

Appendix J

Noise and Vibration Assessment



Hydro
Tasmania

Executive Summary

Hydro Tasmania is proposing to redevelop existing and construct new infrastructure around the existing Tarraleah Power Station, as part of Hydro Tasmania's 'Major Projects Program'.

The project scope comprises significant tunnelling works over nominally 16 km (the works area and immediate surrounds are hereafter referred to as 'the site'), which is proposed to be achieved primarily via drilling and blasting. To support these works, project lay-down yards and administrative areas are proposed within Tarraleah Village and at locations along the proposed tunnel. In addition to the tunnelling works, transmission lines are proposed to the east of Tarraleah Village. Initially, 'northern' and 'southern' options are being explored, with only one option to be constructed as part of the project.

This document provides an assessment of the expected noise and vibration impacts from the project, and details background information, methodologies, applicable legislation, standards and guidelines, and summarises the resulting findings and recommendations to manage potential impacts. It is noted that this assessment does not discuss blasting or its associated emissions.

During the propose redevelopment works, the existing visitor accommodation within Tarraleah Village will be used for housing of workers. It is noted that visitors will be allowed to access the existing penstock viewing platform, with visitation to the remainder of Tarraleah Village restricted to day time hours only.

Equipment is primarily expected to be mobile plant, including front-end loaders, bulldozers, excavators, vibratory rollers, etc., with some fixed crushing plants. Down-the-hole (DTH) hammer drilling is proposed to facilitate piling for the proposed Tarraleah Power Station 2 (TAPS2). For the transmissions lines, mobile plant similar to the general redevelopment works are proposed to be used, with a helicopter also proposed, to be used for stringing the transmission lines. The use of the helicopter is likely to last 3 to 4 days, and is to be used for the transmission lines only.

To determine the existing acoustic environment, measurements of the existing noise environment within Tarraleah Village were carried out, with measured background noise levels of nominally 30 dBA and 27 dBA during the day and night times respectively.

The NSW Interim Construction Noise Guideline is the primary source of criteria for the assessment of noise emissions related to construction works, with a Noise Management Level (NML) and Highly Noise Affected Level (HNAL) of 40 dBA (measured existing RBL + 10 dB) and 75 dBA, respectively, adopted. Additionally, the Tas. Noise EPP and AS 2107 have been referenced to determine appropriate levels for the protection of the amenity of surrounding sensitive receivers and workers within Tarraleah Village, with an external noise level of 55 dBA for non-sleeping areas, and an internal noise level of 30 dBA for sleeping areas.

'Assessing Vibration - A Technical Guideline' by the Department of Environment and Conservation NSW is referenced for suitable ground-borne vibration criteria for human comfort, whilst Australian Standard AS 2187.2 (App. J), the British Standard BS 7385-2, and the German Standard DIN 4150 (Part 3) have been referenced to determine appropriate ground-borne vibration criteria for buildings and structures.

Noise and vibration modelling have been carried out to determine likely noise emissions across site and at the nearest sensitive receivers in other ownership, as well as any management and mitigation requirements for noise and ground-borne vibration.

From the noise modelling, the following key findings are relevant:

- Noise levels are predicted to be entirely inaudible at the nearest sensitive receivers in other ownership during all works, with noise levels predicted to be generally less than 20 dBA.
- Noise with Tarraleah Village is predicted to exceed the NML. However, internal noise levels satisfy the 30 dBA criteria for sleeping areas as outlined within AS 2107 assuming basic facade construction.

- During the use of the helicopter, noise is predicted to exceed the NML at all receivers within nominally 12.5 km of the helicopter.
 - Given the operating area and duration over which the helicopter is proposed to operate, the use of the helicopter is unlikely to result in nuisance, with levels only predicted to exceed the HNAL if the distance between the helicopter and sensitive receiver is under 225 m for prolonged periods.
- Ground vibration levels due to vibratory rolling and tunnel boring may exceed ground vibration management levels for structures and buildings when this equipment is operating within nominally 20 m of said structures, with a minimum distance of 16 m recommended for DTH hammer drilling. Use of all modelled equipment within nominally 100 m of habitable space has the potential to result in ground vibration levels that exceed the identified criteria for human comfort. It is noted that given the likely location of works within Tarraleah Village, it is unlikely that significant machinery will operate within 100 m of habitable space for significant periods of time.

Noise monitoring is recommended to be carried out within Tarraleah Village whilst works are being carried out within nominally 1.5 km of Tarraleah Village, with two initially identified monitoring locations proposed. In general, helicopter use requires some implementation of noise management practices, primarily involving the restriction of its operating hours to the day time period (7AM to 6PM) where feasible and reasonable.

It is noted that during DTH hammer drilling, it is strongly recommended that ground vibration monitoring is carried out in the vicinity of the existing Tarraleah Power Station and the penstocks. It is also recommended that ground vibration monitoring be conducted when tunnel boring equipment is used within nominally 140 m of any structures that are particularly vibration sensitive.

The modelling of noise and ground vibration has demonstrated that such emissions from the proposed works and associated equipment is not expected to impact the residential amenity or structural integrity of people and buildings / structures within Tarraleah Village or the surrounding area, provided the recommended management distances are maintained.

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1. BACKGROUND

Hydro Tasmania are proposing to redevelop existing and construct new infrastructure around the existing Tarraleah Power Station, as part of Hydro Tasmania’s ‘Major Projects Program’.

The project scope comprises significant works over nominally 16 km, with extensive tunnelling, as well as approximately 4 km of above-ground headrace pipeline, and construction of a new switchyard and power station (TAPS2) adjacent the existing Tarraleah Power Station. In addition to the main redevelopment works, two transmission line options are proposed, with the preferred option yet to be decided. The works are proposed to be achieved via drilling and blasting, and various mobile plant, with potential use of a tunnel boring machine if required. To support these works, project lay-down yards are proposed, with a primary lay-down yard adjacent Tarraleah Village comprising site offices and significant mobile and fixed equipment. It is proposed that underground works are to occur 24-hours a day and are expected to last nominally 3 years, comprising significant earth works, as well as construction of infrastructure and services to support the redevelopment. The construction phase of the project is expected to take nominally 6 years in total.

NVC has been engaged to conduct a noise and vibration assessment of the project, which is detailed within this report. This assessment has included noise measurements to quantify the existing ambient noise environment in the area, and noise and vibration modelling to quantify the expected impact of noise and vibration on the nearest sensitive use, and vibration on nearby sensitive building structures. It is noted that blasting and its associated processes, and the resulting air-overpressure / vibration emissions are not discussed or assessed within this report.

1.1. SITE AND SURROUNDING AREA

The overall areas within which works are proposed comprises Tarraleah Village, the south-eastern side of Lake King William, and the intervening land between both of these locations. This overall area is referred to as the ‘site’ for the remainder of this report.

The existing Tarraleah Village is currently owned by Hydro Tasmania, and comprises visitor accommodation in the form of cottages and a caravan park, a visitor information centre, a cafe, a restaurant, and a golf course. The site is located nominally 6 km from the nearest sensitive use in other ownership; Bradys Lake — a low density residential zone to the site’s north-east (Location B).

Figure 1.1, below, shows a high-level overview of site, showing where the sensitive receivers in other ownership are located, as well as the proposed headrace tunnel (broken white line), the above-ground headrace pipeline (solid blue line), and the intake tunnel which is out of the scope of work for this assessment (solid yellow line). Green lines denote the proposed transmission lines, with northern and southern options, only one of which will be constructed as part of the project.

The key sensitive receivers are summarised in Table 1.1, below.

TABLE 1.1: NEAREST SENSITIVE RECEIVERS

	Address	Description
Location A	Oldina Drive, Tarraleah Village	Existing row of accommodation cottages within Tarraleah Village. Cottages are currently used as holiday accommodation but will house workers associated with the proposed works during the redevelopment. Note that access to Tarraleah Village will be limited to the public during construction.
Location B	Bradys Lake	A small residential area nominally 6 km to the north-east of Tarraleah. This location is nominally 4 km from the northern transmission line option.
Location C	Bronte Lagoon	A very small residential area nominally 12 km to the north of Tarraleah.
Location D	Wayatinah	A small residential area nominally 10 km to the south-east of Tarraleah. This location is nominally 1.3 km from the end of the southern transmission line option.

Typically, sensitive use is defined as residential premises, libraries, schools, hospitals, aged and child-care facilities, caravan parks and other places at which individuals may abide for long periods for reasons other than employment or active recreation. As such, camping areas and recreational users around the surrounding lakes have not been included as sensitive use.

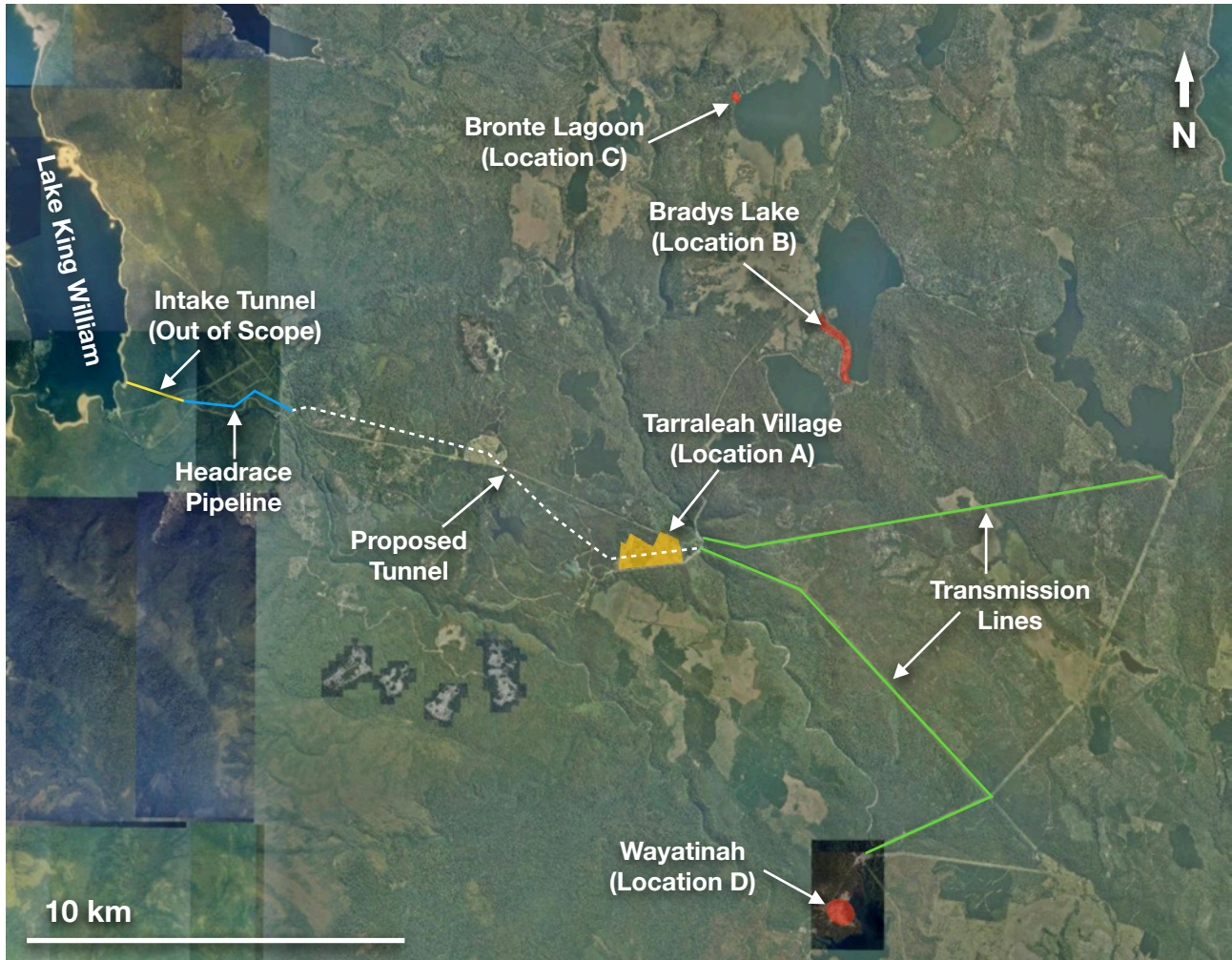


FIGURE 1.1: SITE AND SURROUNDING AREA

1.2. EXISTING SITE OPERATIONS

The existing site comprises a hydro-electric power station and the associated penstocks and penstock infrastructure, Tarraleah Village, and existing open canals to transport water from Lake King William to the top of the penstocks, where it is then delivered to the power station. The existing operations produce negligible noise emissions, with the power station’s operation requiring no mobile equipment, except where maintenance is required. The power station itself houses turbines within a large masonry building relatively distant from nearby sensitive use, which results in minimal noise emissions.

1.3. PROPOSED DEVELOPMENT

The proposed development primarily comprises construction of a new power station and penstocks, as well as replacement of the existing open canal with a combination of an underground intake tunnel (out of scope), above-ground headrace pipeline, and underground headrace tunnel between Lake King William and Tarraleah Power Station. The project includes the establishment of lay-down areas within Tarraleah Village, adjacent the existing Tarraleah Power Station, and at various locations along the proposed pipeline. Additionally, construction of a new power station and switchyard is proposed adjacent the existing power station, with transmission line options to the north-east (‘northern option’) and south-east (‘southern option’), with the preferred option yet to be determined. The overall project

is expected to take nominally 6 years, with the tunnelling component expected to last nominally 3 years.

Due to the duration of the project, construction compounds are proposed within, and adjacent to, the existing Tarraleah Village, to provide accommodation and associated services for workers, as well as site offices for the coordination of the site's redevelopment. It is noted that the existing visitor accommodation within Tarraleah Village is to be used for housing of workers for the duration of the project, with public access to Tarraleah Village restricted to day time hours only whilst work is underway.

Construction of the headrace pipeline and underground tunnel, as well as the proposed switchyard, power station, lay-down yards, and transmissions lines are the subject of this Noise and Vibration Impact Assessment.

A project description of the overall project has been provided by Hydro Tasmania, and has been reproduced below:

“Hydro Tasmania is proposing to redevelop the Tarraleah Hydropower Scheme to replace end of life assets and provide a more flexible and efficient scheme to ensure a reliable and safe renewable energy source into the future. The key permanent components of the Tarraleah Redevelopment Project are outlined below:

- *An approximately 4.2 km headrace pipeline and associated service roads connecting the Lake King William tunnel (under construction) to the headrace tunnel.*
- *An approximately 9.8 km low pressure headrace tunnel.*
- *An approximately 2.3 km long high pressure power tunnel that splits into two short penstocks before entering the power station.*
- *A partially underground power station with an installed capacity of approximately 180 MW and rated flow of 60 m³/s located adjacent to the existing Tarraleah Power Station.*
- *A surge facility consisting of a 70 m high (above ground level) surge tower and associated underground approximately 265 m high surge shaft to control water pressure in the headrace and power tunnels.*
- *An approximately 6 m³/s pumping station and approximately 0.8 km rising main to transfer water from the existing No. 2 Pond to the power and headrace tunnels via the surge tower.*
- *A transformer yard and switchyard located close to the power station connecting the power station to the proposed transmission line.*
- *A new 22 kV power supply from the existing 22 kV network to the western, mid access and Paddy's Quarry portals, pump station, surge tower and power station will provide power during construction and operation.*
- *A new 220 kV transmission line. There are currently two transmission line options being considered:*
 - *A 14 km double circuit line from the existing Tungatinah Switchyard to the existing Dee Lagoon tee (northern option), or*
 - *A 15 km double circuit line from the proposed Tarraleah Switchyard to the existing Liapootah substation (southern option)*
- *Access tunnels, tunnel portals and access roads to provide access to the headrace and power tunnels. Excess spoil from tunnel, power station and portal excavations will be stored in one of three permanent spoil emplacement areas located at the western portal, mid tunnel access portal and Paddy's Quarry portals.*

Construction of the Tarraleah Redevelopment Project underground works will be completed using drill and blast techniques and may be supported by a tunnel boring machine. Above-ground works will be completed by conventional earth moving and mechanical excavation. To support construction, the following key temporary infrastructure is proposed:

- A construction compound at Tarraleah Village supported by smaller construction compounds located at each of the tunnel portals and the power station. Construction compounds will include site administration facilities and workshops, handle and store materials and equipment imported to site and concrete batching and crushing and screening plant.
- Explosives for excavation work are required to be stored in a dedicated facility. Two explosive magazines will be located both off Butlers Gorge Road.
- To facilitate construction of the power station, a temporary bridge will be built over the Nive River.
- A temporary workforce accommodation facility will be constructed on land adjacent to Tarraleah Village. The facility will consist of prefabricated accommodation units (up to 300 beds) along with recreation facilities, dining hall, canteen, laundry facilities and associated utilities (power, water and sewer).

Upon the completion of works, all temporary construction sites will be rehabilitated.”

The figures on the following pages show an overview of the proposed project layout, with Figure 1.2 showing a layout plan of the entire project, and Figure 1.3 showing the area immediately adjacent the existing Tarraleah Power Station and Tarraleah Village.

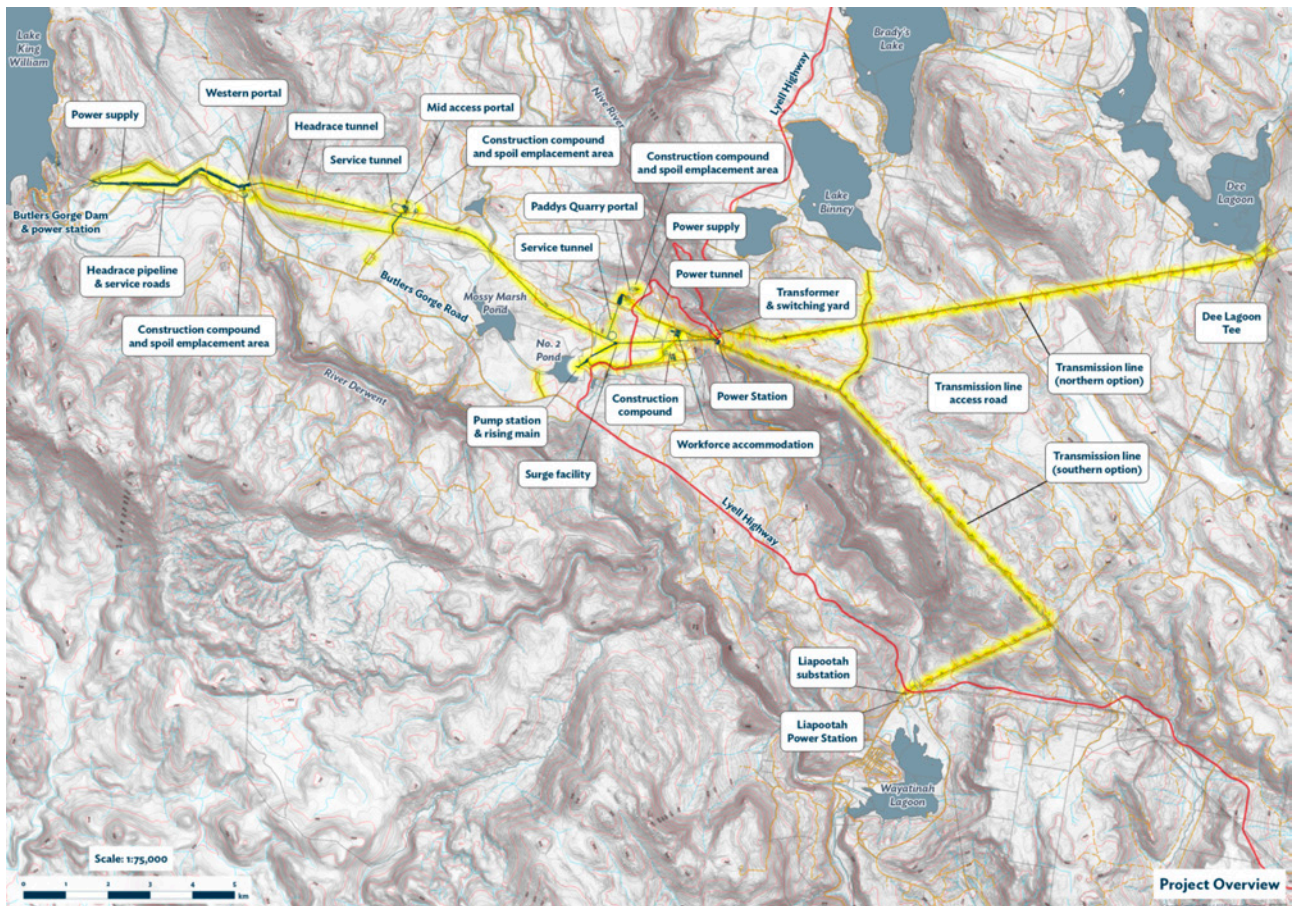


FIGURE 1.2: TARRALEAH REDEVELOPMENT - PROPOSED LAYOUT PLAN



FIGURE 1.3: TARRALEAH POWER STATION 2 (TAPS2) - PROPOSED LAYOUT PLAN

2. CRITERIA

2.1. NOISE CRITERIA - BACKGROUND

When determining appropriate noise criteria for the proposed Tarraleah redevelopment works, various legislation, standards, and guidelines have been referred to. In Tasmania, the legislation generally considered most relevant to environmental noise is the *Tasmanian Environment Protection Policy (Noise) 2009* (the Noise EPP)¹. However, the Noise EPP does not contain any comment or criteria specifically relevant to noise from construction activities; it is regarded as primarily relevant to typical regularly occurring noise sources. As such, the NSW Interim Construction Noise Guideline² is deemed the most relevant reference for the management of noise emissions from construction activities in Australia. The NSW Interim Construction Noise Guideline does not provide absolute numerical criteria, but instead focuses on ensuring that noise emissions from construction work — a noise source that is finite in duration — minimises the impact on sensitive use, and that all ‘feasible’ and ‘reasonable’ work practices are applied to minimise construction noise.

In order to define an acceptable noise level for construction noise at nearby sensitive use as a result of the Tarraleah redevelopment, the NSW Interim Construction Noise Guideline is primarily referred to, with the Tas. Noise EPP and AS 2107 referenced to establish noise levels that are appropriate for the protection of the residential amenity of surrounding sensitive receivers.

The criteria are separated below into two primary sections, summarised as follows:

The ‘Noise Criteria - NSW Interim Construction Noise Guideline’ section focuses on their application and is considered the primary criteria relevant to this assessment.

The ‘Supplementary Noise Criteria - Residential Amenity’ section which outlines standards and guidelines used to determine appropriate noise levels for ensuring no unreasonable loss of amenity. It is noted that the standards and guidelines referenced within this section are not specific to construction noise, and thus are used as a guide only and may be considered to be ‘best-practice’ noise levels.

2.2. NOISE CRITERIA - NSW INTERIM CONSTRUCTION NOISE GUIDELINE

As noted above, the NSW Interim Construction Noise is deemed the most relevant guideline on the management of noise emissions from construction activities in Australia. Where this document cites ‘relevant guideline’, the NSW Interim Construction Noise Guideline is referred to. The following sections provides an overview of the noise management process and appropriate noise management levels.

2.2.1. Noise Management Overview

Construction, by its very nature, is noisy and of finite duration. Acknowledging this, the aforementioned relevant guideline for construction noise is not based on maintaining noise levels below a set level, but rather to, *“focus on applying all ‘feasible’ and ‘reasonable’ work practices to minimise construction noise impacts.”*²

The following general steps are therefore indicated in management of noise emissions from site:

- A. Identify sensitive or affected receivers of site noise.
- B. Identify noise generating equipment to be used and establish which equipment requires further consideration of noise management.
- C. Communicate with the neighbours so they are not “surprised” by noisy works on site, and thus are able to manage their time to limit the impact the noise has on them. *This communication is a critical aspect in the management of construction noise - the importance of this communication cannot be overstated.*

¹ ‘Environmental Protection Policy (Noise) 2009’, Department of Environment, Parks, Heritage and Arts, 2009

² ‘Interim Construction Noise Guideline’, Department of Environment and Climate change NSW, 2009

D. Communicate with site workers so they are aware of the importance in managing site noise emissions. This should be included in any site inductions / toolbox meetings.

2.2.2. Noise Management Levels

In determining which noise sources require further consideration of noise mitigation and management, the relevant guideline utilises the concept of a ‘noise management level’ (NML), which is defined as the ‘Rating Background Level’ (RBL) + 10 dB. The noise management level refers to a level of construction noise at a nearby noise sensitive premises above which there may be some community reaction, and thus noise mitigation and management requires specific consideration.

A secondary level is also noted, above which sensitive receivers are considered ‘highly noise affected’, and there may be strong community reaction.

These levels are based on the NSW Interim Construction Noise Guideline, with the established levels summarised in Table 2.1, below.

TABLE 2.1: SUMMARY OF NOISE MANAGEMENT LEVELS

Location	Address	Sound Pressure Level, 15-minute (dBA)		
		Existing RBL	Noise Management Level (NML)	Highly Noise Affected Level (HNAL)
A	Oldina Drive, Tarraleah Village	30	40	75
B	Bradys Lake	30 *	40	75
C	Bronte Lagoon	30 *	40	75
D	Wyatinah	30 *	40	75

* The existing RBL has not been measured at these locations, and thus they have been inferred based on the assumption that noise due to passing vehicles, residential activities, birds, etc. is equivalent to Tarraleah Village.

It is noted that due to the existing background noise levels at the sensitive receiver locations, the NML is much lower than what would typically be used for construction noise management, and thus is extremely conservative. For context, an NML of 40 dBA is likely to be consistently exceeded by non-construction related noise sources such as passing vehicles, bird and insect noise, general residential noise, etc.

2.3. SUPPLEMENTARY NOISE CRITERIA - RESIDENTIAL AMENITY

Whilst the NSW Interim Construction Noise Guideline uses the concept of a noise management level, it does not focus on maintaining noise levels below a specific level. Therefore, to determine numerical criteria below which the residential amenity of a given receiver is deemed to be protected, various standards and guidelines are referenced to determine appropriate noise levels. The following sections summarise the standards and guidelines considered relevant to the protection of the residential amenity of surrounding sensitive receivers, including workers within Tarraleah Village.

2.3.1. Tasmanian Environmental Protection Policy (Noise) 2009 (Tas. Noise EPP)

The Tasmanian Environment Protection Policy (Noise) 2009 (the Noise EPP) is typically deemed to be the legislation most relevant to noise in Tasmania, the objective of which is to ensure:

“...The environmental values to be protected under this policy are the qualities of the acoustic environment that are conducive to –

(a) the wellbeing of the community or a part of the community, including its social and economic amenity; or

(b) the wellbeing of an individual, including the individual's –

(i) health; and

(ii) opportunity to work and study and to have sleep, relaxation and conversation without unreasonable interference from noise.”

However, it is noted that the Tas. Noise EPP does not contain any comment or criteria related to construction noise, and thus it is referenced here to provide indicative noise levels for which the environmental values specified in the policy “...will be protected for the majority of the human population where the acoustic environment indicator levels are not exceeded...”

Table 1 of the Tas. Noise EPP, a list of Acoustic Environmental Indicator levels are given, with a section of that table reproduced here in Table 2.2.

TABLE 2.2: ACOUSTIC ENVIRONMENTAL INDICATOR LEVELS - TAS. NOISE EPP

Specific Environment	Critical Health Effect	Leq dBA	Time hrs	Lmax dBA
Outdoor living area	Serious annoyance, daytime and evening	55	16	-
	Moderate annoyance, daytime and evening	50	16	-
Outside bedrooms	Sleep disturbance, window open (outdoor values)	45	8	60

It is noted that the 16-hour (day) and 8-hour (night) LAeq time periods refer to the hours of 6AM to 10PM and 10PM to 6AM respectively.

2.3.2. AS 2107

In determining appropriate internal noise levels, AS 2107³ is referenced which provides recommended internal design sound levels for residential buildings in *Item 7 of Table 1*. Due to the location of the proposed worker accommodation (within Tarraleah Village) and the surrounding residential dwellings, the internal design sound level range for ‘houses in rural areas’ from *Table 1* is deemed most appropriate, with the relevant parts reproduced in Table 2.3, below.

TABLE 2.3: INTERNAL DESIGN SOUND LEVEL RANGE - AS 2107

Item	Type of occupancy/activity	Design sound level (L _{Aeq,t}) range	Design reverberation time (T) range, s
7	RESIDENTIAL BUILDINGS (see Note 5 and Clause 5.2)		
	Houses in rural areas with negligible transportation—		
	Sleeping areas (night time)	25 to 30	—

2.4. ADOPTED NOISE CRITERIA

Given the above, the most appropriate criteria is taken from the NSW Interim Construction Noise Guideline, with a ‘noise management level’ of 40 dBA, and a ‘highly noise affected level’ of 75 dBA. As described above, any construction works expected to exceed the NML of 40 dBA will require consideration of noise management strategies. Any works exceeding the HNAL of 75 dBA are required to stop whilst alternative work methods are assessed for their feasibility and practicability.

TABLE 2.4: ADOPTED PROJECT CRITERIA - NSW INTERIM CONSTRUCTION NOISE GUIDELINE

Sound Pressure Level (dBA)	Metric	Noise Management Action	Location Applicable	Hours
40	NML, Leq _(15-minute)	Requires consideration of noise management strategies.	All locations - external	Day time

³ ‘AS 2107 - Recommended design sound levels and reverberation times for building interiors’, Standards Australia, 2016

Sound Pressure Level (dBA)	Metric	Noise Management Action	Location Applicable	Hours
75	HNAL, Leq _(15-minute)	Requires work to be paused if feasible. Assess the duration of the subject noise source and provide respite periods.	All locations - external	Day time

In addition to the above adopted project criteria, additional noise best-practice noise levels are outlined within Table 2.4, below. These noise levels are relevant in ensuring that noise levels are maintained at a reasonable level and will not result in an unreasonable loss of amenity.

TABLE 2.4: BEST-PRACTICE NOISE LEVELS

Source	Sound Pressure Level (dBA)	Metric	Location Applicable	Hours
Tas. EPP	55	Leq _(16-hour)	Tarraleah Village - external	At all times
AS 2107	30	Leq _(1-hour)	Tarraleah Village - internal	At all times

As the worker camp proposed within Tarraleah Village will house shift workers who will be required to sleep during the day time, the AS 2107 internal noise level range for sleeping areas is considered most appropriate, with the Tas. Noise EPP noise level for ‘serious annoyance’ applicable externally outside of Tarraleah Village.

Additionally, it is noted that criteria relevant to worker accommodation as it pertains specifically to worker health and safety have not been included. It is assumed that compliance with the internal noise levels for typical residential use, as outlined by AS 2107 (see Table 2.2, above), will result in noise levels that are acceptable for worker accommodation.

NVC has been informed that worker health and safety is to be managed in accordance with the project’s health and safety system requirements, and thus is not discussed in detail within this report.

2.5. GROUND VIBRATION CRITERIA

Appropriate numerical criteria for the assessment of permissible ground vibration during construction are defined in the following sections, based on two factors: the protection of buildings and other structures (particularly heritage/sensitive structures) from cosmetic or structural damage, and human comfort.

2.5.1. Human Comfort

Regarding vibration assessment during construction, the NSW Interim Construction Noise Guidelines state that “Human comfort vibration from construction works...is to be assessed in accordance with section 2.5 ‘Short-term works’ in *Assessing Vibration – a technical guideline* (DEC 2006).” The DEC Guideline⁴ includes criteria for human exposure to vibration in Table C1.1, which is reproduced here in Table 2.4.

TABLE 2.4: CRITERIA FOR HUMAN EXPOSURE TO VIBRATION (FROM NSW DEC GUIDELINE)

Place	PPV [mm/s]	
	Preferred	Maximum
Continuous Vibration*		
Residences	0.28	0.56
Offices	0.56	1.1
Impulsive Vibration*		
Residences	8.6	17
Offices	18	36

* “The criteria presented in Table C1.1 for continuous vibration relate to vibration that continues uninterrupted for a defined period (usually throughout the daytime or night-time), e.g. continuous construction or maintenance activity. The criteria presented in Table C1.1 for impulsive vibration relate to vibration that builds up rapidly to a peak followed by a damped decay and that may or may not involve several cycles of vibration.”

Vibration sources on site are expected to be a combination of impulsive and continuous. Peak vibration levels from construction are likely to be sourced from rock breaking or other excavation activity involving the movement or breakage of massive objects. In addition, the continuous use of tunnel boring equipment is likely to produce continuous vibration, and thus the adoption and monitoring of both continuous and impulsive (short term) vibration levels is deemed appropriate.

2.5.2. Building Structures

Assessing vibration effects on building structures considers principally protecting the structural integrity of buildings, and avoiding cosmetic damage, i.e. visible cracks in mortar or plasterboard.

To determine a trigger level for ground vibrations appropriate to prompt management, various standards are referred to, as follows.

⁴ *Assessing Vibration - A Technical Guideline*, Department of Environment and Conservation NSW, February 2006.

AS 2436:2010⁵ states “BS 7385-2 provides information on managing ground-borne vibration and its potential effects on buildings.” As such, the British Standard BS7385-2⁶ is referred to, as well as the Australian Standard AS 2187.2 App. J, and the German Standard DIN 4150 Part 3⁷.

The cosmetic damage criteria for these standards are listed in Table 2.5. It is noted that the criteria given by the standards is frequency dependant, as higher frequency vibration is more likely to cause building deterioration at a given magnitude.

TABLE 2.5: REFERENCES FOR COSMETIC DAMAGE VIBRATION CRITERIA

Standard	Type of Structure	Vibration Duration	Criteria	
			Frequency [Hz]	PPV [mm/s]
BS7385_2 & AS2187.2	Reinforced concrete	Transient	> 4	50
	Light buildings	Transient	4 < f < 15	15 - 20
			> 15	20 - 50
AS2187.2	Steel / reinforced concrete	Transient	–	25
DIN 4150	Commercial & Industrial	Short	< 10	20
			10 - 50	20 - 40
			50 - 100	40 - 50
	Residential	Short	< 10	5
			10 - 50	5 - 15
			50 - 100	15 - 20
	Heritage-listed	Short	< 10	3
			10 - 50	3 - 8
			50 - 100	8 - 10

The German Standard DIN 4150 is commonly referred to when structures with potential vibration sensitivity may be present, as it specifies criteria specific to these types of structures. Three types of structures are referenced within the standard, with the respective descriptions for each of the three structures defined under the standard as follows:

Commercial & Industrial: Buildings used for commercial purposes, industrial buildings and buildings of similar design.

Residential: Dwellings and buildings of similar design and/or use.

Heritage-listed: Structures that, because of their particular sensitivity to vibration, do not correspond to those listed above and are of great intrinsic value (e.g. buildings that are under a preservation order).

It is acknowledged that no buildings or structures within Tarraleah are formally heritage-listed. However, certain structures (detailed in Section 2.2.3, below) in the area exhibit characteristics that may render them more sensitive to vibration impacts due to their age, construction type, or functional importance. Accordingly, while the “heritage-listed” category under DIN 4150 does not strictly apply,

⁵ AS 2436:2010, Guide to noise and vibration control on construction, demolition and maintenance sites. Standards Australia, 2010.

⁶ BS 7385 Part 2: 1993, Evaluation and measurement for vibration in buildings. Part 2: Guide to damage levels from ground borne vibration. British Standards, 1993.

⁷ DIN 4150-3: 2016-12 Vibration in buildings. Part 3: Effects on structures. German Institute for Standardisation, December 2016.

its use here represents a conservative approach to help safeguard these potentially vulnerable structures.

Based on the above, the criteria from this standard are adopted as vibration management criteria for this project. Figure 2.1, below, provides a graphical representation of the DIN4150 criteria and their frequency dependence.

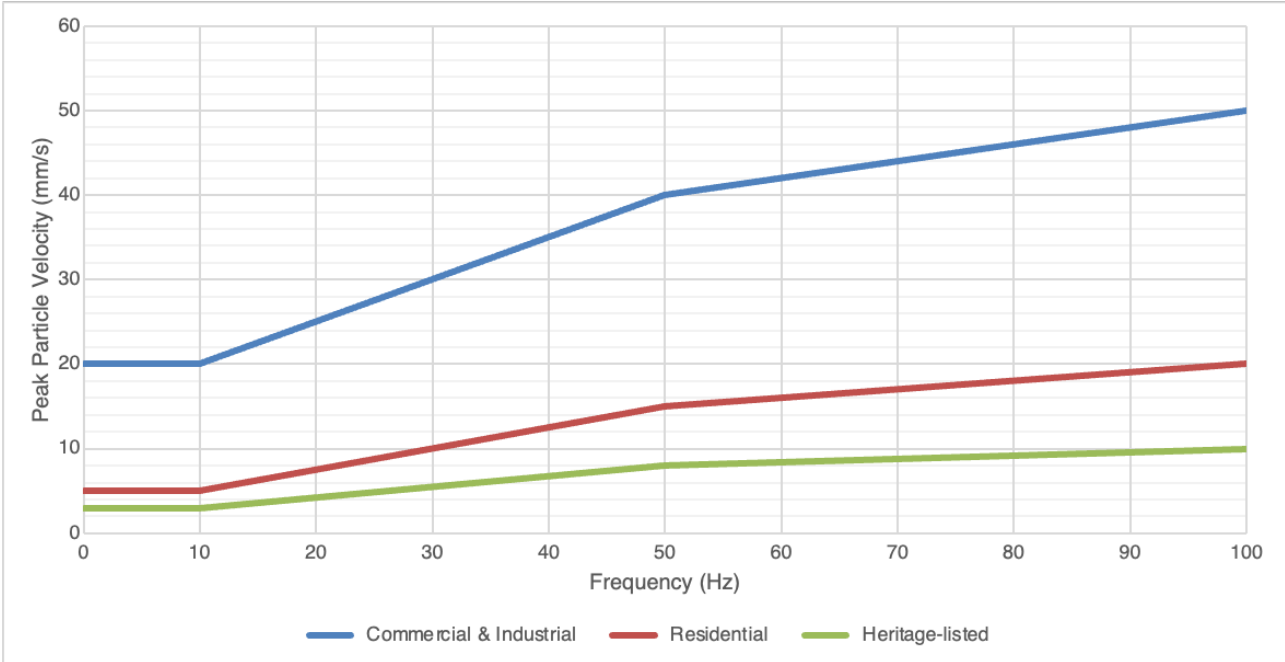


FIGURE 2.1: DIN 4150 VIBRATION CRITERIA

DIN 4150 also provides recommended vibration criteria for underground pipework, which are reproduced in Table 2.6, below.

TABLE 2.6: UNDERGROUND PIPEWORK VIBRATION CRITERIA - DIN 4150

Pipework Type	Peak Particle Velocity, [mm/s]
Steel (including welded pipes)	100
Clay, reinforced concrete, metal (other than steel)	80
Non-reinforced concrete, masonry, plaster	50

The above criteria assumes pipework constructed to modern standards. Where the condition and/or construction quality of the pipework is not known, it is typically appropriate to adopt the commercial building criterion, which is considered conservative for such assets.

Prior to commencing works likely to generate significant vibration, it is strongly recommended that a dilapidation survey of the existing infrastructure in the area be conducted to determine the locations and existing condition of any potentially sensitive structures. Where infrastructure is of historical significance, has existing deterioration, or is constructed on potentially unstable ground/footings, the adoption of the “heritage-listed” building vibration criterion is typically appropriate. Where these structures do not meet any of these conditions, the commercial structure vibration criterion is typically appropriate.

2.5.3. Adopted Vibration Management Levels

The adopted vibration management levels from the various standards and guidelines discussed in sections 2.2.1 and 2.2.2, above, are shown in Table 2.7, below.

TABLE 2.7: GROUND VIBRATION ASSESSMENT CRITERIA

	Peak Particle Velocity, [mm/s]		
	Human Comfort	Sensitive Structures	Commercial Structures
Warning Level	0.56	3	20
Alarm Level	1.1	5	25

The following existing structures are noted as being of high criticality and/or significance:

- The open canals.
- The pipework running through and adjacent Tarraleah Village
- The penstocks and accompanying infrastructure adjacent Tarraleah Village.
- The original school house and church.
- The accommodation cottages and visitors lodge.
- The road / bridge adjacent the existing Tarraleah Power Station.
- The existing Tarraleah Power Station.

These structures would not typically be considered assessable under the DIN 4150 criteria for heritage or sensitive structures, as its values have been empirically determined to prevent even minor cosmetic damage to fragile items such as plaster and paintwork, rather than commercial infrastructure and relatively modern buildings. As such, the adoption of this criteria for potentially sensitive structures is extremely conservative.

3. NOISE MEASUREMENTS

Unattended noise measurements were made on site between the 5th and 15th April 2024, to quantify existing noise levels in the area. Measurements used a Svan Type 1 sound level meter, logging in A-weighted decibels with a *Fast* response time. The data set comprised overall levels, one-third octave spectra and full statistical data. Measurements were made within Tarraleah Village adjacent existing accommodation cottages (location A), which was chosen as being representative of the existing noise levels within Tarraleah Village in general. The results of the noise measurements are summarised in Table 3.1, below.

TABLE 3.1: SUMMARY OF MEASURED NOISE LEVELS - LOCATION A

Time Period	Sound Pressure Level, dBA		
	Location A		
	L10	L90	LEQ
Day Time (6AM – 10PM)	40	30	43
Night Time (10PM – 6AM)	31	27	31

The weather over the measurement period was *fine*, with the wind speed in the area, as measured at the Butler’s Gorge BOM weather station⁸, summarised in Figure 3.1, below.

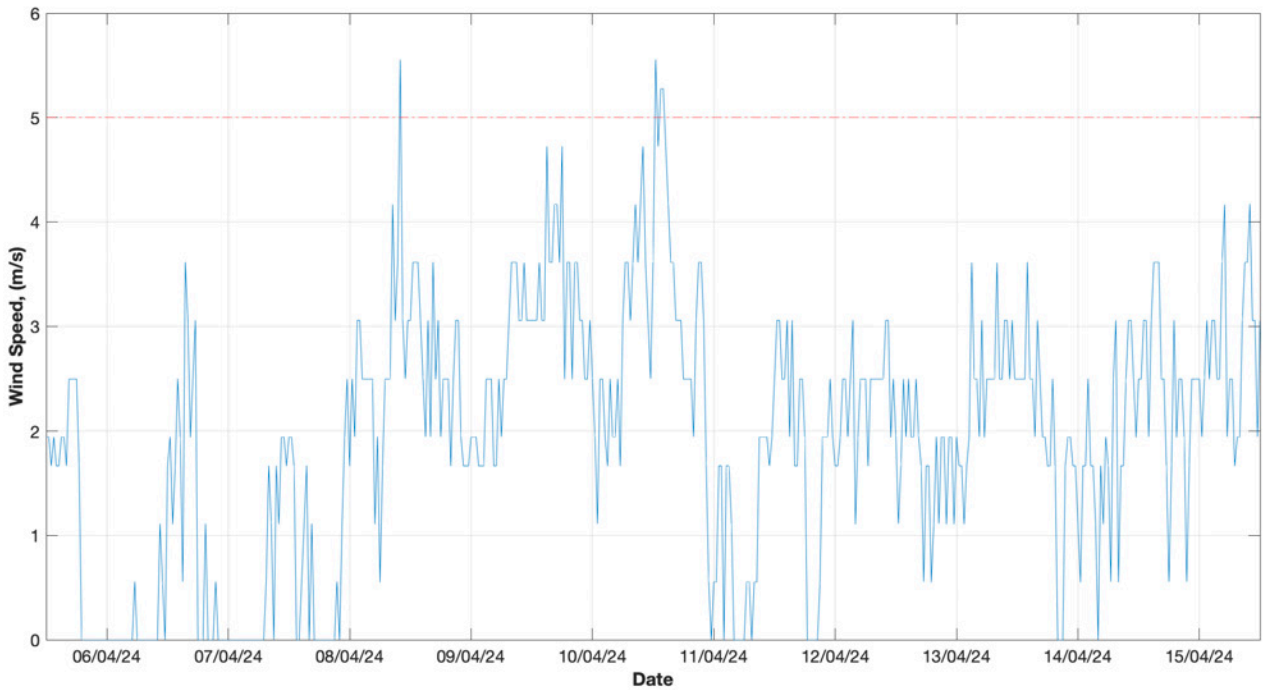


FIGURE 3.1: MEASURED WIND SPEED

As seen in Figure 3.1, the wind speed exceeded the 5 m/s limit outlined by the Tasmanian Noise Measurement Procedures Manual on the 8th and 10th of April. The measured noise levels during these periods have been omitted from the noise levels summarised in Table 3.1, above.

⁸ Bureau of Meteorology Weather Station ID: 096003

4. NOISE MODELLING

To quantify the predicted noise levels at the various surrounding receivers, a software noise propagation model has been constructed. Nine key work areas have been identified, with software noise modelling of the proposed equipment within each work area implemented using *iNoise*⁹ software. The relevant noise sources have been split into three distinct scenarios, an ‘implementation’ scenario, ‘operational’ scenario, and a scenario for the construction of the transmission lines, each of which is outlined within its own section below. It is noted that when assessing noise levels across Tarraleah Village as a result of construction works, an additional receiver location has been included on the eastern side of the existing accommodation cottages, denoted location A.2. This location has been included to ensure a conservative approach due to the greater exposure to noise emissions from works within the TAPS2 and Switchyard work areas.

The work areas included within each of the modelled scenarios are summarised below.

Implementation Scenario:

- Tarraleah (Implementation)

Operational Scenario:

- Tarraleah Village (Operational)
- Paddy’s Quarry & Surge Access Tunnel Portal
- Tarraleah Power Station 2 (TAPS2)
- Switchyard
- Surge Tower & Pump House
- Mid Access Portal
- Western Portal
- Headrace Pipeline

Transmission Line Scenario:

- Transmission Lines

⁹ *iNoise* V2024.1 Pro, DGMR Software

4.1. GENERAL MODELLING ASSUMPTIONS

iNoise software implements the ISO 9613¹⁰ algorithms for environmental noise. The predictions account for geometric divergence, barrier attenuation, atmospheric absorption, reflections / screening from buildings, and ground absorption. The following assumptions have been made in the predictions and are shared across the models:

- 5 m topographical contours (from LiDAR data) have been used to model the site and surrounding area.
 - 10 m topographical contours (from LiDAR data) have been used to model the noise emissions from the transmission lines (see Section 4.12)
- The ground has been assumed to have a ground factor of 0.5 (50% reflective) across the entire model.
 - Given the land surrounding the source and receivers comprises thick vegetation, this is conservative.
- All building facades have been modelled with a reflection factor of 0.8 (80% reflective).
- As per the Tasmanian Noise Measurement Procedures Manual, noise levels are predicted at 1.2 m above ground level.
- The equipment modelled has been taken from a spreadsheet of proposed plant and timeline¹¹ provided by Hydro Tasmania, with modelled equipment in each working area representative of a period deemed to reflect worst-case works.
 - Equipment related to the transmission lines have been taken from a spreadsheet¹² provided by Hydro Tasmania.

¹⁰ 'ISO 9613 - Attenuation of sound during propagation outdoors', International Organization for Standardization, 1993

¹¹ 'Tarraleah Redevelopment - Plant and Imported Materials Estimate NVC', provided by Hydro Tasmania, 17/04/24

¹² 'Plant and Equipment Noise Levels for Construction Activities Transmission Lines', provided by Hydro Tasmania, 11/06/25

4.2. IMPLEMENTATION SCENARIO

The ‘implementation’ scenario is representative of the works associated with the implementation, construction and setup of the worker village within Tarraleah Village. During this period, the only noise sources are those within Tarraleah Village.

4.2.1. Noise Modelling - Tarraleah Village (Implementation)

The key details relating to the noise modelling of noise sources within Tarraleah Village during the ‘implementation’ scenario summarised below:

- Nominally 30 dump truck movements have been modelled during the day time period, representative of three trucks travelling between Tarraleah Village and Paddy’s Quarry five times each.
 - The primary source of heavy vehicle noise is the engine / exhaust system, and so the source is modelled at a height of 1 m above ground level (AGL).
- The sound power levels of the dump trucks have been taken from previous measurements conducted by NVC of fully loaded B-doubles travelling up an incline. This is considered to be conservative.

Figure 4.1, below, shows the modelled locations of the noise sources, with Table 4.1 summarising the modelled noise sources and their quantities, sound power levels and modelled heights above ground level (AGL). Note that the broken white line denotes the approximate location of the proposed tunnel.

TABLE 4.1: MODELLED NOISE SOURCES - TARRALEAH VILLAGE - IMPLEMENTATION

Equipment	Qty.	Sound Power Level (dBA)	Height AGL (m)
Excavator (22 T)	1	103	1.5
Excavator (32 T)	1	104	1.5
30 T Dump Truck	3	103 each	1
D7 Dozer (28 T)	1	107	1.5
WA200 Wheeled Loader	1	101	1.5
15 T Multi-Wheeled Roller	1	102	1.5

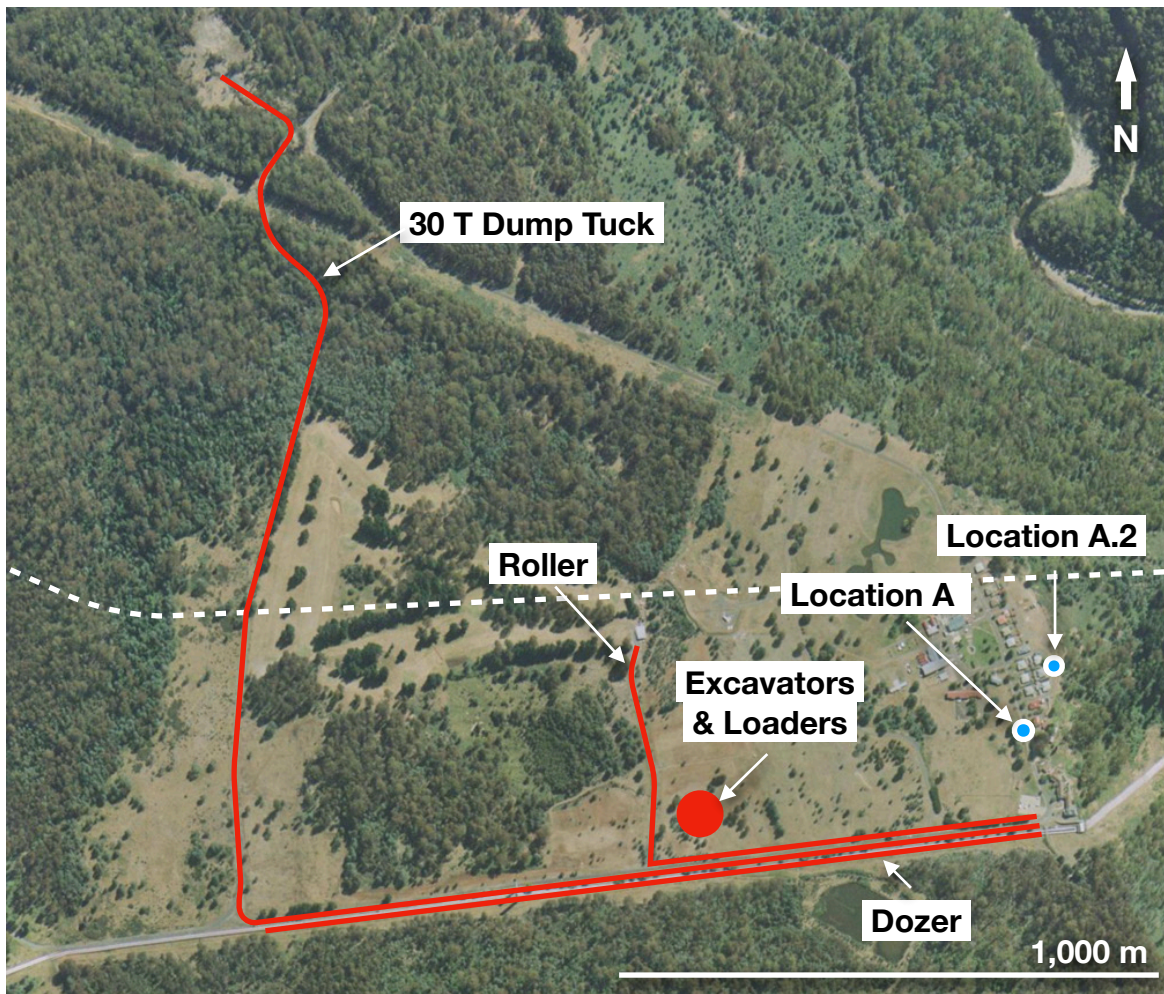


FIGURE 4.1: MODELLED NOISE SOURCES - TARRALEAH VILLAGE - IMPLEMENTATION

4.2.2. Results (Implementation)

During the implementation scenario, only works within Tarraleah Village associated with the implementation of the Tarraleah work area have been modelled. This is representative of works within Tarraleah Village that are carried out to ‘set up’ the worker camps, administrative areas, lay-down yards, etc., with the modelled sources outlined in Section 4.2.1, above. Table 4.2, below, summarises the predicted noise levels at the four key sensitive receivers, with a fifth receiver (location A.2) included to determine likely noise levels on the eastern side of the existing accommodation cottages in Tarraleah.

TABLE 4.2: PREDICTED NOISE LEVELS - IMPLEMENTATION

Noise Source	Predicted Sound Pressure Level (dBA)				
	A	A.2	B	C	D
Tarraleah Village - Implementation	40	33	< 20	< 20	< 20

Figure 4.2, below, presents the predictive noise contours over Tarraleah Village during the implementation scenario.

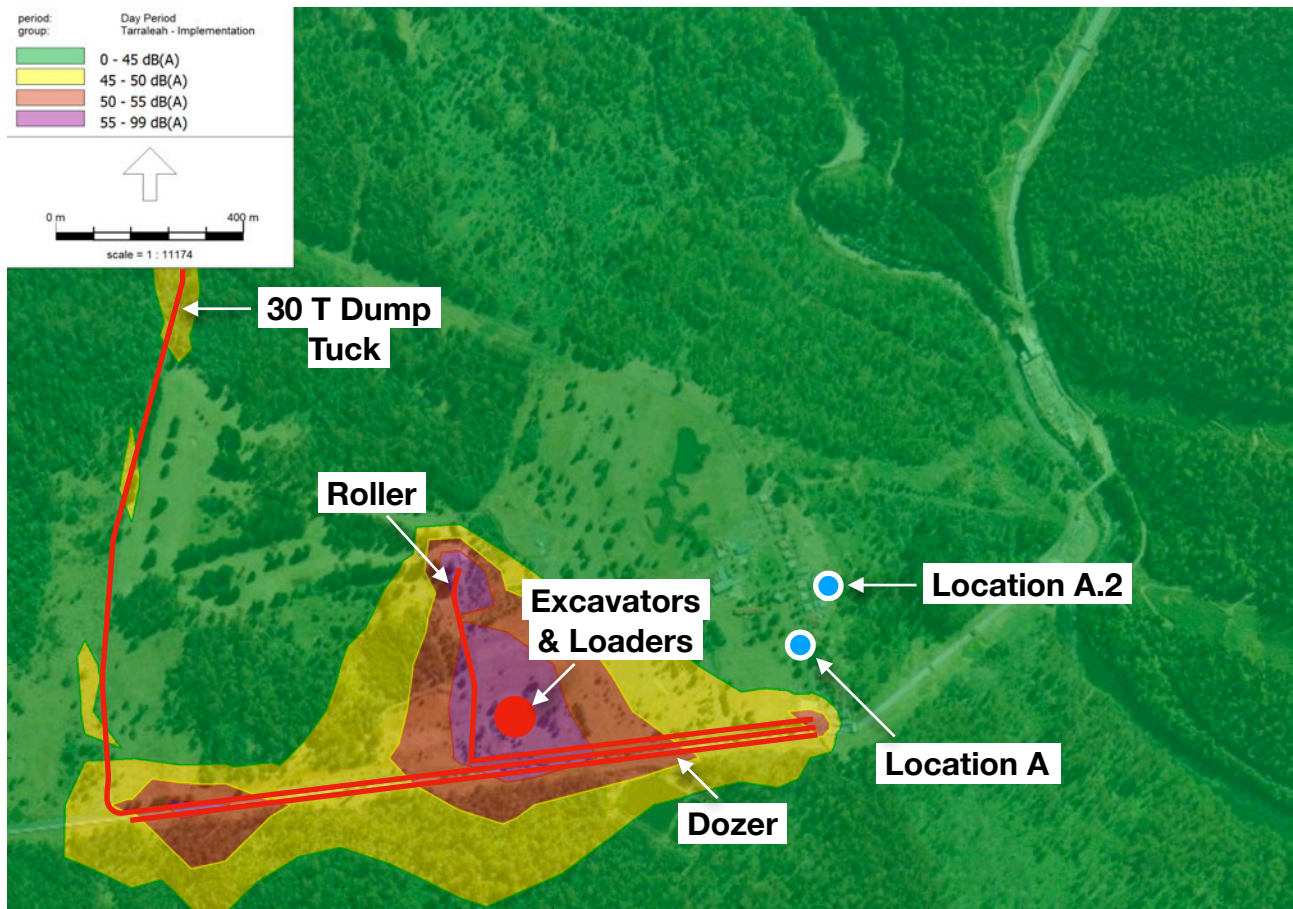


FIGURE 4.2: PREDICTIVE NOISE CONTOURS (IMPLEMENTATION) - TARRALEAH VILLAGE

4.3. OPERATIONAL SCENARIO

The ‘operational’ scenario is representative of the works associated with the ongoing construction of the Tarraleah redevelopment project. During this period, key noise sources spread across the entire project site are included, with a key details of the modelling for each work area outlined within its own section below.

4.3.1. Tarraleah Village (Operational)

The key details relating to the noise modelling of noise sources within Tarraleah Village during the ‘operational’ scenario are as follows:

- Nominally 20 tipper truck movements have been modelled during the day time period, representative of a single tipper truck travelling between Tarraleah Village and Paddy’s Quarry 10 times.
 - The primary source of heavy vehicle noise is the engine / exhaust system, and so the source is modelled at a height of 1 m above ground level (AGL).
- The sound power levels of the 12 T tipper trucks have been taken from previous measurements conducted by NVC of fully loaded B-doubles travelling up an incline. This is considered to be conservative.

Figure 4.3, below, shows the modelled locations of the noise sources, with Table 4.3 summarising the modelled noise sources and their quantities, sound power levels and modelled height above ground level (AGL). Note that the broken white line denotes the approximate location of the proposed tunnel.

TABLE 4.3: MODELLED NOISE SOURCES - TARRALEAH VILLAGE - OPERATIONAL SCENARIO

Equipment	Qty.	Sound Power Level (dBA)	Height AGL (m)
Excavator (2.8 T)	1	95	1
Excavator (8 T)	1	99	1.5
12 T Tipper Truck	2	103 each	1

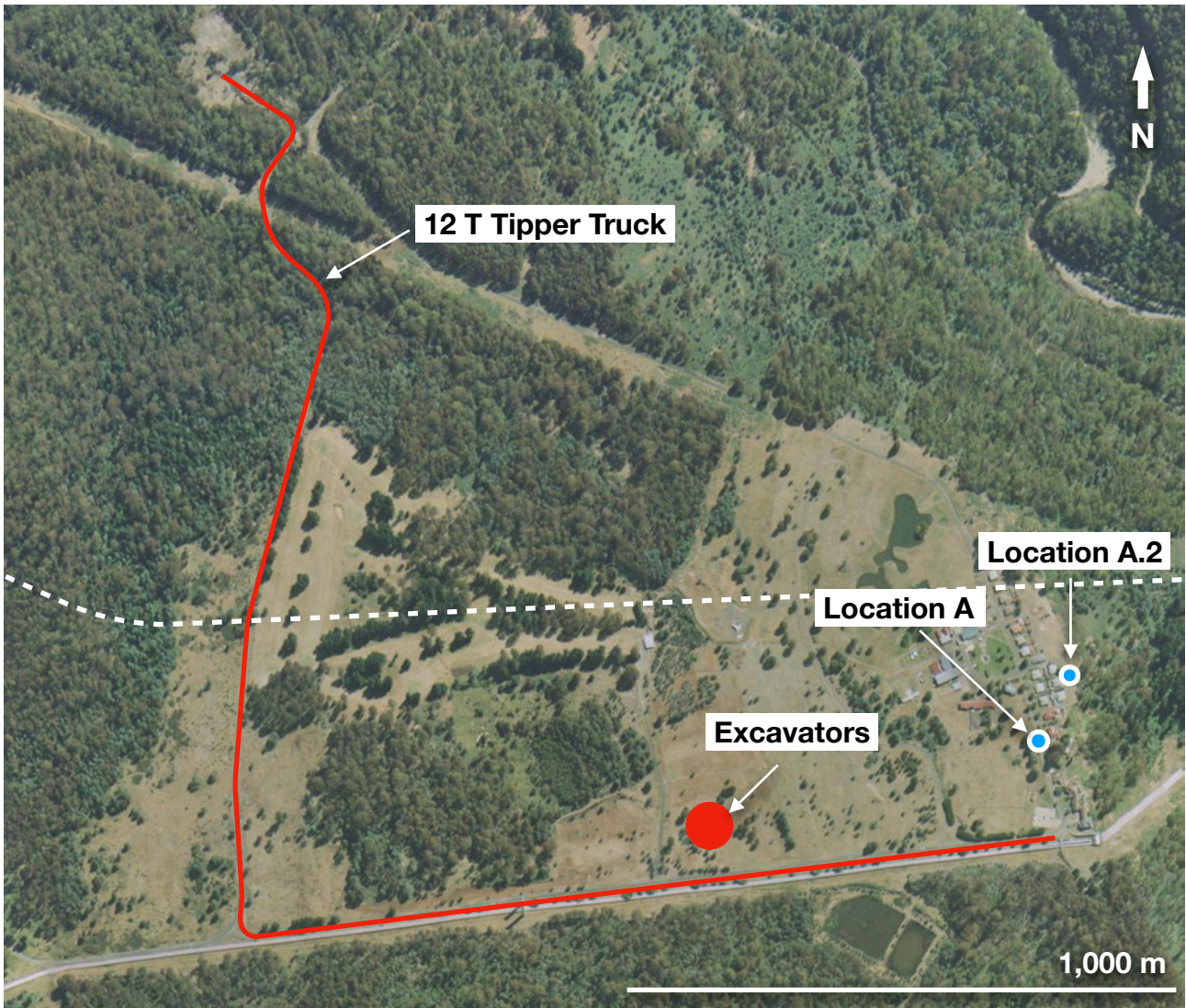


FIGURE 4.3: MODELLED NOISE SOURCES - TARRALEAH VILLAGE - OPERATIONAL SCENARIO

4.3.2. Paddy’s Quarry & Surge Access Tunnel Portal

The key details relating to the noise modelling of noise sources within the Paddy’s Quarry & Surge Access Tunnel Portal area are as follows:

- A single worst-case scenario has been modelled, representative of a period within the project’s timeline in which noise emissions from works within Paddy’s Quarry are likely to be the worst.
 - Note that noise emissions from trucks travelling between Tarraleah Village and Paddy’s Quarry have been included in Section 4.3.1, above, and thus are omitted here.
- The crusher modelled within Paddy’s Quarry is typical of a significant quarrying operation crushing hard product such as dolerite. It is noted that given the likely use case of the proposed Paddy’s Quarry crusher, this is conservative and represents a worst-case scenario.
- A heavy vehicle has been modelled within Paddy’s Quarry, typical of a truck transporting materials across site and carrying out low speed manoeuvring.

Figure 4.4, below, shows the modelled locations of the noise sources, with Table 4.4 summarising the modelled noise sources and their quantity, sound power level and modelled height above ground level (AGL). Note that the broken white line denotes the approximate location of the proposed tunnel.

TABLE 4.4: MODELLED NOISE SOURCES - PADDY’S QUARRY & SURGE ACCESS TUNNEL PORTAL

Equipment	Qty.	Sound Power Level (dBA)	Height AGL (m)
Excavator (32 T)	1	104	1.5
12 T Tipper Truck	1	103	1
D9 Dozer (50 T)	1	114	1.5
Cone Crusher	1	128	2

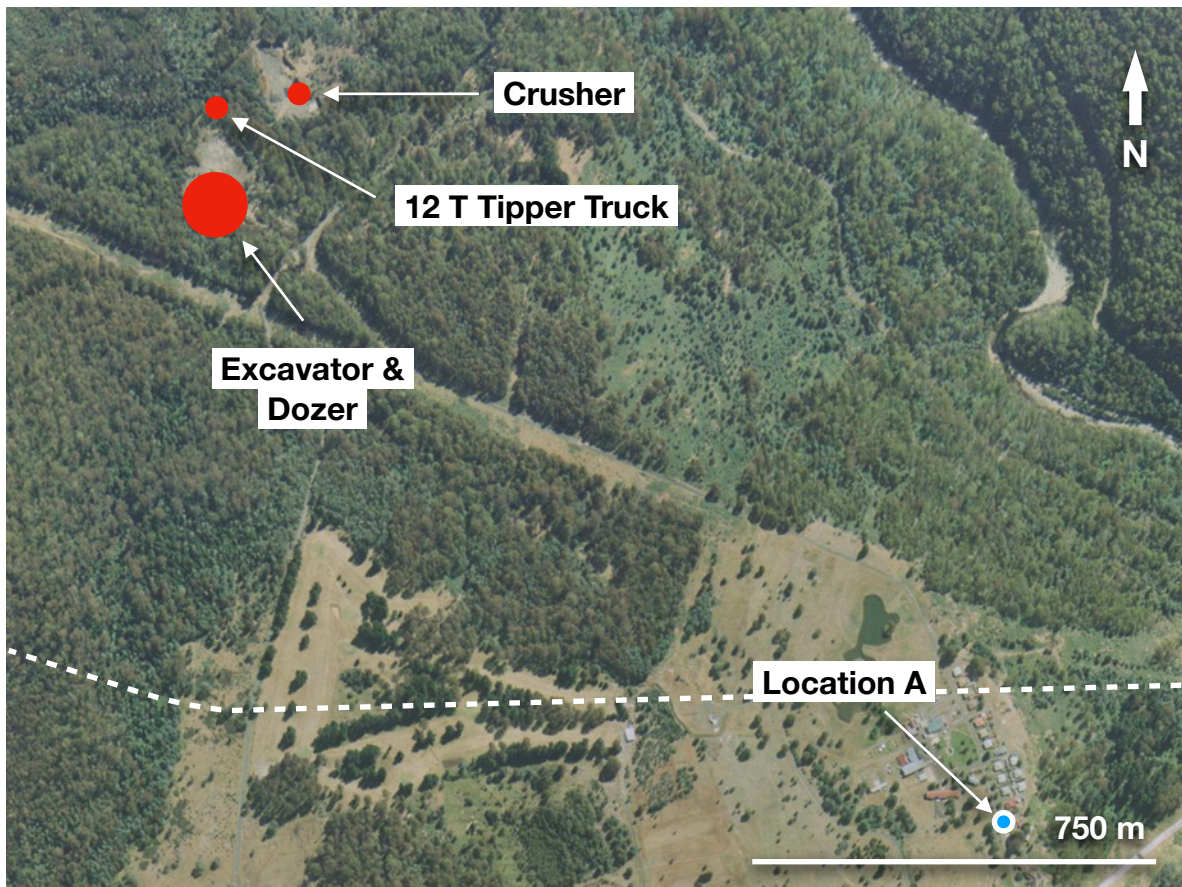


FIGURE 4.4: MODELLED NOISE SOURCES - PADDY’S QUARRY & SURGE ACCESS TUNNEL PORTAL

4.3.3. Tarraleah Power Station (TAPS2)

The key details relating to the noise modelling of noise sources associated with construction within the Tarraleah Power Station 2 (TAPS2) area are as follows:

- A single worst-case scenario has been modelled, representative of a period within the project's timeline in which noise emissions from works within the vicinity of TAPS2, and the surrounding area, are likely to be the worst. This includes truck movements between TAPS2 and Paddy's Quarry.
 - Note that noise emissions from trucks travelling between TAPS2 and Paddy's Quarry have been included in the noise modelling within this section.
 - No noise sources from activities within Paddy's Quarry itself have been included in this scenario.
- Nominally 20 dump and tipper truck movements have been modelled during the day time period, representative of one of each truck travelling between TAPS2 and Paddy's Quarry ten times each.
- The primary source of heavy vehicle noise is the engine / exhaust system, and so the source is modelled at a height of 1 m above ground level (AGL).
- The sound power level of all trucks have been taken from previous measurements conducted by NVC of a fully loaded B-double travelling up an incline.
 - Due to the gradient of the area surrounding Tarraleah, noise levels may decrease, depending on whether trucks are travelling on a gradient or on flat ground. As such, the modelled noise source is considered to be conservative.
- Noise emissions from 'down-the-hole' (DTH) hammer drilling have been included within this section.
 - A source sound power level spectrum based on comparison between excavator mounted rock breakers, drill rigs, handheld jackhammers, and various Australian Standards and Guidelines has been modelled. The resulting sound power level of 125 dBA is nominally 5 dB greater than typical rock breakers and quarry drill rigs, and thus is very conservative and is representative of worst-case.
 - The source has been modelled at ground level. It is noted that noise from DTH hammer drilling is primarily sourced from impacts at the head of the drill shaft, and thus the noise source will be underground for the majority of the time. Therefore, modelling the source at ground level is considered to be conservative.

Figure 4.5, below, shows the modelled locations of the noise sources, with Table 4.5 summarising the modelled noise sources and their quantity, sound power level and modelled height above ground level (AGL). Note that the broken white line denotes the approximate location of the proposed tunnel.

TABLE 4.5: MODELLED NOISE SOURCES - TARRALEAH POWER STATION 2 (TAPS2)

Equipment	Qty.	Sound Power Level (dBA)	Height AGL (m)
Excavator (2.8 T)	1	95	1
Excavator (8 T)	1	99	1.5
Excavator (22 T)	1	103	1.5
Excavator (32 T)	1	104	1.5
30 T Dump Truck	1	103	1
12 T Tipper Truck	1	103	1
D6 Dozer (23 T)	1	107	1.5
D9 Dozer (50 T)	1	114	1.5
WA200 Wheeled Loader	1	101	1.5
Down-The-Hole Hammer Drill	1	125	0

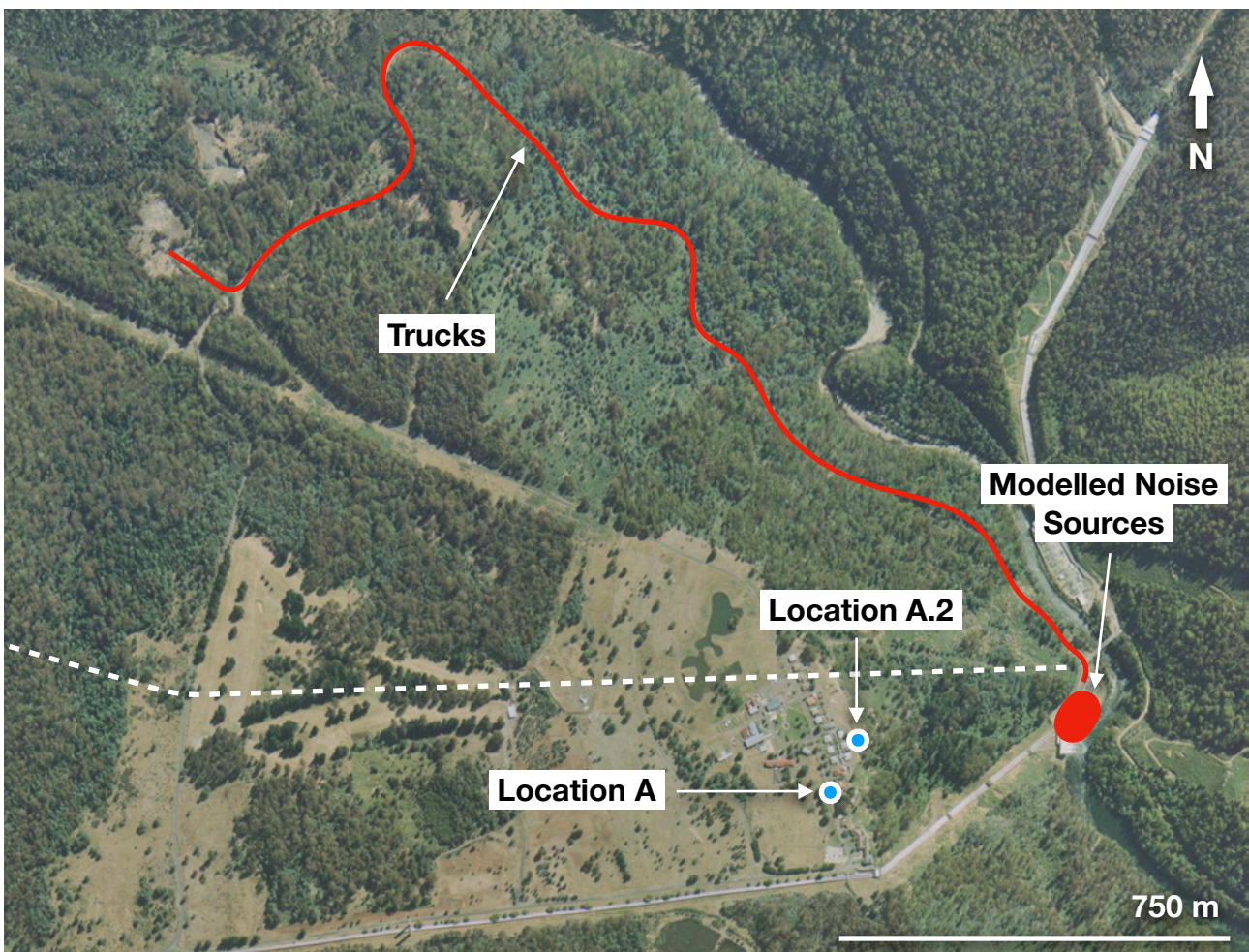


FIGURE 4.5: MODELLED NOISE SOURCES - TARRALEAH POWER STATION 2 (TAPS2)

4.3.4. Switchyard

The key details relating to the noise modelling of construction noise sources within the Switchyard area are as follows:

- A single worst-case scenario has been modelled, representative of a period within the project’s timeline in which noise emissions from works within the vicinity of the Switchyard, and the surrounding area, are likely to be the worst. This includes truck movements between the Switchyard and Paddy’s Quarry.
- Nominally 20 dump and tipper truck movements each have been modelled during the day time period, representative of one of each truck travelling between the Switchyard and Paddy’s Quarry ten times each.

Figure 4.6, below, shows the modelled locations of the noise sources, with Table 4.6 summarising the modelled noise sources and their quantity, sound power level and modelled height above ground level (AGL). Note that the broken white line denotes the approximate location of the proposed tunnel.

TABLE 4.6: MODELLED NOISE SOURCES - SWITCHYARD

Equipment	Qty.	Sound Power Level (dBA)	Height AGL (m)
Excavator (32 T)	1	104	1.5
30 T Dump Truck	1	103	1
12 T Tipper Truck	1	103	1
D9 Dozer (50 T)	1	114	1.5
WA200 Wheeled Loader	1	101	1.5

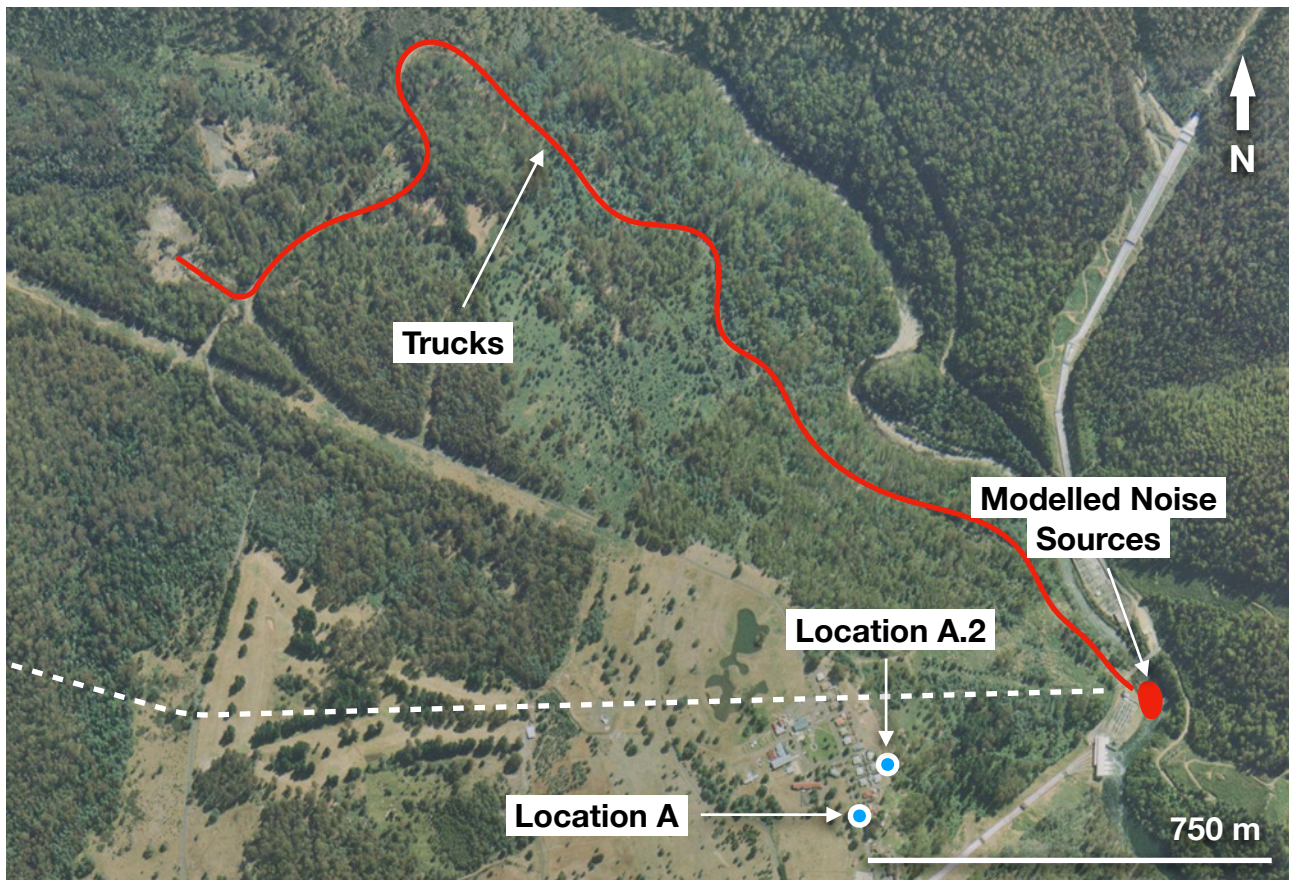


FIGURE 4.6: MODELLED NOISE SOURCES - SWITCHYARD

4.3.5. Surge Tower & Pump House

The key details relating to the noise modelling of construction noise sources within the Surge Tower & Pump House area are as follows:

- A single worst-case scenario has been modelled, approximately representative of a period within the project’s timeline in which noise emissions from works within the vicinity of the Switchyard, and the surrounding area, are likely to be the worst. This includes truck movements between the Surge Tower & Pump House and Paddy’s Quarry.
- Nominally 20 dump and tipper truck movements each have been modelled during the day time period, representative of one of each truck travelling between the Surge Tower & Pump House and Paddy’s Quarry ten times each.

Figure 4.7, below, shows the modelled locations of the noise sources, with Table 4.7 summarising the modelled noise sources and their quantity, sound power level and modelled height above ground level (AGL). Note that the broken white line denotes the approximate location of the proposed tunnel.

TABLE 4.7: MODELLED NOISE SOURCES - SURGE TOWER & PUMP HOUSE

Equipment	Qty.	Sound Power Level (dBA)	Height AGL (m)
Excavator (32 T)	1	104	1.5
Excavator (71 T)	1	105	1.5
Excavator (89 T)	1	108	1.5
30 T Dump Truck	1	103 each	1
D6 Dozer (23 T)	1	107	1.5
WA200 Wheeled Loader	1	101	1.5
3 T Twin Roller	1	101	1.5

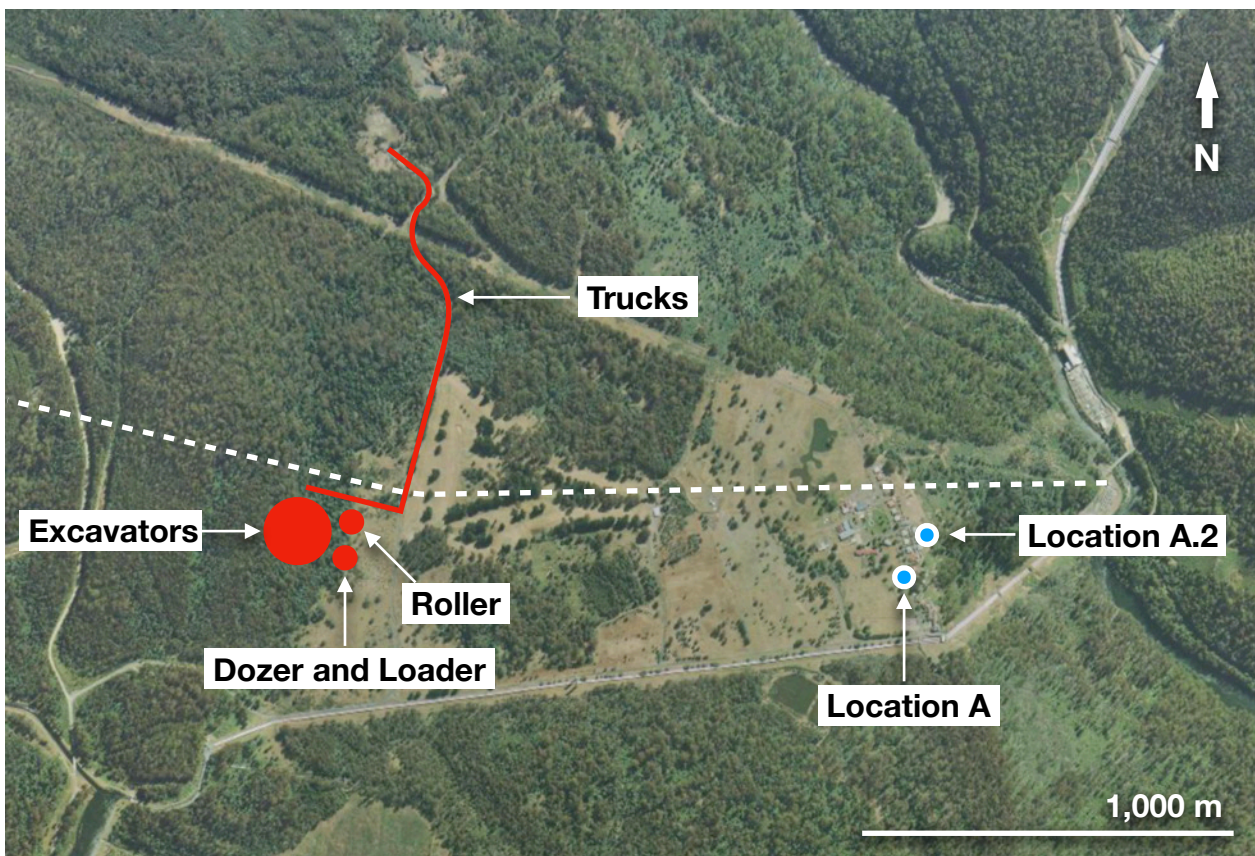


FIGURE 4.7: MODELLED NOISE SOURCES - SURGE TOWER & PUMP HOUSE

4.3.6. Mid Access Portal

The key details relating to the noise modelling of noise sources within the Mid Access Portal work area are as follows:

- This location only includes mobile plant, with excavators and dozers being the primary equipment operated with any meaningful noise emissions.
- This location is nominally 7.6 km and 11 km from Tarraleah Village and the nearest sensitive use in other ownership, respectively.
 - Due to the significant distances involved, the location of the nearest sensitive use in other ownership has been omitted from Figure 4.8 to maintain a reasonable scale.

Figure 4.8, below, shows the modelled locations of the noise sources, with Table 4.8 summarising the modelled noise sources and their quantity, sound power level and modelled height above ground level (AGL). Note that the broken white line denotes the approximate location of the proposed tunnel.

TABLE 4.8: MODELLED NOISE SOURCES - MID ACCESS PORTAL

Equipment	Qty.	Sound Power Level (dBA)	Height AGL (m)
Excavator (32 T)	1	104	1.5
Excavator (40 T)	1	107	1.5
D9 Dozer (50 T)	2	114 each	1.5

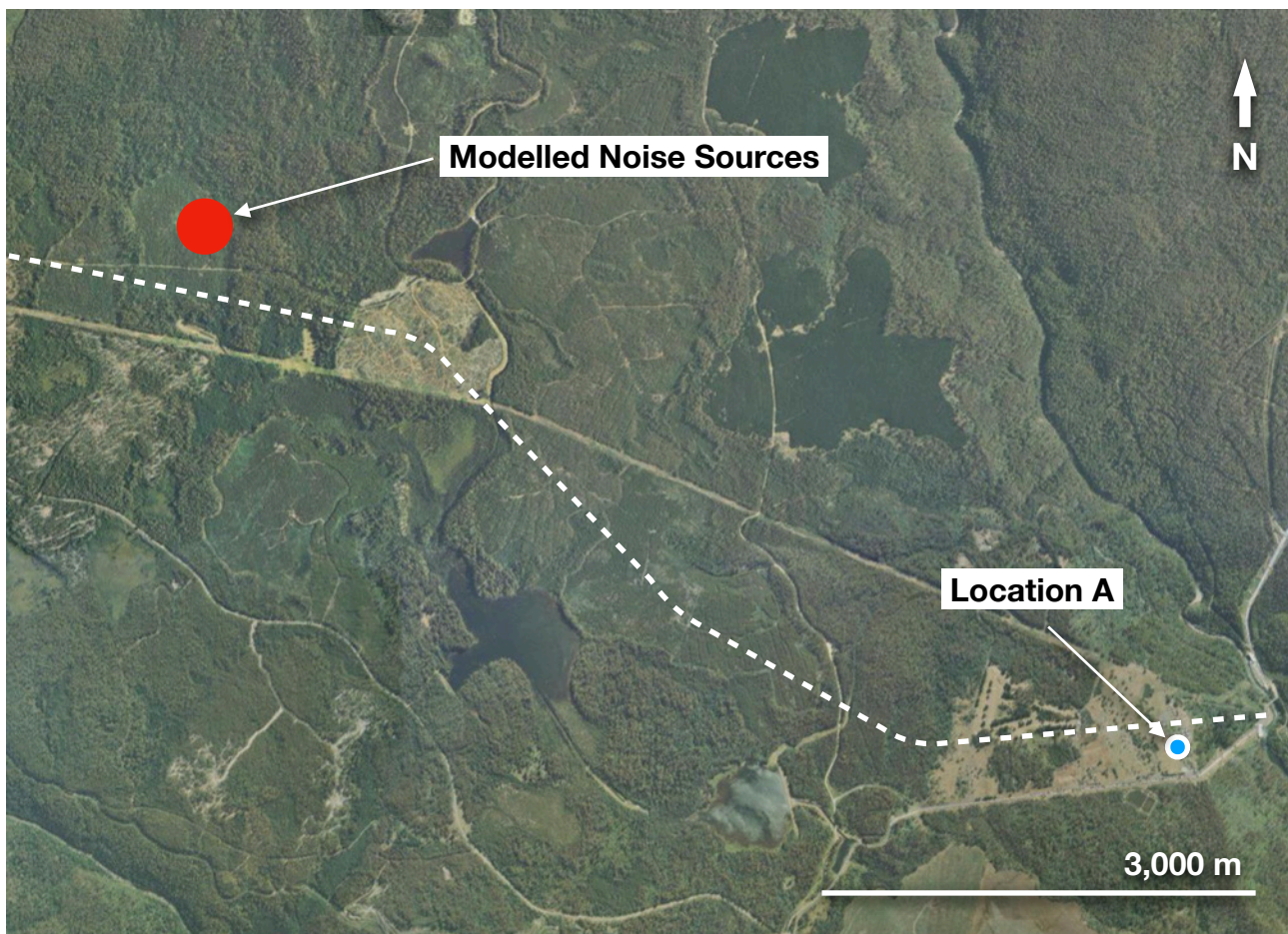


FIGURE 4.8: MODELLED NOISE SOURCES - MID ACCESS PORTAL

4.3.7. Western Portal

The key details relating to the noise modelling of noise sources within the Western Portal are as follows:

- This location includes various mobile plant, modelled in a single location, and a crusher, modelled to the north-west of the mobile plant. This crusher is typical of a significant quarrying operation crushing hard product such as dolerite. It is noted that given the likely use case of the proposed crusher, this is conservative and represents a worst-case scenario.
- This location is nominally 11 km and 15 km from Tarraleah Village and the nearest sensitive use in other ownership respectively.
 - Due to the significant distances involved, these locations are omitted from Figure 4.9, below, to maintain a reasonable scale.

Figure 4.9, below, shows the modelled locations of the noise sources, with Table 4.9 summarising the modelled noise sources and their quantity, sound power level and modelled height above ground level (AGL). Note that the broken white line denotes the approximate location of the proposed tunnel. The blue line denotes the headrace pipeline, with the yellow line denoting the intake tunnel, which is outside of the scope of this assessment.

TABLE 4.9: MODELLED NOISE SOURCES - WESTERN PORTAL

Equipment	Qty.	Sound Power Level (dBA)	Height AGL (m)
Excavator (32 T)	2	104 each	1.5
Excavator (40 T)	1	114	1.5
D9 Dozer (50 T)	1	107	1.5
Cone Crusher	1	128	2

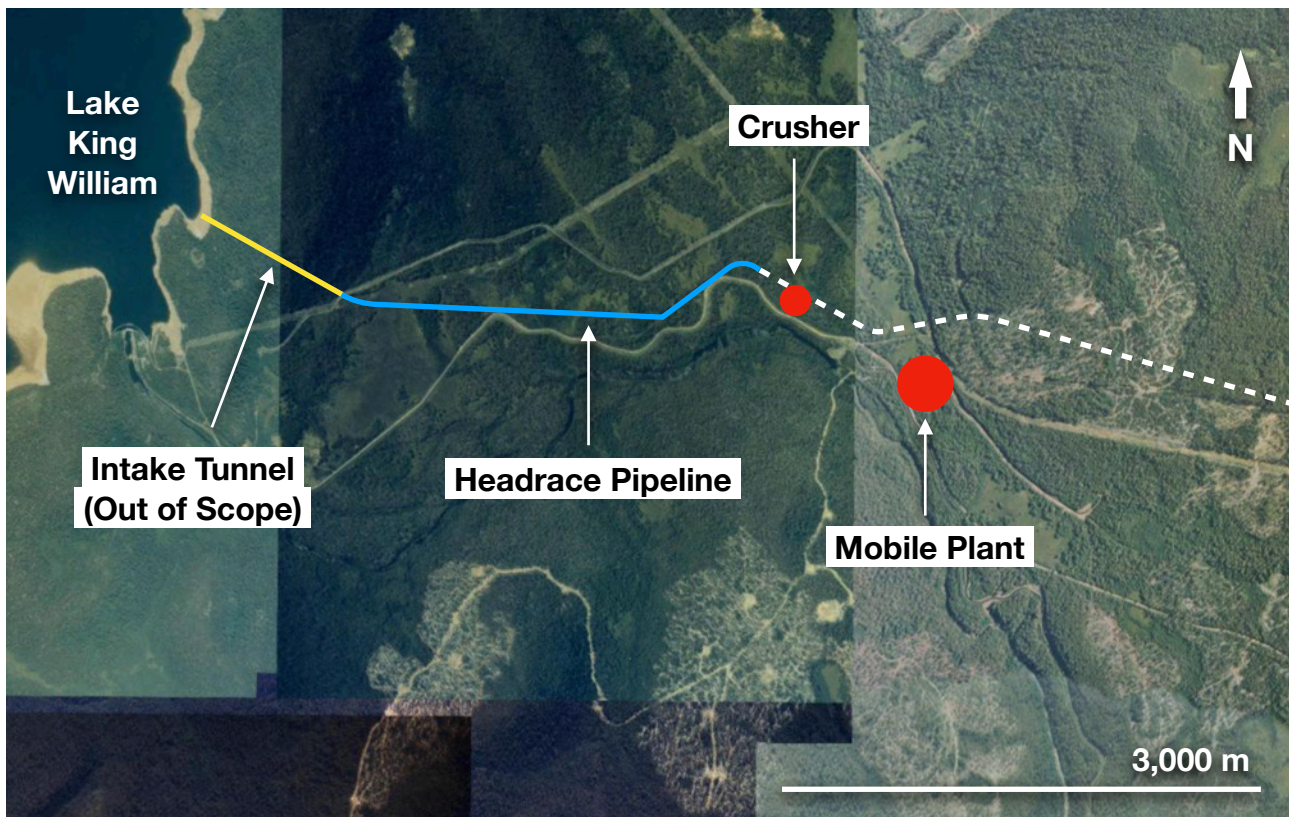


FIGURE 4.9: MODELLED NOISE SOURCES - WESTERN PORTAL

4.3.8. Headrace Pipeline

The key details relating to the noise modelling of noise sources within the headrace pipeline working area are as follows:

- Noise sources have been modelled on the eastern end of the headrace pipeline, as close to the surrounding sensitive receivers as is practicable.
- This location is nominally 12 km and 16 km from Tarraleah Village and the nearest sensitive use in other ownership (location B - Bradys Lake) respectively.
 - Due to the significant distances involved, these locations are omitted from Figure 4.10, below, to maintain a reasonable scale.

Figure 4.10, below, shows the modelled locations of the noise sources, with Table 4.10 summarising the modelled noise sources and their quantity, sound power level and modelled height above ground level (AGL). Note that the broken white line denotes the approximate location of the proposed tunnel. The blue line denotes the headrace pipeline, with the yellow line denoting the intake tunnel which is outside of the scope of this assessment.

TABLE 4.10: MODELLED NOISE SOURCES - HEADRACE PIPELINE

Equipment	Qty.	Sound Power Level (dBA)	Height AGL (m)
Excavator (22 T)	1	103	1.5
Excavator (40 T)	1	114	1.5
30 T dump truck	1	103	1.5
20 T Franna Crane	1	98	2
3 T Twin Roller	1	101	1.5

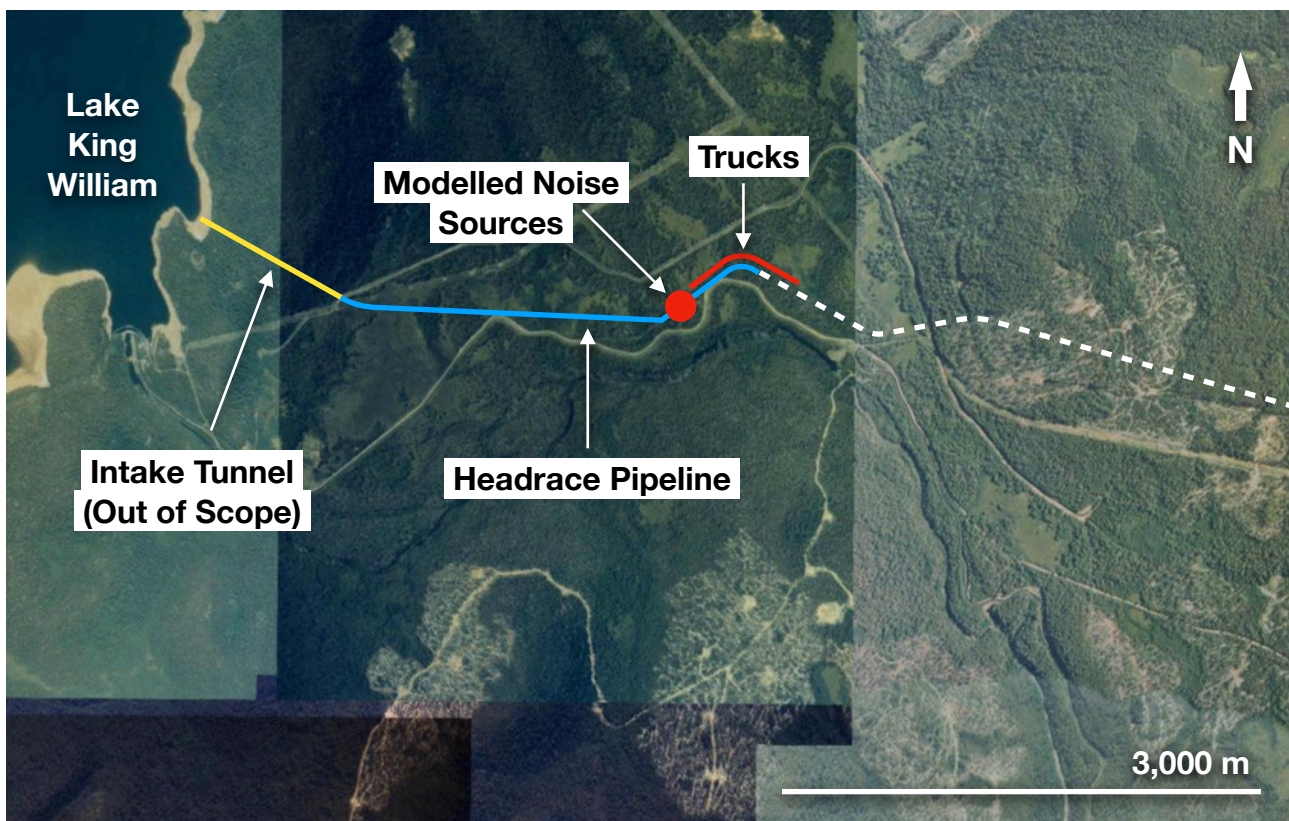


FIGURE 4.10: MODELLED NOISE SOURCES - HEADRACE PIPELINE

4.3.9. Results (Operational)

The noise modelling of the key noise sources during the operational scenario is outlined in sections 4.3.1 to 4.3.8, above, with the predicted noise levels at the five identified receiver locations (locations A, B, C and D) summarised in Table 4.11, below.

TABLE 4.11: PREDICTED NOISE LEVELS - OPERATIONAL (WITH DTH HAMMER DRILLING)

Noise Source	Predicted Sound Pressure Level (dBA)				
	A	A.2	B	C	D
Tarraleah Village - Operational	26	25	< 20	< 20	< 20
Paddy's Quarry & Surge Access Tunnel Portal	40	40	22	< 20	< 20
Tarraleah Power Station 2 (TAPS2)	31	44 *	< 20	< 20	< 20
Switchyard	23	36	< 20	< 20	< 20
Surge Tower & Pump House	28	28	< 20	< 20	< 20
Mid Access Portal	< 20	< 20	< 20	< 20	< 20
Western Portal	< 20	< 20	< 20	< 20	< 20
Headrace Pipeline	< 20	< 20	< 20	< 20	< 20
Total	41	46	23	< 20	< 20

* DTH hammer drilling is the dominant noise source here, with noise levels from DTH hammer drilling alone predicted to be nominally 42 dBA. All other noise sources related to TAPS2 works (excluding DTH hammer drilling) are predicted to result in a noise level of nominally 38 dBA.

Figure 4.11, below, presents the predictive noise contours of the whole site, with locations denoted A, B and C showing the identified receiver locations of Tarraleah Village, Bradys Lake, and Bronte Lagoon respectively. Note that location D (Wayatinah) has been omitted from the image to ensure a reasonable scale. Figure 4.12 presents predictive noise contours of Tarraleah Village. The scaling of the coloured noise contours is equal across all figures, and thus the predicted noise levels represented by the colours are comparable across all figures.

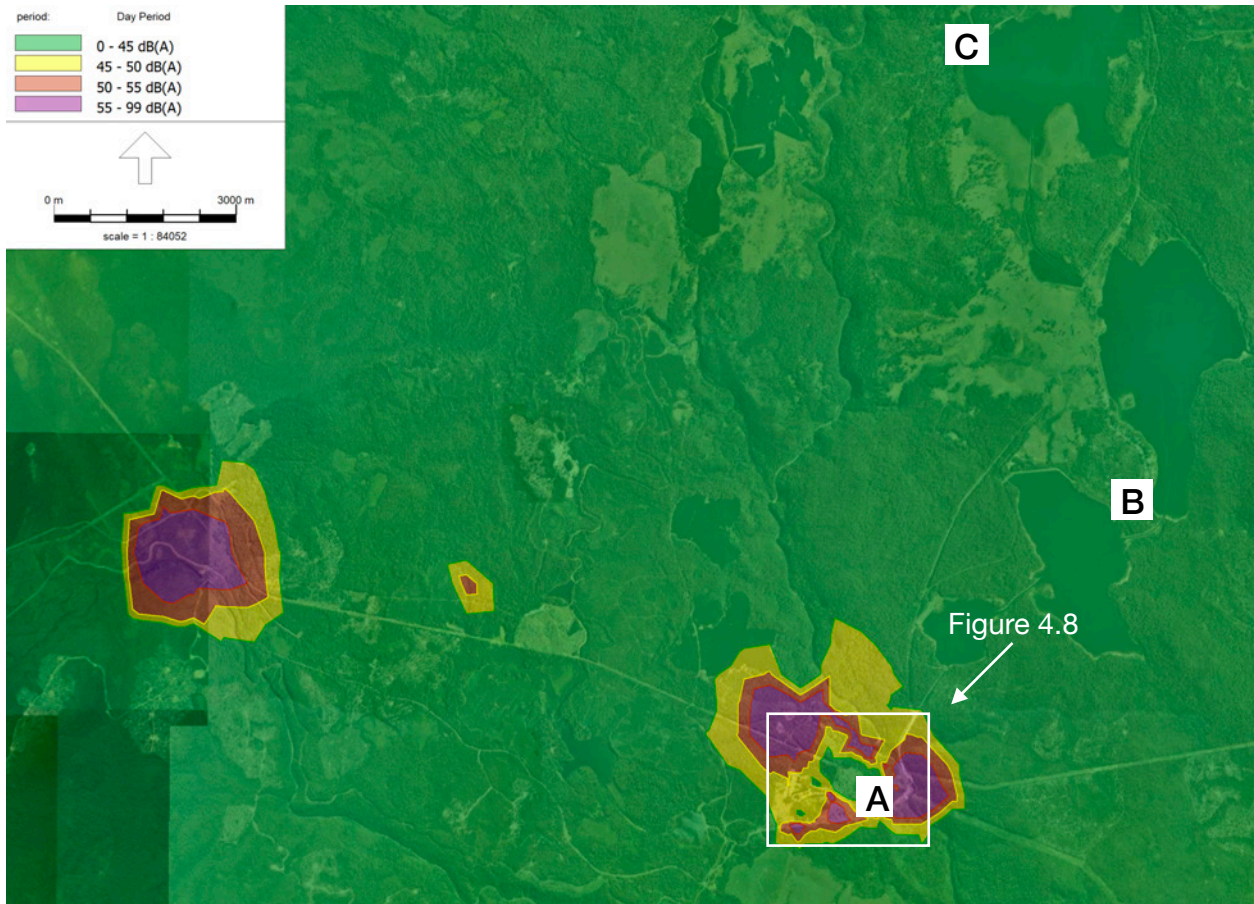


FIGURE 4.11: PREDICTIVE NOISE CONTOURS (OPERATIONAL) - WHOLE SITE

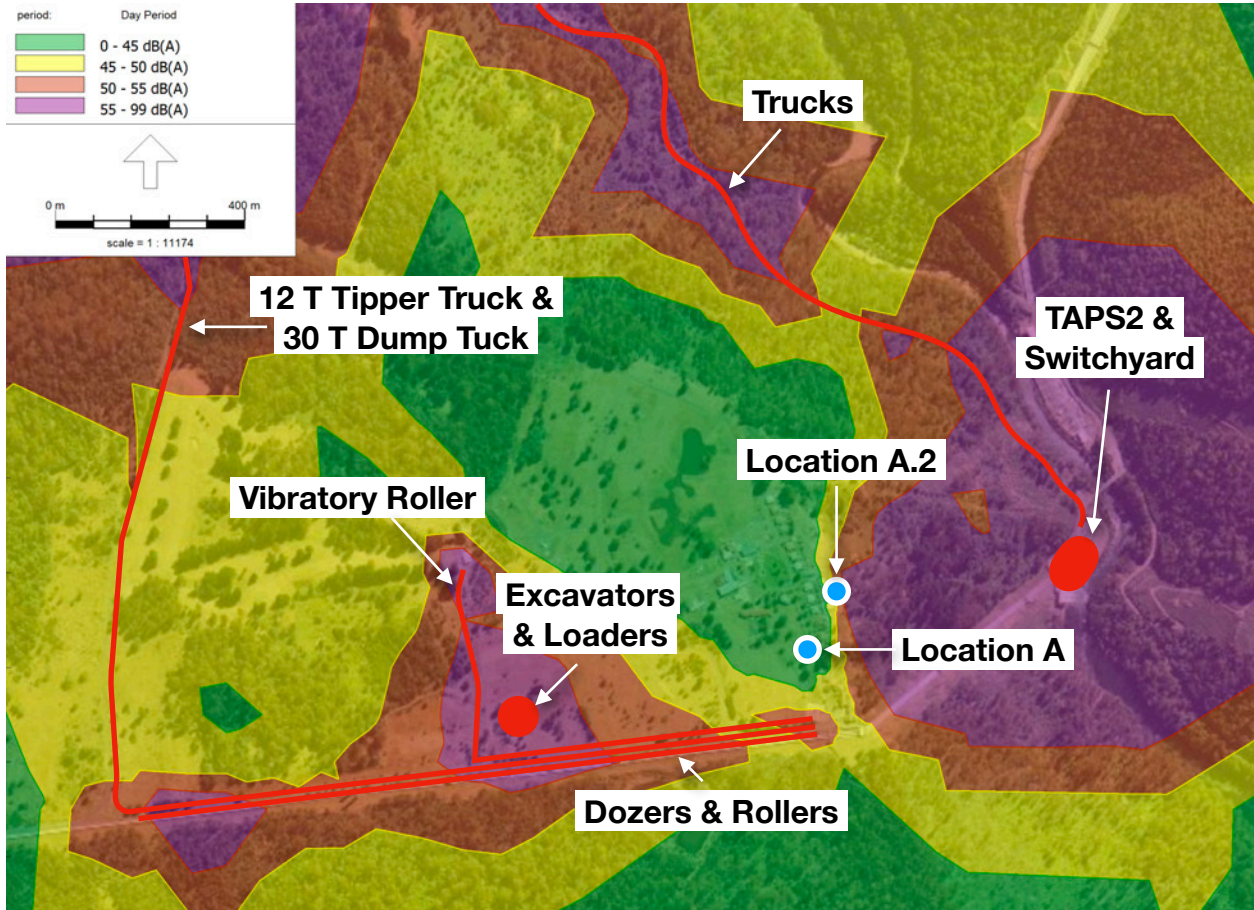


FIGURE 4.12: PREDICTIVE NOISE CONTOURS (OPERATIONAL) - TARRALEAH VILLAGE

Noise modelling of the noise sources within the operational scenario has resulted in the following key findings:

- Noise levels in Tarraleah Village are the greatest on the eastern side of the residential accommodation (location A.2), with noise levels predicted to be nominally 44 dBA whilst works are occurring within the TAPS2 area.
 - This noise is controlled by noise emissions from DTH hammer drilling occurring within the TAPS2 area, with noise from DTH hammer drilling alone reaching nominally 42 dBA. This exceeds the NML, and thus consideration of suitable noise management practices are required and discussed further in Section 4.6, below.
 - All other noise sources (excluding DTH hammer drilling) result in a noise level of nominally 38 dBA.
 - In the absence of DTH hammer drilling, overall noise levels are predicted to decrease at location A.2, with noise levels predicted to see a 3 dB decrease compared to whilst DTH hammer drilling is operational, with an overall noise level of nominally 43 dBA, resulting from all other noise sources operating simultaneously. Figure 4.13, below, presents the predictive noise contours over Tarraleah Village during a period in which no DTH hammer drilling occurs.
- Measurements conducted adjacent the existing accommodation cottages (location A) show low background noise levels of nominally 30 and 27 dBA during the day and night times respectively. Therefore, noise emissions from works in the vicinity of TAPS2 are expected to be clearly audible externally, with noise emissions from Paddy's Quarry & the Surge Access Tunnel Portal predicted to be readily audible within Tarraleah Village.
 - Noise sources from TAPS2 during DTH hammer drilling, and Paddy's Quarry & Surge Access Tunnel exceed, or are on the NML, and thus consideration of suitable noise management practices are required, as outlined in Section 4.5, below.
- Noise levels from construction works are likely to be inaudible at the nearest sensitive receivers in other ownership (locations B, C and D), with levels below 20 dBA except for Bradys Lake, where noise levels are predicted to reach nominally 22 dBA during works within Paddy's Quarry & the Surge Access Tunnel Portal. Note that at this level, noise from construction works will still be entirely inaudible at location B.
 - Noise levels from works within the Mid Access and Western Portals are predicted to be entirely inaudible at all sensitive receivers, with levels below 20 dBA.

Figure 4.13, below, presents the predicted noise levels across Tarraleah Village during a period where all sources are operating simultaneously *except for* DTH hammer drilling. This is representative of a reasonable worst-case scenario, as noise from DTH hammer drilling is primarily sourced from the drill head which will be underground for the vast majority of the time.

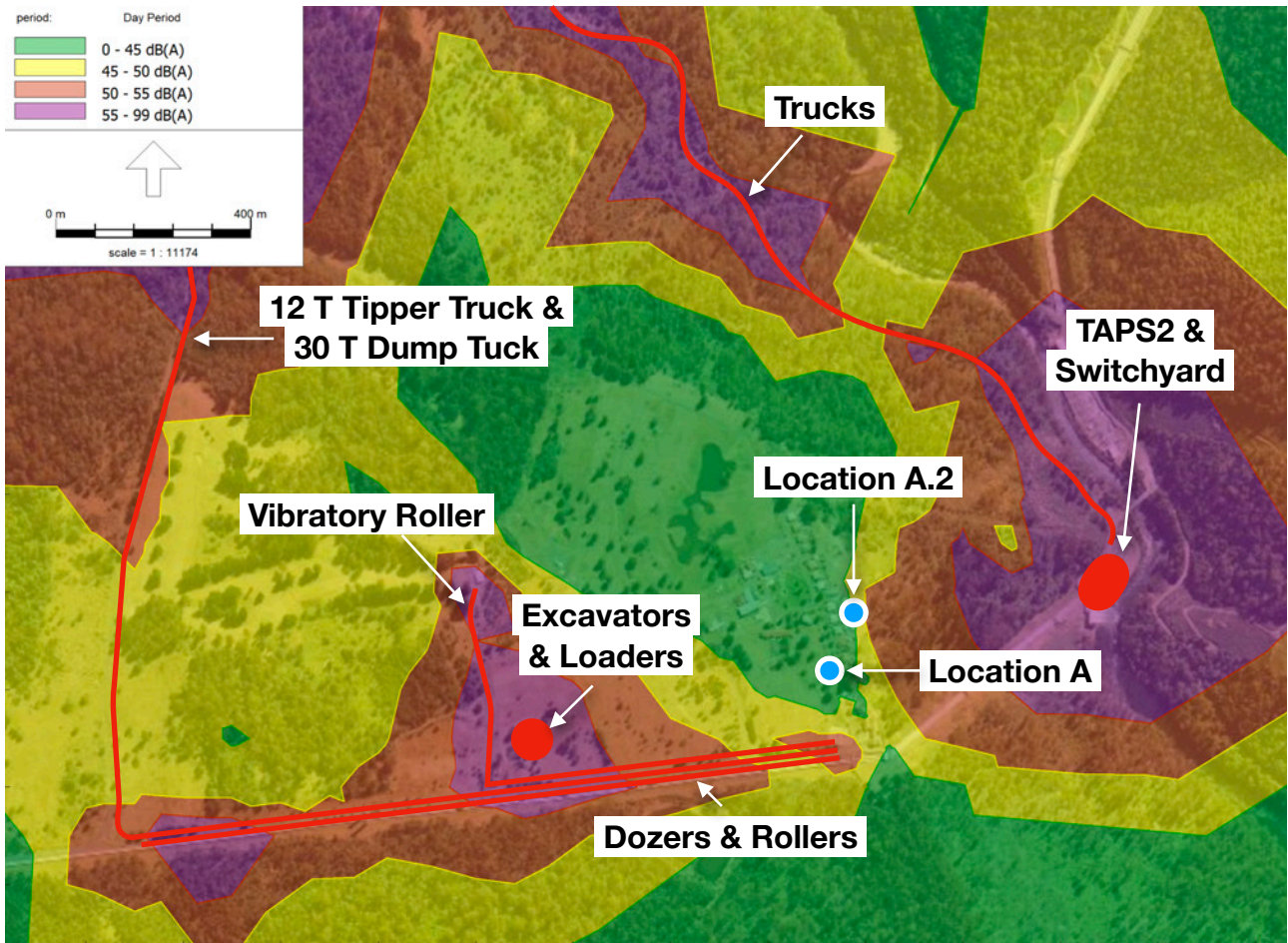


FIGURE 4.13: PREDICTIVE NOISE CONTOURS (OPERATIONAL - NO DTH) - TARRALEAH VILLAGE

4.3.10. Dominant or Intrusive Characteristics

Assessment for intrusive or dominant characteristics has been carried out as per the Tas. Noise Measurement Procedures Manual. The following key points relating to such an assessment are noted:

- Only predicted noise levels at locations in which the overall noise level exceeds the existing measured background noise levels are deemed assessable, as any locations where the predicted overall noise levels are below the measured background noise level will result in construction noise being inaudible.
- Assessed noise levels are representative of predicted spectra during periods where all noise sources are operating simultaneously and continuously, including DTH hammer drilling. This is an absolute worst-case scenario.
- In the absence of measured data at the various receiver locations, the likely noise characteristics have been inferred by NVC’s past experience and observations of such equipment.
 - A 2 dB adjustment has been applied for impulsiveness to all locations in which crushing and DTH hammer drilling is predicted to be audible (locations A and A.2). Note that a 2 dB adjustment is typical of a noise environment in which impulsiveness is ‘just detectable’.
 - No adjustments are applicable for tonality, low-frequency, or modulation.
- All assessment for intrusive or dominant characteristics have been carried out in the absence of the existing noise environment, and thus are extremely conservative.
 - In practice, the existing / future noise environment will mask some of the intrusive or dominant characteristics, and thus any adjustments applied may not be applicable in practice (i.e. other activities nearby will significantly raise the noise floor, and thus any intrusive or dominant characteristics are likely to be ‘masked’).

TABLE 4.12: SUMMARY OF INTRUSIVE OR DOMINANT CHARACTERISTICS

Location	Sound Pressure Level					
	Required Adjustment (dB)				Predicted Overall (dBA)	Adjusted Overall (dBA _{adj})
	Tonality	Low-frequency	Impulsiveness	Modulation		
A	-	-	+ 2	-	41	43
A.2	-	-	+ 2	-	46	48
B	-	-	Inaudible	-	23	23
C	-	-	Inaudible	-	< 20	< 20
D	-	-	Inaudible	-	< 20	< 20

4.4. TRANSMISSION LINES

As part of the Tarraleah redevelopment project, two transmission line options are proposed; the 'northern option' and the 'southern option', which are denoted by the blue and green outlines respectively in Figure 4.14, below.

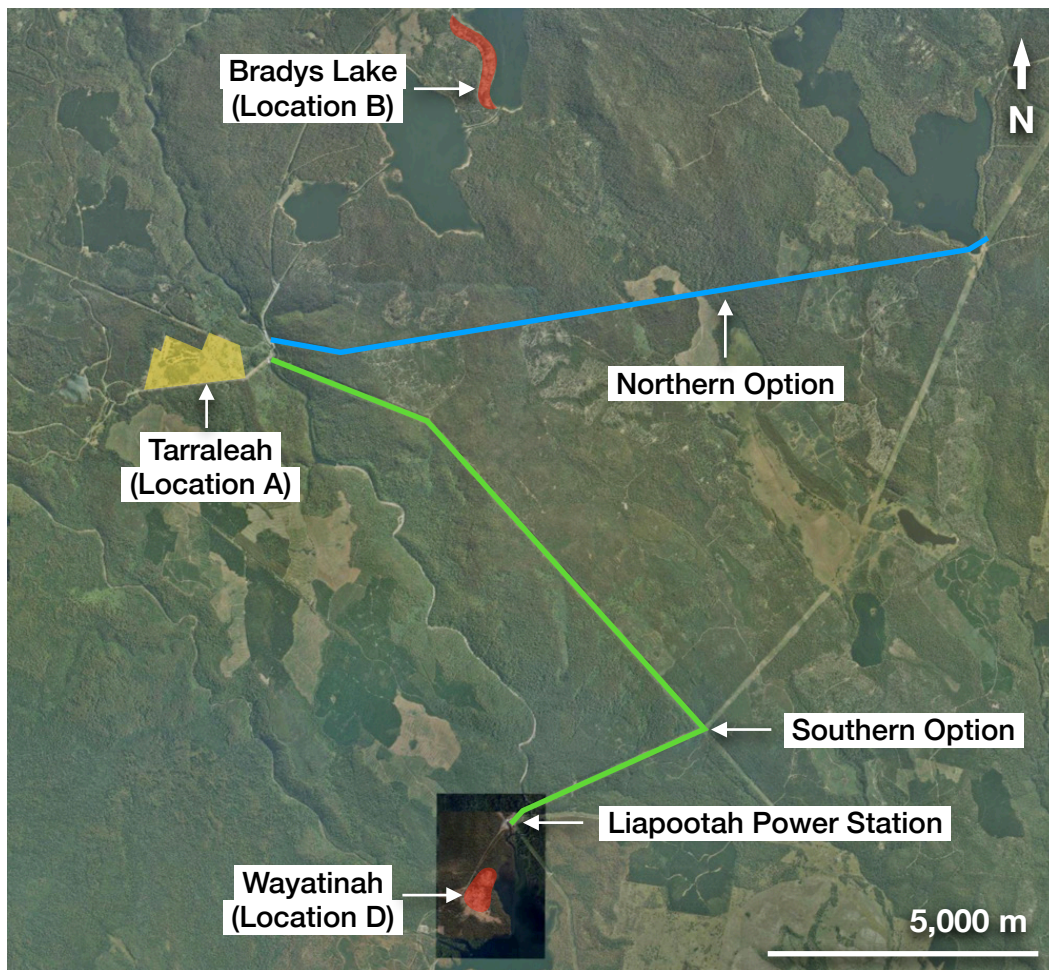


FIGURE 4.14: OVERVIEW OF TRANSMISSION LINE OPTIONS

The key details relating to the noise modelling of noise sources related to the transmission lines are as follows:

- Noise sources have been modelled along each of the proposed transmission line options, with five 'clusters' of noise sources along each transmission line path. The sources for each option are modelled to be operating simultaneously (all 'northern option' sources operating simultaneously with no 'southern option' sources, and vice versa), and thus is an extremely conservative representation of the likely noise emissions from each transmission line option.
- 10 m topographical contours (from LiDAR data) have been used to model the noise emissions from the transmission lines.
- The ground has been assumed to have a ground factor of 0.5 (50% reflective) across the entire model.
 - Given the land surrounding the source and receivers comprises thick vegetation, this is conservative.
- As per the Tasmanian Noise Measurement Procedures Manual, noise levels are predicted at 1.2 m above ground level.
- Equipment related to the transmission lines have been taken from a spreadsheet¹³ provided by Hydro Tasmania.

¹³ 'Plant and Equipment Noise Levels for Construction Activities Transmission Lines', provided by Hydro Tasmania, 11/06/25

Figure 4.15, below, shows the modelled locations of the noise sources, with the modelled pole IDs noted for clarity, and details of the modelled noise sources for each pole summarised in Table 4.13. Note that the broken white lines denote the paths of the two transmission line options.

TABLE 4.13: MODELLED NOISE SOURCES - TRANSMISSION LINES

Equipment	Qty.	Sound Power Level (dBA)	Height AGL (m)
Excavator (8 T)	1	99	1.5
Excavator (22 T)	1	103	1.5
D7 Dozer (28 T)	1	107	1.5
WA200 Wheeled Loader	1	101	1.5
12 T Tipper Truck	1	103	1
Chainsaws	2	109 each	1

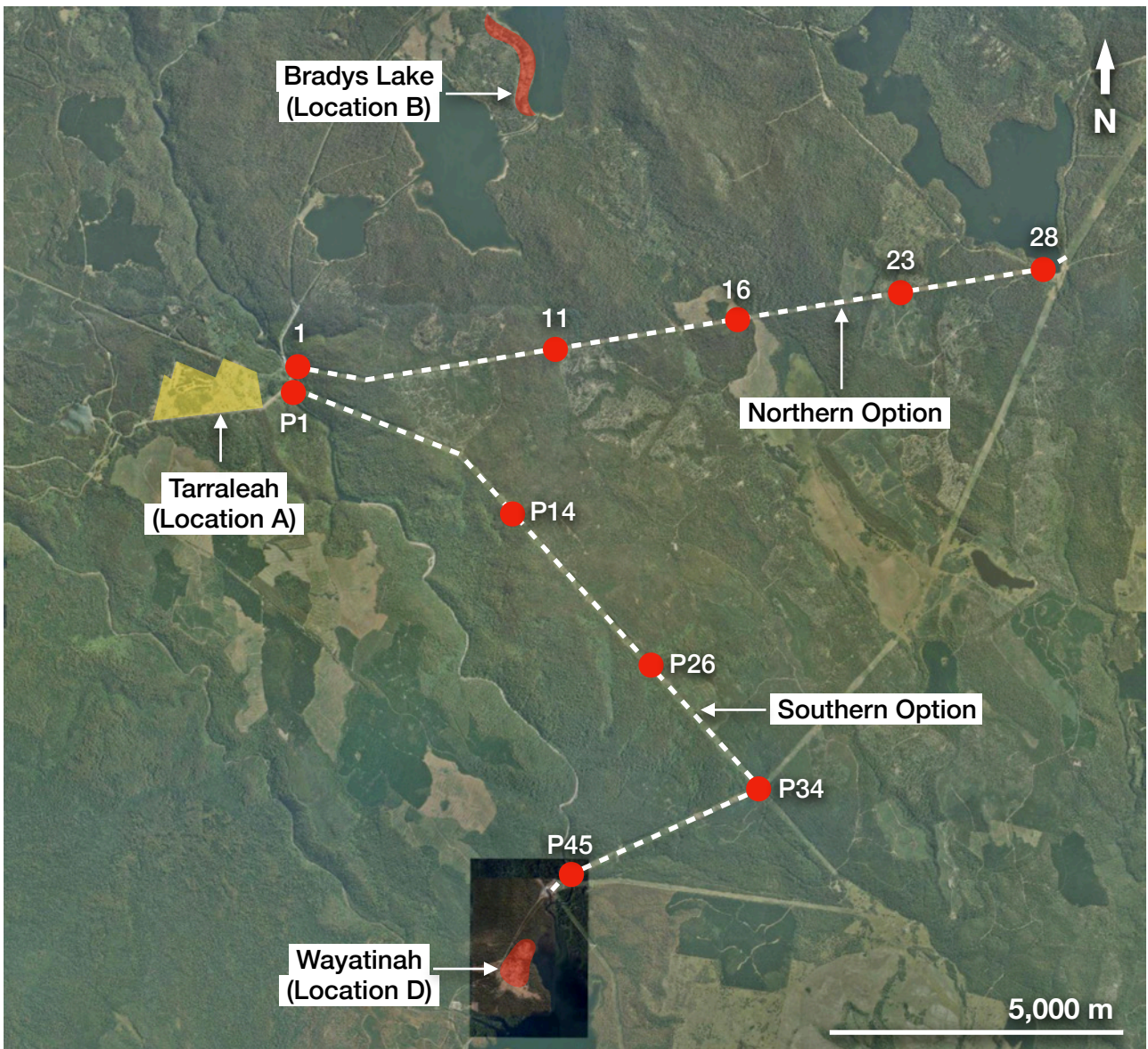


FIGURE 4.15: MODELLED NOISE SOURCES - TRANSMISSION LINES

Table 4.14, below, summarises the predicted noise levels resulting from each of the transmission line options, with Figures 4.16 and 4.17, below, presenting the predictive noise contours over the surrounding area and Tarraleah Village.

TABLE 4.14: PREDICTED NOISE LEVELS - TRANSMISSION LINES

Noise Source	Predicted Sound Pressure Level (dBA)				
	A	A.2	B	C	D
Transmission Line - Northern Option	34	37	< 20	< 20	< 20
Transmission Line - Southern Option	32	37	< 20	< 20	34

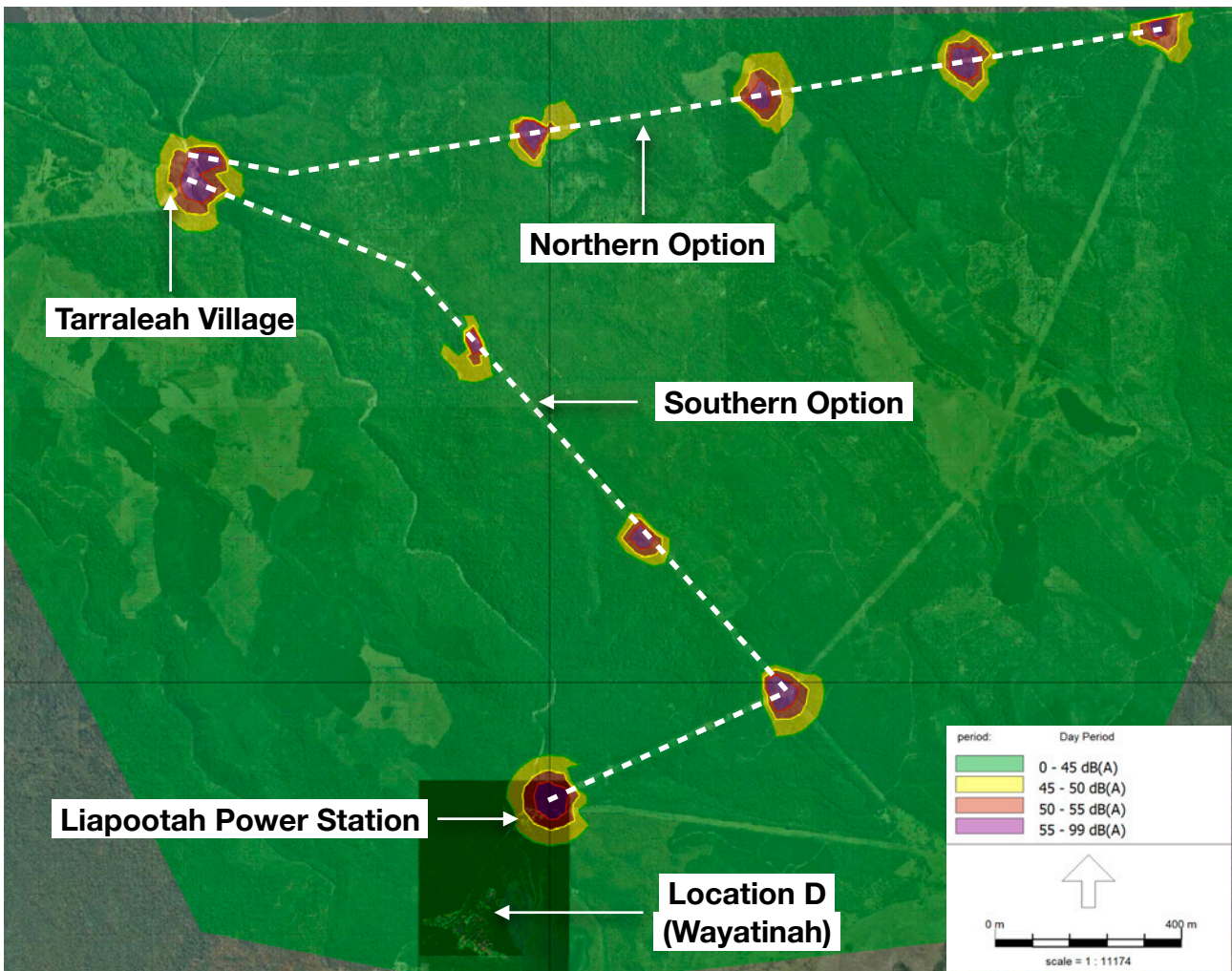


FIGURE 4.16: PREDICTIVE NOISE CONTOURS (TRANSMISSION LINES) - WHOLE SITE

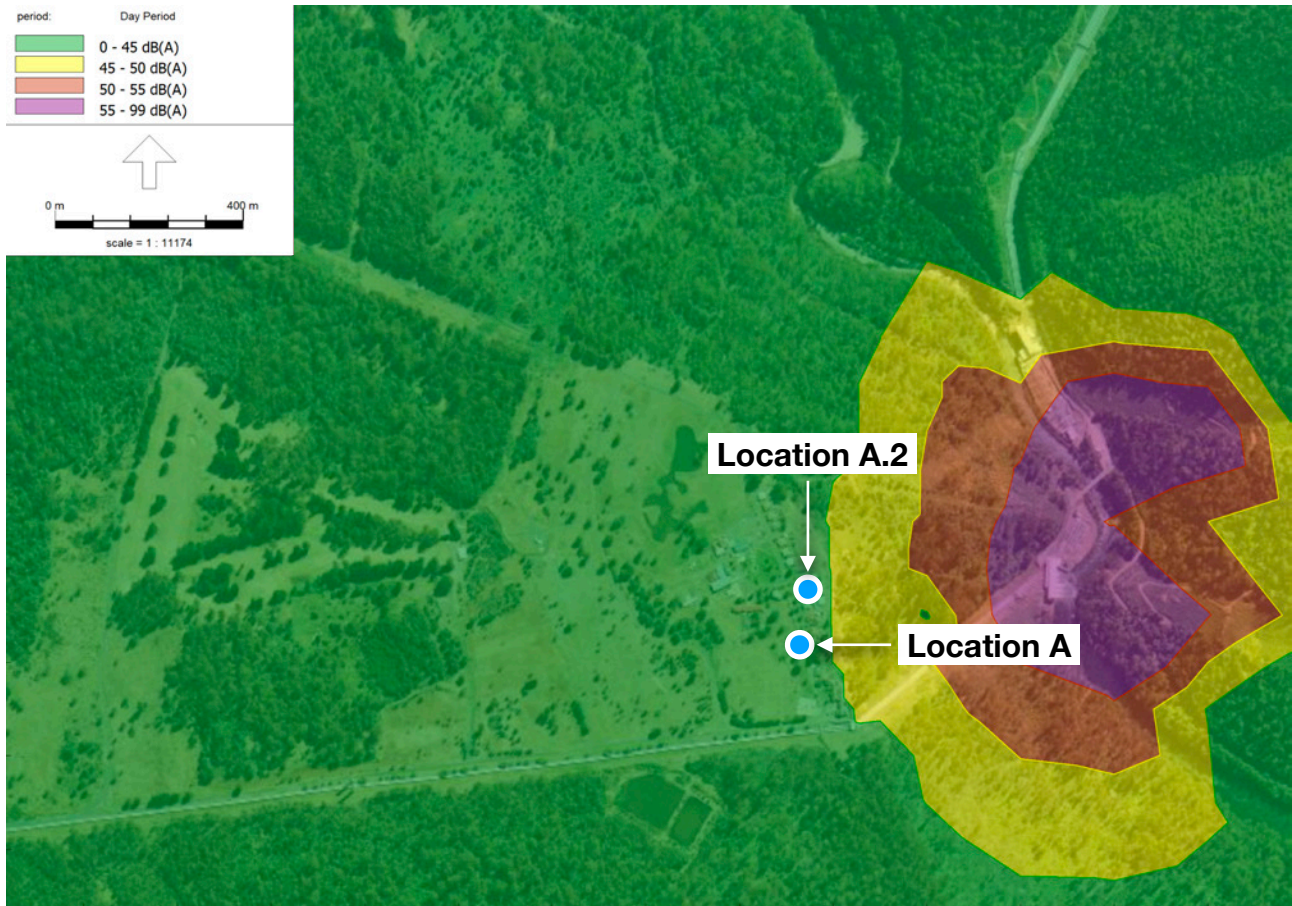


FIGURE 4.17: PREDICTIVE NOISE CONTOURS (TRANSMISSION LINES) - TARRALEAH VILLAGE

The following key points are related to the noise emissions from the transmission lines' construction:

- Noise from construction of the transmission line poles is predicted to be greatest on the eastern side of Tarraleah Village (location A.2). This is primarily due to works being carried out at poles 1 and P1 which are in close proximity to the eastern side of Tarraleah Village.
 - Noise at all other sensitive receivers is predicted to be entirely inaudible except for at Wayatinah (location D) during the 'southern option', where noise from construction of the poles is likely to be just audible. This is due to the relatively close proximity (nominally 1.3 km) of the transmission line's termination at the Liapootah power station and the township of Wayatinah.
 - It is noted that noise from the transmission line works is below the NML at all locations, and significantly below the Tas. Noise EPP environmental indicator levels.
- In addition to the above modelled noise sources, an Airbus Helicopters AS350 B3 helicopter is proposed to facilitate the stringing of transmission lines and will operate over a nominal three or four day period, depending on the transmission line option selected. The proposed helicopter will be based out of Devonport, and thus will travel to site each day to facilitate the stringing of the lines. The following key points are relevant to the helicopter.
 - A sound power level of nominally 130 dBA has been assumed for the helicopter. This is a conservative representation of a typical modern emergency search and rescue helicopter.
 - Table 4.15, below, presents the various distances between the helicopter and sensitive receiver at which the HNAL and NML are exceeded.

TABLE 4.15: MINIMUM DISTANCES - HELICOPTER

	Noise Level (dBA)	Minimum Distance to Receiver
Highly Noise Affected Level (HNAL)	75	225 m
Noise Management Level (NML)	40	12.5 km

- As shown in Table 4.15, above, predictions show that helicopters would need to operate within nominally 225 m of a sensitive receiver and hover at this distance for 15-minutes to exceed the HNAL of 75 dBA Leq(15-minute).
 - As far as NVC is aware, there are no instances in which the helicopter is proposed to hover within 225 m of any sensitive receivers for any extended period, and thus it is not expected that any sensitive receivers will be exposed to ongoing noise levels above the HNAL.
- Helicopters hovering within nominally 12.5 km of a sensitive receiver are predicted to result in noise levels that exceed NML. This results in helicopter noise exceeding the NML when operating at all transmission line poles except for poles 24 to 30. As such, consideration of the use of the helicopter is required to minimise the impact of helicopter noise on surrounding sensitive uses as much as is reasonable and feasible. Specific noise management practices relevant to the helicopter are outlined in Section 4.7, below.

4.5. NOISE MANAGEMENT - TARRALEAH VILLAGE

As shown in the above sections, noise levels are predicted to be entirely inaudible and be significantly under the 'noise management level' of 40 dBA at all sensitive receivers in other ownership (locations B, C and D). This also satisfies the Tas. Noise EPP day and night time criteria, and the recommended internal design sound levels outlined within AS 2107 for sleeping areas. As such, the proposed works are considered acceptable from the perspective of these areas, with no specific noise management requirements.

However, noise management practices are recommended to ensure that the amenity of workers within Tarraleah Village is protected. The following noise management considerations are relevant for all activities carried out within relatively close proximity (nominally 1.5 km) to Tarraleah Village (including Paddy's Quarry, Tarraleah Village, TAPS2, and Switchyard):

4.5.1. Equipment and Process Selection

Prior to using equipment in work areas which may have high noise emissions (Paddy's Quarry, TAPS2, and Switchyard), assess the equipment and processes used to conduct the work and determine if there are reasonable and feasible alternatives that may result in lower noise emissions. The following are initially identified:

- For large fixed equipment such as the crusher in Paddy's Quarry, can the equipment be located such that the natural topography of the land provides additional screening? If excavation is required, it is recommended that the over-burden is located between the crusher and Tarraleah Village.
- Can the work be conducted further away from sensitive receivers? This is particularly relevant within Tarraleah Village where works are proposed within close proximity to the worker camps. Given the close proximity, moderate increases in distance will result in a significant decrease in noise levels (a doubling of distance between source and receiver will result in a nominal 6 dB reduction in noise levels at the receiver).

4.5.2. General Work Practices

The following general practices are recommended in order to reduce impact of noise emissions from the site on the surrounding sensitive receivers:

- Work practices should be designed or revised to be as quiet as reasonably and feasibly possible, particular when operating near the worker camp where shift workers may be required to sleep.
- Portable noise barriers should be used around noisy mobile equipment where possible, including angle grinders, are required to be used around all noisy mobile equipment, including concrete saws and rock breakers.
- Install broad-band type reverse beacons instead of tonal beacons on mobile plant that is to remain at the Tarraleah, TAPS2, and Paddy's Quarry & Surge Access Tunnel Portal work areas for longer than nominally one week.
- Where repetitive tasks are required (cutting or grinding metal, assembling parts, etc.), fixed work stations are preferable to mobile equipment where possible. This allows for work stations to be located appropriately and acoustic barriers can be located such that they screen line of sight to Tarraleah Village.

4.5.3. Community Engagement

It is strongly recommended that a comprehensive communication strategy is in place, with the following points relevant:

- The construction contractor should have a single person who is responsible for the management of community noise issues. Surrounding sensitive receivers are to have the contact details of this person.

- Neighbours should be regularly informed (ideally weekly) of planned site works and when noisy activities may be occurring. This means the workers within Tarraleah Village are not caught unaware by high noise levels, and have an understanding of how long they will be exposed to the noise.
- Any feedback from workers within Tarraleah Village, and surrounding sensitive receivers neighbours is to be formally logged and responded to in a timely manner, noting the following:
 - The location of the complainant, the time of the complaint, and the nature of it (i.e. the noise source, how it was perceived, etc.).
 - Identification of the activity / equipment causing the complaint, including its location within the site.
 - A review of the noisy activity and a review of reasonable and feasible noise mitigation.

4.5.4. Noise Monitoring

It is recommended that noise monitoring is carried out whilst construction work is occurring within close proximity to Tarraleah Village, to ensure that any potential impacts upon residents within the village, particularly regarding sleep disturbance, are proactively identified and resolved. This includes where work is carried out at Paddy’s Quarry, TAPS2, and the Switchyard. The following key points are relevant to the construction noise monitoring:

- Two noise loggers are initially recommended, with locations A and A.2 identified as preferred locations.
- It is initially recommended that the noise loggers remain in place for the duration of works within these work areas and features SMS alerts to alert relevant site personnel when noise levels are approaching unreasonable levels and warrant further management consideration.
- The duration and monitoring locations may be varied as construction works progress, based on feedback from workers and community members.

4.6. DTH HAMMER DRILLING

Analysis of the predicted noise levels shows that the primary source of noise within Tarraleah Village is expected to be DTH hammer drilling. As such, the following noise management practices relate specifically to the DTH hammer drilling carried out within the TAPS2 works:

- Ensure that workers within Tarraleah Village are given prior notice that DTH hammer drilling is to occur, so that they are not caught unawares and are able to prepare (keep windows closed, relocate to rooms on the western side of the dwellings if possible, etc.).
- Identify the time of day that the least number of workers will be sleeping and ensure that DTH hammer drilling is carried out within this period where feasible and reasonable.
 - It is noted that noise due to DTH hammer drilling is predicted to comfortably satisfy the internal noise criteria outlined by AS 2107 with a basic external facade construction, and thus is not expected to result in an unreasonable loss of amenity or disrupt sleep.

4.7. HELICOPTER

The following noise management practices are relevant to the use of the helicopter:

- It is strongly recommended that residents of the surrounding communities (Bradys Lake, Bronte Lagoon, and Wayatinah) and workers within Tarraleah Village are provided with days and times that the helicopter is to operate at least one week in advance. This ensures that residents are not caught unaware by the potentially high noise levels generated by the helicopter.
 - Calculations show that use of the helicopter within 2.2 km of a sensitive receiver will result in noise levels exceeding the ‘serious annoyance’ noise level outlined within the Tas. Noise EPP. As such, it is essential that surrounding residents are provided with prior warning when operating near to residential dwellings. The red overlay in Figure 4.18, below, shows the area within 2.2 km of the transmission lines, and thus the area within which receivers

are predicted to experience noise levels exceeding the 'serious annoyance' noise level from the helicopter. Note that the Tas. Noise EPP day time noise levels use the $Leq_{(16-hour)}$ metric, and thus the denoted 2.2 km area is extremely conservative as the helicopter is unlikely to spend substantial periods of time at a single location.

- Use of the helicopter should be restricted to the day time period as outlined within the NSW Interim Construction Noise Guideline only (7AM to 6PM), particularly when operating near Tarraleah Village or Wayatinah.

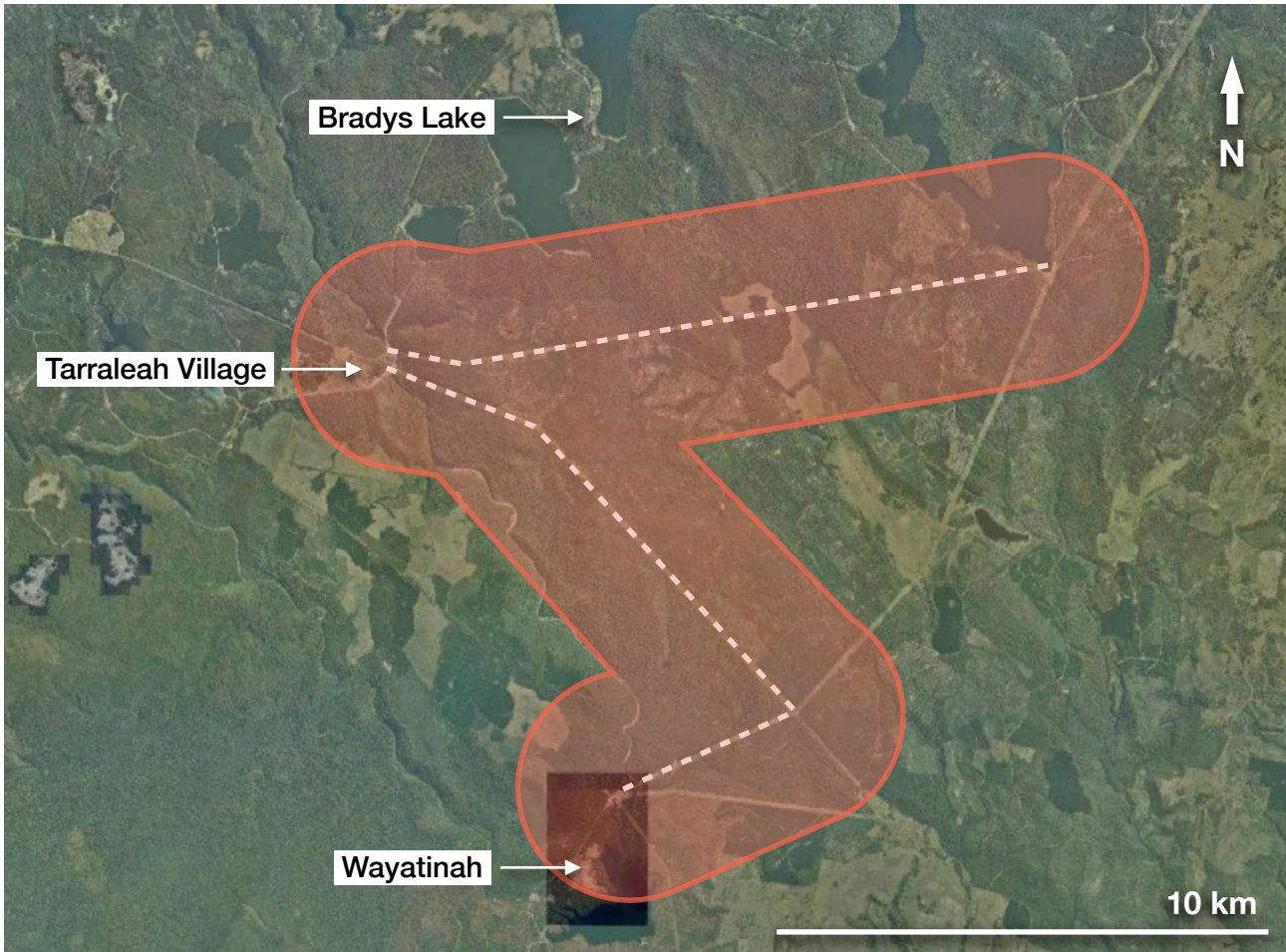


FIGURE 4.18: OVERLAY OF PREDICTED 'SERIOUS ANNOYANCE' DUE TO HELICOPTER

5. GROUND VIBRATION PREDICTIONS

Expected ground vibration propagation from the key construction activities has been calculated using an exponential decay model developed by Amick¹⁴. The model is used to calculate the magnitude of peak ground vibrations expected to arise from key vibration sources expected to be utilised during construction. The model accounts for the following key factors: vibration source characteristics, distance from the source activity, soil properties and geometrical attenuation.

5.1. MODEL CONDITIONS AND ASSUMPTIONS

Soil / ground properties both at the source location and in the intervening land between the source and receiver have a significant influence on the propagation of vibration, and thus the resulting magnitude at a given sensitive receiver location. As such, these calculations generally rely upon conservative assumptions, and are intended to indicate typical maximum distances at which vibration may be expected to either impact human comfort or cause potential cosmetic damage to buildings.

The following points are relevant to the calculations and assumptions relied upon to determine the results:

- The calculations assume vibration travels via surface wave propagation, which is generally appropriate provided the source and receivers are at natural ground level.
 - The exception to this is underground tunnel boring when close-by to potentially sensitive receivers (i.e. the receiver is the closest point at ground level to the boring machine). Table 5.3 includes a row specific to this case.
- The calculations depend on the soil properties in the intervening land between the source and receiver, with the descriptions provided by Amick included in Table 5.1, below.
 - It is noted that, due to the unknown soil conditions in the area between the source and receivers, the vibration magnitude at any given receiver can vary significantly. As such, a conservative assumption regarding the soil type has been made to determine the predicted levels, to estimate a feasible worst-case level.
 - For the results presented below, it is assumed that the Soil Damping Loss is $1.8 \times 10^{-6} \text{ m}^{-1}\text{Hz}^{-1}$ (i.e. on the boundary of classes 3 and 4 in Table 5.1). In reality, the soil is likely to be made up of a variety of conditions in the intervening area between source and receiver, some of which are likely to be softer (i.e. have higher damping loss) than the assumed value.

TABLE 5.1: SOIL TYPES AND DAMPING LOSS VALUES

Class	Description of Soil	Soil Damping Loss ($\text{m}^{-1}\text{Hz}^{-1}$)
1	Weak or soft soils (shovel penetrates easily): Lossy soils, peat, loose beach/dune sand, topsoil, mud.	6.1×10^{-5} to 1.8×10^{-4}
2	Competent soils (can dig with shovel): Most sands, sandy clay, silty clay, gravel, silt, completely weathered rock.	1.8×10^{-5} to 6.1×10^{-5}
3	Hard soil (cannot dig with shovel, pick required to break up): Dense compacted sand, dry consolidated clay, moderately weathered rock.	1.8×10^{-6} to 1.8×10^{-5}
4	Hard rock (difficult to break with a hammer): Bedrock, freshly exposed hard rock.	$< 1.8 \times 10^{-6}$

¹⁴ A Frequency-Dependent Soil Propagation Model, Proceedings of SPIE Conference on Current Developments in Vibration Control for Optomechanical Systems, Denver, Colorado, Amick, H, July 1999.

5.2. RESULTS

The results of the vibration propagation calculations are presented in two formats, in Tables 5.2 and 5.3. Table 5.2 presents the typical expected vibration levels (Peak Particle Velocity (PPV), mm/s) at given distances of 20 m, 100 m and 1000 m from the source, based on the above assumptions.

TABLE 5.2: PREDICTED VIBRATION VELOCITIES AT STATED DISTANCES

Equipment	Typical PPV (mm/s) at Stated Distance		
	20 m	100 m	1000 m
Rock breaker on 30 T excavator	2.1	0.8	0.0
Dozer 20 T (D6)	2.0	0.8	0.1
Excavator 30 T	2.5	1.0	0.1
Excavator 5 T	1.0	0.4	0.0
Vibratory roller 20 T	7.0	2.8	0.2
Vibratory roller 7 T	3.9	1.5	0.1
Truck and trailer (laden, rough surface)	0.7	0.3	0.0
Tunnel boring machine (at or near surface)	10.0	3.8	0.2
Tunnel boring machine (underground)	7.1	1.2	0.0
Down-The-Hole (DTH) Hammer Drill	2.7	1.1	0.1

Table 5.3 presents typically appropriate vibration management distances to ensure vibration levels generated by various equipment do not exceed the criteria. Separate attenuation distances are given for the protection of human comfort, sensitive structures, and commercial structures respectively.

TABLE 5.3: TYPICAL VIBRATION MANAGEMENT DISTANCES FOR CONSTRUCTION EQUIPMENT

Equipment	Vibration Management Distance (m) for Stated Criteria		
	Human Comfort (0.56 mm/s)	Sensitive Structures (3 mm/s)	Commercial Structures (20 mm/s)
Rock breaker on 30 T excavator	150	10	Avoid Contact
Dozer 20 T (D6)	170	9	Avoid Contact
Excavator 30 T	200	15	Avoid Contact
Excavator 5 T	60	< 5	Avoid Contact
Vibratory roller 20 T	570	90	3
Vibratory roller 7 T	350	33	Avoid Contact
Truck and trailer (laden, rough surface)	30	< 5	Avoid Contact
Tunnel boring machine (at or near surface)	610	140	6
Tunnel boring machine (underground)	190	45	8
Down-The-Hole (DTH) Hammer Drill	250	16	Avoid Contact

5.3. VIBRATION MANAGEMENT

5.3.1. Human Comfort

The majority of the works are to occur substantially further from residential dwellings than the stated vibration management distances in Table 5.3, and thus in these circumstances no special consideration for vibration management is required.

Some works comprising the reconstruction of the roadways and other infrastructure directly adjacent Tarraleah Village are expected to occur within the attenuation distances. In particular, the use of vibratory rollers and excavators, and potentially bulldozers.

As Tarraleah Village is to be inhabited during construction by people related to the construction project, it is deemed that the management of vibration during these works may be achieved via ensuring that these sources do not operate within the attenuation zone outside the standard construction hours outlined in Table 5.4, as outlined in the NSW Interim Construction Noise guideline.

TABLE 5.4: RECOMMENDED STANDARD HOURS OF OPERATION

Days	Recommended Hours
Monday to Friday	7AM - 6PM
Saturday	8AM - 1PM
Sunday	No Work
Public Holidays	No Work

Note that in general, tunnelling works are expected to be carried out 24/7, with high noise and vibration emissions activities such as DTH hammer drilling proposed to be carried out between 6AM and 6PM only.

5.3.2. Building Structures

The following scenarios have been identified in which the vibration management levels for vibration sensitive structures, as outlined in Table 2.7, may be exceeded:

- Vibratory rolling of the new roadway within Tarraleah Village may exceed the management limit for the existing sensitive penstock infrastructure when work is carried out at the eastern end of Oldina Drive.
- Tunnelling may exceed the management limit in the following circumstances:
 - At Tarraleah Village, when tunnelling is being carried out beneath it.
 - At the existing penstock infrastructure when tunnelling is being carried out under Tarraleah Village.
 - At the existing Tarraleah Power Station, when tunnelling is commenced nearby.
 - At the existing open canals when tunnel boring machinery is operating nearby.
 - DTH drilling may exceed the management limit at the existing Tarraleah Power Station when drilling occurs within nominally 16 m of any potentially sensitive infrastructure (potentially longer distances if drilling occurs into bedrock which forms the foundations of the existing power station).
- When heavy and/or large excavators and dozers are required to operate within very close proximity (< 15 m) to existing historical infrastructure, the management limit may be exceeded.

5.3.3. Vibration Monitoring and Management

In the above scenarios, it is anticipated that the vibration management levels may be exceeded. It is noted that these predictions are based on conservative assumptions (particularly the geological

conditions of the area), and thus in these instances it is suggested that vibration monitoring be conducted during construction at the location of the nearest of worst-affected sensitive structure or receiver, to ensure that vibration generated by construction activities does not unreasonably impact upon human comfort or risk damage to existing structures.

It is initially suggested that monitoring be conducted in the following scenarios:

- At the existing Tarraleah Power Station when works in this area commence, in particular the use of a tunnel boring machine, DTH drilling, or large vibratory rollers.
- At Tarraleah Village when tunnelling occurs underneath or when vibratory rolling is occurring on roadways nearby.
- At any potentially sensitive structure (i.e. open canals) when tunnel boring or other heavy works are occurring nearby (i.e. where distances between the sensitive structure and vibration generating equipment are beneath the management distances in Table 5.3).
- At any location where the distances between equipment and the sensitive structure / human occupants is less than those stated in columns 2 and 3 of Table 5.3, above.

This monitoring should provide real-time feedback to construction personnel when the vibration level exceeds either the *warning* or *alarm* criteria identified in Table 2.7.

If the *warning* level is exceeded, this should serve as an alert that vibration is occurring at a level approaching concern. Construction activities may continue, however, site personnel should be notified, and an internal check of work methods and equipment should be undertaken to ensure best practices are being followed. Increased vigilance is recommended, and monitoring should be closely reviewed for any upward trends.

If the *alarm* level is exceeded, all vibration-generating activities near to the relevant monitor should pause temporarily, to allow for investigation of the exceedance and the adoption of suitable mitigation measures before work resumes. While the determination of specific mitigation measures is beyond the scope of this report, typical best-practice responses may include:

- Staging or rescheduling high-vibration activities to periods of lower risk (e.g. when sensitive structures are not occupied or load conditions are reduced);
- Changing or limiting the type of equipment in use (e.g. switching to smaller or lower-energy plant);
- Adjusting work methods (e.g. reducing drop heights, using manual rather than mechanical means where practicable);
- Introducing isolation or damping measures (e.g. temporary ground mats, trenching between source and receiver); and/or
- Modifying the location or sequence of specific works, where feasible.

Note: Provided the vibration management distances outlined in Table 5.3 are maintained during construction, exceedances of the alarm level, and thus the need for reactive mitigation, are not expected to be required.

It is noted that this report does not comprise any vibration management advice for the protection of the tunnel itself during its construction. It is assumed that the construction contractor is to take precautions to ensure that vibration produced as a result of the tunnelling works does not impact the integrity of the tunnel whilst under construction.

6. DISCUSSION

Noise and vibration modelling has been carried out to determine the likely noise levels at surrounding sensitive receivers in both same and other ownership, and to determine the likely impact of vibration levels on the structural integrity of structures and the human comfort of workers within Tarraleah Village.

The following key findings are deemed relevant to the assessment, with the findings split into sections for the three modelled scenarios, as well as a generalised section:

Implementation Scenario:

- Noise during the 'implementation' scenario is predicted to be entirely inaudible at the surrounding sensitive receivers in other ownership (locations B, C and D).
- Noise within Tarraleah Village is predicted to reach the NML on the western side.
 - A generally conservative approach outlined by the World Health Organization is to consider the difference between external and internal noise levels to be nominally 15 dB with a window partially open¹⁵. As such, internal noise levels are predicted to be nominally 25 dBA which comfortably satisfies the recommended internal design sound levels for sleeping areas, as outlined by AS 2107. Therefore, it is not expected that noise due to construction works will result in sleep disturbance.

Operational Scenario:

- Construction noise during the 'operational' scenario is predicted to be inaudible at the surrounding sensitive receivers in other ownership (locations B, C and D), with noise levels reaching a maximum of nominally 22 dBA at location B.
 - This is significantly below the 'noise management level' and Tas. Noise EPP for day and night time use. Internal noise levels at these locations will be entirely inaudible.
- Noise levels within Tarraleah Village are predicted to be, at worst, nominally 46 dBA when all sources are operating simultaneously, including DTH hammer drilling on the surface within the TAPS2 working area.
 - These predicted noise levels exceed the day and night time existing background and ambient noise levels, and thus will be clearly audible externally.
 - Noise levels are predicted to be above the NML of 40 dBA, and thus consideration of specific noise management practices is required, with Section 4.5, above, providing some key considerations.
 - Noise levels are largely controlled by DTH hammer drilling. Assuming reasonable but still conservative conditions (DTH hammer drill head in the ground and all other noise sources operating simultaneously and continuously), noise levels are predicted to reach nominally 43 dBA at the eastern side of Tarraleah Village (location A.2). This is significantly below the HNAL of 75 dBA, and is also below the Tas. Noise EPP noise levels for day and night time use.
 - As noted above, assuming a difference of 15 dB between outside and inside, internal noise levels are predicted to be 28 dBA which comfortably satisfies the recommended internal design sound levels for sleeping areas, as outlined by AS 2107.
 - It is noted that all noise predictions are worst-case, assuming all equipment operating simultaneously. In reality, noise from all sources are unlikely to be occurring simultaneously at all times, and thus noise levels are expected to be lower in practice.

¹⁵ 'Environmental Noise Guidelines for the European Region', World Health Organisation (WHO), 2018

- It is noted that DTH hammer drilling is proposed to only occur during day time hours (6AM - 6PM) for a nominal 4-month period.
 - NVC has been informed that sleep disturbance has the potential to be an issue during the day time due to shift work to allow for 24-hour operations. As such, it is expected that shift workers sleeping during DTH hammer drilling will need to keep all windows closed. With windows closed, internal noise levels will be below the 30 dBA noise criteria outlined by AS 2107.
- It is noted that the occupants of the accommodation cottages are to comprise only workers associated with the redevelopment, with public access to Tarraleah Village limited to specific day time hours during the period of the redevelopment works, with no public accommodation. Therefore, the accommodation cottages are not considered sensitive receivers *in other ownership*, and hence noise levels are deemed to be acceptable.

Transmission Lines:

- During general construction of transmissions line poles (no helicopter), noise levels within Tarraleah Village are predicted to stay comfortably below the NML.
- Noise from construction of the transmission lines is predicted to be just audible at location D (Wayatinah) should the ‘southern option’ be chosen.
 - Use of the helicopter is likely to be just audible at locations B and C, and clearly audible at location D (Wayatinah) and location A (Tarraleah Village), due to the close proximity of some transmission line poles to locations A and D.
- Noise from the helicopter is likely to be clearly audible within Tarraleah Village when the helicopter is working on the western transmission poles. It is noted that noise due to the helicopter is not expected to exceed the HNAL, due to no prolonged helicopter operations within nominally 225 m of sensitive receivers.

General:

- Vibration levels at surrounding sensitive receivers in other ownership are predicted to be significantly below the identified management (warning) levels (see Table 2.7).
- Vibration levels from equipment operating within, and adjacent to, Tarraleah Village are likely to exceed the identified vibration management level for human comfort from various equipment when operating within Tarraleah Village. Note that operation of significant vibration inducing equipment within meaningful distance to the accommodation cottages is unlikely to occur for significant periods.
- Predicted vibration levels are expected to remain under the adopted criteria (see Table 2.7) for the preservation of sensitive structures for the majority of the duration of works within and adjacent Tarraleah Village.
 - When vibratory rolling is to occur at the eastern end of Oldina Drive, vibration levels may exceed the adopted 3 mm/s management (warning) level for the existing penstock infrastructure.
 - Similarly, vibration levels from tunnelling may exceed the management level when tunnel boring equipment is operating near to sensitive / critical structures (existing open-air canals, roadways, penstocks, etc.)
 - Note that NVC has not considered any noise and vibration emissions from blasting.
- The primary source of attenuation across all source and receiver combinations is provided by the geometric divergence of the source sound power, resulting from the significant distances involved. The next most significant source of attenuation is due to topographical screening.
- Noise due to vehicles have been modelled within the vicinity of Tarraleah Village only, primarily comprising trucks between the TAPS2 site and Tarraleah Village, and Paddy’s Quarry & Surge

Access Tunnel Portal. Noise due to vehicles on surrounding roads is not included due to it being on public roads.

- The likely infrequent nature of vehicles passing and the extremely low existing ambient noise levels, will generally result in long-term Leq noise levels that are likely to be well below the criteria outlined by the Tas. Noise EPP.
- It is also noted that other vehicles regularly use the surrounding roads (primarily the Lyell Highway), with existing power stations, electrical infrastructure, logging and forestry areas, etc., all of which are already serviced by light and heavy vehicles. As such, noise due to vehicles is an existing noise source for the surrounding areas, and the increase in likely noise emissions from vehicles on the Lyell highway associated with the Tarraleah redevelopment is unlikely to have any meaningful impact on noise levels at surrounding residential receivers.

7. ASSESSMENT

Given the above key findings, noise and vibration levels as a result of works surrounding Tarraleah Village are unlikely to have a negative impact on workers housed within the existing accommodation cottages within Tarraleah Village.

Noise and vibration levels at surrounding sensitive receivers in other ownership are unlikely to result in any impact, with noise and vibration levels significantly below all identified criteria.

Therefore, works associated with the proposed Tarraleah Redevelopment are predicted to result in noise and vibration levels that are unlikely to have a significant impact on the structural integrity of nearby buildings and structures, as well as the amenity of people within Tarraleah Village or surrounding residential zones.

It is noted that ground vibration monitoring within the vicinity of the existing Tarraleah Power Station and the penstocks is strongly recommended during DTH hammer drilling due to the potential for large variations in vibration magnitudes given the lack of available detail on the ground conditions. Additionally, noise monitoring within Tarraleah Village is initially recommended when works are being carried out within nominally 1.5 km of Tarraleah Village, to ensure the amenity of workers within the village is protected.

Appendix A – Acoustic Glossary

<i>Ambient Noise</i>	All noise associated with a measurement, and typically ignoring the particular noise under investigation. Typically measured as L_{eq} and will usually comprise noise from many sources.
<i>Background Noise</i>	Background noise describes the underlying level of noise present in the ambient noise. It may be described as the average of the minimum noise levels measured, and is typically measured by the statistical L90 level.
<i>Decibel [dB]</i>	The scale used for describing sound. It is a logarithmic scale that uses a reference sound pressure of 20 μPa , or reference sound power of 10^{-12} Watts.
<i>dBA</i>	A-weighted decibel. The human ear does not perform linearly and is better at hearing high frequency rather than low frequency sounds, ie. low frequency sound at the same dB level as a high frequency sound will be perceived as quieter. To replicate the human ear response a frequency weighting, denoted as an A-weighting, is applied to the sound. A sound measured in this way is then an A-weighted sound pressure level with units dBA. Practically all noise is measured using the A-weighting.
<i>Leq</i>	Energy averaged sound pressure level over a period of time, usually 10 to 15 minutes. Units of decibels, typically A weighted (L_{Aeq}). Because the decibel scale is a logarithmic ratio, the higher noise levels have far more sound energy, and therefore the L_{eq} level tends to indicate an average which is strongly influenced by short-term, high level noise events. Many studies show that human reaction to level-varying sounds tends to relate closer to the L_{Aeq} noise level than any other descriptor.
<i>Frequency</i>	Frequency is synonymous with pitch and has the units of Hertz (Hz) or cycles per second. A bass drum produces a low frequency sound, and a small bell a high frequency sound. The frequency range for human hearing is approximately 30 Hz to 16 kHz.
<i>L10, L90...</i>	L_n is the sound pressure level that is exceeded for n% of the time. Hence the L10 describes the noisier events during the interval, and L90 the quieter events. The L90 is often used to describe the background level. A significant variation between the L10 and L90 would indicate an environment where there is a strong variation in noise levels, and the background is not the dominant source. As the variation between the L10 and L90 decreases, the background becomes more dominant.
<i>Lmax</i>	The instantaneous maximum level using the time response and frequency weighting set for the meter (typically <i>Fast</i> response, A weighted).
<i>Inversion</i>	A condition typically occurring on clear, still nights which is characterised by the air near the ground being colder than air at higher altitudes. The increasing speed of sound with altitude bends the sound back towards the ground causing a focussing of the sound in a small area. The inversion effect can cause increases in noise levels of 5 to 10 dB with greater increases in exceptional circumstances.

Appendix B – Additional Data

The predicted values in Table B.1, below, present the predicted sound pressure levels at the respective receivers as a result of noise emissions from works related to the implementation scenario, and the operational scenario, including and not including DTH hammer drilling.

TABLE B.1: PREDICTED 1/3 OCTAVE SPECTRA (IMPLEMENTATION)

One-Third Octave Centre Frequency Band	Predicted Sound Pressure Level (dBA)				
	A Tarraleah Village	A.2 Tarraleah Village (East)	B Bradys Lake	C Bronte Lagoon	D Wayatinah
32	< 20	< 20	< 20	< 20	< 20
40	< 20	< 20	< 20	< 20	< 20
50	< 20	< 20	< 20	< 20	< 20
63	< 20	< 20	< 20	< 20	< 20
80	< 20	< 20	< 20	< 20	< 20
100	24	21	< 20	< 20	< 20
125	24	21	< 20	< 20	< 20
160	24	21	< 20	< 20	< 20
200	22	20	< 20	< 20	< 20
250	22	20	< 20	< 20	< 20
315	21	19	< 20	< 20	< 20
400	27	24	< 20	< 20	< 20
500	27	23	< 20	< 20	< 20
630	26	23	< 20	< 20	< 20
800	29	23	< 20	< 20	< 20
1000	28	22	< 20	< 20	< 20
1250	28	22	< 20	< 20	< 20
1600	29	20	< 20	< 20	< 20
2000	28	< 20	< 20	< 20	< 20
2500	28	< 20	< 20	< 20	< 20
3150	32	< 20	< 20	< 20	< 20
4000	30	< 20	< 20	< 20	< 20
5000	28	< 20	< 20	< 20	< 20
6300	< 20	< 20	< 20	< 20	< 20
8000	< 20	< 20	< 20	< 20	< 20
10000	< 20	< 20	< 20	< 20	< 20
Overall	40	33	< 20	< 20	< 20

TABLE B.2: PREDICTED 1/3 OCTAVE SPECTRA (OPERATIONAL) - WITH DTH HAMMER DRILLING

One-Third Octave Centre Frequency Band	Predicted Sound Pressure Level (dBA)				
	A Tarraleah Village	A.2 Tarraleah Village (East)	B Bradys Lake	C Bronte Lagoon	D Wayatinah
32	< 20	< 20	< 20	< 20	< 20
40	< 20	< 20	< 20	< 20	< 20
50	< 20	21	< 20	< 20	< 20
63	< 20	21	< 20	< 20	< 20
80	< 20	21	< 20	< 20	< 20
100	27	32	< 20	< 20	< 20
125	27	32	< 20	< 20	< 20
160	26	33	< 20	< 20	< 20
200	32	35	< 20	< 20	< 20
250	31	34	< 20	< 20	< 20
315	30	34	< 20	< 20	< 20
400	33	37	< 20	< 20	< 20
500	32	37	< 20	< 20	< 20
630	30	35	< 20	< 20	< 20
800	29	35	< 20	< 20	< 20
1000	27	35	< 20	< 20	< 20
1250	26	34	< 20	< 20	< 20
1600	23	31	< 20	< 20	< 20
2000	21	30	< 20	< 20	< 20
2500	< 20	28	< 20	< 20	< 20
3150	< 20	20	< 20	< 20	< 20
4000	< 20	< 20	< 20	< 20	< 20
5000	< 20	< 20	< 20	< 20	< 20
6300	< 20	< 20	< 20	< 20	< 20
8000	< 20	< 20	< 20	< 20	< 20
10000	< 20	< 20	< 20	< 20	< 20
Overall	41	46	23	< 20	< 20

TABLE B.3: PREDICTED 1/3 OCTAVE SPECTRA (OPERATIONAL) - NO DTH HAMMER DRILLING

One-Third Octave Centre Frequency Band	Predicted Sound Pressure Level (dBA)				
	A Tarraleah Village	A.2 Tarraleah Village (East)	B Bradys Lake	C Bronte Lagoon	D Wayatinah
32	< 20	< 20	< 20	< 20	< 20
40	< 20	< 20	< 20	< 20	< 20
50	< 20	21	< 20	< 20	< 20
63	< 20	20	< 20	< 20	< 20
80	< 20	20	< 20	< 20	< 20
100	27	31	< 20	< 20	< 20
125	26	31	< 20	< 20	< 20
160	26	30	< 20	< 20	< 20
200	32	34	< 20	< 20	< 20
250	31	33	< 20	< 20	< 20
315	30	32	< 20	< 20	< 20
400	33	35	< 20	< 20	< 20
500	31	34	< 20	< 20	< 20
630	30	32	< 20	< 20	< 20
800	28	32	< 20	< 20	< 20
1000	27	31	< 20	< 20	< 20
1250	25	29	< 20	< 20	< 20
1600	21	26	< 20	< 20	< 20
2000	< 20	23	< 20	< 20	< 20
2500	< 20	20	< 20	< 20	< 20
3150	< 20	< 20	< 20	< 20	< 20
4000	< 20	< 20	< 20	< 20	< 20
5000	< 20	< 20	< 20	< 20	< 20
6300	< 20	< 20	< 20	< 20	< 20
8000	< 20	< 20	< 20	< 20	< 20
10000	< 20	< 20	< 20	< 20	< 20
Overall	41	43	23	< 20	< 20