Bonney Downs Wind Farm Noise Assessment

Prepared for Fortescue

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Executive Summary

This report is a summary of an environmental noise assessment for the Bonney Downs Wind Farm Project.

The Bonney Downs Wind Farm Project proposes to construct and operate a wind farm containing up to 201 Wind Turbine Generators (WTG's) and power transmission infrastructure, located within the Bonney Downs Pastoral Lease approximately 130 km north of Newman in the Pilbara Region of Western Australia.

The Project will comprise of up to 201 7.8MW Envision WTG's. The construction of the WTG's will include the development of 200 x 200m pads.

The major findings of the noise study are as follows:

- Background levels were found to be very quiet at night-time, where the measured LA90 noise levels were between 19 to 33 dB(A).
- Clearing/earthworks was the noisiest construction activity modelled. As construction activities are spread over a wide area, the predicted levels at the receivers will only occur when construction is being undertaken close to the receiver locations. In accordance with the Noise Regulations a construction noise management plan will be required for the Homestead if activities close to the Homestead if they take place during night-time hours. A summary of the construction noise findings can be found in section 5.1.
- Noise from the Wind Farm complies with the threshold levels at the majority of modelled locations, except for the following locations which exceed the threshold levels:
    - Bonney Downs Homestead for hub height windspeeds ≥6m/s.
    - Fortescue Camp for hub height windspeeds ≥5m/s.
    - Corkbark springs for hub height windspeeds ≥7m/s.

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Definitions, Abbreviations and Acronyms

	Description
Definitions	
Noise Monitor Locations	Locations where Noise Monitors were placed to record background noise levels.
Cultural Receptor	A location visited where a noise sensitive activity (e.g., hunting, camping, ceremonial use) is undertaken.
Decibel or dB	The unit of measurement for noise
Decibel A-weighted or dB(A)	Decibel or dB is the unit of measurement for noise, and "A" weighting represents the hearing bandwidth and capability of humans.
Noise Sensitive Receiver	A premises defined as noise sensitive in the Environmental Protection (Noise) Regulations 1997.
Noise sensitive area	An area visited where a noise value activity is undertaken.
Noise sensitive activity	An activity which has the potential to be affected by high noise levels. For Native Title Stakeholders, this includes traditional activities such as camping, hunting, and ceremonial.
Acronyms and Abbreviations	
AS	Australian Standard
CONCAWE	Conservation of Clean Air and Water in Europe
dB	Decibel
dB(A)	Decibel A-weighted
EIA	Environmental Impact Assessment
EPA	Environmental Protection Authority
ESE	East South East
IF	Influencing Factor
ISO	International Standardisation Organisation
Km	Kilometre
M	metre
DE	Development Envelope
PSC	Pasquill Stability Class
SLM	Sound Level Meter
SWL	Sound Power Level
UTM	Universal Transverse Mercator
WTG	Wind Turbine Generator

1 Introduction

This report summarises an environmental noise assessment undertaken for the Bonney Downs Wind Farm Project (the Project).

1.1 Aim

The aim of this study is to quantify the potential received noise levels during construction and operation phases of the Project at surrounding noise sensitive receivers and Cultural Receptors.

1.2 Operations Overview

Fortescue are proposing to construct and operate a large-scale wind farm containing up to 201 Wind Turbine Generators (WTG's), located within the Bonney Downs Pastoral Lease, approximately 130 km north of Newman in the Pilbara Region of Western Australia.

The Project will include the following elements:

- Construction activities including clearing, earthworks, concreting and WTG assembly.
- Wind farm operations (up to 201 WTG's).

1.3 Receivers

Two types of receivers are applicable for this assessment, as follows:

- Noise sensitive receivers as defined in the Environmental Protection (Noise) Regulations 1997; and
- Cultural Receptors (provided by Fortescue through consultation with native title stakeholders).

Table 1-1 and Figure 1-1 show the location of receiving locations included in the noise model. Section 2 provides more detailed information on the assessment criteria adopted for receivers in this study.

Table 1-1 Coordinates of modelled receiver locations/noise monitoring locations

Receiver	Coordinates (UTM, Zone 50K)	
	Easting	Northing
Noise Sensitive Receiver		
Bonney Downs Homestead	802615	7543943
Nullagine Town	821079	7576913
Fortescue Camp	798630	7548319
Cultural Receptor		
Bonnie Pool	809200	7566859
Cookindina Pool	789785	7567617
4 Mile Well	784784	7537264
Emu Spring/Well	790407	7543779
Daylight Rockhole	811359	7556401
18 Mile Pool & Warrabu Site	810940	7559025
Mooringinya Spring	805314	7567326
Coobinacoola Pool	787639	7566425

Receiver	Coordinates (UTM, Zone 50K)	
	Easting	Northing
Minderungumya Hill	789797	7560475
Bronzewing Pool	796177	7572891
Trig Hill Well	785576	7553995
Corkbark Spring	793521	7561577
Wild Dog Spring	803300	7549261
Tundununya Soak	787573	7572306
Cattle Well	799733	7536465
Noise Monitor Locations		
BD_NM_01	802770	7568153
BD_NM_02	809090	7566973
BD_NM_03	799944	7557985
BD_NM_04	802234	7543753
BD_NM_05	790272	7555345
BD_NM_06	811273	7558498
BD_NM_07	788196	7538662
BD_NM_08	801456	7549658

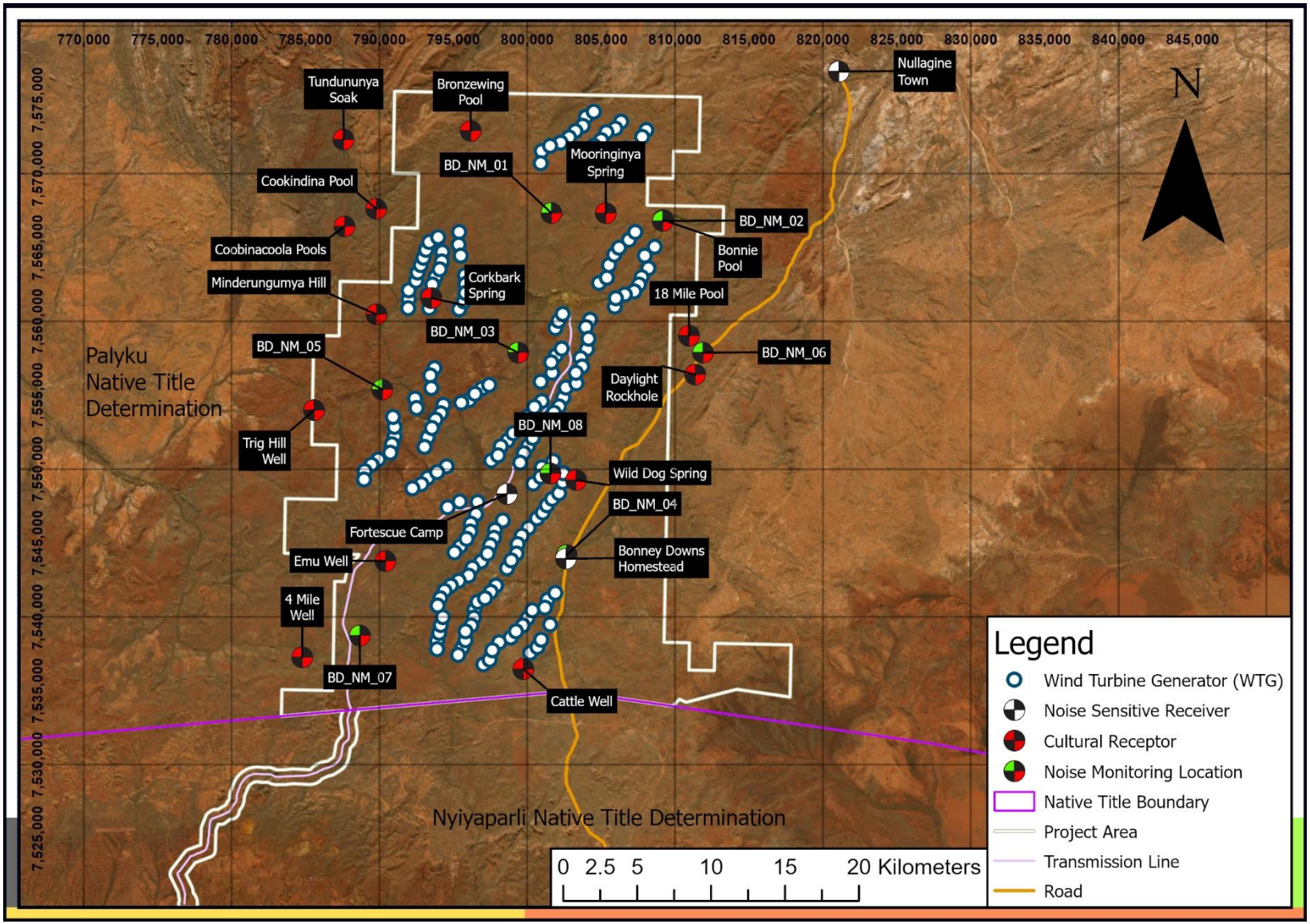

Figure 1-1 Location Map – Project Development Envelope, WTG's and Modelled Receiver Locations

1.4 Noise Level Overview

Noise is measured using a decibel (dB) scale which makes it a non-linear number. This means that every 3 dB is a doubling of acoustic energy (for example 10 dB + 10 dB = 13 dB). The measured levels are quoted as dB(A), which means it is an A-weighted decibel value. A-weighting gives more value to frequencies in the middle of the human hearing spectrum and less value to frequencies at the edges, as compared to a flat audio decibel measurement.

Hearing sound at 70 to 75 dB(A) is equivalent to someone shouting at 1m from your ear, 60 to 65 dB(A) is equivalent to someone speaking at 1 m from your ear and 30 to 35 dB(A) is equivalent to someone whispering at 1m from your ear (see Figure 1-2 for some additional examples).

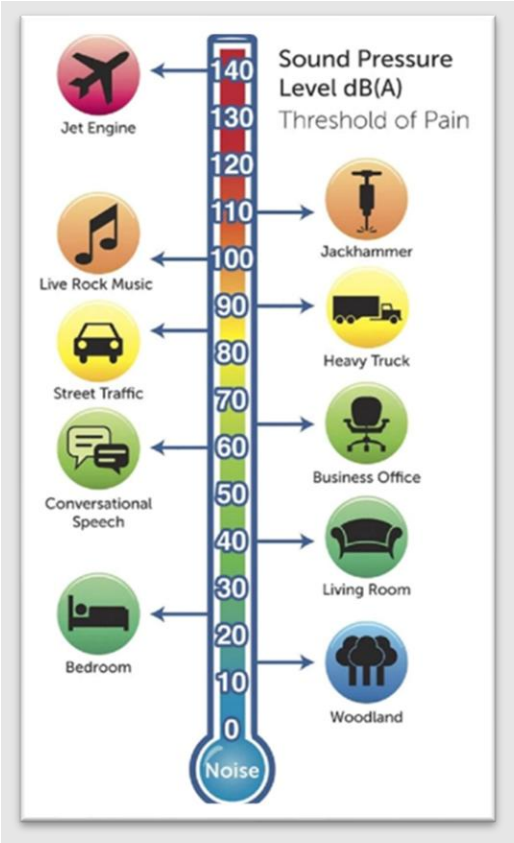

Figure 1-2 Noise Thermometer

2 Assessment Criteria

2.1 Overview of Applicable Regulatory Documents

Table 2-1 provides a summary of the Regulatory documents that have been considered for determining applicable noise threshold levels for the impact assessment.

Table 2-1 Applicable Documents

Ref	Document Name	Application
[1]	*Environmental Protection Act 1986* (EP Act)	The EP Act defines noise as an emission which is considered to be unreasonable if it interferes with the health, welfare, convenience, comfort, or amenity of any person. The EP Act requires the occupier of any prescribed premises who causes an emission or alters the nature or volume of noise from the prescribed premises to ensure that their noise emissions are not unreasonable.
[2]	Environmental Protection (Noise) Regulations 1997 (the Regulations)	The Regulations defines noise emissions that, if found to be in contravention of the standard prescribed in the regulations, will be considered as unreasonable.
[3]	DWER Draft Guideline "Assessment of environmental noise emissions", May 2021	The Guideline ensures adequate information is provided to the Department of Water and Environment Regulation for assessing applications with noise emissions, as regulated under the EP Act.
[4]	EPA Environmental Factor Guideline: Social Surroundings, November 2023	The Guideline communicates how the factor Social Surroundings is considered by the Environmental Protection Authority (EPA) in the environmental impact assessment (EIA) process.
[5]	EPA Technical Guidance Environmental impact assessment of Social Surroundings – Aboriginal cultural heritage, November 2023	This Technical Guidance has been developed to: • Outline the EPA EIA process for Social Surroundings – Aboriginal cultural heritage (ACH) under the EP Act. Provide the information requirements for the EPA to decide: • whether a proposal is likely to have a significant effect on the social surroundings environmental factor, as it relates to ACH, and if it should be assessed by the EPA; • if ACH is being assessed by the EPA, the information needed for assessment; and

Ref	Document Name	Application
		if the EPA decides the proposal may be implemented, whether reasonable conditions can be applied to protect ACH from significant harm.
[6]	AS2107 Acoustics - Recommended design sound levels and reverberation times for building interiors	AS2107 defines maximum noise levels for internal spaces, including sleeping areas. It has been used, in combination with the noise Regulations, to determine noise impacts on Heritage receptors.
[7]	South Australia EPA "Wind farms – environmental noise guidelines", July 2009	The Guideline provides information on how to assess the noise impact of wind farms on the surrounding environment.
[8]	Planning Bulletin 67 – "Guidelines for Wind Farm Development", May 2004	The Planning Bulletin provides a guide to the assessment of land-based wind farm developments in Western Australia.

2.2 Wind Farm Noise Guidelines

The potential noise impact from WTG's have been assessed against the criteria defined in the South Australian Wind Farms environmental noise guidelines [7]. These guidelines have been endorsed by the Western Australian EPA and the Western Australian Planning Commission (see Planning Bulletin 67 [8]), as an appropriate approach for assessing noise impacts from Wind Farms.

The South Australian guideline states that the predicted equivalent noise level (LAeq,10min), adjusted for tonality in accordance with these guidelines, should not exceed:

- 35 dB(A) at relevant receivers in localities[1] which are primarily intended for rural living, or
- 40 dB(A) at relevant receivers in localities in other zones, or
- The background noise (LA90, 10min) by more than 5 dB(A).

Whichever of the above values is greater, for wind speeds from cut-in to rated power of the WTG.

[1] South Australian Wind Farms noise guidelines define locality as an approximation of the officially recognised area outside cities and larger towns as defined by the State and Territory governments of Australia (see https://www.abs.gov.au/statistics/standards/australian-statistical-geography-standard-asgs-edition-3/jul2021-jun2026/non-abs-structures/suburbs-and-localities).

Note that "Locality" is defined as "an approximation of the officially recognised areas outside cities and larger towns as defined by the State and Territory governments of Australia.[2]

2.3 Social Surroundings

2.3.1 Overview

The EP Act 1986 defines Social Surroundings as, '*the social surroundings of man are his aesthetic, cultural, economic and social surroundings to the extent that those surroundings directly affect or are affected by his physical or biological surroundings (Subsection 3(2))'.* A more detailed overview of the guidance documentation is provided in Appendix A.

The EPA's environmental objective for the factor Social Surroundings is '*To protect social surroundings from significant harm*'. The objective recognises the importance of ensuring that social surroundings are not significantly affected because of implementation of a Project or scheme.

Noise has the potential to unreasonably interfere with the health, welfare, convenience, and comfort of people. As a result, the EPA requires that the following noise considerations be included:

- Emissions of noise are considered in the context of relevant legislation, criteria, or standards.
- The level of confidence with which the predicted impacts to social surroundings have been made and the risk should those predictions be incorrect.
- Analysis, modelling, and predictions of impacts from noise, including likely impacts during the worst, best and most likely case scenarios.
- Model predictions could be validated with on-site measurements.
- Characterisation of proximity to sensitive receptors.
- Summary of proposed technologies, emission reduction equipment and management practices.
- Description of proposed management and monitoring arrangements.
- Analysis of cumulative impacts, including existing and reasonably foreseeable emissions.

2.3.2 Details of Cultural Receptors

The Project is located within the Palyku and Nyiyaparli Native Title Determination areas (the NTD areas). Noise sensitive areas were identified during consultation with Palyku who raised concerns about the level of noise during construction and operation phases of the project, and how far these could be heard from the project area. Nyiyaparli did not identify any noise sensitive areas as they did not raise any concerns regarding noise generated by this project. Figure 1-1 shows the locations of the Cultural Receptors included in the noise model.

[2] As defined in "Australian Statistical Geography Standard (ASGS) Edition 3 https://www.abs.gov.au/statistics/standards/australian-statistical-geography-standard-asgs-edition-3/jul2021-jun2026/non-abs-structures/suburbs-and-localities.

The Project area is a large area and therefore noise model contour maps (Section 5.3) will provide context on noise levels across the surrounding area.

2.3.3 Identified Noise Related Values

Based on consultation with Palyku and Nyiyaparli, it is understood that both groups use the area within and surrounding the Project for traditional activities. Therefore, the following values have been assumed for the Project:

- That continued or sporadic access may occur for cultural and recreational purposes including camping, hunting, fishing, and ceremonial use.
- Native Title group have raised concerns about noise impacts on native animals during consultation.

2.3.4 Proposed Applicable Noise Criteria for Noise Sensitive Activities

Activities which have noise related value (e.g. Camping, Hunting, and Ceremonial use) are not defined in the Environmental Protection (Noise) Regulations 1997 (the Regulations). There is also a lack of previous information and proxy data to inform the assessment, and the appropriate noise target criteria.

To determine reasonable noise target levels for the different noise sensitive activities, the following legislative documents, standards, and guidance documentation have been considered:

- The EP Act requires that noise emissions received at another premises are reasonable. The Regulations consider receiver types and not activities. The assigned noise levels defined in the Regulations are the levels below which the Regulator considers noise to be reasonable. Compliance with the assigned levels does not imply that the noise is inaudible.
- Australian Standard AS2107 considers appropriate internal noise levels for different types of rooms in which various activities are undertaken. The activities have been related back to noise related values.
- Neither the Regulations nor AS2107 consider hunting activity. It has therefore been assumed that hunting at night, where the hunter is dependent on auditory senses, will require similar background noise levels to sleeping areas and night-time assigned noise levels defined in the Regulations.

At locations that fall outside of the definition of sensitive receivers such as tourist look-out areas and unregistered camping grounds, a noise threshold level of 50 dB(A) has been used. This was first applied for a Methanol Complex near Hearson Cove on the Burrup Peninsula and has subsequently been used for Tullis Bridge near Boddington, Lake Douglas near Kalgoorlie, and Bibra Lake near Roe Highway. As a result, 50 dB(A) has been used as a noise threshold level for Cultural Receptors.

Table 2-2 details proposed noise target and threshold levels for each activity of noise related value.

Based on the identified values, there are three activities that need to be considered when developing appropriate target noise levels. These are as follows:

- **Camping (at night)**: Noise could result in sleep disturbance and annoyance. Target noise levels need to take this into account.
- **Hunting**: It is expected that hunting will only take place during daylight hours where the hunter uses visual cues. Night-time hunting is not expected, but if undertaken, will require low noise levels as the hunter is dependent on auditory cues.

- **Day Use / Ceremonial use**: Speech intelligibility and annoyance needs to be considered for activities undertaken during the day or ceremonial use.

2.4 Applicable Noise Targets for the Project

Table 2-2 gives the proposed noise target and threshold levels adopted for the Project for noise sensitive activities undertaken at Cultural Receptors, noise Sensitive Areas and receptors. The target levels are only for management if identified as an impact when people are using the area.

Table 2-3 gives the night-time Regulatory assigned levels for nearby sensitive receivers (i.e. the Town of Nullagine and Bonney Downs Homestead).

Table 2-2 Activity Based Noise Target Levels for Cultural Receptors

Activity	Target Noise Level (LAeq,10min)	Threshold Noise Level (LAeq,10min)	Comment
Camping (night-time)	30	50	The night-time target levels are based on avoiding noise induced sleep disturbance and annoyance. The target levels adopted have used the Noise Regulations and AS2107 noise levels for sleeping areas.
Hunting (daytime)	45	50	The daytime hunting target levels are based on the assigned levels in the Noise Regulations and assume that the hunter uses visual cues during the day (whereas the hunter is more dependent on auditory cues during night).
Daytime use / Ceremonial	35/45	50	The target levels are based on avoiding annoyance. It should be noted that these levels are set for activities where speaking to others is involved. The target levels adopted are based on AS2107 levels for educational buildings. 45 dB(A) applies to ceremonies if amplification through a microphone speaker system is used.

Table 2-3 Noise Regulation Assigned Noise Level.

Receiver	Threshold Noise Level (LAeq,10min)
	Rural Receiver Limit (for Windfarms)
Sensitive Receivers	35

3 Noise Monitoring – Baseline Noise Environment

3.1 Overview

To develop an understanding of current background noise levels in the area, baseline noise monitoring was undertaken at eight locations for a month from the 6 August to 8 September 2024. The monitoring has been used to estimate the expected increase in noise levels throughout the project area as a result of construction and operation of the Project.

The noise monitoring systems were setup to measure overall and statistical noise levels at 15-minute intervals, so that noise levels during day, evening and night-time periods could be determined.

3.2 Monitoring Locations

Table 3-1 provides the locations of the baseline noise monitoring, which are also the modelled receiver locations shown as BD_NM_01 to BD_NM_08 in Figure 1-1. The noise monitoring locations were chosen to provide an indication of the existing noise field for the entire area. Table 3-2 shows photos of the noise monitor setup at each monitoring location in the field.

Table 3-1 Monitoring Locations (UTM, Zone 50K)

Logger Ref	X [m]	Y [m]	Description of surrounding area
BD_NM_01	802770	7568153	Flat, low lying sparse shrubs.
BD_NM_02	809090	7566973	Slightly hilly, low lying sparse shrubs.
BD_NM_03	799944	7557985	Dense low-lying shrubs.
BD_NM_04	802234	7543753	Hilly, low lying sparse shrubs
BD_NM_05	790272	7555345	Flat, Low lying mild amount of shrubs.
BD_NM_06	811273	7558498	Slightly hilly, low-lying shrubs.
BD_NM_07	788196	7538662	Hilly, shrubs.
BD_NM_08	801456	7549658	Dense trees, shrubs.

Table 3-2 Images of Noise Monitoring Locations

Logger Ref	Image of Location	Logger Ref	Image of Location
BD_NM_01		BD_NM_05	
BD_NM_02		BD_NM_06	
BD_NM_03		BD_NM_07	
BD_NM_04		BD_NM_08	

3.3 Monitoring Results

Table 3-3 provides a summary of the noise monitoring results at each location[3], separated into day (7am to 7pm), evening (7pm to 10pm) and night (10pm to 7am). The minimum, maximum and average levels for each time and each parameter are provided. The noise parameters used include:

- **LAeq:** the average noise level during each time of day.
- **LA10:** the LA10[4] noise level during each time of day.
- **LA90**: the LA90[5] noise level during each time of day.

The results show that night-time was the quietest at all locations. Night time LA90 noise levels in the area were between 19 to 32 dB(A) with the loudest levels occurring during the daytime periods. Detailed graphs of the noise logging results can be found in Appendix C.

Table 3-3 Baseline Noise Monitoring Results Summary (dB(A))

Name	Time of Day	Average		
		LAeq	LA10	LA90
BD_NM_02	Day	**48**	**47**	**32**
	Evening	**23**	**25**	**20**
	Night	**25**	**26**	**19**
BD_NM_03	Day	**56**	**70**	**48**
	Evening	**26**	**28**	**26**
	Night	**31**	**38**	**26**
BD_NM_04	Day	**48**	**51**	**35**
	Evening	**33**	**36**	**31**
	Night	**37**	**38**	**32**
BD_NM_05	Day	**64**	**67**	**38**
	Evening	**30**	**32**	**27**
	Night	**45**	**40**	**27**

[3] Noise monitor BD_NM_01 only recorded a partial dataset due to a technical fault. Therefore, this data has been omitted from the results.

[4] LA10 is the noise level that is present for 10% of time.

[5] LA90 is the noise level that is present for 90% of time.

Name	Time of Day	Average		
		LAeq	LA10	LA90
BD_NM_06	Day	**44**	**64**	**30**
	Evening	**25**	**26**	**25**
	Night	**29**	**37**	**26**
BD_NM_07	Day	**63**	**73**	**57**
	Evening	**28**	**32**	**27**
	Night	**36**	**43**	**29**
BD_NM_08	Day	**61**	**75**	**55**
	Evening	**26**	**28**	**26**
	Night	**30**	**37**	**26**

4 Noise Modelling Overview

4.1 Noise Model Software

A desktop environmental noise model was created to simulate the Project using SoundPLAN v8.2 software program. This software package calculates sound pressure levels at nominated receiver locations and produces noise contours over a defined area of interest. SoundPLAN can be used to model different types of noise, such as industrial noise, traffic noise and aircraft noise.

The inputs required by the SoundPLAN modelling software are noise sources, ground topographical and absorption data, meteorological data, and sensitive receiver point locations. SoundPLAN has been setup for the study to utilise ISO9613 "Acoustics - Attenuation of sound during propagation outdoors" for calculating the attenuation of sound during outside propagation and the CONCAWE[6,7] prediction algorithm. The CONCAWE algorithm is accepted by the Department of Water and Environment Regulation (DWER).

The model has been used to predict point received noise levels and to generate noise contour maps for the wider area.

4.2 Noise Model Inputs

4.2.1 Modelled Receptors

The receiver locations as listed in section 1.3 have been included in the noise model as point receivers, used to undertake the noise assessment.

4.2.2 Topography and Ground Absorption

Topographical data for the area was provided by Fortescue, which was used to create a digital ground map. The acoustic properties of the ground surface influence noise propagation. Flat, non-porous surfaces such as concrete, asphalt and water are more reflective, whereas soft, porous surfaces such as foliage and grass are more absorptive. A CONCAWE ground factor of 0.5 was applied to the model, which is indicative of hard ground and considered representative of the area.

4.2.3 Meteorological Conditions

SoundPLAN calculates noise levels for defined meteorological conditions. Temperature, relative humidity, wind speed and direction data are required as inputs to the model.

Table 4-1 presents the worst-case meteorological conditions applied to the model, which are defined in the DWER "*Draft Guideline on Environmental Noise for Prescribed Premises*".

[6] CONCAWE (Conservation of Clean Air and Water in Europe) was established in 1963 by a group of oil companies to carry out research on environmental issues relevant to the oil industry.

[7] The propagation of noise from petroleum and petrochemical complexes to neighbouring communities, CONCAWE Report 4/81, 1981.

Table 4-1: Worst-Case Meteorological Conditions used for modelling.

Time of day	Temperature	Relative Humidity	Wind Speed	Wind Direction	Pasquil Stability Category (PSC)
Night (19:00 - 07:00)	15° Celsius	50%	3 m/s	Worst case (Noise source to receiver)	F

4.2.4 Noise Sources

Table 4-2 provides a summary of the modelled noise source Sound Power Levels (SWLs) and activities for construction. A detailed list of SWLs can be found in APPENDIX B.

For the wind farm noise sources (see Table 4-3), the noise emissions of WTG's increase with hub-height wind speeds from 5 m/s (cut-in speed) to 12 m/s (rated power and maximum noise emissions). SWLs have been calculated and allocated to the WTG's using vendor information for 6 MW WTG's, operating at increments of 1m/s wind speed increase from cut-in wind speeds to rated power (i.e. highest SWL emission). The modelling is based on a wind speed at 10 m above ground level. The hub-height wind speeds at 200 m have therefore been back calculated to 10 m for noise modelling using the wind profile law[8]. The WTG noise sources were placed at a height of 200m above the topographical ground layer, to represent the WTG hub-heights.

A summary of the SWL's spectral data used for construction and the WTG's can be found in APPENDIX B.

Table 4-2 Construction Activities and Sound Power Levels

Construction Activities	Equipment	Sound Power Level (dBA)	Quantity
Clearing	Excavator	116.5	1
	Moxy Truck	112.6	2
	Dozer	113.7	1
	Loader	112.6	1
	Scraper	111.8	2
	Rock Breaker	107.4	1
Concreting	Concrete Vibrator	112.2	1
	Concrete Truck	109.0	2

[8] Touma, J.S., 1977, Dependence of the wind profile power law on stability for various locations, J. Air Pollution Control Association. v2=v1*ln(h2/z0)/ln(h1/z0), where z0 is the roughness length of which 0.1 was used.

Construction Activities	Equipment	Sound Power Level (dBA)	Quantity
	Concrete Pump	108.6	2
	Compressor	102.4	1

Table 4-3 WTG Sound Power Levels

Wind farm Activities	Equipment	Sound Power Level (dBA)	Quantity
Wind speed Hub-Height 5m/s[9]	Wind Turbine	103.9	201
Wind speed Hub-Height 6m/s	Wind Turbine	107.9	201
Wind speed Hub-Height 7m/s	Wind Turbine	111.2	201
Wind speed Hub-Height 8m/s	Wind Turbine	112.9	201
Wind speed Hub-Height 9m/s	Wind Turbine	113.7	201
Wind speed Hub-Height 10m/s[9]	Wind Turbine	114.0	201
Wind speed Hub-Height 11m/s	Wind Turbine	114.0	201
Wind speed Hub-Height 12 m/s[9]	Wind turbine	114.0	201
Substations	Substations	85	6

4.3 Noise Model Layout

The locations of the WTGs were provided by Fortescue, and were used to position the WTG noise sources in the noise model.

4.4 Noise Model Scenarios

- **Construction Activities** – Construction activities will be undertaken at the base of each WTG and at locations along the power transmission line. Noise model outcomes are provided for WTG or transmission line construction activities that are closest to each receptor.
- **Wind Farm Operations** – All WTG's operating simultaneously at various wind speeds.

[9] Hub-height wind speed 5m/s = 2.9m/s @ 10m; Hub-height wind speed 10m/s = 6m/s @ 10m; Hub-height wind speed 12m/s = 7m/s @ 10m

5 Noise Modelling Results

5.1 Construction

Table 5-1 shows predicted received noise levels from construction activities. The results represent the construction noise source positioned at the closest WTG location to each receiver (i.e. worst-case results).

The following can be concluded from the noise modelling:

- The noisiest construction activity modelled is clearing/earthworks using mobile equipment.
- Noise sensitive receivers at Nullagine Town predicted to receive very low noise levels.
- Bonney Downs Homestead's highest noise level is predicted to be 38.9 dB(A) when construction activities are being undertaken at WTG pads close to the Homestead. A construction noise management plan will be required for activities close to the Homestead if they take place during nighttime hours.
- Similarly, Fortescue Camp's highest noise level is predicted to be 42.4 dB(A) during construction activities at nearby WTG pads. A construction noise management plan will be required to mitigate noise levels at the Camp.
- Cultural Receptors at Corkbark Spring and Wild Dog Spring are predicted to receive noise levels that exceed the threshold level of 50 dB(A).
- As construction activities are spread over a wide area, the higher levels at all receiver types only occur when construction is being undertaken close to those locations.

Table 5-1 - Noise Model Results – Construction

Receiver	Closest WTG Tag Number or Transmission Line	Noise model result (dBA)		Target Level (worst-case scenario)	Threshold Level (worst-case scenario)
		Clearing	Concreting		
Noise Sensitive Receivers					
Bonney Downs Homestead	WT106	38.9	33.4	35	35
Nullagine Town	WT183	8	<1		
Fortescue Camp	WT068	42.4	37.0	40[10]	40[10]
Cultural Receptors					
Bonnie Pool	WT043	42.5	35.5		50
Cookindina Pool	WT160	10.9	4.7		

[10] In accordance with [3]

Receiver	Closest WTG Tag Number or Transmission Line	Noise model result (dBA)		Target Level (worst-case scenario)	Threshold Level (worst-case scenario)
		Clearing	Concreting		
4 Mile Well	Transmission	41.0	34.0	30 (Camping, night-time) 45 (Hunting / Day-time use / Ceremonial)	
Emu Spring/Well	Transmission	42.0	36		
Daylight Rockhole	WT031	20.9	14.3		
18 Mile Pool & Warrabu Site	WT031	28.0	22.0		
Mooringinya Spring	WT043	40.7	33.6		
Coobinacoola Pool	WT158	9.9	3.5		
Minderungumya Hill	WT152	29.6	23.6		
Bronzewing Pool	WT200	26.5	20.7		
Trig Hill Well	WT150	26.0	19.8		
Corkbark Spring	WT163	59.5	54.6		
Wild Dog Spring	WT056	50.4	45.4		
Tundununya Soak	WT160	15.9	8.8		
Cattle Well	WT121	47.4	42.3		
Noise Monitor					
BD_NM_01	WT184	35.4	29.7	N/A	N/A
BD_NM_02	WT043	42.8	35.8		
BD_NM_03	WT006	39.4	33.9		
BD_NM_04	WT106	37.4	31.8		
BD_NM_05	WT143	41.4	36		
BD_NM_06	WT031	23.1	16.7		
BD_NM_07	Transmission	47.4	42.3		
BD_NM_08	WT053	53.1	48.1		

5.2 Wind Farm Operations

The model results for wind farm operations with worst case weather conditions are given in Table 5-2. From the results, the following has been concluded:

- The predicted received levels comply with the Cultural Receptors threshold level of 50dB(A) for all times of day (i.e. day, evening and night), except for Corkbark Springs when hub height wind speeds are greater than 6m/s.
- The Bonney Downs Homestead noise levels are predicted to exceed the threshold levels for hub height windspeeds ≥5m/s. Modelling has shown that Easterly winds will result in a 1 to 2dB drop in noise levels at the Homestead.
- Nullagine Town is expected to comply with threshold levels during all times of day.

- Predicted levels at Fortescue Camp comply with the Threshold level at windspeeds less than 6m/s

- It should be noted that for high windspeeds (i.e. when the WTGs are noisiest), localised noise generated by the wind as it moves through foliage will increase. As a result, background noise will be higher and potentially mask noise from the WTGs at Cultural Receptors and Noise Sensitive Receivers.

Table 5-2 - Noise Model Results (LAeq,10min) – Wind Farm Operations – Worst Case Scenario

Receiver	Threshold Level[11]	Wind Speed (hub height)							
		5m/s	6m/s	7m/s	8m/s	9m/s	10m/s	11m/s	12m/s
Noise Sensitive Receivers									
Bonney Downs Homestead	35	31	35.6	38.5	40.2	41.0	41.3	41.3	41.3
Nullagine Town		<5	8.0	12.0	14.5	15.6	15.7	15.7	15.7
Fortescue Camp	40	37	42.8	44.5	46.1	46.7	47.2	47.2	47.2
Cultural Receptors									
Bonnie Pool	50	31.7	35.7	39.0	40.6	41.5	41.8	41.8	41.8
Cookindina Pool		14.1	18.1	21.4	23.0	23.9	24.2	24.2	24.2
4 Mile Well		13.9	17.3	20.6	22.3	23.1	23.4	23.4	23.4
Emu Spring/Well		26.5	30.0	33.2	34.9	35.7	36.0	36.0	36.0
Daylight Rockhole		18.9	22.7	26.0	27.6	28.5	28.8	28.8	28.8
18 Mile Pool & Warrabu Site		21.6	25.5	28.8	30.4	31.3	31.6	31.6	31.6
Mooringinya Spring		32.6	36.5	39.8	41.5	42.3	42.6	42.6	42.6
Coobinacoola Pools		20.7	24.6	27.9	29.6	30.4	30.7	30.7	30.7
Minderungumya Hill		25.0	29.0	32.3	33.9	34.8	35.1	35.1	35.1
Bronzewing Pool		19.0	22.9	26.2	27.9	28.7	29.0	29.0	29.0
Trig Hill Well		21.7	25.5	28.8	30.5	31.3	31.6	31.6	31.6
Corkbark Spring		45.0	49.0	52.3	53.9	54.8	55.1	55.1	55.1
Wild Dog Spring		39.1	42.9	46.2	47.8	48.7	49.0	49.0	49.0

[11] See Table 2-2

Receiver	Threshold Level[11]	Wind Speed (hub height)							
		5m/s	6m/s	7m/s	8m/s	9m/s	10m/s	11m/s	12m/s
Tundununya Soak		12.8	16.7	20.0	21.6	22.5	22.8	22.8	22.8
Cattle Well		35.9	39.8	43.2	44.8	45.7	46.0	46.0	46.0
Noise Monitors									
BD_NM_01	N/A	28.1	32.1	35.4	37.1	37.9	38.2	38.2	38.2
BD_NM_02		32.0	36.0	39.3	40.9	41.8	42.1	42.1	42.1
BD_NM_03		33.1	37.0	40.3	42.0	42.8	43.1	43.1	43.1
BD_NM_04		31.2	35.2	38.5	40.2	41.0	41.3	41.3	41.3
BD_NM_05		31.8	35.8	39.1	40.8	41.6	41.9	41.9	41.9
BD_NM_06		19.2	23.2	26.5	28.2	29.0	29.3	29.3	29.3
BD_NM_07		21.0	25.0	28.3	30.0	30.8	31.1	31.1	31.1
BD_NM_08		43.4	47.3	50.6	52.3	53.1	53.4	53.4	53.4

5.3 Noise Contour Maps

Figure 5-1 to Figure 5-7 show various noise contour maps for the noisiest construction activity at the closest WTGs, representing the worst-case construction scenario.

Figure 5-8 and Figure 5-9 are predicted noise contour maps for the wind farm operations at the cut-in wind speed and rated capacity, which provides the noise level range from the WTGs as wind speed changes.

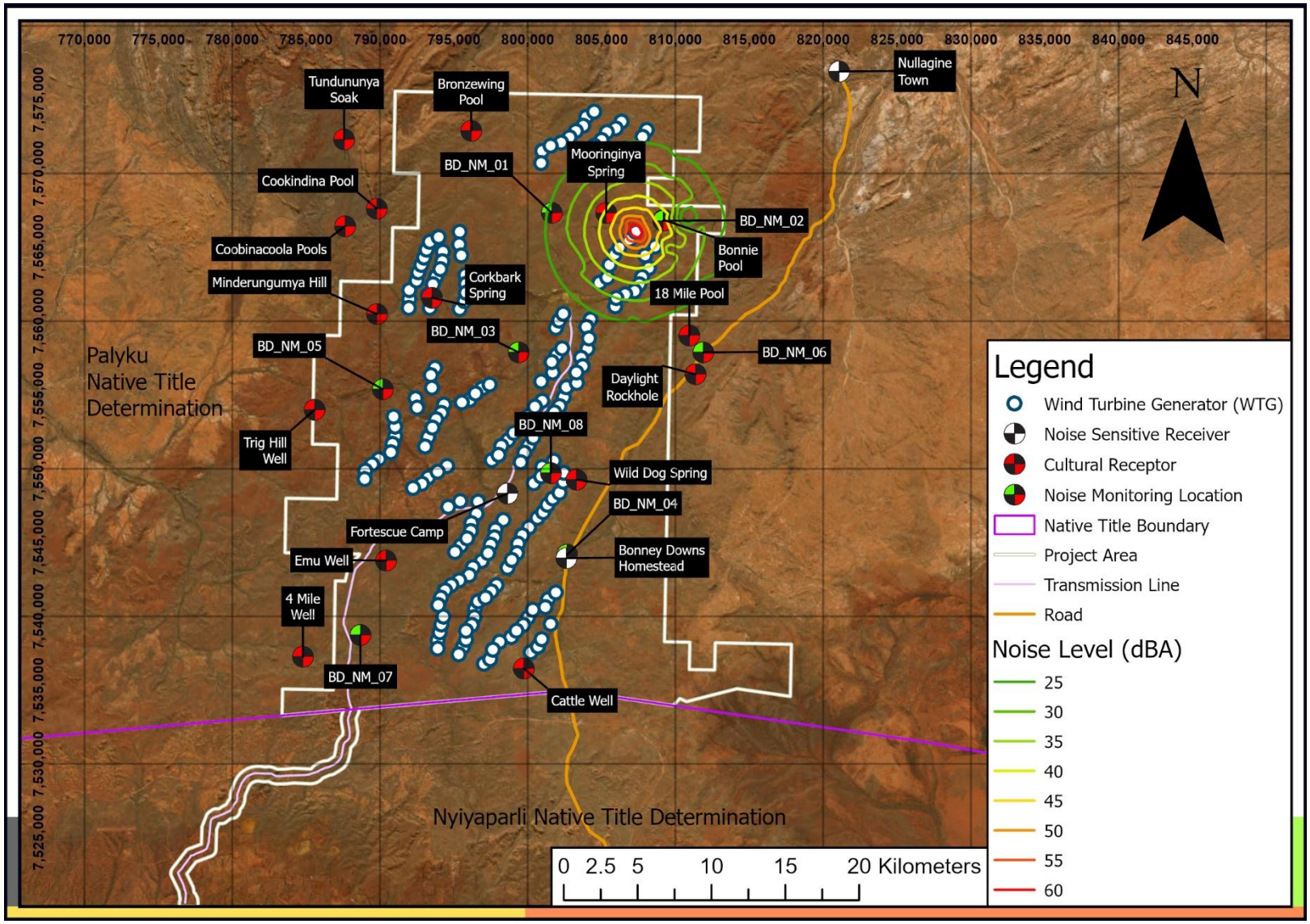

Figure 5-1 Clearing Works at WT043 (closest to Bonnie Pool)

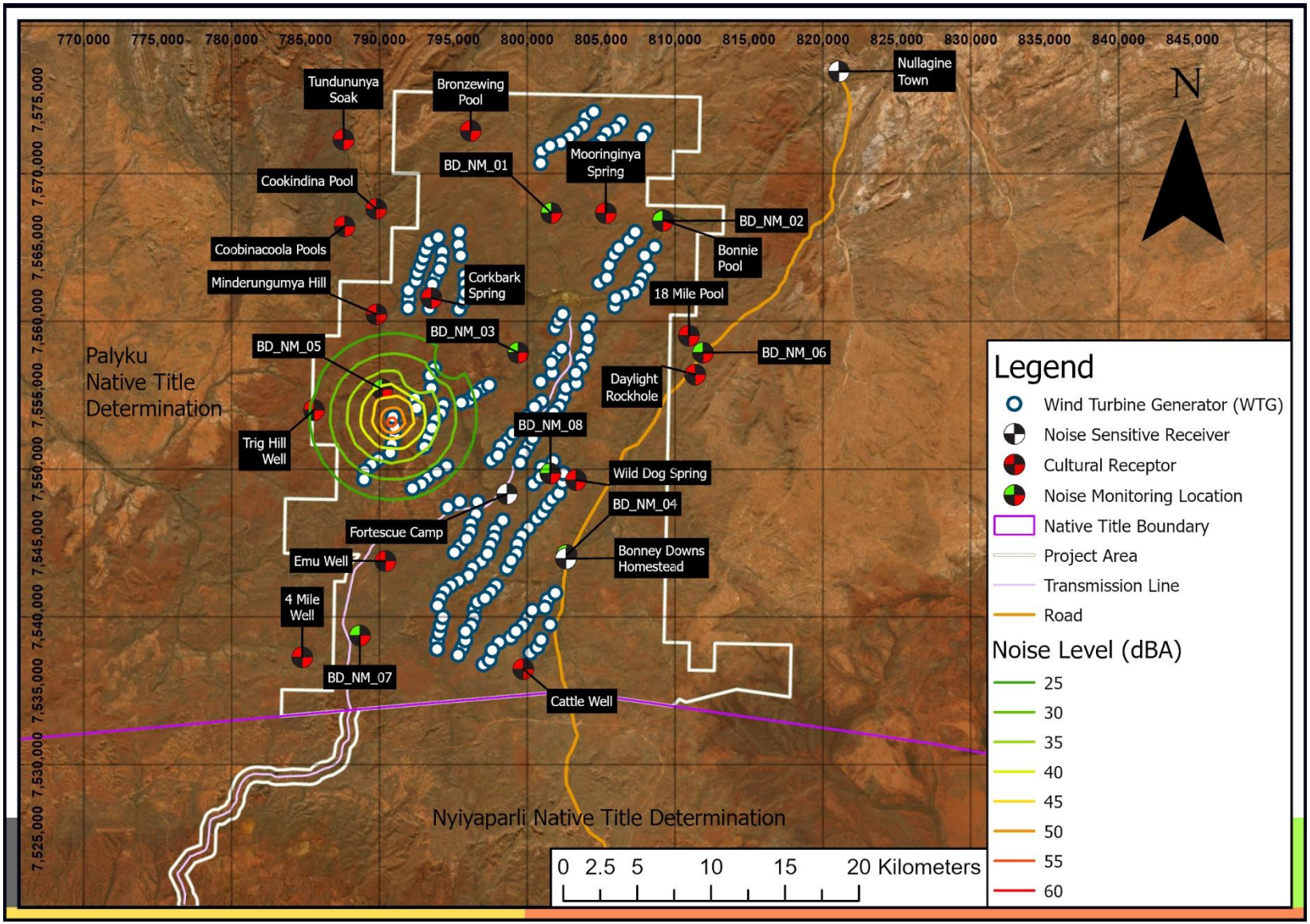

Figure 5-2 Clearing Works at WT143 (closest to BD_NM_05)

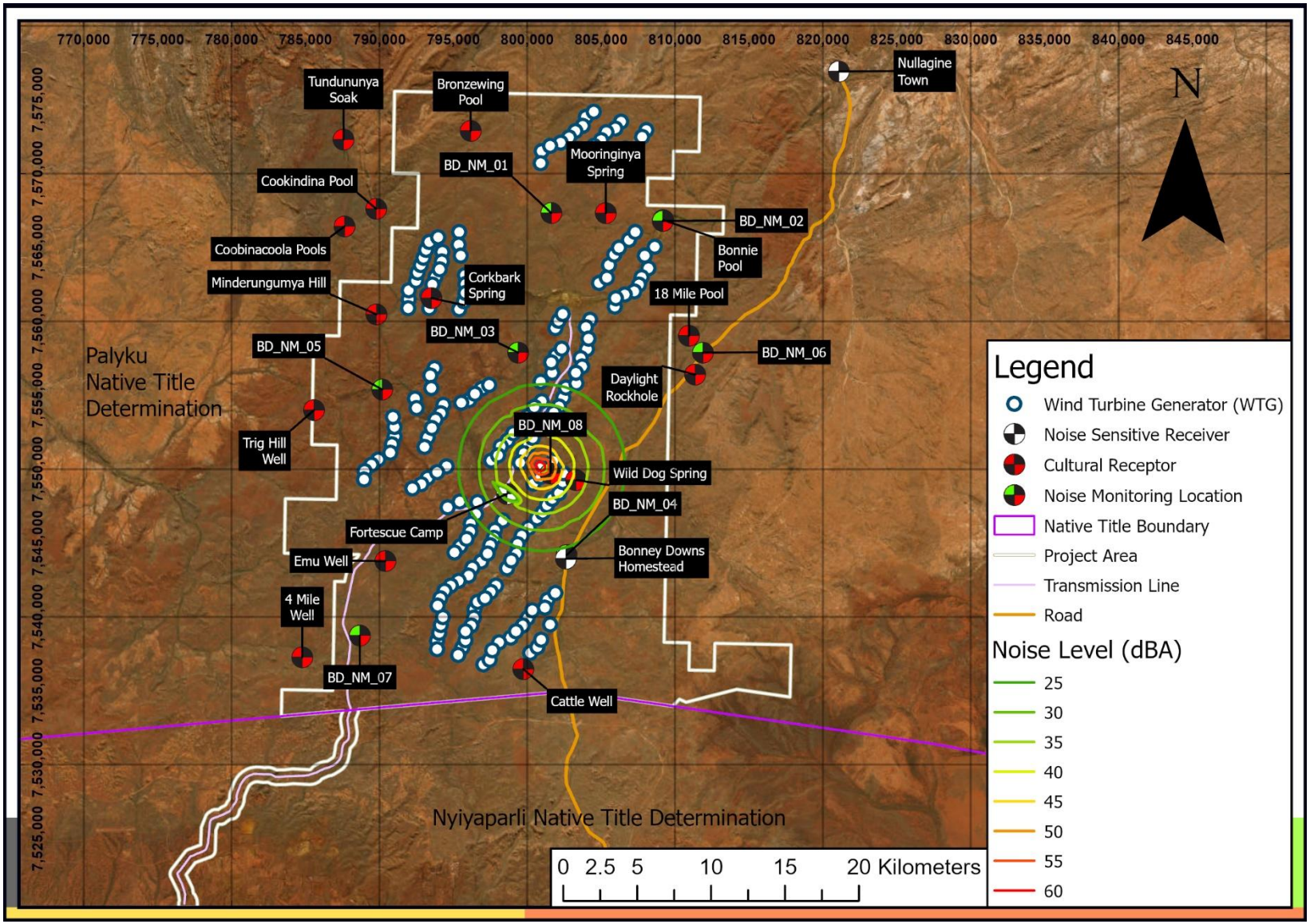

Figure 5-3 Clearing Works at WT053(Closest to BD_NM_08)

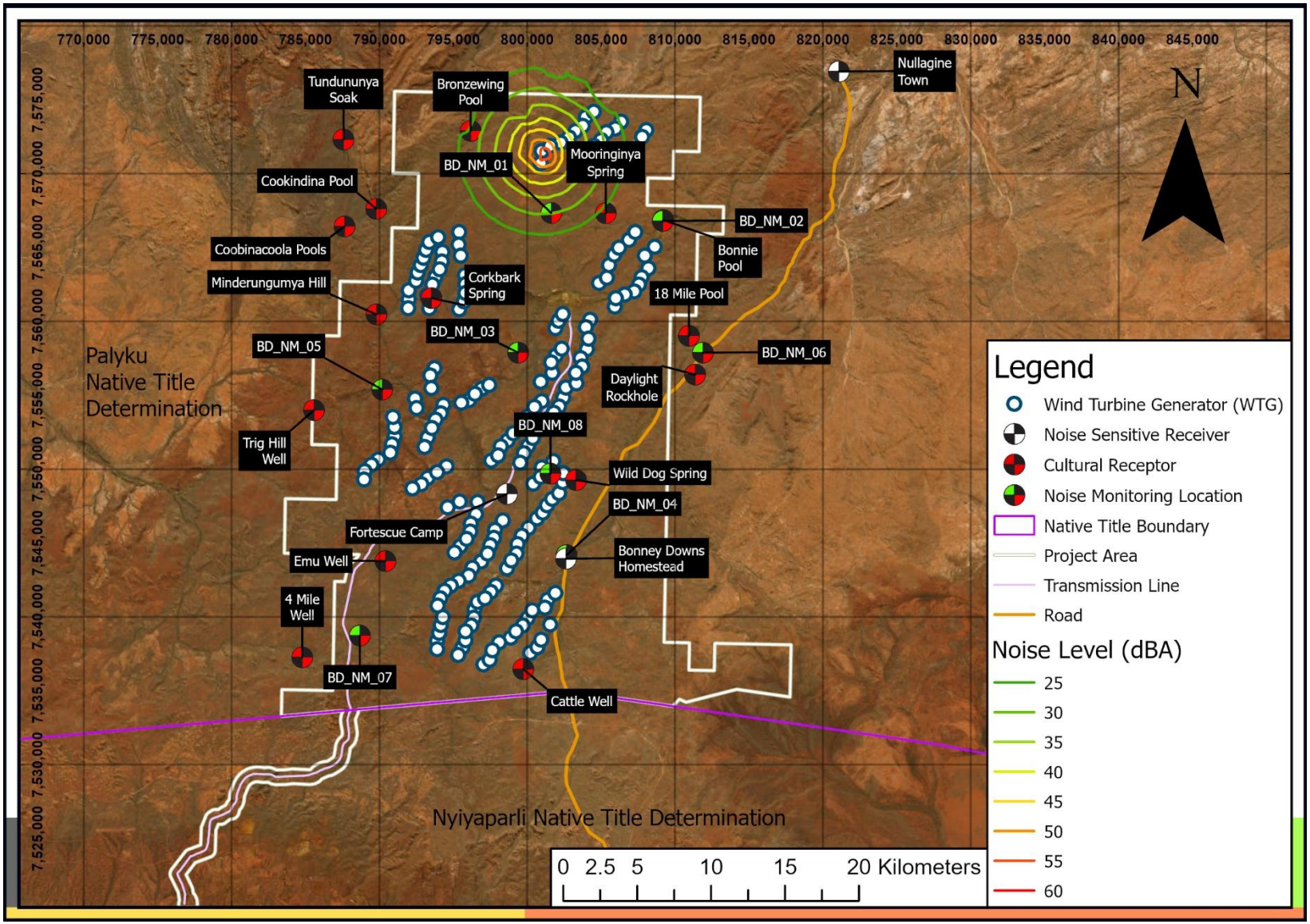

Figure 5-4 Clearing Works at WT200 (closest to Bronzewing Pool)

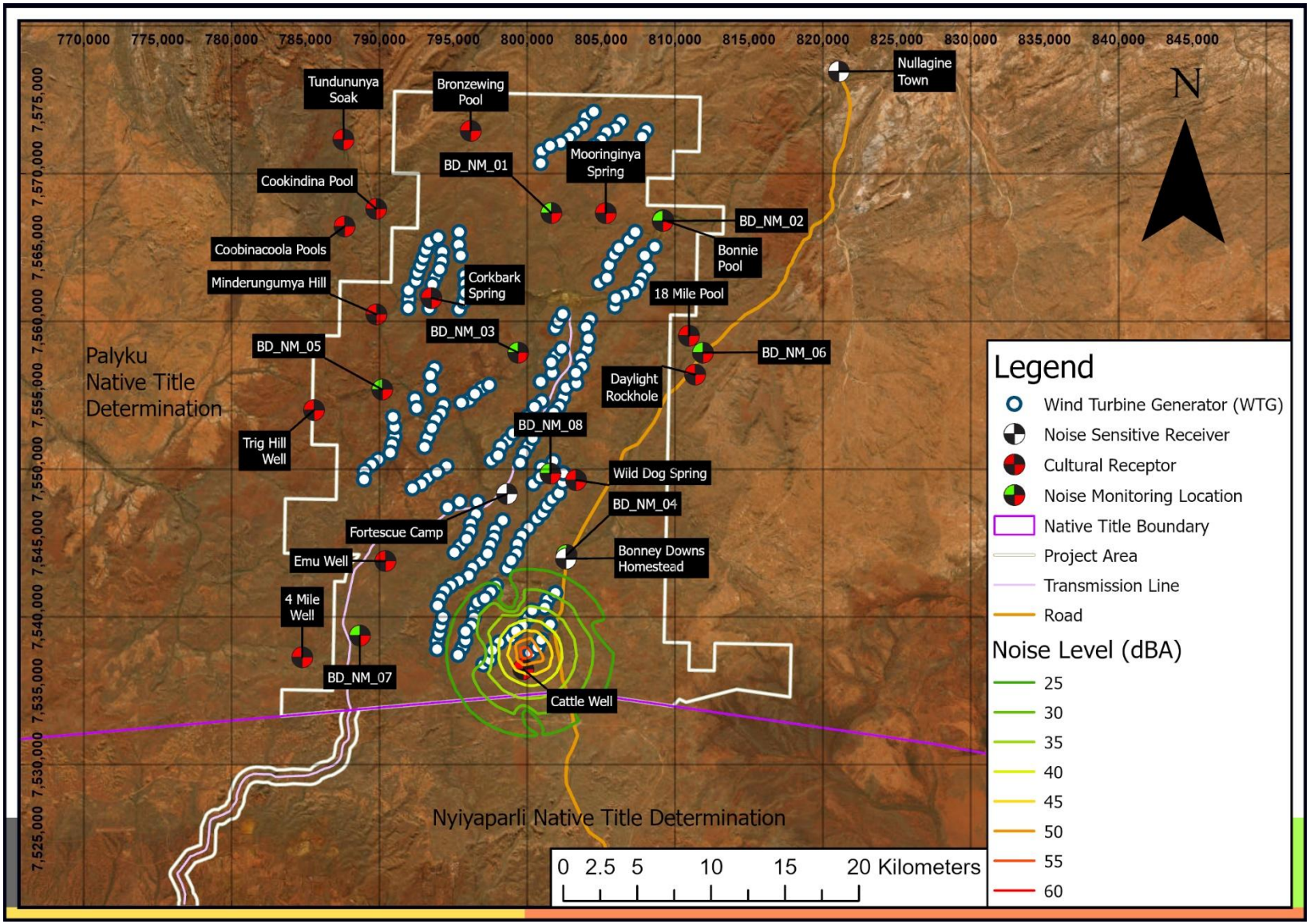

Figure 5-5 Clearing Works at WT121 (closest to Cattle Well)

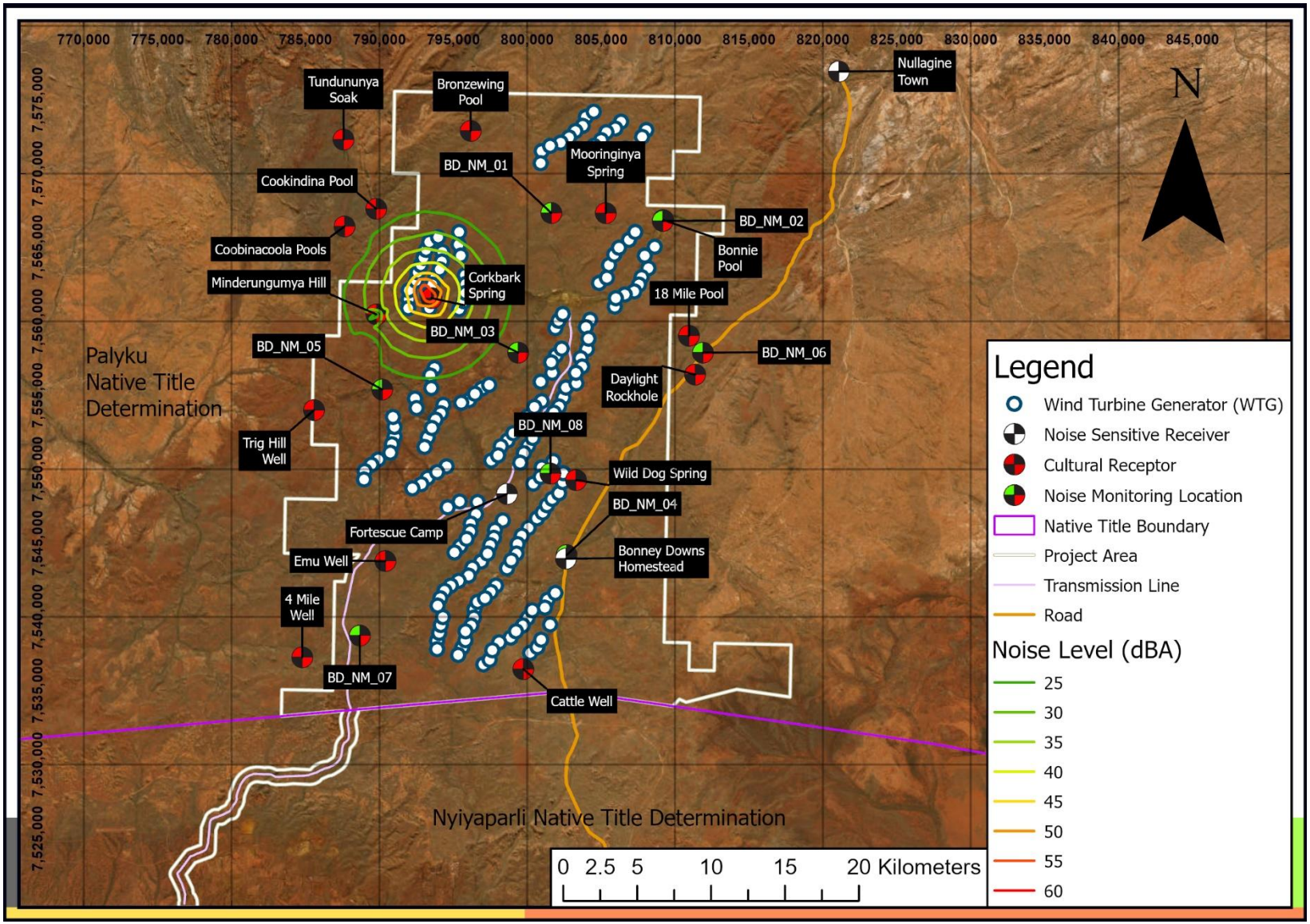

Figure 5-6 Clearing Works at WT163 (closest to Corkbark Spring)

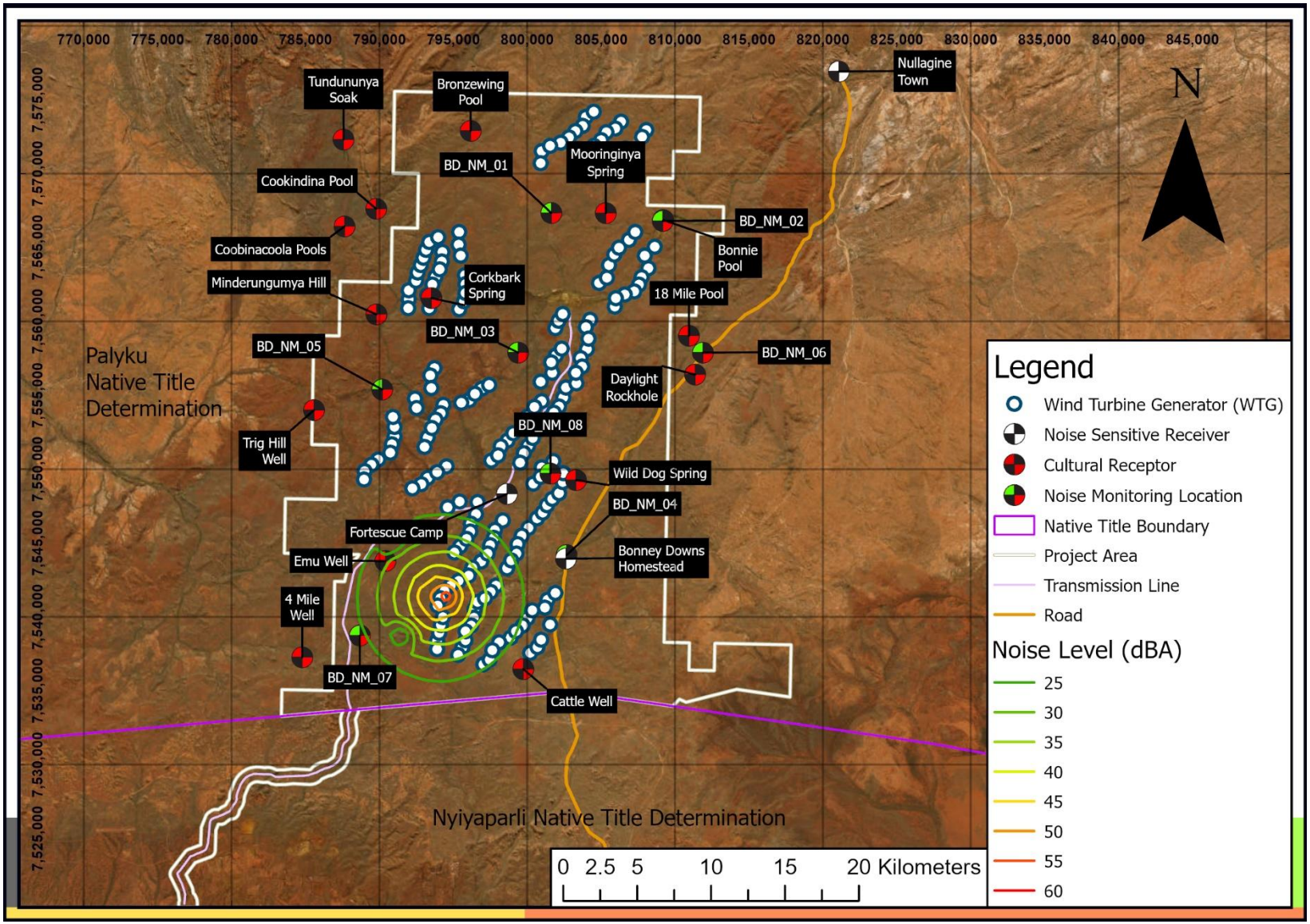

Figure 5-7 Clearing Works at WT088 (Closest to Emu Well)

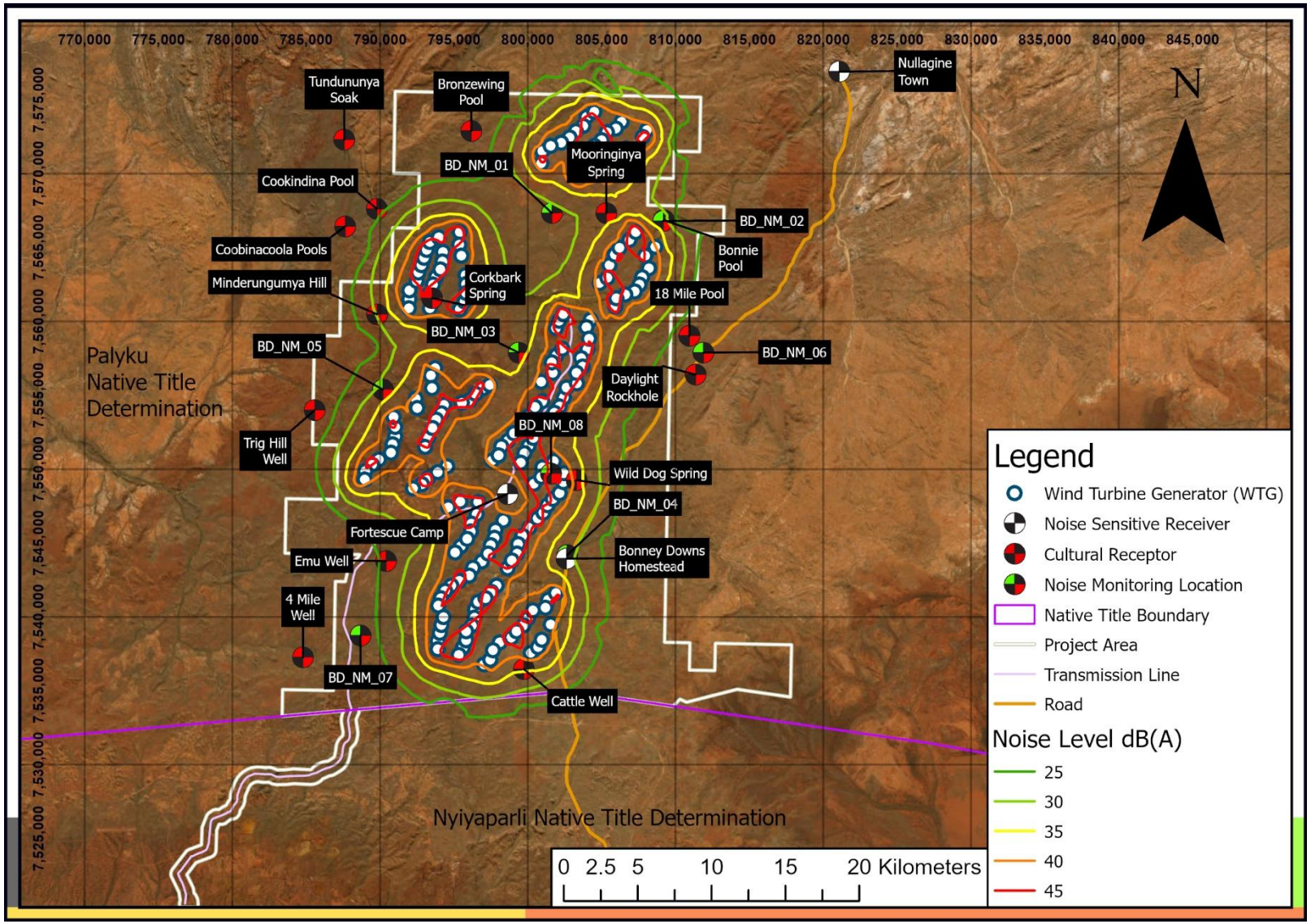

Figure 5-8 – Noise Contour Map – Wind Farm Operations 5m/s

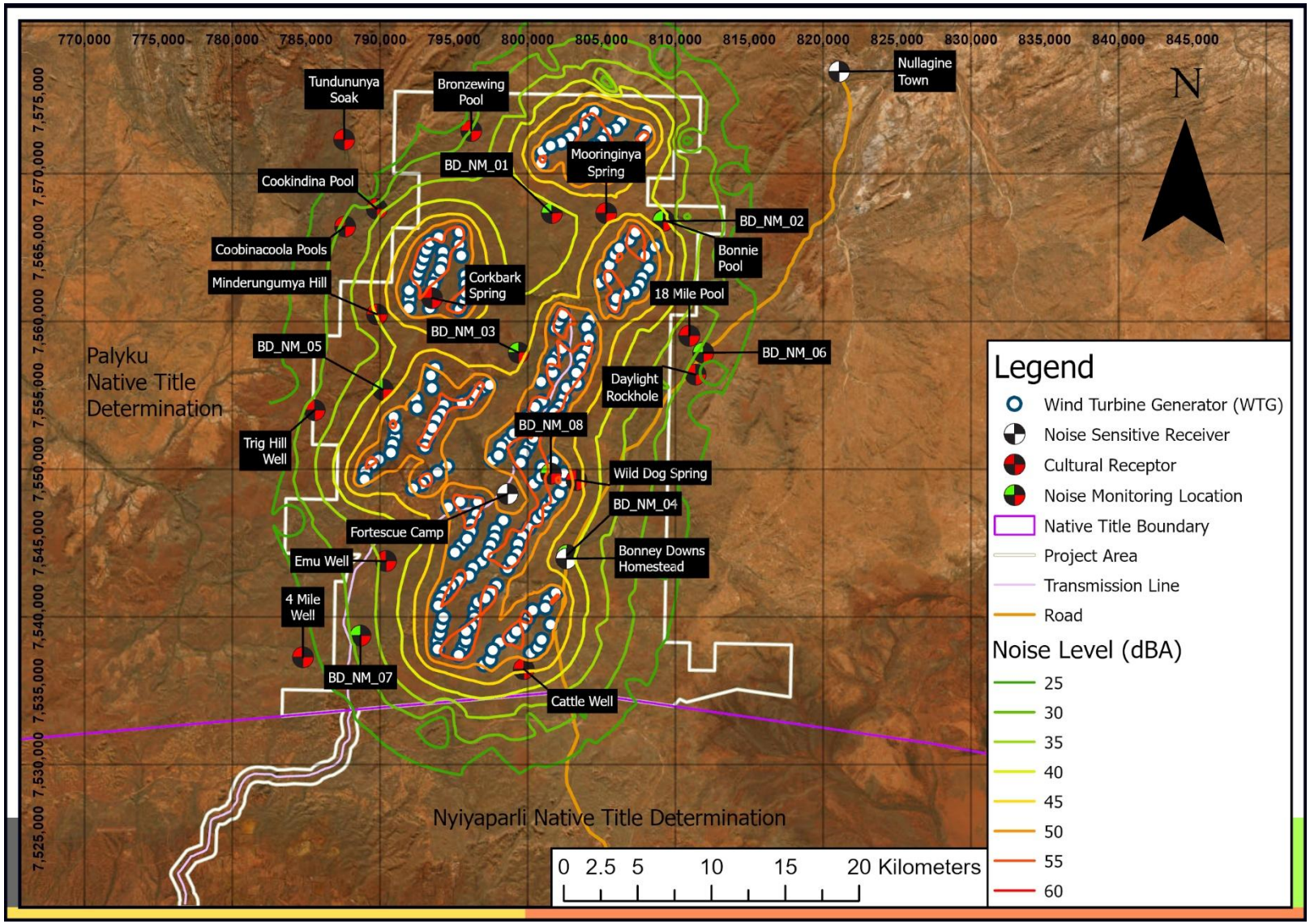

Figure 5-9 – Noise Contour Map – Wind Farm Operations 12m/s

6 Conclusions

Based on the modelling and analysis undertaken, the following has been concluded:

Background noise levels:

- Background levels were found to be very quiet at night-time, where the measured LA90 noise levels were low between 19 to 33 dB(A).

Construction activities:

- The noisiest construction activity modelled is clearing/earthworks using mobile equipment.
- Cultural Receptors at Corkbark Spring and Wild Dog Spring are predicted to receive noise levels that exceed the threshold level of 50 dB(A).
- Noise sensitive receiver at Nullagine Town is predicted to receive very low noise levels.
- Bonney Downs Homestead's highest noise level is predicted to be 38.9 dB(A) when construction activities are being undertaken at WTG pads close to the Homestead. A construction noise management plan will be required for activities close to the Homestead if they take place during nighttime hours.
- Similarly, Fortescue Camp's highest noise level is predicted to be 42.4 dB(A) during construction activities at nearby WTG pads.
- As construction activities are spread over a wide area, the higher levels at all receiver types only occur when construction is being undertaken close to those locations.

Wind farm operations Worst Case:

- The predicted received levels comply with the Cultural Receptors threshold level of 50dB(A) for all times of day (i.e. day, evening and night), except for Corkbark Springs when hub height wind speeds are greater than 6m/s.
- The Bonney Downs Homestead noise levels are predicted to exceed the threshold levels for hub height windspeeds ≥5m/s. Modelling has shown that Easterly winds will result in a 1 to 2dB drop in noise levels at the Homestead.
- Nullagine Town is expected to comply with threshold levels during all times of day.
- Predicted levels at Fortescue Camp comply with the Threshold level at windspeeds less than 6m/s
- It should be noted that for high windspeeds (i.e. when the WTGs are noisiest), localised noise generated by the wind as it moves through foliage will increase. As a result, background noise will be higher and potentially mask noise from the WTGs at Cultural Receptors and Noise Sensitive Receivers.

APPENDIX A
Noise Legislation

A.1 Environmental Protection (Noise) Regulations 1997

Noise management in Western Australia is implemented through the Environmental Protection (Noise) Regulations 1997 (the Regulations), which operate under the *Environmental Protection Act 1986*. The Regulations specify maximum noise levels (assigned noise levels) which are the highest noise levels that can be received at noise-sensitive (residential), commercial and industrial premises.

Assigned noise levels are defined differently for noise sensitive premises, commercial premises, and industrial premises. For noise sensitive premises, an Influencing Factor (IF) is included in the assigned noise levels. The IF depends on the presence of major/minor roads and commercial/industrial land use zonings within circles of 100 metres and 450 metres radius from the noise receiver.

For noise sensitive residences, the time of day also affects the assigned levels. The regulations define three types of assigned noise level:

- L_{ASMAX} means an assigned level that is not to be exceeded at any time.
- L_{AS1} means an assigned level that is not to be exceeded for more than 1% of time.
- L_{AS10} means an assigned level that is not to be exceeded for more than 10% of time.

Table A 1: Assigned Noise Levels for Noise Sensitive Receivers

Type of premises receiving noise	Time of day	Assigned Levels (dB)		
		LA10	L_{A1}	L_{Amax}
Noise sensitive premises: highly sensitive area	0700 Project to 1900 hours Monday to Saturday	45 + influencing factor	55 + influencing factor	65 + influencing factor
	0900 to 1900 hours Sunday and public holidays	40 + influencing factor	50 + influencing factor	65 + influencing factor
	1900 to 2200 hours all days	40 + influencing factor	50 + influencing factor	55 + influencing factor
	2200 hours on any day to 0700 hours Monday to Saturday and 0900 hours Sunday and public holidays	35 + influencing factor	45 + influencing factor	55 + influencing factor

Type of premises receiving noise	Time of day	Assigned Levels (dB)		
		LA10	L_{A1}	L_{Amax}
Noise sensitive premises: any area other than highly sensitive area	All hours	60	75	80
Commercial premises	All hours	60	75	80
Industrial and utility premises other than those in the Kwinana Industrial Area	All hours	65	80	90
Industrial and utility premises in the Kwinana Industrial Area	All hours	75	85	90

Environmental Protection (Noise) Regulations 1997

Influencing Factors

The Influencing Factor (IF) is based on the surrounding land use adjacent to each of the noise sensitive receivers, including the amount (%) of industrial and commercial premises as well as the number and proximity of major and secondary roads.

The following steps were taken to calculate IF.

1. Two circles of radius 100m and 450m centred on each of the identified receivers were drawn.
2. The circles were used to determine and calculate the area of industrial and commercial premises and the presence major/secondary roads within the circles.

The calculated IF is 0.

Adjustments for intrusive or dominant characteristics

Received noise levels are subject to adjustments if the noise exhibits intrusive or dominant characteristics i.e. if the noise is impulsive, tonal or modulating. These adjustments, shown in Table A 2, are cumulative up to a maximum of 15 dB.

Section 9 of the Regulations sets out objective tests to assess whether the received noise is free of these characteristics.

Table A 2 Adjustments for intrusive and dominant characteristics

Tonality	Modulation	Impulsiveness
+ 5dB	+5 dB	+10 dB

A.2 EPA Environmental Factor Guideline: Social Surroundings

The EPA's environmental objective for the factor Social Surroundings is: '*To protect social surroundings from significant harm*'. The objective recognises the importance of ensuring that social surroundings are not significantly affected because of implementation of a Project or scheme.

Considerations for EIA for the factor Social Surroundings include:

- Application of the mitigation hierarchy to avoid or minimise impacts on social surroundings, where possible.
- The aesthetic, cultural, economic and/or social values which may be impacted, and whether those values are significant.
- The contribution implementation of the Project or scheme may make to existing or predicted cumulative impacts to aesthetic, cultural or social values.
- That emissions of noise, odour or dust are considered in the context of relevant legislation, criteria or standards.
- The level of confidence with which the predicted impacts to social surroundings have been made, and what is the risk should those predictions be incorrect
- whether proposed management or mitigation of impacts to aesthetic, cultural, economic and/or social surroundings is technically and practically feasible.

Aboriginal heritage and culture

It is an offence to interfere with any Aboriginal site knowingly or where it would be reasonable to know, regardless of whether or not it is registered. In addition to Aboriginal heritage, matters of Aboriginal cultural associations, including traditional Aboriginal customs, directly linked to the physical or biological aspects of the environment, may also be considered significant. This may include, for example, traditional hunting and gathering activities for native fauna and flora as bush tucker.

Amenity

Amenity is a broad term that generally means the qualities, attributes and characteristics of a place that make a positive contribution to quality of life. For the purpose of EIA, amenity values include both visual amenity, and the ability for people to live and recreate within their surroundings without any unreasonable interference with their health, welfare, convenience and comfort. Noise has the potential to unreasonably interfere with the health, welfare, convenience and comfort of people. Amenity values can be highly subjective. What may have amenity value for one person, may not be valued by another. Similarly, people have different levels of perception or tolerance for things that may impact amenity, such as noise, odour and dust.

Predicting the impacts of noise, dust and odour

While modelling the potential impacts of noise and dust may be technically complex, methodologies and practices are generally well understood and accepted. Predictions can also be validated with on-site measurements or proxy data, as noise and dust can be quantitively measured.

Information required for EIA

Where social surroundings has been identified as an environmental factor the EPA may require the proponent to include information or studies within the following broad topics:

- Analysis, modelling and predictions of impacts from odour, dust and noise, including likely impacts during, worst, best and most likely case scenarios
- Characterisation of proximity to sensitive receptors
- Summary of proposed technologies, emission reduction equipment and management practices
- Description of proposed management and monitoring arrangements
- Analysis of cumulative impacts, including existing and reasonably foreseeable emission sources

APPENDIX B

Noise Source Sound Power Levels (SWLs)

Appendix Table B-1 – Modelled Noise Source Sound Power Levels (SWLs)

Noise source	Octave Band Levels, dB(A)									O/A
	31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1 KHz	2 KHz	4KHz	8KHz	
Scraper	61.9	77.3	93.4	100.1	104.6	107.2	106.0	101.1	95.7	**111.8**
Service Truck	67.0	83.4	91.4	97.9	102.1	101.9	97.4	89.1	80.1	**106.6**
D10 Dozer	78.3	84.1	89.8	105.3	108.9	107.8	104.9	98.7	91.9	**113.4**
Loader	65.9	81.2	99.1	101.2	105.5	107.2	106.5	102.6	98.1	**112.5**
Moxy Trucks	65.9	81.2	99.1	101.2	105.5	107.2	106.5	102.6	98.1	**112.5**
Water Carts	64.1	84.5	94.6	102.1	106.0	105.4	103.8	99.0	93.7	**111.1**
Grader	61.9	77.3	93.4	100.1	104.6	107.2	106.0	101.1	95.7	**111.8**
Roller	61.9	77.2	95.1	97.2	101.5	103.2	102.5	98.6	94.1	**108.5**
Diesel Welders	77.0	78.8	89.9	98.4	100.8	99.1	94.5	86.5	77.8	**105.0**
Air Compressors	65.2	77.5	86.3	91.4	96.7	97.1	96.1	92.1	87.5	**102.5**
Wind Turbine 5m/s	66	79.2	87.9	93.4	94	91.4	83.7	69.2	58.9	**98.5**
Wind Turbine 6m/s	69.9	83.1	91.8	97.3	97.9	95.3	87.6	73.1	59.8	**102.4**
Wind Turbine 7m/s	73.3	86.5	95.2	100.7	101.3	98.7	91	76.5	63.2	**105.8**
Wind Turbine 8m/s	75.7	88.9	97.6	103.1	103.7	101.1	93.4	78.9	65.6	**108.2**
Wind Turbine 9m/s	77.2	90.4	99.1	104.6	105.2	102.6	94.9	80.4	67.1	**109.7**
Wind Turbine 10m/s	78	91.2	99.9	105.4	106	103.4	95.7	81.2	67.9	**110.5**
Wind Turbine 11m/s	78	91.2	99.9	105.4	106	103.4	95.7	81.2	67.9	**110.3**
Wind Turbine 12m/s	78.2	91.4	100.1	105.6	106.2	103.6	95.9	81.4	68.1	**110.6**

APPENDIX C
Noise Logging

Appendix Table C-1 Pilot study Noise Logger Details

Noise monitoring location	Name of equipment used
BD_NM_02	SLM#2731810
BD_NM_03	Hex#186
BD_NM_04	Hex#187
BD_NM_05	Hex#343
BD_NM_06	Hex#346
BD_NM_07	Hex#336
BD_NM_08	Hex#188

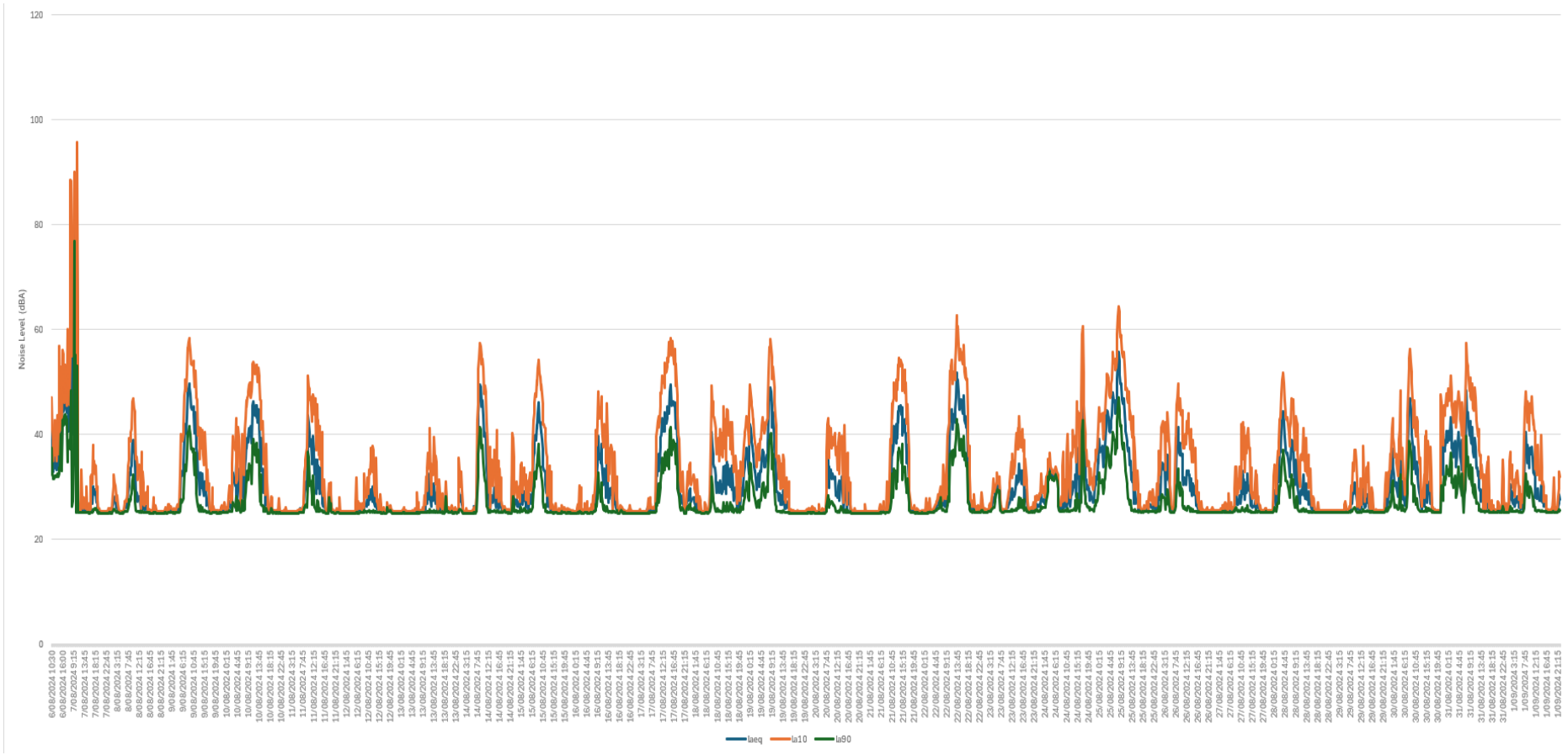

Figure 6-1 Background Noise Monitoring at BD_NM_02

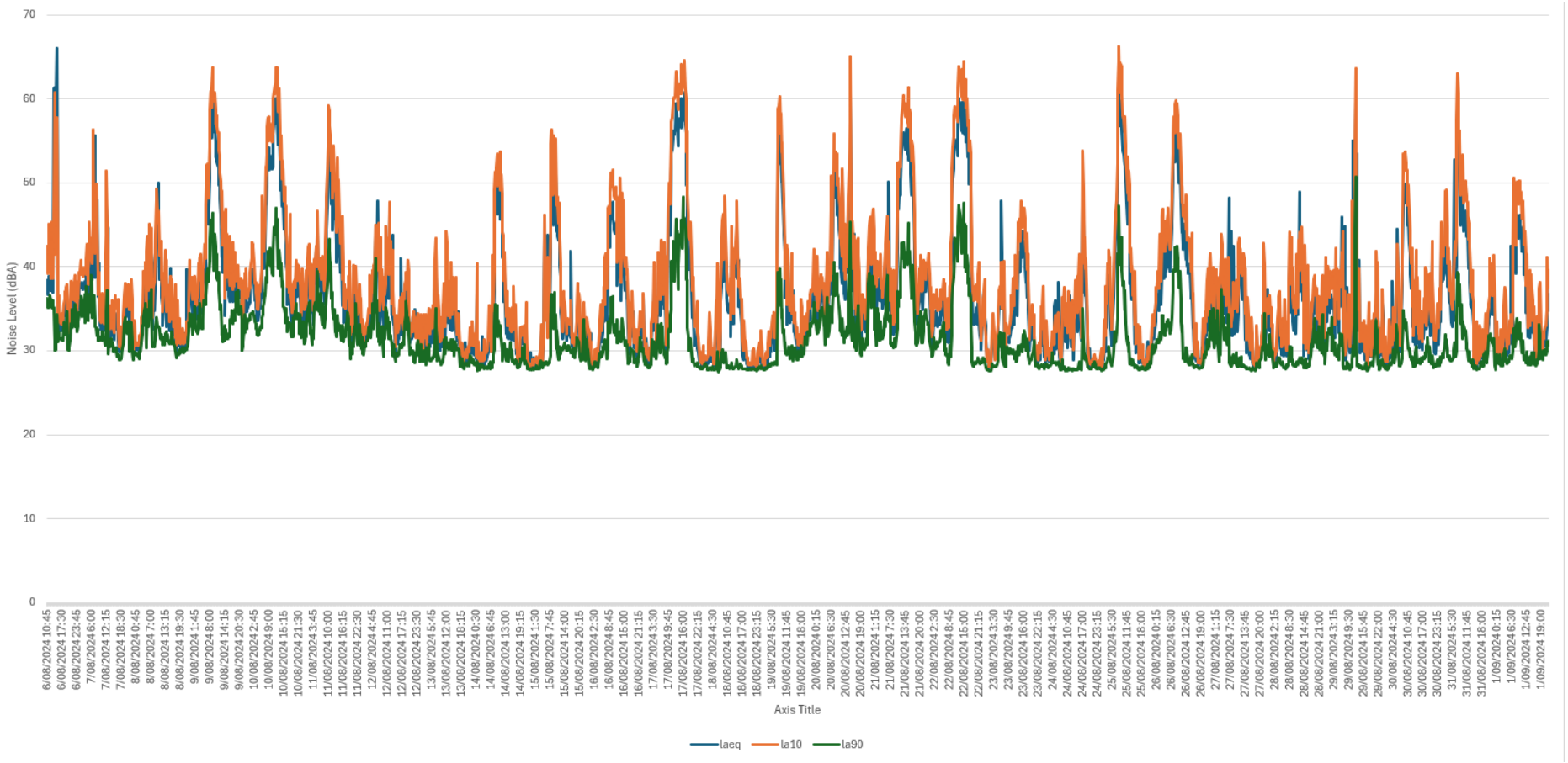

Figure 6-2 Background Noise Monitoring at BD_NM_03

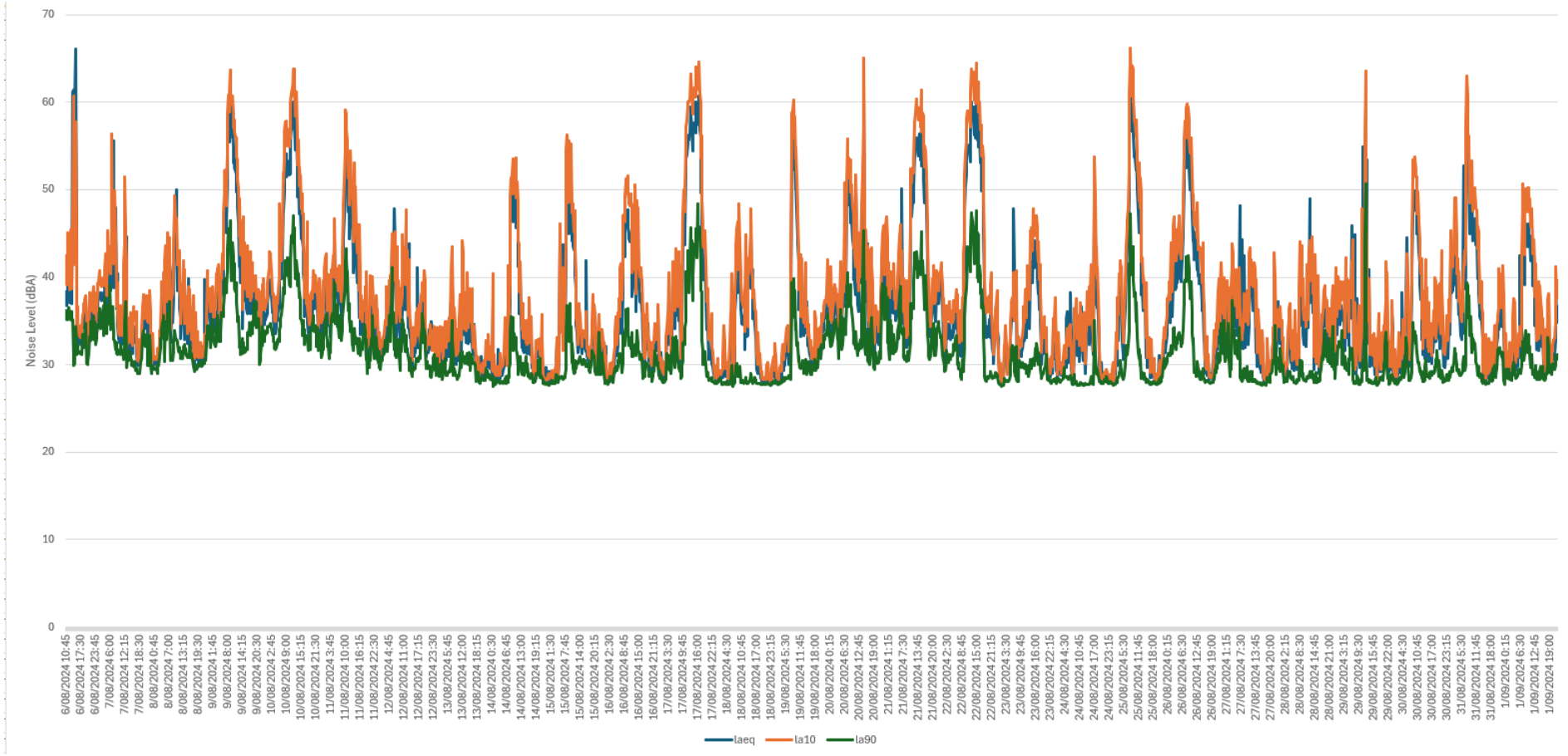

Figure 6-3 Background Noise Monitoring at BD_NM_04

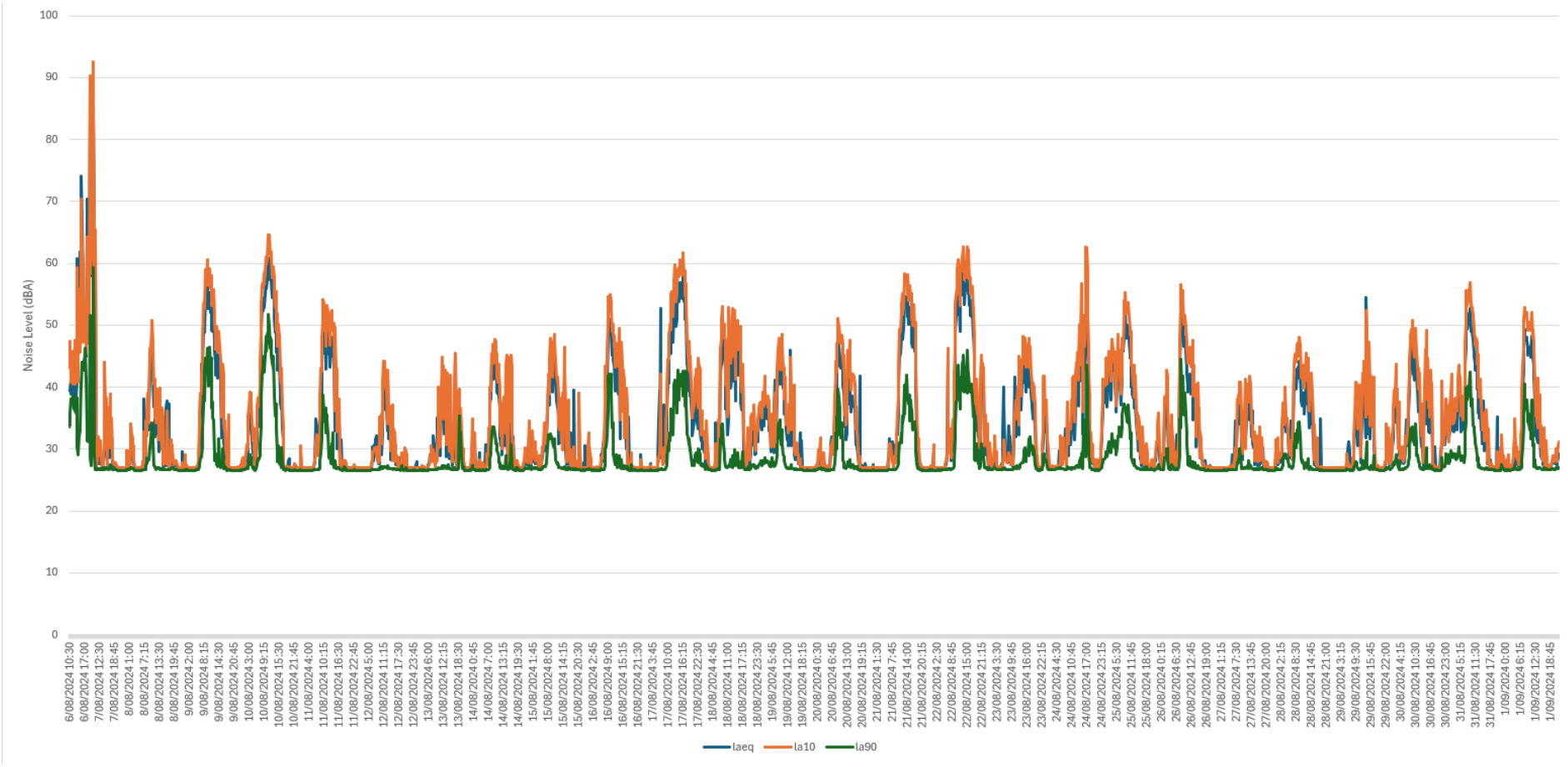

Figure 6-4 Background Noise Monitoring at BD_NM_05

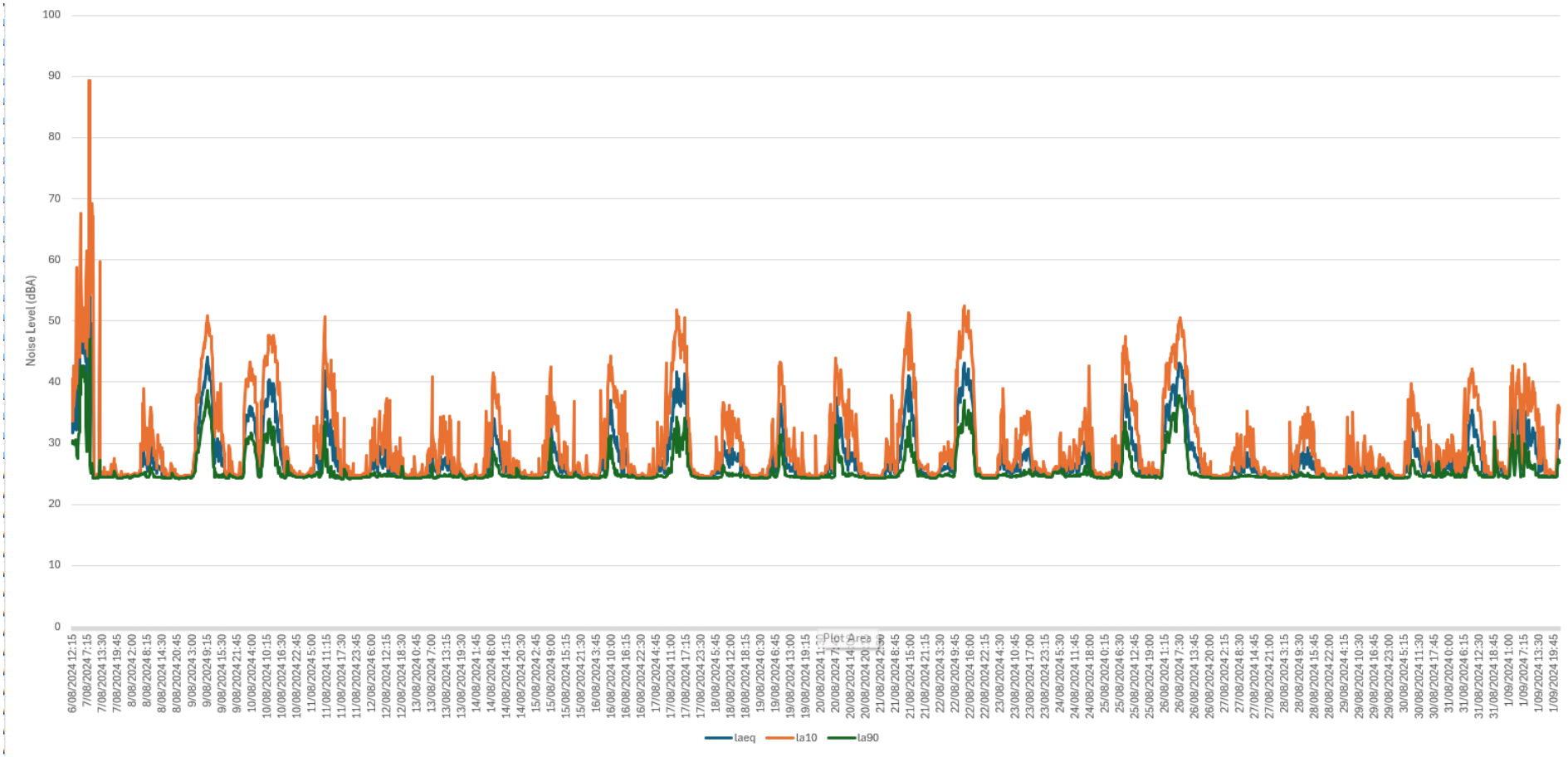

Figure 6-5 Background Noise Monitoring at BD_NM_06

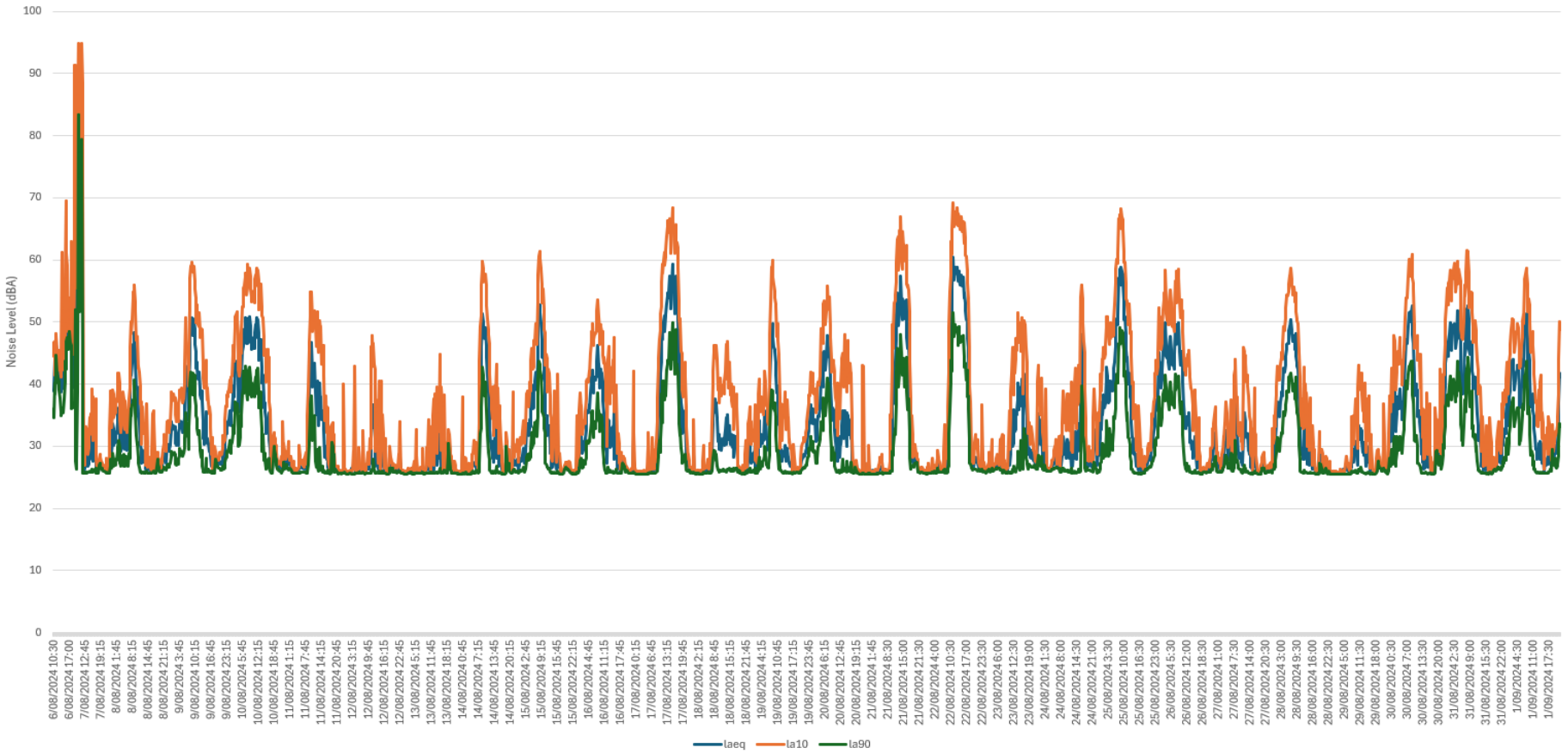

Figure 6-6 Background Noise Monitoring at BD_NM_07

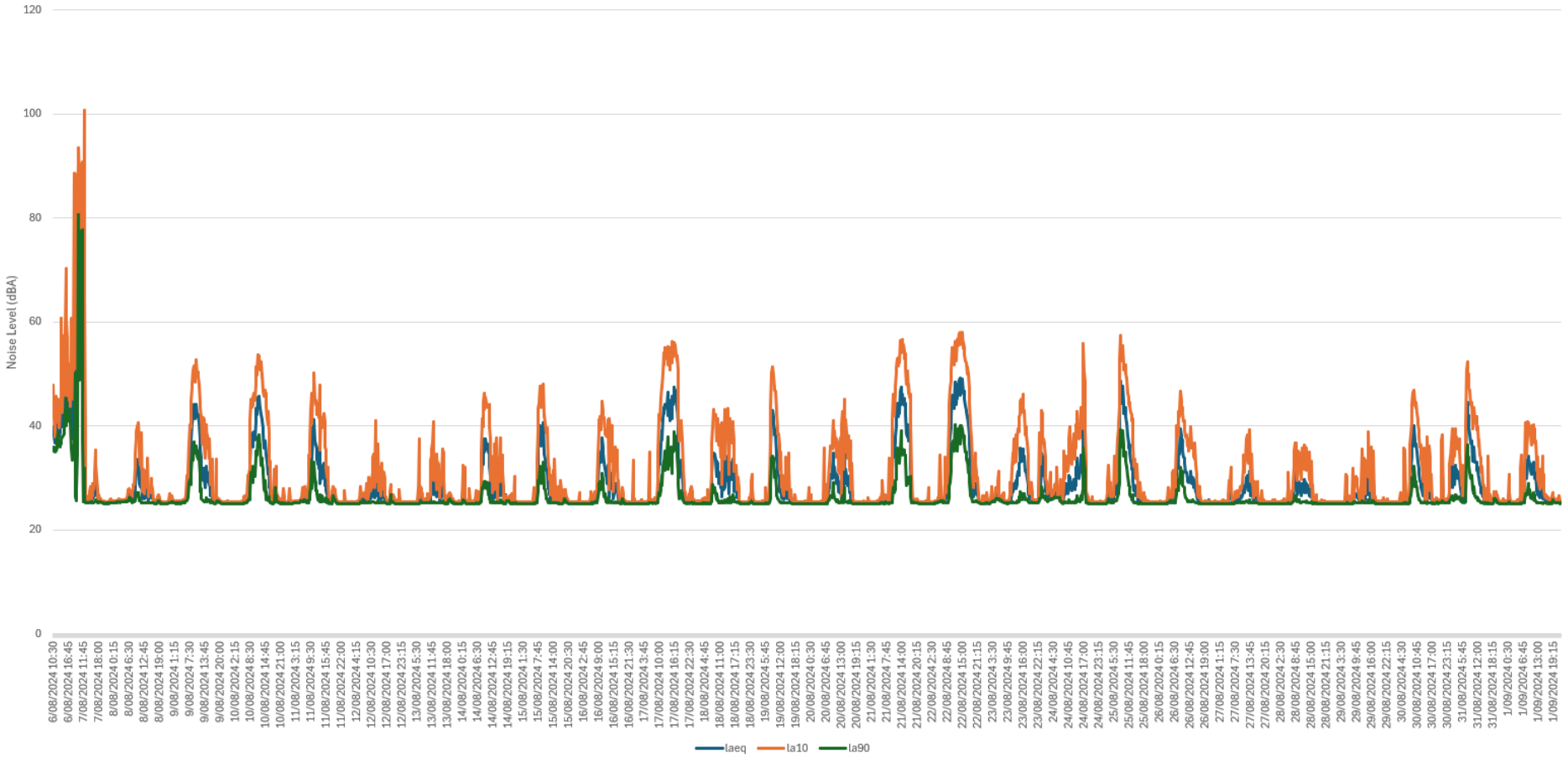

Figure 6-7 Background Noise Monitoring at BD_NM_08

Assets | Engineering | Environment | Noise | Spatial | Waste

Talis Consultants

Head Office
Level 1, 604 Newcastle Street,
Leederville
Western Australia 6007

PO Box 454,
Leederville
Western Australia 6903

NSW Office
5/62 North Street, Nowra
New South Wales, 2541

PO Box 1189, Nowra
New South Wales, 2541

P: 1300 251 070
E: info@talisconsultants.com.au