Appendix I

Noise and Vibration Impact Assessment

Department of Infrastructure, Planning & Logistics

Terrestrial Biodiversity surveys for Melville Island roads
Noise and Vibration Impact Assessment

March 2022

Executive summary

Overview

Sealing the selected roads (Milikapiti Access Road, Pirlangimpi Access Road and Pickertaramoor Access Road) on Melville Island will help unlock the economic potential of the region and open up a range of new long-term economic and social opportunities for people across the island community (the 'Project'). Milikapiti Access Road has not yet been designed and as such, the environmental impact of this section of road will be assessed in the future once the road design has been determined.

This Noise and Vibration Impact Assessment (NVIA) considers potential noise and vibration impacts that may be caused by the Project at surrounding sensitive land use areas during the construction phase of the Project, specifically at the communities located at Pirlangimpi and Pickertaramoor.

Construction noise impacts

Six indicative construction scenarios have been modelled based on buffer distances using the ISO 9613-2 calculation method for environmental noise propagation. The results indicated that the noise levels at sensitive receptors may exceed the Noise Affected Levels (NALs) of the Noise Management Framework Guideline (NMFG) (NT EPA, 2018) when construction works are within 550 metres of sensitive receptors. No construction noise impacts are anticipated as a result of the works at the gravel pits areas as the closest sensitive receptor is more than 1.5 kilometres from a gravel pit area.

Construction vibration impacts

Vibratory rolling works have been identified as being the most vibration intensive construction activity associated with the Project. Safe working distances for cosmetic damage to standard structures, cosmetic damage for heritage structures and for human comfort have been provided.

Pirlangimpi Club and two dwellings located in Pickertaramoor have been identified as falling within the safe working distances for cosmetic damage to standard structures (20 metres from vibratory rolling works).

Sensitive receptors in Pirlangimpi and Pickertaramoor have been identified as falling within the safe working distance for human comfort (100 metres from vibratory rolling works).

Mitigation measures

To reduce potential noise impacts as a result of construction works, the following noise mitigation strategy has been recommended:

- Mitigating noise at the source, including:
  - Work ethics
  - Substitution of equipment
  - Modification of existing equipment
  - Use and siting of plant
  - Regular and effective maintenance
  - Involvement of workers in minimising noise
- Notifying the community of the construction works prior to commencement
- A procedure for handling potential complaints

Acronyms and abbreviations

Term	Definition
dB	Decibel is the unit used for expressing the sound pressure level (SPL) or power level (SWL) in acoustics.
dBA	Decibel expressed with the frequency weighting filter used to measure 'A-weighted' sound pressure levels, which conforms approximately to the human ear response, as our hearing is less sensitive at low and high frequencies.
CEMP	Construction Environmental Management Plan
DEC	Department of Environment and Conservation (NSW)
DoT	Department of Transport (NT)
EPA	Environmental Protection Authority
ISO	International Standards Organisation
$L_{Aeq(period)}$	Equivalent sound pressure level: the steady sound level that, over a specified period of time, would produce the same energy equivalence as the fluctuating sound level actually occurring.
$L_{A90(period)}$	The sound pressure level that is exceeded for 90% of the measurement period.
NAL	Noise Affected Level as per the NMFG
NCA	Noise Catchment Area
NMFG	Noise Management Framework Guideline
NSW	New South Wales
NT	Northern Territory
PPV	PPV is peak particle velocity in mm/s. It is the maximum vector sum of three orthogonal time-synchronized velocity components regardless of whether these component maxima occurred simultaneously.
RBL	Rating Background Level . The overall single-figure background level representing each assessment period (day/evening/night) over the whole monitoring period.
rms	Root Mean Square Amplitude (rms) is the square root of the average of the squared values of the waveform. In the case of the sine wave, the RMS value is 0.707 times the peak value, but this is only true in the case of the sine wave.
SWL	Sound Power Level
VDV	VDV is the vibration dose value in $m/s^{1.75}$ It is generally a cumulative measurement of the vibration level received over an 8-hour or 16-hour period

Common Terms

Term	Definition
A weighting	The human ear responds more to frequencies between 500 Hz and 8 kHz and is less sensitive to very low-pitch or high-pitch noises. The frequency weightings used in sound level measurements are often related to the response of the human ear to ensure that the meter better responds to what you actually hear
Ambient noise	The all-encompassing noise associated within a given environment. It is the composite of sounds from many sources, both near and far. This is described using the Leq descriptor
Background noise	The underlying level of noise present in the ambient noise, excluding the noise source under investigation, when extraneous noise is removed. This is described using the L90 descriptor
EIA	Environmental Impact Assessment
Feasible and reasonable measures	Feasibility relates to engineering considerations and what is practical to build. reasonableness relates to the application of judgement in arriving at a decision, taking into account the following factors: - • Noise mitigation benefits (amount of noise reduction provided, number of people protected); • Cost of mitigation (cost of mitigation versus benefit provided); • Community views (aesthetic impacts and community wishes); • Noise levels for affected land uses (existing and future levels, and changes in noise levels)
Hertz	The measure of frequency of sound wave oscillations per second. 1 oscillation per second equals 1 hertz.
Meteorological conditions	Wind and temperature inversion conditions
Noise Affected Level (NAL)	The Noise Affected Level (NAL) as defined as the EPA's NMFG. To be measured and assessed at the property boundary that is most exposed to construction noise, and at a height of 1.5 m above ground level. If the residential property boundary is more than 30 m from the residence, the location for measuring or predicting noise levels is at the most affected point within 30 m of the residence.
Noise sensitive receptor	An area or place potentially affected by noise which includes: • a residential dwelling • an educational institution, library, childcare centre or kindergarten • a hospital, surgery or other medical institution • an active (e.g., sports field, golf course) or passive (e.g., national park) recreational area • commercial or industrial premises • a place of worship.
Project	The construction works associated with the upgrading, realignment and sealing of the roads between three-ways in Melville Island to Pirlangimpi, Pickertaramoor and Milikapiti..
Resonance	Resonance describes the phenomenon of increased amplitude that occurs when the frequency of a periodically applied force is equal or close to a natural frequency of the system on which it acts.
Study area	Land in the vicinity of, and including, the proposal site. The 'study area' is the wider area surrounding the proposal site where the is potential of noise impacts (generally within 1 kilometre of construction works).

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1. Introduction

1.1 Project overview

The Australian Government committed to the upgrade of Tiwi Island roads on Melville Island, announcing an investment of $60 million in its 2019 Budget. A 20% co-contribution of $15 million from the Northern Territory Government has increased the total funding available to $75 million. All roads on the Tiwi Islands are under the control of the Tiwi Islands Regional Council (TIRC). TIRC is responsible for the management of approximately 925 kilometres of listed roads and tracks on a land mass of approximately 8,320 square kilometres.

In recent years, road usage, particularly on Melville Island, has grown with the operations of the timber plantation and population growth. This has affected the existing gravel road and its drainage features that are generally in poor condition and are subject to deterioration and inundation during the wet season. During the wet season, major weather events cause sections of the roads to become impassable or subject to prolonged restrictions due to flooding and saturated road pavements. An upgrade to priority sections of the road will improve flood immunity and reduce the duration of restrictions and road closures during major weather events.

1.2 Project objectives

Sealing the selected roads on Melville Island will help unlock the economic potential of the region and open up a range of new long-term economic and social opportunities for people across the island community. Economic opportunities include tourism, forestry, mining and energy developments and employment opportunities in those industries. It will contribute to the Closing the Gap initiative through improving access to health and educational services, facilitate social and cultural connections and reduce barriers to development, including operating costs for business.

1.3 Noise and vibration assessment objectives

This Noise and Vibration Impact Assessment (NVIA) considers potential noise and vibration impacts that may be caused by the Project at surrounding sensitive land use areas during the construction phase of the Project, particularly at the communities located at Pirlangimpi and Pickertaramoor. This NVIA will supplement the Environmental Impact Assessment (EIA) for the Project. Milikapiti Access Road has not yet been designed and as such, the environmental impact of this section of road will be assessed in the future once the road design has been determined.

An assessment of potential noise impacts during the operation of the Project has not been included in this assessment due to the following reasons:

- The *Road Traffic Noise Guideline on NT Government Controlled Roads* (NT DoT, 2014) is applicable for new roads only (not for existing roads or upgrades to existing roads). As no ‘future roads’ are proposed as part of the project, an assessment to residential receptors or other noise-sensitive receptors is not considered necessary.
- Traffic volumes along these roads are anticipated to be low due to the relatively low population numbers at each community. As such, road noise levels during operation are not anticipated to cause significant noise impacts.
- Road noise levels are anticipated to reduce as a result of the Project as sealed roads generally result in lower noise levels than unsealed roads.

1.4 Scope and structure of this report

1.4.1 Scope of report

GHD has assessed potential impacts of noise and vibration from machinery and equipment on the main project site and satellite sites. The assessment has involved the following tasks:

- Initial desktop review using aerial photography to identify environmental noise and vibration sensitive receivers
- Establishment of recommended Noise Affected Levels (NALs) for residential receptors based on minimum rating background levels (RBLs) in accordance with the NT Noise Management Framework Guideline (NMFG) (NT EPA, 2018)
- Establishment of recommended NALs for non-residential receptors in accordance with the NMFG
- Identification of the likely principal noise and vibration sources of the Project
- Noise calculations to predict noise levels at nominal distances from the construction noise source including calculations of buffer distances where NALs are likely to be exceeded.
- Identification of typical mitigation measures or controls that may be adopted during the Project to manage noise and vibration impacts

This scope of work has been completed in consideration of, or in general accordance with the following guidelines:

- *NT Noise Management Framework Guideline (NMFG)* (NT EPA, 2018)
- *Road Traffic Noise on NT Government Controlled Roads* (NT DoT, 2014)
- *Assessing Vibration: A Technical Guideline* (DEC, 2006)
- *BS 7385.2:1993 – Evaluation and Measurement for Vibration in Buildings: Part 2 – Guide to Damage Levels from Ground Borne Vibration* (British Standards, 1993)
- *DIN 4150-3: 1999 Structural Vibration – Part 3: Effects of Vibration on Structures* (German Standards , 1999)

1.4.2 Report structure

- **Chapter 1 – Introduction:** identifies the project and sites assessed
- **Chapter 2 – Project overview:** describes details, methods and timing of the proposed construction works, relevant to the noise and vibration impact assessment
- **Chapter 3 – Existing environment:** summarises the existing environmental noise conditions and details the noise monitoring methodology
- **Chapter 4 – Regulatory requirements:** outlines Commonwealth and State legislation and relevant guidelines and assessment criteria pertaining to noise or vibration.
- **Chapter 5 – Methodology:** outlines the modelling methodology for the noise and vibration assessment.
- **Chapter 6 – Impact assessment:** presents a summary of the noise and vibration modelling and identifies potential noise and vibration impacts of the proposed works
- **Chapter 7 – Management and mitigation measures:** provides an overview of proposed noise and vibration mitigation measures for the operational phase of the Project
- **Chapter 8 – Conclusion:** summarises potential noise and vibration impacts and principal conclusions of the assessment.
- **Chapter 9 – References:** lists documents used or referenced within this report

1.5 Limitations

This report: has been prepared by GHD for Department of Infrastructure, Planning & Logistics and *may only be used and relied on by Department of Infrastructure, Planning & Logistics for the purpose agreed between GHD and the Department of Infrastructure, Planning & Logistics as set out in section 1.4.1 of this report.*

GHD otherwise disclaims responsibility to any person other than Department of Infrastructure, Planning & Logistics arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

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

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

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

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

2. Project overview

2.1 Project location

The Project can be categorised into two (2) main sections being:

- Pirlangimpi to the three-ways intersection (Pirlangimpi Access Road), including the gravel pit areas
- Pickertaramoor to the three-ways intersection (Pickertaramoor Access Road), including the gravel pit areas

2.2 Project timing

Works will be commencing on-site from 2021 for approximately six to eight years every dry season (April to October) Pirlangimpi Access Road and Pickertaramoor Access Road.

2.3 Key construction activities

Roads works will generally include the following construction activities:

- Clearing and grubbing (most of the road is already cleared. Majority of the clearing will be undertaken for the re-alignment sections)
- Earthworks in cut and fill
- Drainage works including multiple transverse drainage structures along the road
- Pavement works
- Sealing with two coat seal
- Line marking
- Signage
- Gravel pit works
- Rehabilitation works

2.4 Operational hours

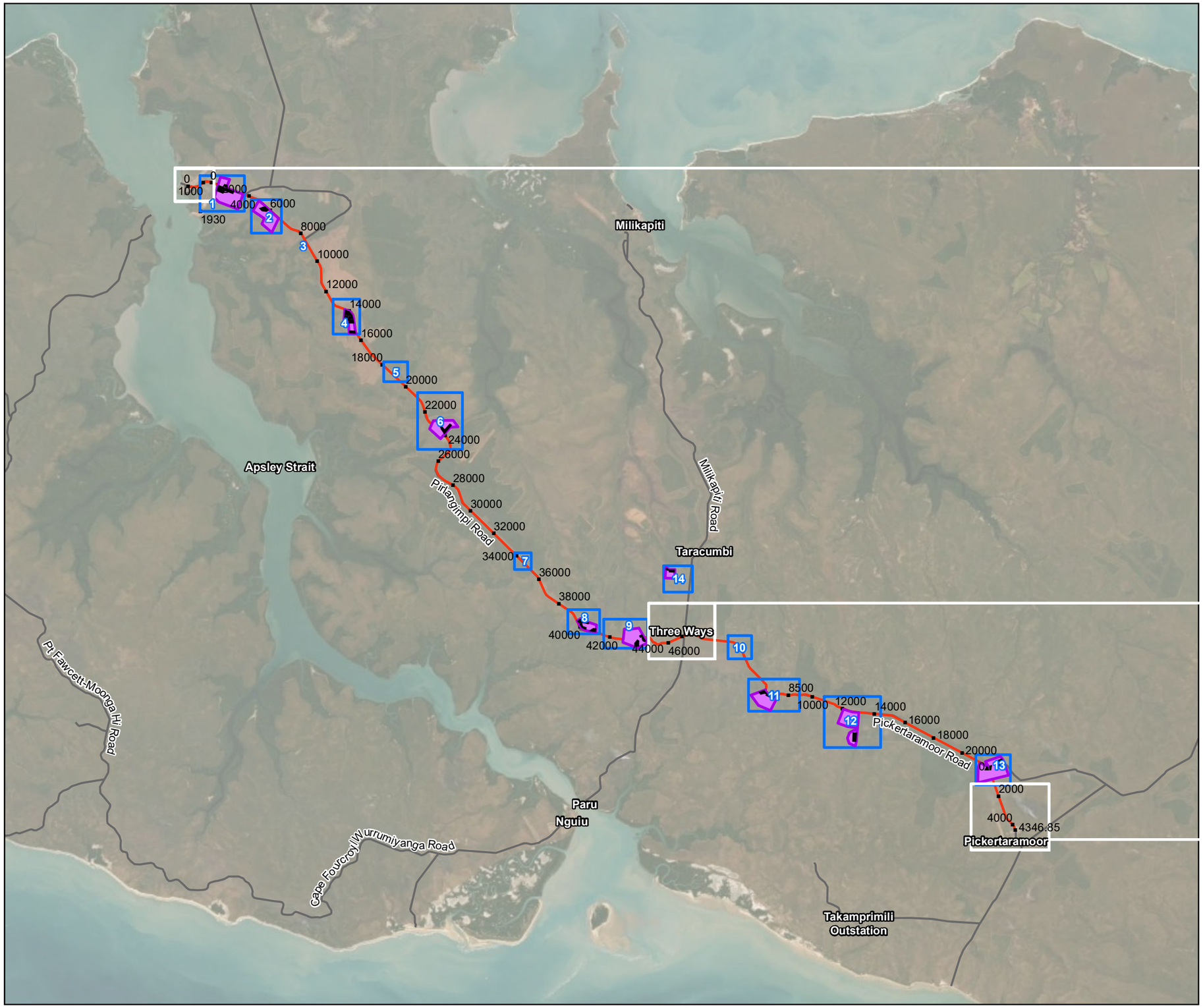
The proposed works are expected to be carried out during the recommended construction hours detailed in the NT NMFG.

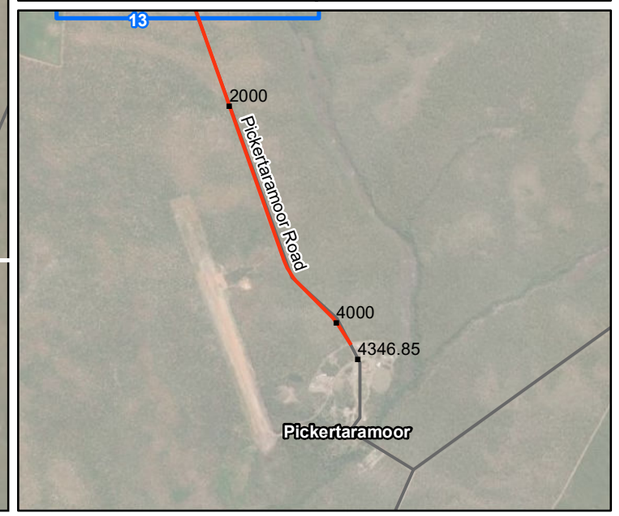
- Monday to Saturday, between the hours of 7 am and 7 pm; and
- Sundays and Public Holidays, between the hours of 9 am and 6 pm

2.5 Workforce

The workforce plan is intended to maximise employment opportunities for members of Traditional Owner communities and local residents, and to maximise benefits of the Project in the region. The total number of workers is anticipated to range between 40 and 50 people each construction year of the Project.

The proposed 12-hour workdays and seven-day per week operation will necessitate rostered working patterns and will therefore utilise interchangeable work crews. Seasonal considerations and material movement limitations will further define working patterns and will require consideration in maintaining stable regional employment levels and patterns.





Legend

- Proposed gravel pit areas
- Potential gravel pit areas
- Map areas
- Road upgrades

1:250,000 @ A3

0 2.5 5 7.5 10

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 52

N

GHD

Department of Infrastructure, Planning and Logistics
Terrestrial biodiversity surveys for
Melville Island roads

Road upgrades

Project No. **12543964**
Revision No. **0**
Date **2/11/2022**

FIGURE 1

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3. Existing environment

3.1 Noise catchment areas (NCAs)

The study area has been categorised into two discrete noise catchment areas (NCAs).

An NCA is an area of similar acoustic environment used to categorise sensitive receivers within a specific geographical extent. The two NCAs can be summarised as:

- NCA1 – The sensitive receptors located in Prilangimpi
- NCA2 – The sensitive receptors located in Pickertaramoor

A review of aerial imagery for the areas between the two NCAs indicate that there are no sensitive receptors adjacent to Prilangimpi Access Road and Pickertaramoor Access (excluding the sensitive receptors listed above).

3.2 Sensitive receivers and land uses

Noise sensitive receivers are defined based upon the type of occupancy and the activities performed within the land parcel. The receivers are classified within the following categories:

- Active recreation areas
- School classrooms
- Commercial premises
- Medical buildings (hospitals/health centres)
- Passive recreation areas
- Place of worship
- Police station (assessed as commercial receivers)
- Residential premises

The number of noise sensitive receptors identified are summarised in Table 3-1. A detailed sensitive receiver map is provided in Appendix A.

The sensitive receptors identified within the study area were based on aerial imagery available at the time of preparing this report and as such, some receivers within the study area may have not been identified. However, compliance at the residential receptors nearest to the main project and satellite sites ensures compliance at residential receptors further afield, as lower noise levels are expected as the distance between the source and receptor increases.

Table 3-1 Sensitive receivers within the study area

Sensitive land use	Number of identified sensitive receptors within each NCA	
	Pickertaramoor	Pirlangimpi
Active recreation area	1	2
Educational institutes (classrooms)	2	2
Commercial	0	1
Medical	0	1
Passive recreation area	1	0
Place of worship	0	1
Police Station	0	1
Residential	34	120

Sensitive land use	Number of identified sensitive receptors within each NCA	
	Pickertaramoor	Pirlangimpi
Total	**38**	**128**

3.3 Existing noise environment

In the absence of background noise monitoring, minimum Rating Background Levels (RBLs) have been assumed in accordance with the NMFG (refer to Table 3-2) to establish the recommended noise affected levels (NALs).

The noise environment in the area is expected to be typically dominated by local traffic noise, as well as natural sounds such as birds, insects, trees and wind.

Table 3-2 Minimum assumed rating background noise levels

Time of Day	Minimum assumed rating background level (RBL), dBA
Day	35
Evening	30
Night	30

Note 1: Daytime 7.00 am to 6.00 pm; Evening 6.00 pm to 10.00 pm; Night-time 10.00 pm to 7.00 am
On Sundays and Public Holidays, Daytime 8.00 am to 6.00 pm; Evening 6.00 pm to 10.00 pm; Night-time 10.00 pm to 8.00 am. Morning shoulder period 6:00 am to 7:00 am.

3.4 Meteorological effects

The Project works are proposed from 7:00 am to 7:00 pm. The noise predictions have been based on calculations using the method of predicting environmental noise propagation detailed in *ISO 9613-2: Acoustics – Attenuation of sound during propagation outdoors* (ISO, 1996). The noise predictions are considered conservative as the algorithm takes into account a moderate wind from source to receiver or a moderate temperature inversion.

4. Regulatory requirements

4.1 Overview of requirements

Table 4-1 summarises the sections in this report that address specific categories of noise and vibration impact.

Table 4-1 Noise and vibration criteria and assessment

Assessment	Component	Criteria section	Methodology section	Assessment section	Mitigation section
Noise	Construction	Section 4.2	Section 5.1	Section 6.1 to Section 6.3	Section 7.1
	Operational road traffic	Section 4.3	N/A	N/A	N/A
Vibration	Structural damage	Section 4.5	Section 5.2	Section 6.4.1 Section 6.4.2	Section 7.2
	Human comfort	Section 4.4	Section 5.2	Section 6.4.3	Section 7.2

4.2 Application of the NT EPA Noise Management Framework Guideline 2018 (Construction Noise)

4.2.1 Recommended standard hours of work

The NT EPA Noise Management Framework Guideline (NMFG) is used to assess noise impacts associated with construction works. The guideline recommends standard hours for construction activities as:

- Monday to Saturday: 7 am to 7 pm;
- Sunday and Public Holidays: 9 am to 6 pm.

4.2.2 Construction outsides the recommended standard hours

The five categories of works that might be undertaken outside the recommended standard hours are:

1. the **delivery of oversized plant or structures** that police or other authorities determine require special arrangements to transport along public roads
2. **emergency work** to avoid the loss of life or damage to property, or to prevent environmental harm
3. **maintenance and repair of public infrastructure** where disruption to essential services and/or considerations of worker safety do not allow work within standard hours
4. **public infrastructure works** that shorten the length of the project and are supported by the affected community, or
5. works where a proponent demonstrates and justifies **a need to operate outside the recommended standard hours. Examples of these are concrete pours in the hot and humid Northern Territory**

It should be noted that the key construction activities associated with the Project (See Section 2.3) are proposed to be undertaken during the recommended standard hours of works.

4.2.3 Recommended assigned construction noise levels at residences

For construction projects that are greater than three weeks in duration, the recommended assigned noise affected levels (NALs) for residential receptors are provided in Table 4-2. The method to determine the NALs for residential receptors is in accordance with the NMFG.

Table 4-2 Recommended assigned construction noise levels for airborne noise at residential premises (Quantitative assessment method)

Time of day	Recommended assigned construction NALs, $L_{Aeq(15\ min)}$	Notes
Construction projects of greater than 3 weeks duration – the quantitative assessment method is used for these projects		
Recommended standard hours	Recommended assigned noise affected level: RBL[1] + 10 dBA **NAL = 45 dBA for standard hours**	The recommended assigned noise affected level represents the point above which there may be some community reaction to noise. Where the predicted or measured L_{Aeq} (15 min) is greater than the recommended assigned noise affected level, proponents should apply all feasible and reasonable work practices to meet the recommended assigned noise affected level. Proponents should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
Outside recommended standard hours	Recommended assigned noise affected level: RBL + 5 dBA	A strong justification would typically be required for works outside the recommended standard hours. Proponents should apply all feasible and reasonable work practices to meet the noise affected level. Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the recommended assigned noise affected level, proponents should negotiate with the community.

4.2.1 Recommended noise affected levels at non-residential receptors

NALs for non-residential sensitive receptors are provided in Table 4-3.

Table 4-3 NALs for non-residential sensitive receptors

Land use	Noise management level, $L_{Aeq(15m)}$ (External)
Active recreation areas	65 dBA
Commercial	70 dBA
Educational institutes (classrooms)	55 dBA (based on 45 dBA internal)[1]
Medical/Health buildings	55 dBA (based on 45 dBA internal)[1]
Passive recreation areas	60 dBA
Places of worship	55 dBA (based on 45 dBA internal)[1]
Police Station	70 dBA (based on commercial receptor)

Notes:
1) Assuming a 10 dBA attenuation through an open window

4.3 Road Traffic Noise on NT Government Controlled Roads 2014 (NT DoT 2014)

The *Road Traffic Noise Guideline on NT Government Controlled Roads* (NT DoT, 2014) is applicable for new roads only. The document outlines a target level for 'Future Roads – Not Currently Planned' of 63 dBA for existing residential receivers and 58 dBA for other noise sensitive receivers. For 'Existing Road', 'Existing Road – Upgrade' or 'Future Road – Not Currently Planned', there are no noise targets or required actions for existing noise receivers.

As no 'future roads' are proposed as part of the project, no assessment to residential receivers or other noise-sensitive receivers is considered necessary.

4.4 Vibration – human comfort

Vibration criteria have been set with consideration to *Assessing Vibration: a technical guideline* (DEC, 2006), as referenced in the NMFG. *BS 6472 – 1992, Guide to Evaluation of Human Exposure to Vibration in Buildings (1 Hz to 80 Hz)* (British Standards, 1992) is recognised by the guideline as the preferred standard for assessing the 'human comfort criteria'.

Typically, construction activities generate ground vibration of an intermittent nature. Intermittent vibration is assessed using the vibration dose value. Acceptable vibration dose values (VDV) are presented in Table 4-4 for sensitive receptors.

Table 4-4 Human comfort intermittent vibration limits (BS 6472-1992)

Receiver type	Period	Intermittent vibration dose value ($m/s^{1.75}$)	
		Preferred value	Maximum value
Residential	Day (7 am and 10 pm)	0.2	0.4
	Night (10 pm and 7 am)	0.13	0.26
Offices, schools, educational institutes and places of worship	When in use	0.4	0.8

Whilst the assessment of response to vibration in *BS 6472-1:1992* is based on vibration dose value (refer to Table 4-4) and weighted acceleration, for construction related vibration, it is considered more appropriate to provide guidance in terms of peak particle velocity (PPV), since this parameter is likely to be more routinely measured based on the more usual concern over potential building damage.

Humans are capable of detecting vibration at levels which are well below those causing risk of damage to a building. The degrees of perception for humans are suggested by the vibration level categories given in *British Standard, BS 5228.2 – 2009, Code of Practice Part 2 Vibration for noise and vibration on construction and open sites – Part 2: Vibration* (British Standards, 2009) and are shown below in Table 4-5.

Typical ground vibration from civil construction activities occurs in the frequency range of approximately 8 Hz to 100 Hz. Within this frequency range, building contents such as blinds and pictures would commence visible movement at PPV 0.5 mm/s. At vibration levels higher than 0.9 mm/s, rattling of windows, crockery or loose objects would be audible and annoying.

Table 4-5 Guidance on effects of vibration levels for human comfort (BS 5228.2-2009)

Vibration level	Effect
0.14 mm/s	Vibration might be just perceptible in the most sensitive situations for most vibration frequencies associated with construction.

Vibration level	Effect
0.3 mm/s	Vibration might be just perceptible in residential environments.
1.0 mm/s	It is likely that vibration at this level in residential environments will cause complaints but can be tolerated if prior warning and explanation has been given to residents.
10 mm/s	Vibration is likely to be intolerable for any more than a very brief exposure.

To assess potential human comfort vibration impacts, safe working distances to comply with the vibration guide values in *Assessing Vibration - a technical guideline* for vibration intensive equipment have been sourced from *Construction Noise and Vibration Guideline* (Transport for NSW, 2016) and are presented in Section 5.2.1.

4.5 Vibration – structural damage

The NMFG references the use of *BS 7385-1:1990 – Evaluation and measurement of vibration in buildings* (British Standards, 1993) to assess vibration induced damage to standard structures or building contents and *DIN 4150-3: Structural vibration – Part 3 Effects of vibration on structures* (German Standards , 1999) to assess vibration-induced damage to heritage structures.

Based on BS 7385, the transient vibration guide values for standard structures are presented in Table 4-6. It should be noted that where dynamic loading caused by continuous vibration may give rise to dynamic magnification due to resonance, especially at the lower frequencies where lower guide values apply, then the guide values in BS 7385 may need to reduce by up to 50 percent. As such, conservative cosmetic damage screening limits of 25 mm/s for reinforced of framed structures and 7.5 mm/s for unreinforced or light framed structures has been adopted.

Table 4-6 Transient vibration guide values–minimal risk of cosmetic damage

Line	Type of Building	Peak Component Particle Velocity in Frequency Range of Predominant Pulse		Peak component particle velocity – cosmetic damage screening limits
		4 – 15 Hz	15 Hz and above	
1	Reinforced or framed structures Industrial and heavy commercial buildings	50 mm/s at 4 Hz and above		25 mm/s
2	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	7.5 mm/s

The guidance values for short-term vibration on heritage structures are presented in Table 4-7, based on DIN 4150. It should be noted that measured values exceeding those listed in Table 4-7 "*… does not necessarily lead to damage; should they be significantly exceeded, however further investigations are necessary."*

Table 4-7 Guidance values for short-term vibration on heritage structures

Line	Type of structure	Guideline values for velocity v(t)[1] (mm/s)		
		1 – 10 Hz	10 – 50 Hz	50 – 100 Hz[2]
At grade structures (DIN 4150.3:1999)				
3	Structures that, because of their particular sensitivity to vibration, cannot be classified under lines 1 and 2 and are of great intrinsic value (e.g., listed buildings under preservation order)	3	3 to 8	8 to 10
Notes:				

Line	Type of structure	Guideline values for velocity v(t)[1] (mm/s)		
		1 – 10 Hz	10 – 50 Hz	50 – 100 Hz[2]

1. The term v refers to vibration levels in any direction (x, y or z axis)
2. Where frequencies are above 100 Hz the 50 – 100 Hz values may be used as minimum values

To assess potential cosmetic damage vibration impacts to buildings, safe working distances to comply with the vibration guide values in BS7835 and DIN 4150 for vibration intensive equipment have been sourced from *Construction Noise and Vibration Guideline* (Transport for NSW, 2016) and are presented in Section 5.2.1.

5. Methodology

5.1 Noise modelling inputs

5.1.1 Construction equipment

To provide a basis for noise and vibration impact assessment, an indicative list of typical construction equipment required for the Project is presented in Table 5-1. The estimated sound power level for each item of equipment is also presented and is sourced from *AS2436 Guide to noise and vibration control on construction, demolition and maintenance sites* (Australian Standards, 2010), *Construction Noise and Vibration Guideline* (Transport for NSW, 2016) and GHD estimates from previous experience. Other similar equipment may be used however it is anticipated that they would produce similar noise emissions.

Table 5-1 Estimated sound power levels (SWLs) for equipment

Equipment	Sound Power Level (SWL), dBA	Source
4WD	106	AS2436:2010
Backhoe	104	AS2436:2010
Bitumen truck and sprayer	108	AS2436:2010
Bulldozer	108	AS2436:2010
Concrete truck	108	AS2436:2010
Crane	105	AS2436:2010
Dump truck	117	AS2436:2010
Excavator (medium)	107	AS2436:2010
Excavator (small)	104	AS2436:2010
Grader	110	AS2436:2010
Loader	105	AS2436:2010
Mini-boring machine	104	GHD
Multi-tyred roller	108	AS2436:2010
Pavement marker	108	CNVG
Road Train	107	AS2436:2010
Smooth drum roller	108	AS2436:2010
Trucks	107	AS2436:2010
Water Cart	107	AS2436:2010

5.1.2 Indicative construction scenarios

The magnitude of noise impacts associated with the Project will depend on a number of factors:

- The intensity and location of construction activities
- The type of equipment used
- Existing background noise levels
- Intervening terrain and structures
- The prevailing weather conditions

Five construction scenarios described in Table 5-2 have been modelled to represent 'worst-case' (noise effect) scenarios associated with the Project and to assess potential noise impacts at the identified sensitive receivers within the study area.

Table 5-2 summarises the assumptions of which equipment will typically be in use within each construction scenario. The following further assumptions have been applied in the modelling to represent worst-case noise conditions:

- All equipment are operating a maximum capacity for the full 15-minute modelled period

- It is assumed that the two loudest items of equipment are operating simultaneously at the edge of the construction area

Table 5-2 Construction scenarios

Scenario	Description	Location	Equipment	Activity sound power level, SWL dBA	Duration
S01	Site establishment	Pirlangimpi Access Road and Pickertaramoor Access Road and gravel pit areas	Trucks, crane, 4WD, Backhoe and Excavator (small)	110	~3 weeks
S02	Gravel pit works	Gravel pits areas	Loader, Excavator (medium), Dump truck, Backhoe and trucks	117	~3 months for each 6-month period
S03	Bulk earthworks	Pirlangimpi Access Road and Pickertaramoor Access Road	Bulldozer, Excavator (medium), Grader, Water cart, Trucks, Smooth drum roller, Bitumen truck and sprayer and 4WD	115	~2 months for each 6-month period
S04	Drainage works	Pirlangimpi Access Road and Pickertaramoor Access Road	Trucks, Excavator (medium), Concrete truck, 4WD and Crane	111	~2 months for each 6-month period (concurrent with S05)
S05	Pavement and finishing works	Pirlangimpi Access Road and Pickertaramoor Access Road	Grader, Bitumen truck and sprayer, Smooth drum roller, Trucks, Pavement marker and mini-boring machine	112	~2 months for each 6-month period (concurrent with S04)

5.1.3 Noise parameters

Noise levels at nominal distances from the construction activities detailed in Table 5-3 were calculated undertaken according to *ISO 9613-2: Acoustics – Attenuation of sound during propagation outdoors* (ISO, 1996). Ground absorption and atmospheric absorption were taken into account in the calculations. It should be noted that acoustic shielding between a noise source and a receiver due to intervening terrain or structures have not been included in the calculations and therefore the predictions are considered conservative.

The ISO 9613 algorithm also takes into account the presence of a well-developed moderate ground-based temperature inversion, such as commonly occurs on clear, calm nights or ‘downwind’ conditions, favourable to sound propagation (and even though the proposed working hours are 7.00 am to 7:00 pm when temperature inversions are unlikely).

General parameters used in the model are listed in Table 5-3.

Table 5-3 Noise modelling parameters

Variable	Parameter Used
Calculation method	ISO 9613-2:1996
Meteorology	Well-developed moderate ground-based temperature inversion, such as commonly occurs on clear, calm nights or 'downwind' conditions which are favourable to sound propagation.
Atmospheric absorption	Based on an average temperature of 10˚C and an average humidity of 70%, to be conservative
Receiver heights	1.5 metres above ground level
Buildings	No buildings were modelled
Ground absorption	0.75 for all areas (0 is non-porous ground and 1 is porous ground such as that found in a rural setting comprising of mainly grass and vegetation)
Source height	All equipment modelled at 2.0 metres above ground level

5.2 Vibration modelling inputs

5.2.1 Safe working distances

The method for the construction vibration assessment included:

- Identifying safe working distances to comply with the human comfort and the cosmetic damage criteria. These buffer distances have been adopted from Construction Noise and Vibration Guideline (Transport for NSW, 2016)
- Safe working buffer distances for heritage buildings were estimated by doubling the buffer distance for standard structures
- Buildings within the safe working distances have been identified for consideration of management measures

Construction works have the potential to impact human comfort and /or cause structural or cosmetic damage to buildings. The following activities are potential sources of vibration:

- Bulk earthworks along the road alignment or at the gravel pit areas
- Grading along the road alignment during the pavement works
- Vibratory rolling along road alignment during the pavement works

Safe working buffer distances to comply with the human comfort, cosmetic damage and heritage structural damage criteria are provided in Table 5-4.

Table 5-4 Vibration safe working buffer distances, metres

Activity	Human comfort	Cosmetic damage (BS 7385)	
		Heritage building/structure	Standard dwellings
Vibratory roller (>18 tonnes)	100 m	50 m	25 m
Vibratory roller (13-18 tonnes)	100 m	40 m	20 m
Vibratory roller (7-13 tonnes)	100 m	30 m	15 m
Vibratory roller (4-6 tonnes)	40 m	24 m	12 m
Vibratory roller (2-4 tonnes)	20 m	12 m	6 m
Vibratory roller (1-2 tonnes)	15 m	10 m	5 m
Small hydraulic hammer 300kg (5-12t excavator)[1]	7 m	4 m	2 m
Medium hydraulic hammer 900 kg (12-18t excavator)	23 m	14 m	7 m

Activity	Human comfort	Cosmetic damage (BS 7385)	
		Heritage building/structure	Standard dwellings
Large hydraulic hammer 1600 kg (18-34t excavator)	73 m	44 m	22 m

Notes:

1) Vibration emissions from a grader a likely to be similar to a small excavator

6. Impact assessment

6.1 Construction noise levels

Based on the methodology described in Section 5.1.3, noise levels at nominal distances from the construction activities detailed in Section 5.1.2 are presented in Table 6-1.

It should be noted that these noise levels are representative of the worst-case scenario and for the majority of the time, the expected noise levels are lower than the predicted noise levels presented in Table 6-1.

Table 6-1 Predicted noise levels at nominal distances

Distance from construction activity	Predicted noise levels for each scenario, $L_{Aeq(15min)}$ dBA				
	S01 SWL 110	S02 SWL 117	S03 SWL 115	S04 SWL 111	S05 SWL 112
10 metres	79	86	84	80	81
25 metres	71	78	76	72	73
50 metres	64	71	69	65	66
75 metres	60	67	65	61	62
100 metres	57	64	62	58	59
250 metres	49	56	54	50	51
500 metres	42	49	47	43	44
750 metres	37	44	42	38	39
1000 metres	34	41	39	35	36

6.2 Buffer distances to comply with Noise Affected Levels

The distances at which the NALs are predicted to be exceed for each sensitive receptor type are presented in Table 6-2.

Table 6-2 Predicted noise affected level buffer distances

$L_{Aeq(15min)}$ noise level, dBA	Associated sensitive receptor type for the noise affected level	Distance at which the relevant noise level is exceeded, metres				
		S01	S02	S03	S04	S05
		Site establishment	Gravel pit area	Bulk earthworks	Drainage works	Pavement works
75	-	16 m	33 m	27 m	18 m	20 m
70	Commercial premises	27 m	54 m	44 m	30 m	33 m
65	Active recreation areas	44 m	89 m	72 m	49 m	54 m
60	Passive recreation areas	72 m	151 m	121 m	80 m	89 m
55	Classrooms, medical buildings and places of worship	121 m	255 m	208 m	135 m	151 m
50	-	208 m	417 m	344 m	230 m	255 m
45	Residential receptors	344 m	658 m	550 m	379 m	417 m

6.3 Discussion of potential noise impacts

The results below are representative of when the construction works are at the closest distance between the receptor and the construction equipment. Potential noise impacts will reduce as the construction equipment move away from the receptors. For the vast majority of the time, where construction works are further than ~650 metres from the nearest sensitive receiver, the noise

affected levels are not anticipated to be exceeded. The predictions below are also conservative as they do not take into account acoustic shielding provided by intervening terrain or buildings.

Scenario 1 – Site establishment works

For the site establishment construction works, the number of residential receptors within 344 metres of works (exceed the noise affected level) is as follows:

- NCA1 – 51 in Pirlangimpi
- NCA2 – 25 in Pickertaramoor

The noise affected levels are also predicted to be exceeded at the following non-residential receptors:

- NCA1 – Pirlangimpi Health Centre
- NCA2 – Tiwi College

Scenario 2 – Gravel pit areas

No residential or non-residential receptors have been identified within the noise affected level buffer distances. As such, no adverse noise impacts are anticipated from construction activities at the gravel pit areas.

Scenario 3 – Bulk earthworks along road alignment

For the site establishment construction works, the number of residential receptors within 550 metres of works (exceed the noise affected level) is as follows:

- NCA1 – 116 in Pirlangimpi

  NCA2 – 33 in Pickertaramoor

The noise affected levels are also predicted to be exceeded at the following non-residential receptors:

- NCA1 – Pirlangimpi Health Centre, Pirlangimpi School, Pirlangimpi Club and Pirlangimpi Oval
- NCA2 – Tiwi College and the Football Ground

Scenario 4 – Drainage works along road alignment

For the site establishment construction works, the number of residential receptors within 379 metres of works (exceed the noise affected level) is as follows:

- NCA1 – 63 in Pirlangimpi
- NCA2 – 26 in Pickertaramoor

The noise affected levels are also predicted to be exceeded at the following non-residential receptors:

- NCA1 - Pirlangimpi Health Centre and Pirlangimpi Club
- NCA2 – Tiwi College

Scenario 5 – Pavement and finishing works along road alignment

For the site establishment construction works, the number of residential receptors within 550 metres of works (exceed the noise affected level) is as follows:

- NCA1 – 81 in Pirlangimpi
- NCA2 – 31 in Pickertaramoor

The noise affected levels are also predicted to be exceeded at the following non-residential receptors:

- NCA1 – Pirlangimpi Health Centre and Pirlangimpi Club
- NCA2 – Tiwi College

6.4 Vibration impacts

It is assumed that a vibratory roller that is greater than 18 tonnes will not be used within 100 metres of sensitive receptors as the results below are based on the most vibratory intensive equipment being a 13 to 18 tonne vibratory roller (smooth drum or multi-tyred). All other identified equipment are anticipated to generate less vibration than a 13 to 18 tonne vibratory roller.

The safe working distances at Pirlangimpi and Pickertaramoor are shown in Figure 6-1 and Figure 6-2, respectively.

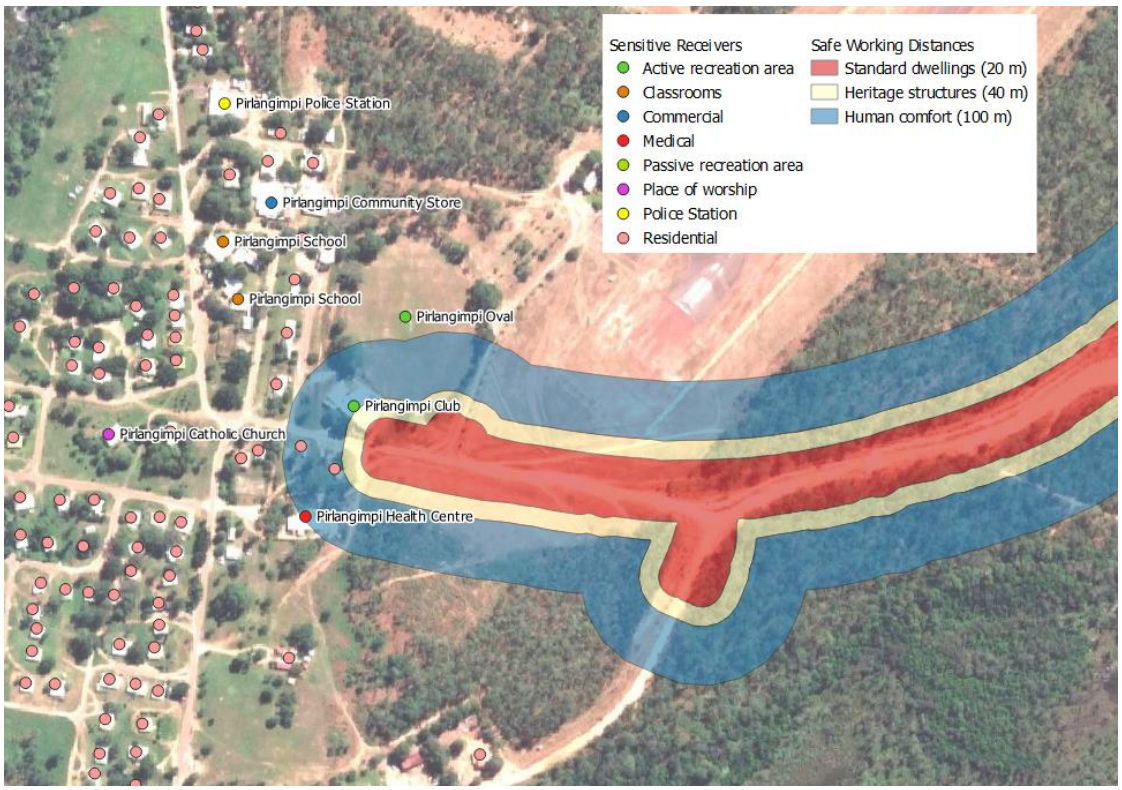

Figure 6-1 Safe working distances – Pirlangimpi

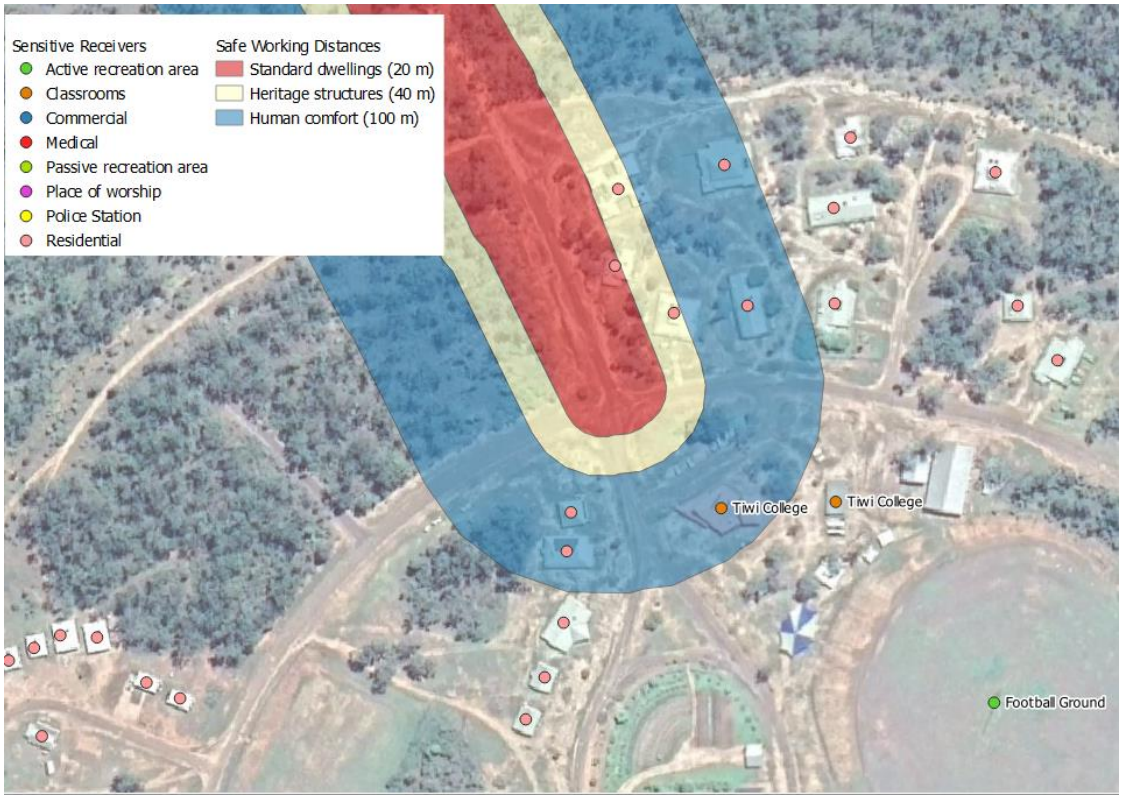

Figure 6-2 Safe working distances – Pickertaramoor

6.4.1 Cosmetic damage to standard dwellings

Pirlangimpi Club has been identified to be located within 20 metres of vibratory rolling works in Pirlangimpi. No other buildings have been identified within the safe working distances.

Two dwellings have been identified as being located within 20 metres of vibratory rolling works in Pickertaramoor.

6.4.2 Cosmetic damage to heritage structures

No heritage structures have been identified within 40 metres of vibratory rolling works at Pirlangimpi or Pickertaramoor. As such, no cosmetic damage impacts are anticipated due to vibratory rolling works as a result of the Project.

6.4.3 Human comfort impacts

Potential human comfort vibration impacts are anticipated for residents within 100 metres of vibratory rolling works.

The sensitive receptors located within 100 metres of vibratory works in Pirlangimpi and Pickertaramoor are shown in Figure 6-1 and Figure 6-2, respectively.

7. Mitigation measures

7.1 Noise mitigation strategies

Generally, there are three mitigation strategies that can be used to reduce noise emission to sensitive receivers, being (from most preferred to least preferred):

1. Control at the source (e.g., selecting quieter equipment, enclosing the source, closing doors at sensitive times, active noise control, times of operation etc.)
2. Control in transmission (noise barriers, mound and bunds and site design to maximise distance or utilise intervening buildings as barriers etc.)
3. Receiver controls (insulation, upgraded glazing and use of mechanical ventilation etc.)

It is recommended that controls at the source be prioritised for the following reasons:

- The plant and equipment required for construction are mobile and not fixed. As such, controls in transmission will not likely be very effective unless unreasonably long noise barriers are used. Controls at the source will be more effective and easier to implement.
- Construction works are temporary in nature and do not result in a permanent loss of amenity for nearby sensitive receptors. As such, controls at the receiver are not considered reasonable as noise levels will reduce significantly as construction works move away from the communities at Pirlangimpi or Pickertaramoor.

7.1.1 Recommended noise mitigation measures (at source)

The following mitigation measures are recommended to reduce noise at the source. The typical and maximum noise reductions due to these measures have been summarised in Table 7-1.

Table 7-1 Noise control measures

Control measure	Type of control	Typical reduction dBA	Maximum reduction dBA	Feasible?	Source
Silencers / mufflers / diffusers	Source	7 - 10	15	Yes	AS2436
Acoustic enclosures[1]	Source	15 - 30	50	No	AS2436
Equipment substitution	Source	5-10	10	Where practical	AS2436
Distance	Source / transmission path	6 per doubling of distance	6 per doubling of distance	Yes	AS2436

Note:
1. Not recommended or feasible due to the majority of equipment in use being mobile.

The following mitigation measures are recommended for construction areas that are within 700 metres of sensitive receptors in Pirlangimpi and Pickertaramoor. Noise and vibration impacts are not anticipated outside of this distance.

These measures should be incorporated in the Construction Environmental Management Plan (CEMP).

Work ethics

- All activities on site should be confined between the hours of 7:00 am to 7:00 pm, Monday to Saturday and between 9:00 am and 6:00 pm on Sundays and Public Holidays

- All personnel on site should be made aware of the potential for noise impacts and should aim to minimise elevated noise levels or noise impacts, where possible

Substitution

- Where reasonably practicable, noisy plant should be replaced by less noisy alternatives

Modification of existing equipment

- All engine covers should be kept closed while equipment is operating
- Mobile plant should be fitted with silencers/mufflers, where possible
- Plant and vehicles should be kept properly serviced
- The use of exhaust brakes should be eliminated, where practical
- Where practical, plant operating on site are to be fitted with broadband reversing alarms

Use and siting of plant

- The offset distance between noisy plant and adjacent sensitive receivers is to be maximised where practical
- Plant used intermittently is to be throttled down or shut off
- Noise-emitting plant is to be directed away from sensitive receivers, where possible

Regular and effective maintenance

- Regularly inspect and maintain equipment to ensure it is in good working order. Also check the condition of mufflers
- Machines found to produce excessive noise compared to industry best practice should be removed from the site or stood down until repairs or modifications can be made
- Return any hired equipment that is causing noise that is not typical for the equipment – the increased noise may indicate the need for repair

Involvement of workers in minimising noise

- Avoid dropping materials from a height, dropping or dragging road plates
- Talk to workers about noise from the works at the identified land uses and how it can be reduced
- Use radios and stereos indoors rather than outdoors.

7.1.2 Community notification practices

- Potentially noise affected neighbours contacted at the earliest possible time before any site work begins. As a minimum it is expected that all potentially affected sensitive noise receptors be given 48 hours' notice prior to the commencement of construction activities
- Potentially noise affected neighbours informed about the nature of the construction stages and the duration of noisier activities – for example, excavation and rock-breaking
- Keeping potentially noise affected neighbours up to date on progress
- Providing contact details on a site board at the front of the site, and maintain a complaints register suited to the scale of works
- Asking about any concerns that potentially noise affected neighbours may have and discuss possible solutions, and

- Providing copies of noise management plans, if available, to potentially noise affected neighbours

7.1.3 Handling complaints

- Keep staff who receive telephone complaints informed regarding current and upcoming works and the relevant contacts for these works
- Handle complaints in a prompt and responsive manner
- Where there are complaints about noise from an identified work activity, review and implement, where feasible and reasonable, actions additional to those described above to minimise noise output, and
- Providing all complaints to the NT EPA Pollution Hotline within 24 hours upon receiving a complaint

7.2 Vibration mitigation strategies

7.2.1 Cosmetic damage to structures

The following buildings have been identified as falling within 20 metres of vibratory rolling works:

- Pirlangimpi Club
- The two dwellings identified in Figure 6-2

Building condition inspections reports are recommended for these structures prior to construction works and subsequent to the completion of the construction works.

Building condition inspection reports should classify the building structure and susceptibility to damage in accordance with the BS 7385 classifications. The resulting building classifications are to be used for determination of the applicable BS 7385 vibration criteria curves. Condition inspections are to identify high-risk buildings where additional vibration restrictions and more stringent criteria may apply.

Where construction activities generating vibration are to be undertaken at distances less than the safe working distances for standard structures shown in Table 5-4 and no alternative (less-vibration intensive) method can be used, initial vibration monitoring trials should be undertaken at the commencement of vibratory rolling or compacting activities. The initial vibration trials should include:

- Determine the frequency dependent BS 7385 vibration criteria from the vibration generating equipment dominant frequencies
- Confirming safe working buffer distances for that equipment in that work area based on the frequency dependent BS 7385 vibration criteria
- When vibration generating equipment is operating within the above confirmed buffer distances, additional vibration monitoring equipment should be deployed at the building foundation with a trigger level based on the frequency dependent BS 7385 vibration criteria. If the vibration level on the equipment is reached a visual alarm should be triggered to alert the operators that the vibration criteria have been exceeded.

7.2.2 Human comfort vibration impacts

The construction works are considered short term by the *Assessing Vibration: A Technical Guideline* (DEC, 2006), therefore where alternative non-vibration inducing construction methods are impractical, the following principles from the guideline can be utilised to assist with minimisation of adverse reactions from the community.

- Confining vibration-generating operations to the least vibration-sensitive part of the shift
- Determining an upper level for vibration impact also considering what is achievable using feasible and reasonable mitigation
- Consulting with the community regarding the proposed events. Receptors that have been identified as being potentially affected by vibratory intensive works (See Figure 6-1 and Figure 6-2) should be contacted at the earliest possible time before any site work begins. As a minimum it is expected that all potentially affected sensitive noise receptors be given 48 hours' notice prior to the commencement of construction activities

8. Conclusion

This Noise and Vibration Impact Assessment (NVIA) considers potential noise and vibration impacts that may be caused by the Project at surrounding sensitive land use areas during the construction phase of the Project, specifically at the communities located at Pirlangimpi and Pickertaramoor.

Five indicative construction scenarios were modelled based on buffer distances using the ISO 9613-2 calculation method for environmental noise propagation. The results indicated that the noise levels at sensitive receptors may exceed the Noise Affected Levels (NALs) of the Noise Management Framework Guideline (NMFG) (NT EPA, 2018) when construction works are within 550 metres of sensitive receptors. No construction noise impacts are anticipated as a result of the works at the gravel pits areas as the closest sensitive receptor is more than 1.5 kilometres from a gravel pit area.

Pirlangimpi Club and two dwellings located in Pickertaramoor have been identified as falling within the safe working distances for cosmetic damage to standard structures (20 metres from vibratory rolling works). Sensitive receptors in Pirlangimpi and Pickertaramoor have been identified as falling within the safe working distance for human comfort (100 metres from vibratory rolling works).

Mitigation measures were provided to reduce the potential for noise and vibration impacts as a result of the Project.

9. References

Australian Standards. (2010). *AS2436 Guide to noise and vibration control on construction, demolition and maintenance sites .*

British Standards. (1992). *BS 6472, Guide to Evaluation of Human Exposure to Vibration in Buildings (1 Hz to 80 Hz).*

British Standards. (1993). *— BS 7385.2:1993 – Evaluation and Measurement for Vibration in Buildings: Part 2 – Guide to Damage Levels from Ground Borne Vibration .*

British Standards. (2009). *BS 5228.2 , Code of Practice Part 2 Vibration for noise and vibration on construction and open sites – Part 2: Vibration .*

DEC. (2006). *Assessing Vibration: A Technical Guideline .*

German Standards . (1999). *DIN 4150-3: 1999 Structural Vibration – Part 3: Effects of Vibration on Structures .*

ISO. (1996). *ISO 9613-2: Acoustics – Attenuation of sound during propagation outdoors .*

NT DoT. (2014). *Road Traffic Noise Guideline on NT Government Controlled Roads .*

NT EPA. (2018). *NT Noise Management Framework .*

Transport for NSW. (2016). *Construction Noise and Vibration Guideline.*

Appendices

Appendix A – Sensitive receptor map

Sensitive Receivers

- Active recreation area
- Classrooms
- Commercial
- Medical
- Passive recreation area
- Place of worship
- Police Station
- Residential

Paper Size ISO A4

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 52

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0 100 200 300 m

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Noise and vibration impact assessment - Sensitive receiver map (Pirlangimpi)

Project No. **12543964**
Revision No. **0**
Date. **17/03/2022**

Appendix A.1

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Sensitive Receivers

- Active recreation area
- Classrooms
- Commercial
- Medical
- Passive recreation area
- Place of worship
- Police Station
- Residential

Paper Size ISO A4

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 52

N

0 100 200 m

GHD

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Noise and vibration impact assessment - Sensitive receiver map (Pickertaramoor)

Project No. **12543964**
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Date. **17/03/2022**

Appendix A.2

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Revision	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
0	M. Velasco	C. Gordon		C. Sylianteng		16/03/2022

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