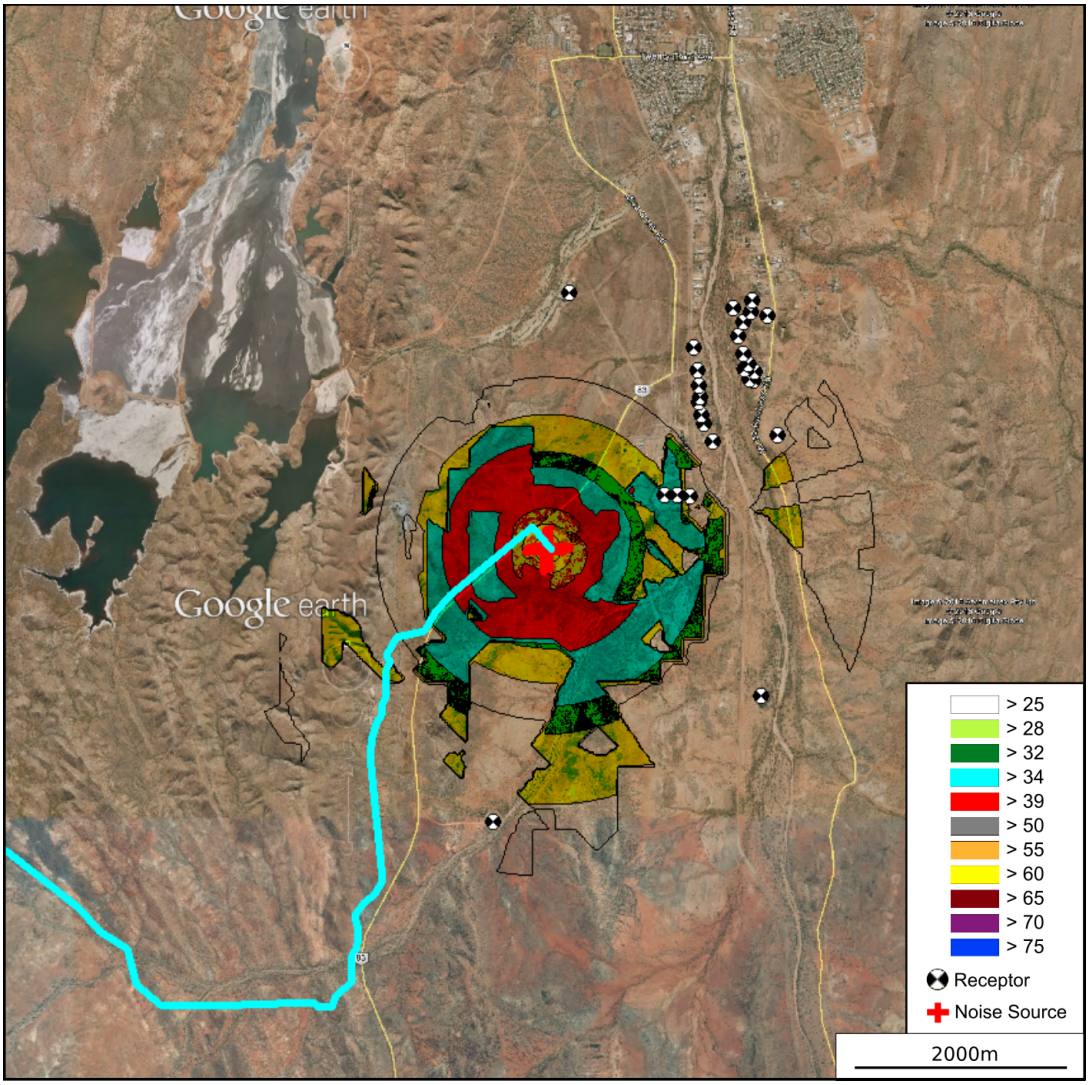


Figure 7.2 - EOL Plant Operation Predicted Noise Levels

Scenario: Gas Venting **Location:** EOL Mt Isa **Height Above Ground:** 1.5 m	**Units:** dB(A) **Noise Parameter:** $L_{Aeq,adj}$ **Criteria:** • 32 dB(A) Mt Isa and Surrounds • 37 dB(A) Powerhouse Road • Fauna – 42 dB(A) (Continuous)

7.2.3 EOL Gas Venting

Table 7.5 presents the highest predicted noise level at the nearest sensitive receptors for gas venting at the EOL facility. Figures 7.3 and 7.4 present predicted noise contours for gas venting at the EOL facility. The predicted L_{AMax} noise levels for gas venting represent predicted noise levels during the commencement of venting when noise levels are highest. Noise levels gradually decrease during the venting process as the pressure differential between the pipeline and atmosphere decreases.

Predictions for L_{Aeq} levels have been made on the assumption the maximum noise level is sustained for up to 5-minutes, and the remaining 10-minutes is at least 20 dB(A) lower.

Table 7.5 - Predicted Noise Levels EOL Gas Venting

Distance / Location	Predicted L_{Aeq}	Short Term Criteria $L_{Aeq,adj}$	Predicted L_{Amax}	Predicted L_{Ceq}	L_{Ceq} - L_{Aeq}[a]
1. South-East of Mt Isa	31.6	**39**	51.6	45.0	10.0
2. Homestead South-West of Mt Isa	31.9	**39**	51.9	45.3	10.3
3. Powerhouse Road	37.9	**44**	57.9	49.7	11.8
4. Mt Isa Township 6	27.4	**39**	47.4	39.2	4.2
5. Mt Isa Township14	21.1	**39**	51.1	44.6	9.6
6. Mt Isa Township15	20.6	**39**	50.6	44.4	9.4
7. Mt Isa Township	21.4	**39**	51.4	44.9	9.9
Criteria	**-**	**-**	***55 dB(A)***	***60 dB(C)***	***No greater than 20 dB***

[a] L_{Aeq} level is inclusive of noise source and minimum ambient noise level.

The gas venting at the EOL facility would only occur during emergency or maintenance activities (approximately once every 6 months for 15-minutes) and would be restricted to daytime operation where possible.

Noise levels are predicted to exceed the L_{Amax} criteria, however are typically within the $L_{Aeq,adj}$ short term criteria and L_{Ceq} criteria. Given the short duration of the maximum noise level during gas venting, which will quickly decrease in noise level during the 15-minute period, this may be an acceptable level of noise, especially during maintenance operations where activities can be restricted to daytime periods.

To achieve compliance with all applicable noise criteria at all times, consideration may be given to include gas vent silencers. A reduction of 3 dB(A) would be required to achieve compliance with the L_{Amax} criteria.

Further detailed design is required to confirm operating noise levels for the MLV sites and any silencers, as a number of factors need to be accounted for such as molecular weight, temperature

and allowable pressure drop. All these factors can also have an influence on the specified noise level and achievable reduction provided by a silencer, and need to be considered in further detail. Adjustments for tonality should be considered in defining the maximum allowable level. These issues would be best addressed at the detailed design stage of the project when specific plant information is available.

Some potential influence on ecological receptors is predicted at distances up to 5 km (12 dB(A) above background). However, due to the short and occasional duration of these noise sources, permanent disturbance of colonies or established animal communities is considered unlikely.

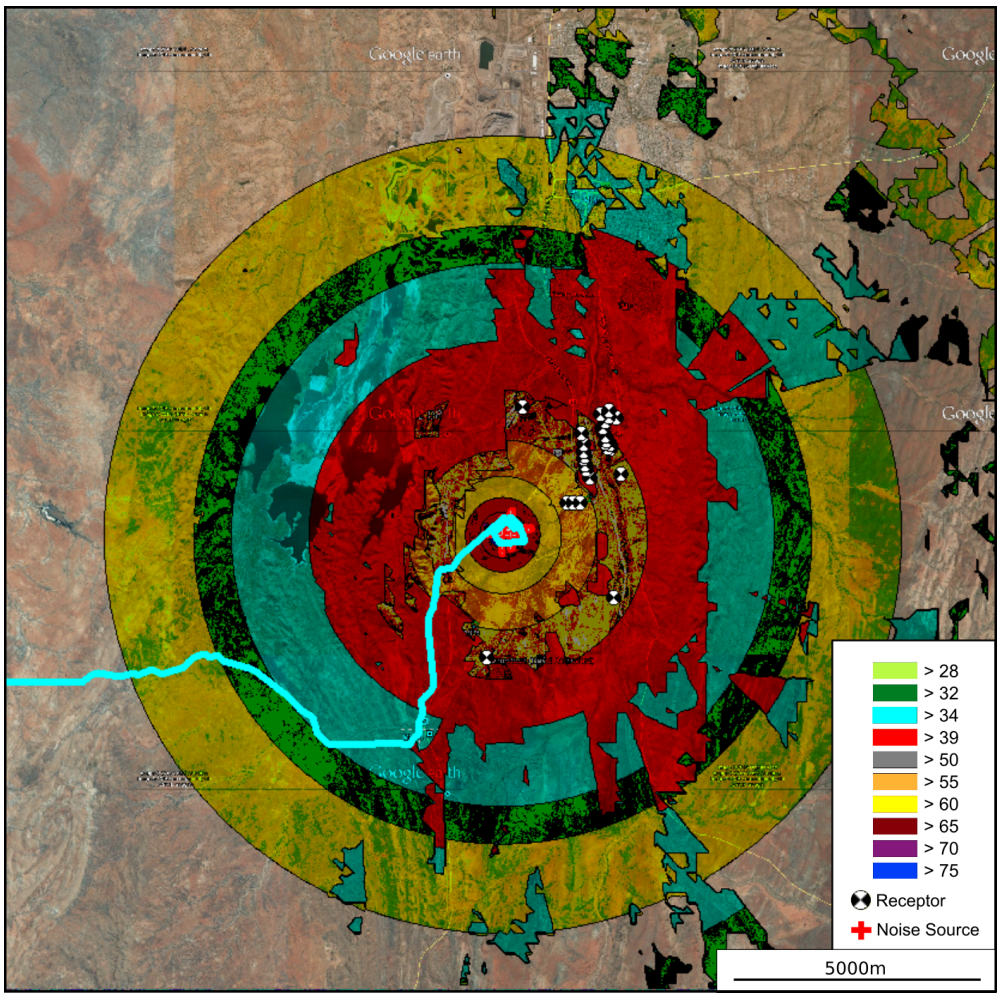


Figure 7.3 - EOL Gas Venting Predicted Noise Levels (Maximum)

Scenario: Gas Venting **Location:** EOL Mt Isa **Height Above Ground:** 1.5 m	**Units:** dB(A) **Noise Parameter:** L_{AMax} **Criteria:** • Sensitive - 55 dB(A) • Fauna – 42 dB(A) (Continuous)

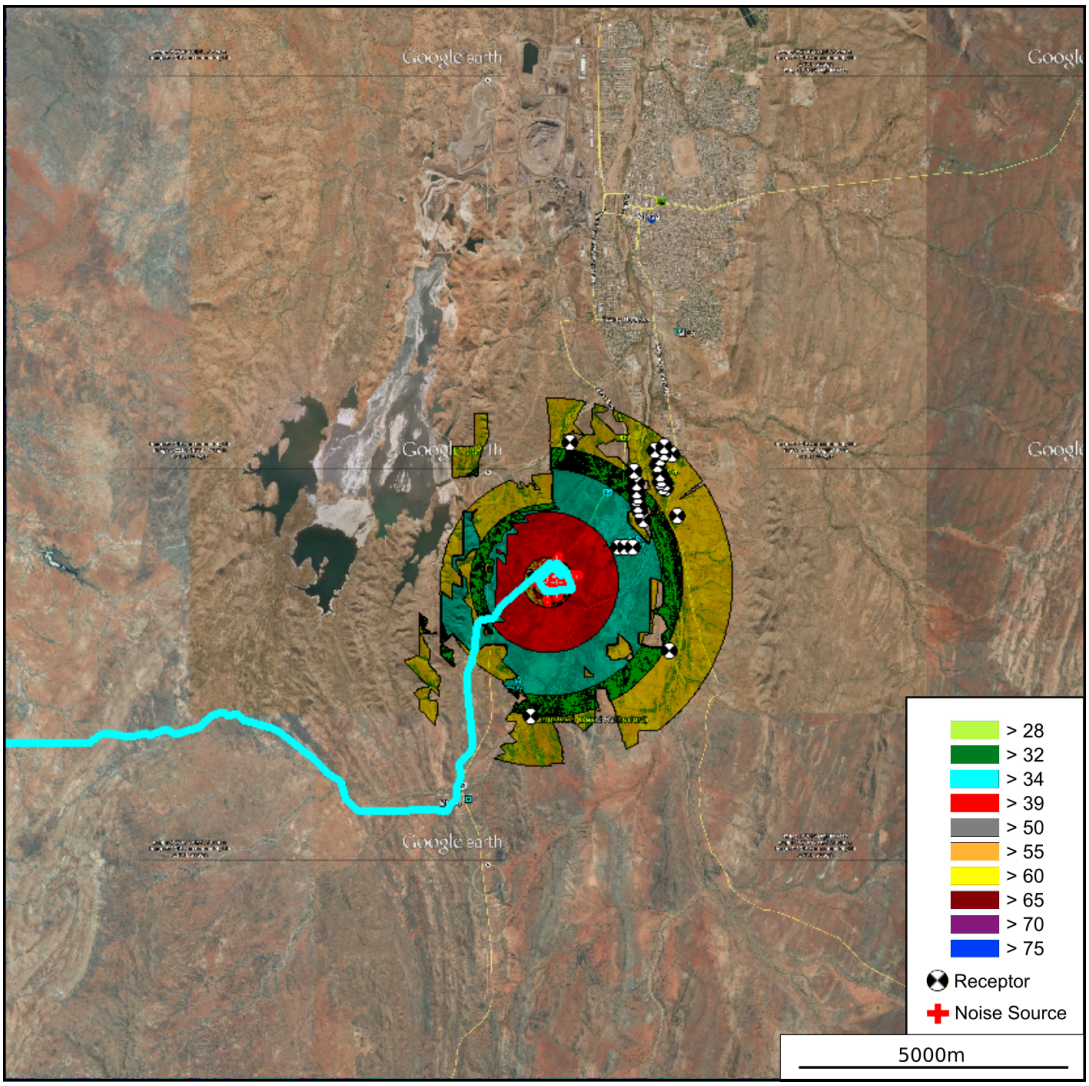


Figure 7.4 - EOL Gas Venting Predicted Noise Levels (Average)

Scenario: Gas Venting **Location:** EOL **Height Above Ground:** 1.5 m	**Units:** dB(A) **Noise Parameter:** $L_{Aeq,adj}$ **Criteria:** • 39 dB(A) Mt Isa and Surrounds • 44 dB(A) Powerhouse Road • Fauna – 65 dB(A) (Short-Term)

7.3 Mainline Valve Locations (MLV)

Table 7.6 presents the highest predicted noise level at various separation distances from the Mainline Valve Locations (MLVs). The predicted L_{AMax} noise levels for gas venting represent levels during the commencement of venting when noise levels are highest. Noise levels gradually decrease during the

venting process as the pressure differential between the pipeline and atmosphere decreases.

Predictions for L_{Aeq} have been made on the assumption that the maximum noise level is sustained for up to 5-minutes, and the remaining 10-minutes is at least 20 dB(A) lower.

Table 7.6 - Predicted Noise Levels MLV Gas Venting

Distance / Location	Predicted L_{Amax}	Predicted L_{Aeq}	Predicted L_{Ceq}	L_{Ceq} - L_{Aeq}[a]
Boundary	79.5	59.5	69.1	9.6
1 km	61.3	41.3	52.6	11.3
2 km	54.7	34.7	47.5	12.5
5 km	43.5	23.5	39.6	4.6
10 km	32.4	12.4	32.3	<0
20 km	26.5	6.5	28.3	<0
Criteria	***Short-Term L_{Amax} 55 dB(A)***	***Short-Term L_{Aeq} 39 dB(A)***	***60 dB(C)***	***No greater than 20 dB***

[a] L_{Aeq} level is inclusive of noise source and minimum ambient noise level.

The gas venting at the MLV facilities would only occur during emergency or maintenance activities (approximately once every 6 months for 15-minutes) and would be restricted to daytime operation where possible.

The nearest sensitive receiver to an MLV is the pastoral homestead (approximately 18 km west of the MLV3 site).

For the MLV3 station noise levels are predicted to be significantly below the adopted criteria and fully compliant at the nearest sensitive receiver.

Further detailed design is required to confirm operating noise levels for the MLV sites and the appropriate acoustic silencers, as a number of factors need to be accounted for such as molecular weight, temperature and allowable pressure drop. All these factors can also have an influence on the specified noise level and achievable reduction provided by a silencer, and need to be considered in further detail. Adjustments for tonality should be considered in defining the maximum allowable level. These issues would be best addressed at the detailed design stage of the project when specific plant information is available.

The nearest sensitive receivers to MLV1 and 2 are 33 km or more from the facility, and are predicted to be fully compliant. Some potential influence on ecological receptors is predicted at distances up to 5 km (12 dB(A) above background) for unsilenced MLV gas venting. However, due to the short and occasional duration of gas venting, these activities are unlikely to permanently disturb colonies or established animal communities.

7.4 Recommended Mitigation

The following mitigation is recommended for the pipeline operations:

- EOL Facility venting – provision of silencer or alternative nozzle to achieve a sound power level of 130 dB(A) or less;

In relation to venting, this activity would only occur during testing every 6 months for a 15-minute period. The typical frequency of gas venting is much less than that defined by the short-term noise criteria specified by the EHP's model conditions for petroleum activities. Nevertheless, given the proximity to a larger population of affected sensitive receivers in the Mt Isa area, consideration of mitigation of noise from gas venting at the EOL facility is recommended. The noise control requirements for these plant items would be best addressed at the detailed design stage of the project when specific design data is available.

8 Conclusion

The noise assessment of the proposed SOL, EOL, flare, gas venting and construction activities for the Northern Gas Pipeline project are summarised below.

8.1 Construction Noise

The modelling results for construction activities result in the following predicted impacts on sensitive receivers:

- Homestead south-west of Mt Isa
  - Mainline Construction - a number of construction activities are predicted to result in exceedance of the adopted noise criteria at this location, generally those activities occurring within 2.5 km of the residence.
- Powerhouse Road residences
  - Mainline Construction - some exceedance of noise criteria at Powerhouse Road residences during ditching, padding and backfilling, hydrotesting and pipe transport,
  - EOL facility - some minor exceedance of noise criteria during venting.

No exceedances of noise criteria are predicted to other sensitive receivers or areas. No exceedances of noise criteria at sensitive receivers are predicted from the Main Mine Camp facilities, or the SOL facility.

8.2 Operational Noise

The following mitigation is recommended for the pipeline operations:

- EOL Facility venting – provision of silencer or alternative nozzle to achieve a sound power level of 130 dB(A) or less.

In relation to venting, this activity would only occur during testing every 6 months for a 15-minute period. It is important to recognise that the typical frequency of gas venting is much less than that defined by the medium-term and short-term noise criteria specified by the EHP's model conditions for petroleum activities. Nevertheless, given the proximity to a larger population of affected sensitive receivers in the Mt Isa area, consideration of mitigation of noise from gas venting at the EOL facility is recommended.

8.3 Fauna

In terms of potential for the disturbance of fauna, especially threatened species, impacts from construction noise is expected to be minimal given that the construction activities occur infrequently and for short durations. For short duration noise, e.g. construction of the mainline, construction would be progressive. Therefore, any fauna in proximity to construction would be affected for very short periods of time only with the 65 dB(A) screening criteria only exceeded within 200 m of the

construction activities.

For blasting, no specific criteria for vibration impacts on fauna have been established. As a screening tool, the sensitive receiver screening value of 115 dBL for air overblast pressure has been considered. Based on the screening criteria, a ground-based survey is recommended to specifically identify sensitive fauna within 400 m of blasting.

During blow-down gas venting and flaring at the facilities, there is the potential for fauna within 1 km to be startled by the onset of noise, however provided the events are of short duration and infrequent unlikely to result in displacement of fauna.

For longer term noise (days/weeks), which may impact on permanent nesting, roosting or colony area noise levels, the potential for noise disturbance is predicted up to 1 km from the activities. Longer term noise is expected to occur where generators and other plant will run for extended periods of time, e.g.:

- mainline valve construction,
- temporary camps, and
- main camp sites.

An assessment of the degree of impact to specific or significant habitat areas, and/or identified threatened species, is being considered by ecologists.

Appendix A – Acoustic Glossary

APPENDIX A: GLOSSARY OF ACOUSTIC TERMINOLOGY	
A-Weighting	A response provided by an electronic circuit which modifies sound in such a way that the resulting level is similar to that perceived by the human ear.
dB (decibel)	This is the scale on which sound pressure level is expressed. It is defined as 20 times the logarithm of the ratio between the root-mean-square pressure of the sound field and the reference pressure ($0.00002 N/m^2$).
dB(A)	This is a measure of the overall noise level of sound across the audible spectrum with a frequency weighting (i.e. 'A' weighting) to compensate for the varying sensitivity of the human ear to sound at different frequencies.
Facade Noise Level	Refers to a sound pressure level determined at a point close to an acoustically reflective surface (in addition to the ground). Typically a distance of 1 metre is used.
Free Field	Refers to a sound pressure level determined at a point away from reflective surfaces other than the ground with no significant contribution due to sound from other reflective surfaces; generally as measured outside and away from buildings.
Hertz (Hz)	A measure of the frequency of sound. It measures the number of pressure peaks per second passing a point when a pure tone is present.
L_{Aeq} Equivalent Continuous Sound Level	This is the equivalent steady sound level in dB(A) containing the same acoustic energy as the actual fluctuating sound level over the given period. For a steady sound with small fluctuations, its value is close to the average sound pressure level.
$L_{A90,T}$	This is the dB(A) level exceeded 90% of the time, T.
$L_{A10,T}$	This is the dB(A) level exceeded 10% of the time, T.
$L_{A50,T}$	This is the dB(A) level exceeded 50% of the time, T.
L_{WA}	The A-weighted sound power level in dB.
Max LpA , 15mins	This is the maximum A-weighted sound pressure level, measured over a time interval of 15 minutes using Fast ("F") meter time response.

LAMax	This is the average of the maximum noise excursions in a representative sample of the same intermittent, repetitive noise event such as vehicle reversing beepers or engine brake applications.
Adj	This is a penalty adjustment which is applied to a measured or calculated noise emission level, to account for annoying characteristics such as tonality or impulsiveness. It is assessed subjectively in accordance with EHP's "Noise Measurement Manual" (2000) and has values of either zero, 2 dB(A) or 5 dB(A).

Appendix B – Noise Monitoring and Meteorological Data

APPENDIX B

Monitoring Positions

Table 1 presents a list and summary of the noise monitoring locations.

Table B1 - Noise Monitoring Locations

Monitoring Position	Distance to Pipeline / Facility	Descriptor of Nearby Receptors	Nearby Receptor Types
MP1	1.8 km	SOL Facility Area, Warrego Station	Tennant Creek and surrounds
MP2	6.8 km	Aboriginal Community (975)	Rural Residential
MP3	3.5 km	Pastoral Homestead	Rural Residential
MP4	2.6 km	Mt Isa (North East of Diamantina and Leichardt Power Stations located on Powerhouse Road)	Urban Residential
MP5	4.9 km	Mt Isa Township (25 Dowsett Cr)	Urban Residential
MP6	930 m	Homestead south of Mt Isa	Rural Residential (adjacent major road)
MP7	1.6 km	Adjacent Diamantina and Leichardt Power Stations located on Powerhouse Road	Urban Residential (adjacent major infrastructure)

Monitoring Position MP1

Table B2 describes the sampling positions and provides a summary of the features of the noise character in the area as identified during the site inspections.

TABLE B2: SUMMARY OF SPECIFIC SOURCES IDENTIFIED DURING SITE INSPECTIONS – POSITION MP1

Position	Surrounding Noise Sources	Noise Sources Identified On-site
MP1	• Warrego Road (5 m east) • Existing Warrego Compressor and Scraper Station (1.8 km east)	• Occasional vehicle movement along Warrego Road • Insect and bird noise • Nearby compressor station inaudible

Table B3 presents a summary of the noise monitoring results for the background monitoring undertaken at Position MP1. Figure B1 presents a summary of the noise monitoring results and meteorological conditions at Position MP1. Figure B2 shows the MP1 noise monitoring and meteorological monitoring positions.

TABLE B3: BASELINE NOISE MONITORING RESULTS – POSITION MP1

Date	Period	L_{AMax}	L_{A1}	L_{A10}	L_{A90}	L_{Aeq}	$minL_{A90,1hr}$
17/04/2016	Day	57.8	49.2	41.0	25.2	43.7	22.1
	Dawn	-[a]	-[a]	-[a]	-[a]	-[a]	-[a]
	Evening	47.0	43.8	41.3	31.2	40.6	27.4
	Night	43.7	32.9	27.6	20.1	59.2	18.0
18/04/2016	Day	54.7	43.1	34.2	22.2	40.4	19.8
	Dawn	66.6	55.8	40.0	18.9	68.4	18.9
	Evening	50.4	48.1	44.7	30.3	53.8	22.6
	Night	38.6	25.3	20.3	18.2	22.8	17.9
19/04/2016	Day	52.1	41.2	31.4	22.4	33.2	19.5
	Dawn	52.4	36.5	25.0	18.7	28.1	18.7
	Evening	48.3	45.3	43.5	35.3	42.2	30.4
	Night	39.2	30.8	26.9	20.6	34.0	18.1
20/04/2016	Day	52.9	42.7	32.6	22.1	44.2	20.2
	Dawn	47.8	35.0	26.1	19.9	27.1	19.9
	Evening	46.6	44.4	42.9	32.5	40.6	28.3
	Night	37.3	30.7	27.6	19.8	33.2	18.1
21/04/2016	Day	52.8	43.9	35.1	22.7	34.7	19.6
	Dawn	45.0	37.6	28.0	18.6	29.6	18.6
	Evening	49.7	47.9	46.5	40.6	45.5	36.4
	Night	42.8	38.9	35.7	25.2	39.2	18.2
22/04/2016	Day	58.9	49.6	41.6	30.5	42.8	24.3
	Dawn	50.6	38.1	29.5	19.9	38.7	19.9
	Evening	46.3	38.7	35.0	25.9	33.7	24.4
	Night	44.8	38.6	33.0	25.0	33.5	20.0
23/04/2016	Day	57.2	51.2	44.0	31.6	44.9	27.2
	Dawn	52.3	43.9	33.8	20.0	33.5	20.0
	Evening	43.9	36.8	33.8	25.4	32.2	23.6
	Night	48.0	40.4	33.9	25.6	35.0	20.4
24/04/2016	Day	54.1	47.5	39.8	26.9	39.7	23.8
	Dawn	49.3	39.9	29.0	19.8	37.4	19.8
	Evening	47.5	41.1	35.9	27.3	35.3	25.6

a Period significantly affected by meteorological conditions, data excluded from consideration

Based on the information in Table B3 above, Table B4 presents a summary of key noise indicators for

monitoring position MP1 as determined for the entire monitoring period.

TABLE B4: SUMMARY OF STATISTICAL INDICATORS – POSITION MP1

Period	Median $L_{Aeq,1\ hour}$	Average L_{Amax}	Average L_{A10}	Average L_{A90}	Median min$L_{A90,1hr}$
Day	36.1	55.1	37.5	25.4	21.1
Dawn	33.5	52	30.2	19.4	19.8
Evening	39.6	47.5	40.4	31.1	26.5
Night	33.3	42	29.3	22.1	18.1

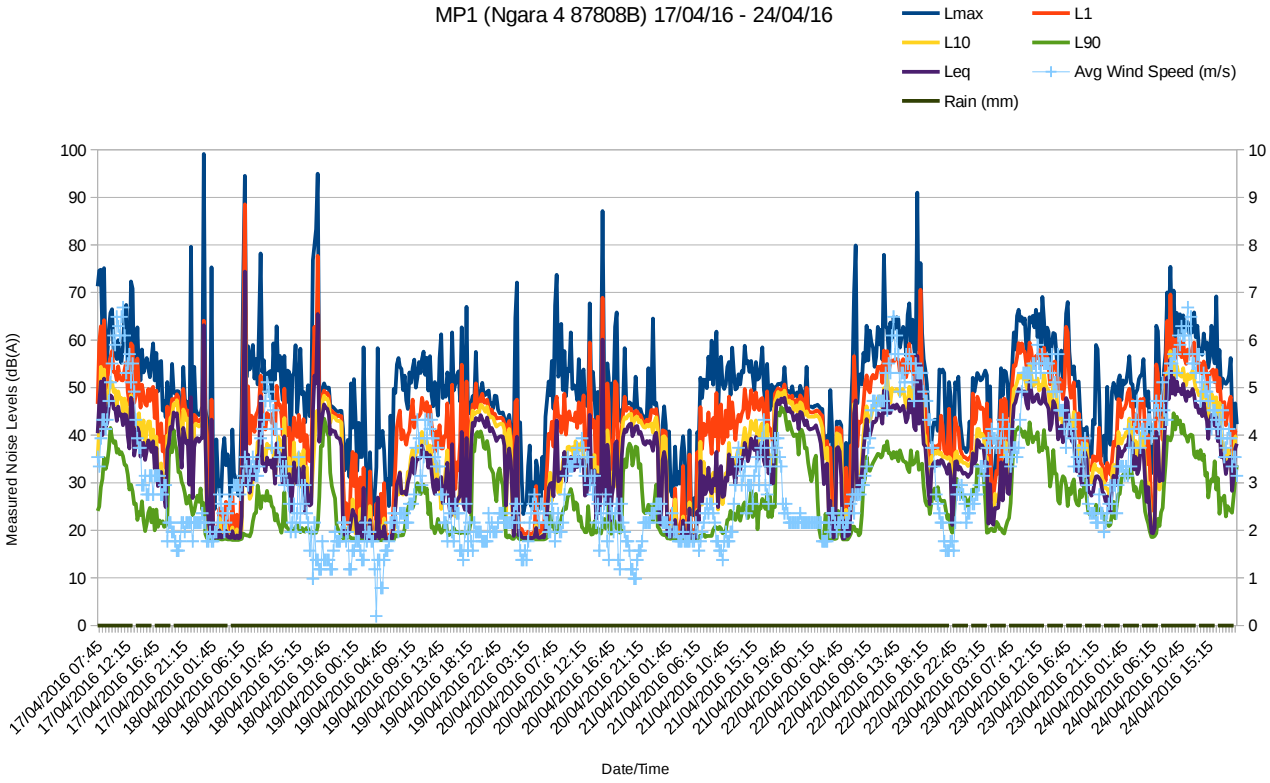


Figure B1: Baseline noise monitoring results – Position MP1

Figure B2: MP1 Noise Instrumentation Setup

Monitoring Position MP2

Table B5 describes the sampling positions and provides a summary of the features of the noise character in the area as identified during the site inspections.

TABLE B5: SUMMARY OF SPECIFIC SOURCES IDENTIFIED DURING SITE INSPECTIONS – POSITION MP2

Position	Surrounding Noise Sources	Noise Sources Identified On-site
MP2	• 100m from community area • Generator within community area	• Noise from residents and children within the community • Insect and bird noise • Generator noise occasionally audible

Table B6 presents a summary of the noise monitoring results for the background monitoring undertaken at Position MP2. Figure B3 presents a summary of the noise monitoring results and meteorological conditions at Position MP2. Figure B4 shows the MP2 noise monitoring and meteorological monitoring positions.

TABLE B6: BASELINE NOISE MONITORING RESULTS – POSITION MP2

Date	Period	L_{AMax}	L_{A1}	L_{A10}	L_{A90}	L_{Aeq}	$minL_{A90,1hr}$
26/05/2016	Day	58.0	46.4	35.3	22.1	37.9	21.2
	Evening	48.3	41.8	38.7	35.3	38.0	31.6
	Night	42.5	38.8	37.8	36.0	37.3	34.3
27/05/2016	Day	57.9	45.0	33.2	21.9	38.7	20.4
	Dawn	49.3	44.6	40.1	36.8	38.9	36.8
	Evening	52.5	42.9	38.4	33.8	38.2	29.1
	Night	46.8	42.1	38.8	35.2	38.2	33.4
28/05/2016	Day	61.2	50.1	42.6	30.5	44.0	23.4
	Dawn	-[a]	-[a]	-[a]	-[a]	-[a]	-[a]
	Evening	51.4	40.5	35.7	30.7	35.1	26.7
	Night	41.7	36.9	35.1	33.1	34.6	32.7
29/05/2016	Day	59.2	47.7	37.1	26.7	50.5	20.7
	Dawn	52.8	43.7	36.6	32.7	36.6	32.7
	Evening	46.0	39.9	36.1	32.7	36.4	29.3
	Night	38.3	35.2	33.9	32.3	33.8	31.5
30/05/2016	Day	59.6	48.0	37.6	25.4	39.2	23.7
	Dawn	55.8	43.0	36.6	32.0	36.6	32.0

Date	Period	L_{AMax}	L_{A1}	L_{A10}	L_{A90}	L_{Aeq}	$minL_{A90,1hr}$
	Evening	48.2	40.5	38.0	33.3	37.9	29.3
	Night	41.9	37.9	35.7	33.5	35.2	32.2
31/05/2016	Day	57.3	46.2	38.6	29.1	38.9	23.4
	Dawn	51.1	43.9	37.5	33.3	37.0	33.3
	Evening	56.3	49.6	45.1	36.6	43.7	35.0
	Night	40.1	36.2	34.1	32.1	33.9	31.7
1/06/2016	Day	59.2	48.5	38.7	26.6	39.3	22.7
	Dawn	54.1	43.3	36.7	33.1	37.4	33.1
	Evening	45.7	39.3	35.8	32.0	35.0	29.2
	Night	38.7	35.5	34.1	32.4	33.8	31.8
2/06/2016	Day	59.6	48.0	36.0	23.7	37.7	20.5
	Dawn	52.8	43.9	37.4	32.5	37.0	32.5
	Evening	43.1	38.7	36.3	32.8	35.6	29.6
	Night	40.7	37.3	35.9	34.2	35.4	33.8

a Period significantly affected by meteorological conditions, data excluded from consideration

Based on the information in Table B6 above, Table B7 presents a summary of key noise indicators for monitoring position MP2 as determined for the entire monitoring period.

TABLE B7: SUMMARY OF STATISTICAL INDICATORS – POSITION MP2

Period	Median $L_{Aeq,1\ hour}$	Average L_{Amax}	Average L_{A10}	Average L_{A90}	Median $minL_{A90,1hr}$
Day	37.5	59	37.4	25.8	21.9
Dawn	37	53.3	37	32.7	32.7
Evening	36.5	48.9	38	33.4	29.3
Night	34.6	41.3	35.7	33.6	32.5

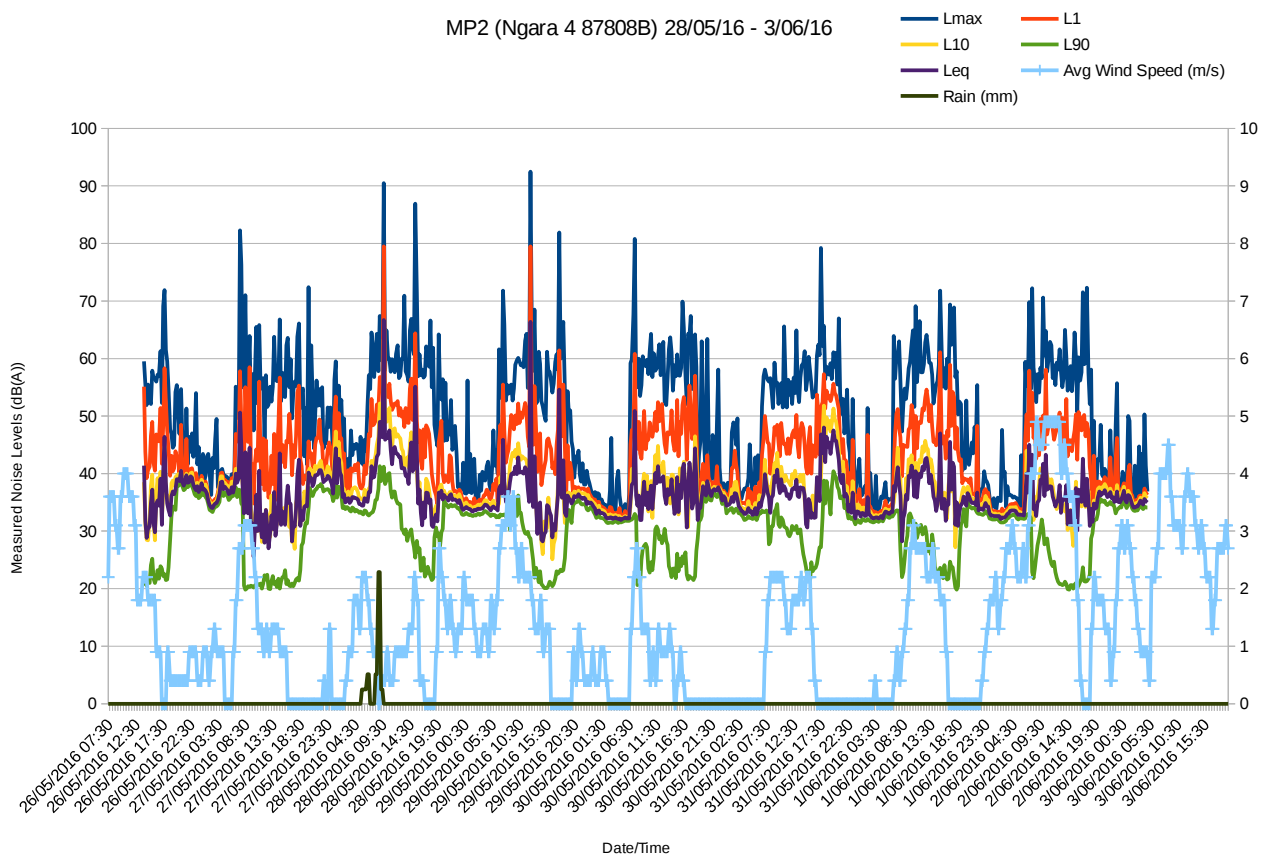


Figure B3: Baseline noise monitoring results – Position MP2

UPDATE

Figure B4: MP2 Noise Instrumentation Setup

Monitoring Position MP3

Table B8 describes the sampling positions and provides a summary of the features of the noise character in the area as identified during the site inspections.

TABLE B8: SUMMARY OF SPECIFIC SOURCES IDENTIFIED DURING SITE INSPECTIONS – POSITION MP3

Position	Surrounding Noise Sources	Noise Sources Identified On-site
MP3	• Generator (220 m north) • Garden sprinklers and irrigation (80 m north west) • Vehicle movements along unsealed roads (600m south and 1 km west).	• Occasional light and heavy vehicle movements along unsealed roads surrounding farm house • Noise from residents at farmhouse • On site garden sprinklers and irrigation • Insect and bird noise

Table B9 presents a summary of the noise monitoring results for the background monitoring undertaken at Position MP3. Figure B5 presents a summary of the noise monitoring results and meteorological conditions at Position MP3. Figure B6 shows the MP3 noise monitoring and meteorological monitoring positions.

TABLE B9: BASELINE NOISE MONITORING RESULTS – POSITION MP3

Date	Period	L_{AMax}	L_{A1}	L_{A10}	L_{A90}	L_{Aeq}	$minL_{A90,1hr}$
16/04/2016	Day	58.5	49.4	40.8	30.1	41.8	26.5
	Evening	53.7	51.0	49.4	45.9	49.4	44.4
	Night	47.3	43.8	41.5	33.0	40.9	28.1
17/04/2016	Day	61.1	51.2	42.4	31.0	53.0	28.5
	Dawn	55.3	46.4	38.5	26.7	36.2	26.7
	Evening	55.8	53.0	52.4	50.2	51.7	49.5
	Night	49.3	45.7	43.1	35.0	45.6	28.1
18/04/2016	Day	58.8	49.2	41.1	31.6	43.7	26.7
	Dawn	60.9	51.9	40.9	29.4	40.5	29.4
	Evening	56.5	53.8	53.2	51.4	52.5	51.2
	Night	49.0	43.9	41.0	33.4	44.9	28.1
19/04/2016	Day	57.0	47.3	39.5	29.4	42.4	26.2
	Dawn	66.2	50.5	41.1	30.1	44.0	30.1
	Evening	55.4	53.7	53.1	50.7	52.3	49.0
	Night	46.0	40.7	38.3	31.5	43.4	26.5
20/04/2016	Day	58.0	47.0	38.6	28.7	40.6	26.8
	Dawn	64.9	52.4	41.5	33.1	47.7	33.1

Date	Period	L_{AMax}	L_{A1}	L_{A10}	L_{A90}	L_{Aeq}	$minL_{A90,1hr}$
	Evening	57.9	56.3	55.6	52.8	55.0	50.0
	Night	50.8	46.4	43.6	38.2	46.2	31.2
21/04/2016	Day	59.9	49.8	42.4	31.5	41.8	28.8
	Dawn	62.0	55.6	48.0	40.1	48.6	40.1
	Evening	56.1	53.0	52.2	49.6	51.5	48.0
	Night	48.5	44.3	40.7	33.4	42.9	26.4
22/04/2016	Day	66.9	53.1	42.9	30.8	52.3	25.5
	Dawn	65.5	49.6	38.5	25.4	41.0	25.4
	Evening	56.1	54.3	53.5	50.7	52.8	48.9
	Night	45.2	40.2	37.6	30.3	40.8	24.5
23/04/2016	Day	62.3	52.6	46.1	35.7	46.0	30.8
	Dawn	55.0	47.3	36.9	25.3	35.8	25.3
	Evening	55.2	54.1	53.3	50.6	52.4	49.3
	Night	56.4	51.0	48.1	42.0	47.9	36.2

Based on the information in Table B9 above, Table B10 presents a summary of key noise indicators for monitoring position MP3 as determined for the entire monitoring period.

TABLE B10: SUMMARY OF STATISTICAL INDICATORS – POSITION MP3

Period	Median $L_{Aeq,1\ hour}$	Average L_{Amax}	Average L_{A10}	Average L_{A90}	Median $minL_{A90,1hr}$
Day	40.9	60.3	41.7	31.1	26.8
Dawn	41	61.4	40.8	30	29.4
Evening	52.1	55.8	52.8	50.2	49.1
Night	41.4	49.1	41.7	34.6	28.1

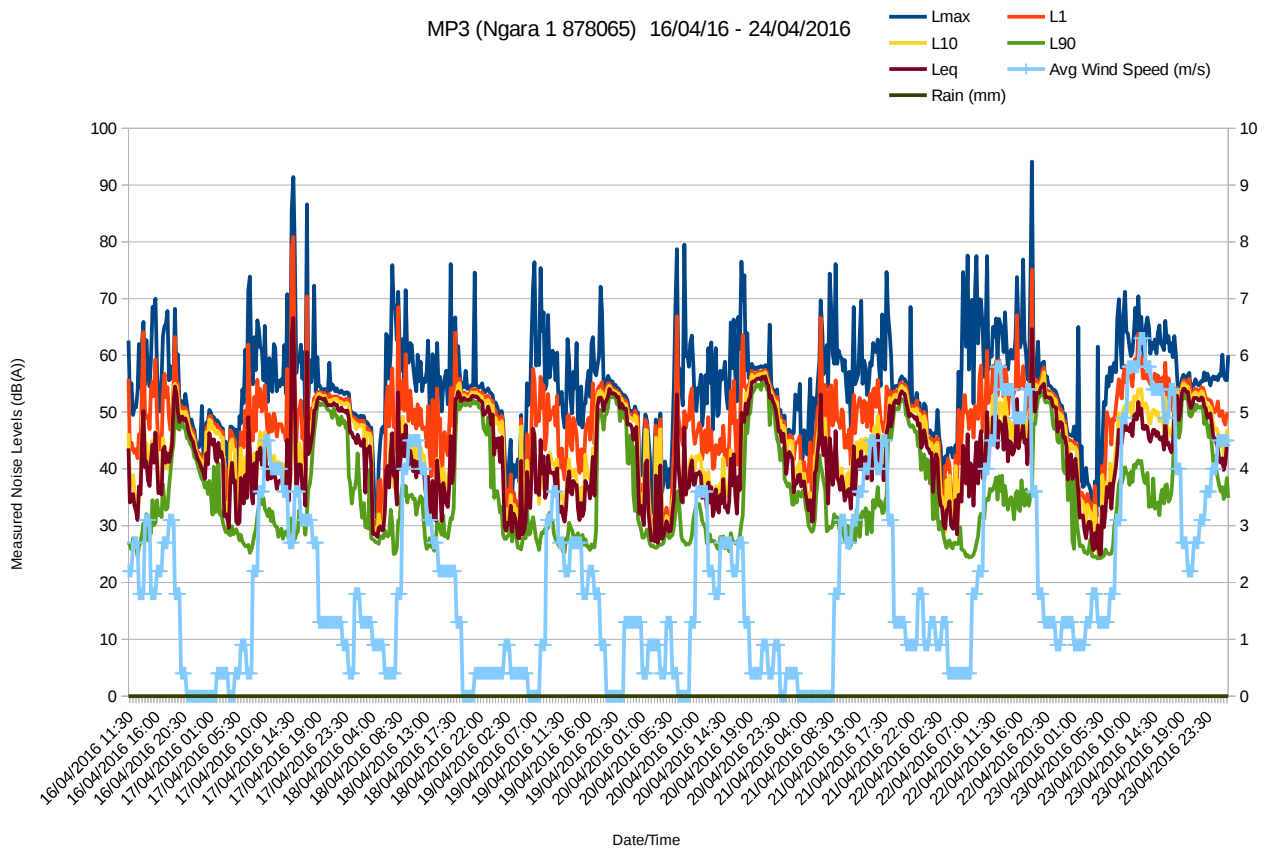


Figure B5: Baseline noise monitoring results – Position MP3

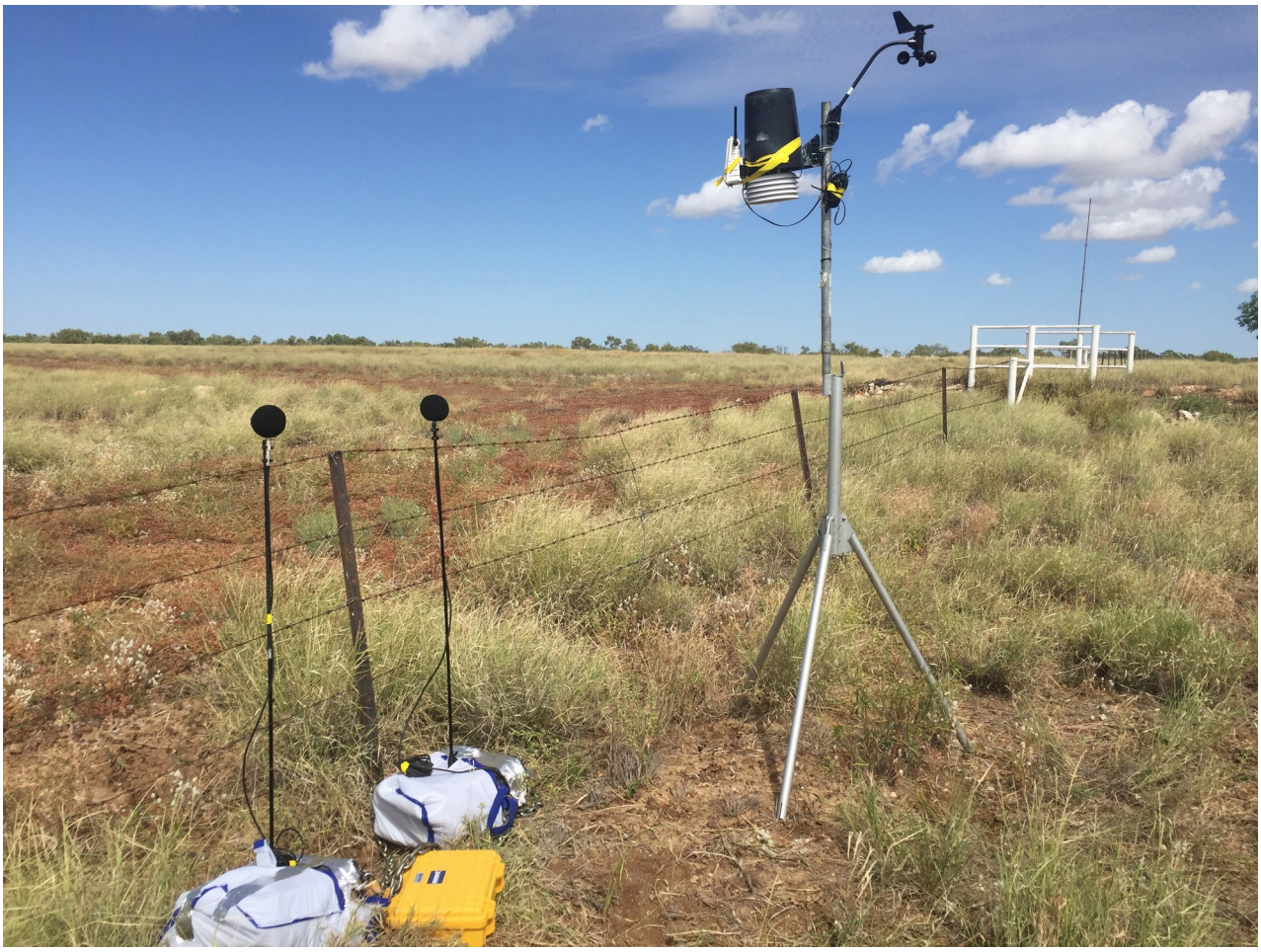


Figure B6: MP3 Noise Instrumentation Setup

Monitoring Position MP4

Table B11 describes the sampling positions and provides a summary of the features of the noise character in the area as identified during the site inspections.

TABLE B11: SUMMARY OF SPECIFIC SOURCES IDENTIFIED DURING SITE INSPECTIONS – POSITION MP4

Position	Surrounding Noise Sources	Noise Sources Identified On-site
MP4	• Mica Creek Power Station (930 m south west) • Mount Isa-Duchess Road (240 m east) • Nearby rural residential properties (145 m south, 120 m north).	• Vehicle movements along Mount Isa-Duchess Road • Noise from nearby residents • Insect and bird noise

Table B12 presents a summary of the noise monitoring results for the background monitoring undertaken at Position MP4. Figure B7 presents a summary of the noise monitoring results and meteorological conditions at Position MP4. Figure B8 shows the MP4 noise monitoring and meteorological monitoring positions.

TABLE B12: BASELINE NOISE MONITORING RESULTS – POSITION MP4

Date	Period	L_{AMax}	L_{A1}	L_{A10}	L_{A90}	L_{Aeq}	$minL_{A90,1hr}$
15/04/2016	Evening	55.9	48.4	45.1	38.6	43.8	33.7
	Night	55.8	52.6	49.8	42.8	50.6	35.1
16/04/2016	Day	59.2	49.5	41.8	31.0	40.9	28.8
	Dawn	58.1	49.5	41.0	28.0	40.1	28.0
	Evening	58.4	54.6	49.5	40.6	50.2	36.4
	Night	49.7	44.1	40.1	33.9	43.9	28.3
17/04/2016	Day	58.8	47.8	40.2	29.0	51.1	27.8
	Dawn	57.5	47.3	40.2	29.6	38.3	29.6
	Evening	61.1	55.1	51.9	44.6	69.6	35.9
	Night	53.7	50.8	48.5	42.2	48.8	30.0
18/04/2016	Day	57.3	46.8	39.1	28.8	39.9	27.8
	Dawn	55.3	46.4	38.1	26.8	36.8	26.8
	Evening	61.4	56.1	51.7	42.6	51.5	33.0
	Night	52.0	45.6	41.3	32.0	44.4	27.5
19/04/2016	Day	58.9	47.8	40.3	31.2	41.0	28.0
	Dawn	56.5	49.0	43.0	35.2	40.8	35.2
	Evening	58.3	53.9	51.0	43.9	52.1	34.9
	Night	52.3	46.5	42.9	35.7	45.8	25.4
20/04/2016	Day	60.5	50.2	42.7	32.9	42.8	28.7

Date	Period	L_{AMax}	L_{A1}	L_{A10}	L_{A90}	L_{Aeq}	$minL_{A90,1hr}$
	Dawn	56.6	49.3	43.2	32.9	41.6	32.9
	Evening	59.6	55.3	51.5	43.8	51.2	35.6
	Night	53.4	51.6	49.8	44.5	49.4	40.9
21/04/2016	Day	62.5	51.6	44.2	33.6	43.2	30.3
	Dawn	52.3	47.6	41.4	27.5	37.9	27.5
	Evening	55.7	51.4	48.4	41.2	48.1	32.3
	Night	51.4	47.1	43.9	36.3	45.1	26.5
22/04/2016	Day	62.4	52.7	45.9	34.8	44.5	33.7
	Dawn	54.8	46.4	38.7	29.0	37.5	29.0
	Evening	57.0	50.6	45.7	39.7	46.7	33.2
	Night	56.3	50.6	47.7	40.4	49.7	32.1
23/04/2016	Day	63.4	50.8	43.5	34.3	43.2	33.6
	Dawn	55.6	45.5	37.9	30.7	38.0	30.7

Based on the information in Table B12 above, Table B13 presents a summary of key noise indicators for monitoring position MP4 as determined for the entire monitoring period.

TABLE B13: SUMMARY OF STATISTICAL INDICATORS – POSITION MP4

Period	Median $L_{Aeq,1\ hour}$	Average L_{Amax}	Average L_{A10}	Average L_{A90}	Median $minL_{A90,1hr}$
Day	40.7	60.4	42.2	32	28.7
Dawn	38.1	55.8	40.4	29.9	29.3
Evening	49.8	58.4	49.3	41.9	34.3
Night	46.2	53.1	45.5	38.5	29.1

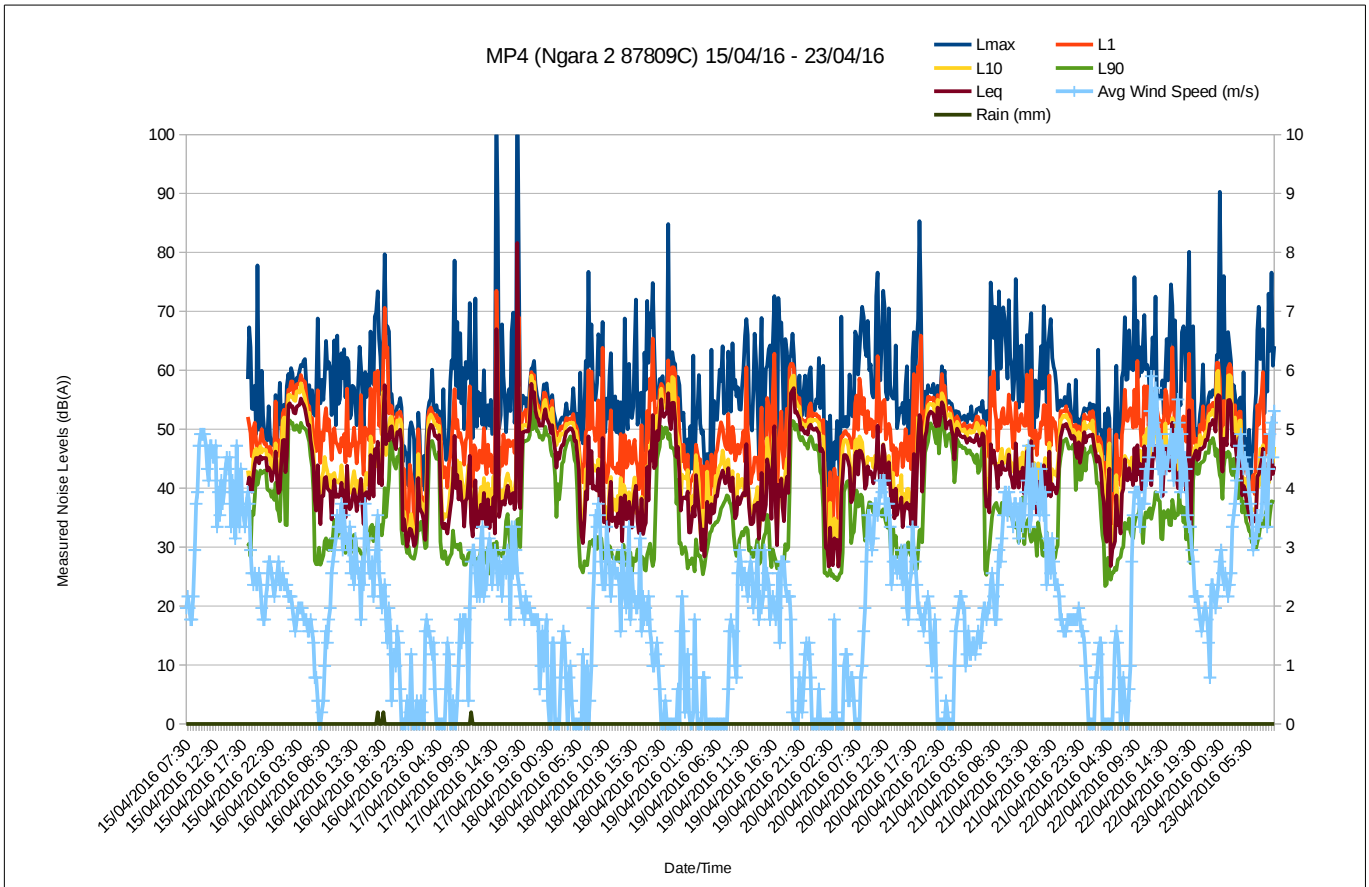


Figure B7: Baseline noise monitoring results – Position MP4

Figure B8: MP4 Noise Instrumentation Setup

Monitoring Position MP5

Table B14 describes the sampling positions and provides a summary of the features of the noise character in the area as identified during the site inspections.

TABLE B14: SUMMARY OF SPECIFIC SOURCES IDENTIFIED DURING SITE INSPECTIONS – POSITION MP5

Position	Surrounding Noise Sources	Noise Sources Identified On-site
MP5	• Neighbouring properties to the east and west • Dowsett Crescent (65 north east) • Mount Isa-Duchess Road (420 m west) • Commercial/light industrial uses (450 m west)	• Local traffic along Dowsett Crescent • Vehicle movements along Mount Isa-Duchess Road • Residential noise from neighbouring properties • Insect and bird noise

Table B15 presents a summary of the noise monitoring results for the background monitoring undertaken at Position MP5. Figure B9 presents a summary of the noise monitoring results and meteorological conditions at Position MP5. Figure B10 shows the MP5 noise monitoring and meteorological monitoring positions.

TABLE B15: BASELINE NOISE MONITORING RESULTS – POSITION MP5

Date	Period	L_{AMax}	L_{A1}	L_{A10}	L_{A90}	L_{Aeq}	$minL_{A90,1hr}$
15/04/2016	Evening	68.1	56.1	50.8	40.1	51.5	35.6
	Night	53.4	50.0	47.2	37.5	47.2	30.6
16/04/2016	Day	66.5	53.2	44.6	34.4	47.0	31.5
	Dawn	62.6	49.2	38.3	29.3	42.1	29.3
	Evening	53.9	48.2	45.8	39.1	44.6	36.7
	Night	50.5	43.9	39.4	33.6	40.9	30.3
17/04/2016	Day	65.4	50.7	41.4	32.5	58.3	30.8
	Dawn	57.7	49.0	42.7	35.3	41.5	35.3
	Evening	58.3	53.5	51.0	44.8	50.1	39.4
	Night	50.4	45.8	42.3	33.1	42.4	27.2
18/04/2016	Day	57.2	47.0	39.2	31.4	40.0	29.9
	Dawn	59.4	50.1	45.5	37.6	43.5	37.6
	Evening	63.8	56.7	49.9	42.1	63.8	37.3
	Night	52.7	45.4	40.1	33.9	41.7	29.5
19/04/2016	Day	59.8	48.6	40.3	33.0	42.3	30.7
	Dawn	59.1	51.2	47.9	42.9	46.1	42.9
	Evening	62.6	53.6	49.0	42.0	48.9	38.6

Date	Period	L_{AMax}	L_{A1}	L_{A10}	L_{A90}	L_{Aeq}	$minL_{A90,1hr}$
	Night	51.0	46.1	42.5	35.1	43.0	28.9
20/04/2016	Day	60.8	50.8	41.5	32.7	46.7	30.5
	Dawn	63.7	53.6	47.7	40.1	46.0	40.1
	Evening	59.7	52.6	50.2	41.3	49.3	36.2
	Night	58.0	55.2	52.3	39.3	54.3	35.9
21/04/2016	Day	60.7	50.5	43.5	34.4	42.0	33.3
	Dawn	56.7	48.3	43.0	34.1	40.8	34.1
	Evening	59.4	54.7	51.7	41.0	51.2	34.4
	Night	59.5	54.2	46.9	35.4	54.1	27.9
22/04/2016	Day	61.8	52.9	45.7	35.2	44.7	32.9
	Dawn	59.2	48.6	44.2	38.0	42.7	38.0
	Evening	62.7	53.2	49.7	42.5	49.3	36.6
	Night	49.7	44.6	40.8	34.0	39.8	32.5
23/04/2016	Day	60.3	52.3	47.3	37.6	45.3	36.2
	Dawn	54.3	46.3	42.3	34.3	39.7	34.3
	Evening	57.5	52.0	48.2	37.6	49.4	33.9
	Night	58.1	53.9	48.4	38.3	49.5	35.2
24/04/2016	Day	60.4	52.0	46.2	36.1	44.1	35.0
	Dawn	59.8	49.4	42.0	34.5	40.3	34.5

Based on the information in Table B15 above, Table B16 presents a summary of key noise indicators for monitoring position MP5 as determined for the entire monitoring period.

TABLE B16: SUMMARY OF STATISTICAL INDICATORS – POSITION MP5

Period	Median $L_{Aeq,1\ hour}$	Average L_{Amax}	Average L_{A10}	Average L_{A90}	Median $minL_{A90,1hr}$
Day	42.3	61.4	43.3	34.1	31.5
Dawn	42.1	59.1	43.7	36.2	35.3
Evening	49	60.6	48.8	40.5	36.4
Night	41.3	53.7	44.4	35.6	30.3

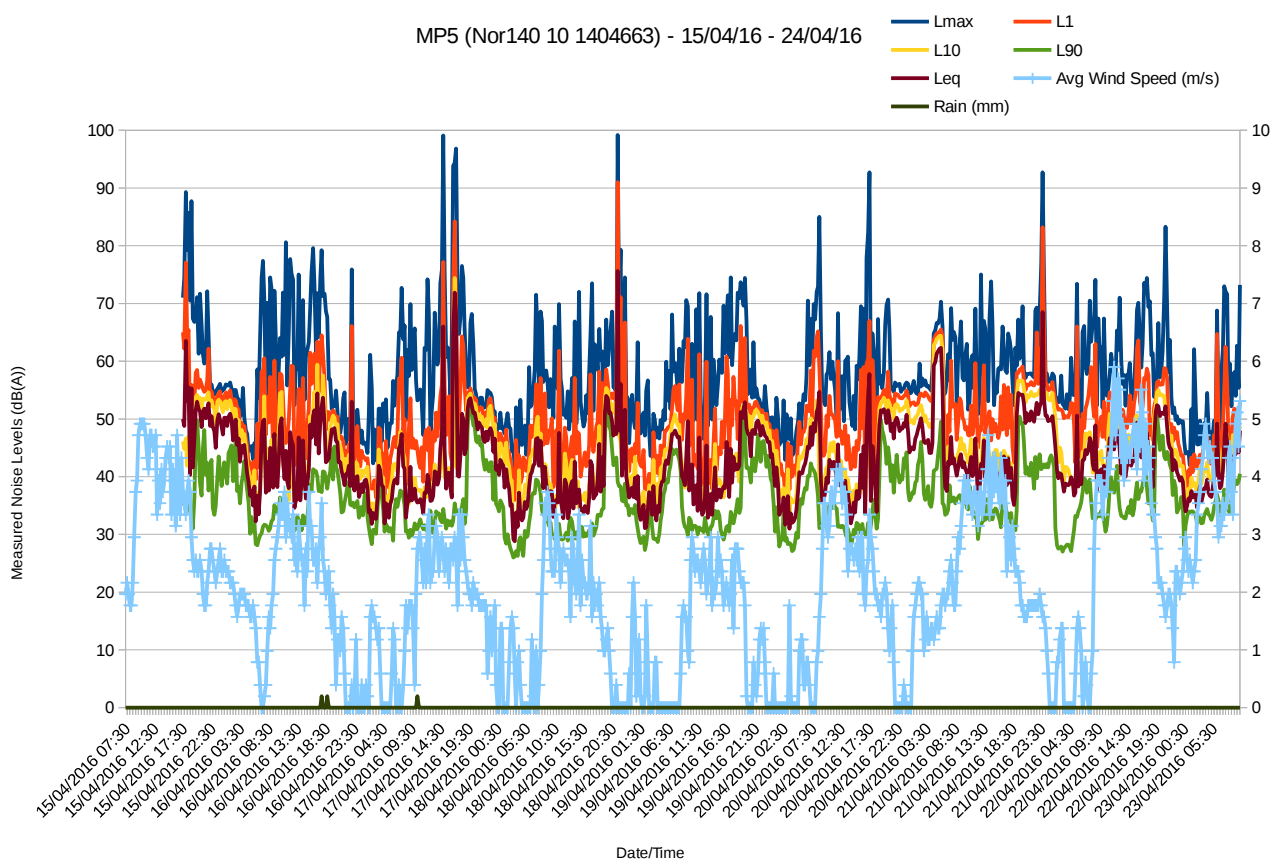


Figure B9: Baseline noise monitoring results – Position MP5

Figure B10: MP5 Noise Instrumentation Setup

Monitoring Position MP6

Table B17 describes the sampling positions and provides a summary of the features of the noise character in the area as identified during the site inspections.

TABLE B17: SUMMARY OF SPECIFIC SOURCES IDENTIFIED DURING SITE INSPECTIONS – POSITION MP6

Position	Surrounding Noise Sources	Noise Sources Identified On-site
MP6	• Diamantina Developmental Road (530 m west) • Earth works and construction of on site shed (439 m south east) • Mica Creek Power Station (3.2 km north east)	• Light and heavy vehicle movements along Diamantina Developmental Road • Insect and bird noise

Table B18 presents a summary of the noise monitoring results for the background monitoring undertaken at Position MP6. Figure B11 presents a summary of the noise monitoring results and meteorological conditions at Position MP6. Figure B12 shows the MP6 noise monitoring and meteorological monitoring positions.

TABLE B18: BASELINE NOISE MONITORING RESULTS – POSITION MP6

Date	Period	L_{AMax}	L_{A1}	L_{A10}	L_{A90}	L_{Aeq}	$minL_{A90,1hr}$
15/04/2016	Day	61.8	49.0	40.8	34.2	40.7	32.5
	Evening	59.7	52.6	49.1	39.4	53.8	33.9
	Night	55.4	52.2	49.4	44.9	49.1	40.6
16/04/2016	Day	61.9	50.4	41.3	30.8	42.4	28.8
	Dawn	63.4	54.5	39.5	31.9	42.2	31.9
	Evening	60.3	56.3	50.7	41.1	51.4	34.5
	Night	56.0	48.2	42.5	36.6	46.2	29.5
17/04/2016	Day	61.5	49.7	42.4	30.9	62.2	29.4
	Dawn	69.5	54.0	39.7	27.0	43.2	27.0
	Evening	57.9	54.6	51.5	39.0	51.5	33.5
	Night	56.7	53.2	50.0	38.5	52.4	25.8
18/04/2016	Day	55.6	45.2	38.0	27.6	39.2	25.0
	Dawn	57.7	43.3	32.4	23.5	33.5	23.5
	Evening	48.6	44.7	41.6	33.9	39.5	33.2
	Night	42.7	38.5	36.4	30.3	36.6	23.5
19/04/2016	Day	59.8	46.7	39.3	30.5	39.8	26.4
	Dawn	48.4	40.1	35.7	32.6	34.6	32.6
	Evening	53.3	49.7	46.3	37.1	51.3	33.4

Date	Period	L_{AMax}	L_{A1}	L_{A10}	L_{A90}	L_{Aeq}	$minL_{A90,1hr}$
	Night	57.2	54.2	51.2	37.7	55.5	30.4
20/04/2016	Day	58.3	49.5	42.1	32.0	41.6	27.5
	Dawn	58.7	48.1	38.5	28.2	39.8	28.2
	Evening	52.0	48.7	45.6	36.5	49.7	33.9
	Night	59.8	57.4	55.1	43.2	55.5	36.4
21/04/2016	Day	60.2	51.5	44.4	32.7	43.3	30.7
	Dawn	55.4	44.8	37.3	31.2	38.1	31.2
	Evening	54.3	51.0	47.6	38.8	56.3	33.7
	Night	53.2	49.5	46.8	38.1	50.0	34.4
22/04/2016	Day	62.5	54.1	47.1	35.9	46.3	33.4
	Dawn	63.1	52.2	42.6	34.9	46.0	34.9
	Evening	49.7	45.8	43.6	36.1	41.7	34.1
	Night	51.0	47.1	43.4	34.2	41.3	31.0
23/04/2016	Day	60.7	55.0	49.9	37.3	47.2	35.0
	Dawn	60.5	51.2	42.6	31.3	42.6	31.3
	Evening	50.4	46.2	43.3	35.7	41.1	33.8
	Night	59.0	56.2	50.9	38.5	48.3	35.9

Based on the information in Table B18 above, Table B19 presents a summary of key noise indicators for monitoring position MP6 as determined for the entire monitoring period.

TABLE B19: SUMMARY OF STATISTICAL INDICATORS – POSITION MP6

Period	Median $L_{Aeq,1\ hour}$	Average L_{Amax}	Average L_{A10}	Average L_{A90}	Median $minL_{A90,1hr}$
Day	41.9	60.3	42.8	32.4	29.4
Dawn	41	59.6	38.5	30.1	31.3
Evening	44.1	54	46.6	37.5	33.8
Night	48.9	54.5	47.3	38	31

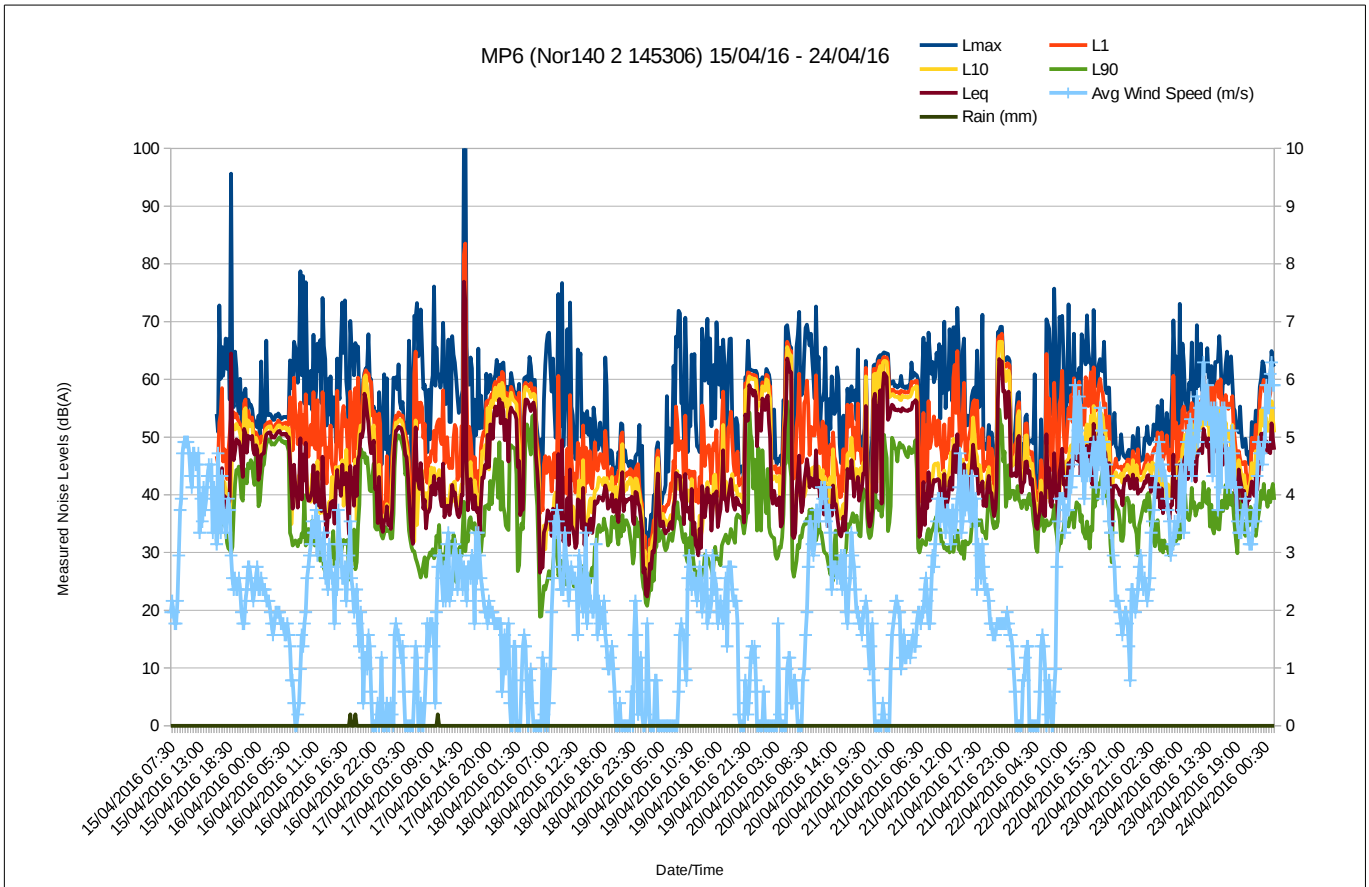


Figure B11: Baseline noise monitoring results – Position MP6

Figure B12: MP6 Noise Instrumentation Setup

Monitoring Position MP7

Table B20 describes the sampling positions and provides a summary of the features of the noise character in the area as identified during the site inspections.

TABLE B20: SUMMARY OF SPECIFIC SOURCES IDENTIFIED DURING SITE INSPECTIONS – POSITION MP7

Position	Surrounding Noise Sources	Noise Sources Identified On-site
MP7	• Pump station (150 m west) • Rail line (20 m west) • Mica Creek Power Station (270 m north west) • Unsealed Old Mica Creek Road (20 m east)	• Continuous noise from pump station to the west • Continuous noise from cooling towers at Mica Creek Power Station • Occasional light vehicle movement along unsealed Old Mica Creek Road • Insect and bird noise

Table B21 presents a summary of the noise monitoring results for the background monitoring undertaken at Position MP7. Figure B13 presents a summary of the noise monitoring results and meteorological conditions at Position MP7. Figure B14 shows the MP7 noise monitoring and meteorological monitoring positions.

TABLE B21: BASELINE NOISE MONITORING RESULTS – POSITION MP7

Date	Period	L_{AMax}	L_{A1}	L_{A10}	L_{A90}	L_{Aeq}	$minL_{A90,1hr}$
1/05/2016	Day	57.9	44.7	39.8	37.8	39.7	37.8
	Evening	54.7	50.3	46.2	42.6	50.2	39.4
	Night	54.9	51.9	49.1	43.6	52.7	39.9
2/05/2016	Day	58.1	50.4	41.3	36.8	51.2	33.9
	Dawn	61.1	47.9	41.8	39.1	43.2	39.1
	Evening	53.8	50.4	48.1	42.5	47.5	39.4
	Night	56.1	52.6	48.8	42.8	53.0	36.1
3/05/2016	Day	51.6	44.2	39.0	34.8	48.6	34.0
	Dawn	61.7	51.6	42.6	34.7	59.2	34.7

Based on the information in Table B21 above, Table B22 presents a summary of key noise indicators for monitoring position MP7 as determined for the entire monitoring period.

TABLE B22: SUMMARY OF STATISTICAL INDICATORS – POSITION MP7

Period	Median $L_{Aeq,1\ hour}$	Average L_{Amax}	Average L_{A10}	Average L_{A90}	Median min$L_{A90,1hr}$
Day	39.7	55.9	40	36.5	34
Dawn	51.2	51.4	42.2	36.9	36.9
Evening	46	54.2	47.2	42.5	39.4
Night	48.2	55.5	49	43.2	38

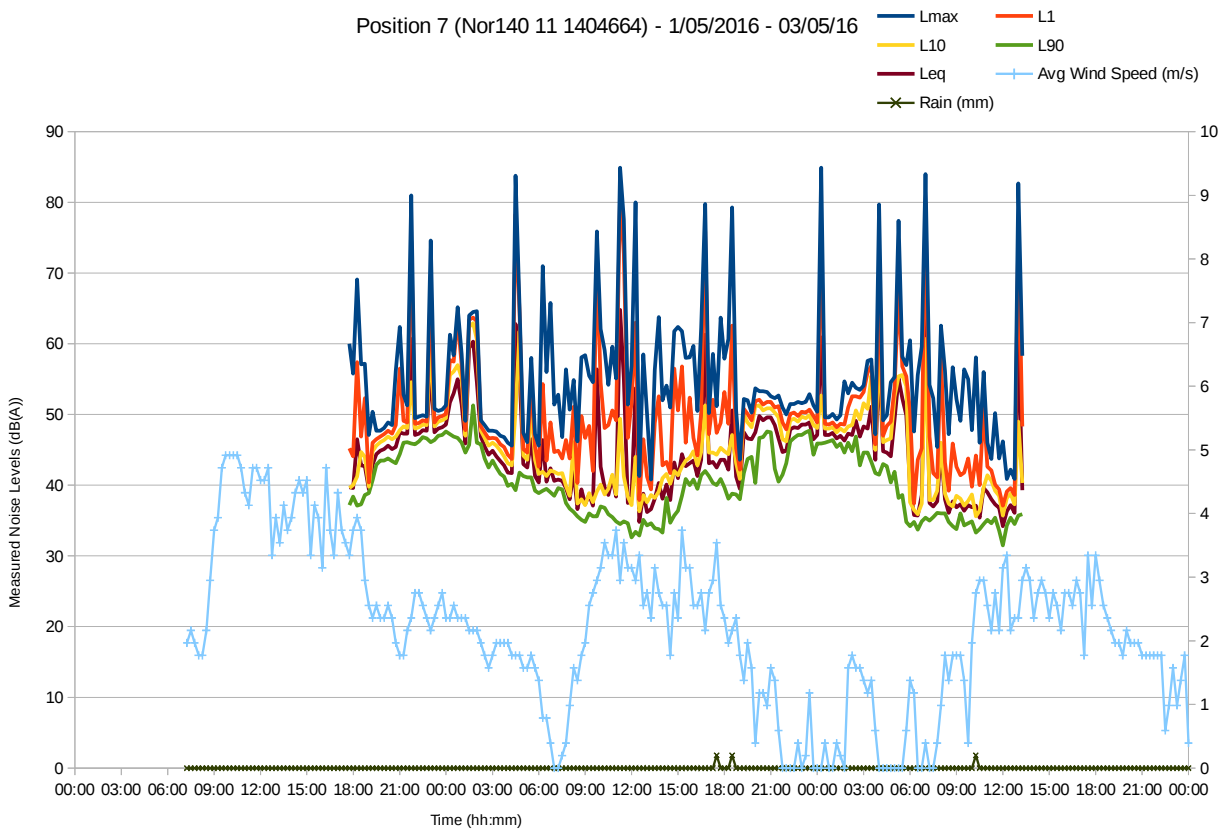


Figure B13: Baseline noise monitoring results – Position MP7

Figure B14: MP7 Noise Instrumentation Setup